Mendoza, Argentina - 26th September / 1st October

18th International Sedimentological Congress

ABSTRACTS VOLUME

18th ISC 2010

Sedimentology at the Foot of the Andes

Edited by Ernesto Schwarz, Sergio M. Georgieff, Eduardo Piovano and Daniel Ariztegui

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INTERNATIONAL ASSOCIATION OF SEDIMENTOLOGISTS

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Sedimentology applied to petroleum exploration and production

MARIO CARMINATTI

E&P - Exploration, Petrobras, Rio de Janeiro, Brazil

The growing contribution of renewable energy resources as an alternative to fossil fuels is an irreversible global tendency. However, for the coming tens of years petroleum will remain the dominant source of energy, bringing the necessity of increasing supply at reasonable costs. The predicted decline in production of the large oil fields and difficulty of finding the so-called "easy oil" (does not require significant technical investments in exploration and production) indicate the need for new discoveries in frontier areas as well as an improved use of technology in the currently producing fields. Such need emphasizes the importance of the decision-making process regarding the exploratory investments which, in turn, strongly depend on the understanding of the geologic aspects related to the rock-fluid characteristics. Sedimentary facies analysis constitutes the milestone to the upscaling and downscaling processes needed to the correct application of depositional models and accurate assessment of the porous system, respectively, which are essential to comprehend the relationships between rocks and their fluids. Sedimentary facies analysis requires a large experience and a continuous practical work in field geology in order to interpret depositional elements by applying the methodology of genetically-linked facies or facies associations. This approach makes it possible the upscaling to the seismic and well log-based frameworks, thus allowing the recognition and mapping of stratigraphic surfaces, stacking patterns and lateral facies changes. A consistent reservoir characterization and production development depends on a reliable facies analysis associated with rock physical parameters (taken from laboratory measurements), then integrated with seismic attributes and well log data. Calibration between rock-fluid properties and geophysical data involves intensive analytical procedures and the use of heavy processing capacity to run seismic inversions and mathematical modeling. Such approach results in three-dimensional models depicting spatial trends of reservoir porosity and permeability, which are critical parameters for oil exploration and production.

Processes for mixing carbonate and siliciclastic sediments

GREGOR P. EBERLI

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Carbonates and siliciclastics coexist and succeed each other. Yet, a paradigm exists that clastics are detrimental for carbonates, in particular for coral reefs. Drowned carbonate platform covered by clastics are often used to prove this point. The modern mixed systems, however, are at odds with this notion. For example, the two longest modern barrier reef systems (Great Barrier Reef and the Belize Barrier Reef) are situated on shelves with a siliciclastic shoreline, while the pure isolated carbonate platforms have smaller and often discontinuous reefal belts. In addition to the lateral coexistence carbonates and clastics succeed each other. The main control in the vertical succession is sea level and the variation is base level. Carbonates produce and export sediments preferentially during highstands whereas clastics are shed preferentially during sea level lowstands. This leads to "reciprocal sedimentation" on the shelf and "180° out-of phase response" of sediment export into the deep-water environment. A process that is often underestimated in the mixing of the two systems is current transport of siliciclastics into the carbonate environment. The current transport occurs both in the shallow and deep-water realm. In the shallow-water coastal long shore transport are efficient in bringing coarse clastics onto the carbonate environment. Examples of this transport exist on the Florida peninsula and in Belize. In the deeper water longshore currents along the slopes and basin floor achieve transport and deposition of clay-sized particles from terrigenous clastic systems, such as deltas. Such longshore currents are caused by either wind-driven water circulation, the gyre in a basin, or tidal waves interacting on a basin scale. Modern examples of these persistent longshore currents are observed in the lakes (e.g. Lake Cardiel in Argentina), the Adriatic Sea and the in the modern mixed system of the Arabian Gulf and the north-eastern coast of South America. In these systems longshore currents distribute fine particles from estuaries along the shores as parallel bars sometimes over hundreds of kilometers. In the ancient, this process is recorded in shore-parallel clinoforms with fines preferentially accumulating in the bottomset, as is observed in the prograding clinoforms in the Cretaceous Bab Basin. In the mixed clinoforms of the Bab Basin, the interaction between these currents and the fluctuating sea level adds to the variable input, transport and deposition of clay-sized particles and the increased carbonate production during sea level highstands.

Geomicrobiology and the sedimentary record: Insights from banded iron formations

KURT O. KONHAUSER, ERNESTO PECOITS, STEFAN V. LALONDE, NATALIE AUBET

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Banded iron formations (BIF) are iron rich (~20-40% Fe) and siliceous (~40-50% SiO_2) sedimentary deposits that precipitated throughout much of the Precambrian. They are characteristically laminated, with alternating Fe-rich and Si-rich layers that can be observed on a wide range of scales. The mineralogy of the least metamorphosed BIF consists of chert, magnetite, hematite, carbonates (siderite, dolomite-ankerite), minnesotaite, stilpnomelane and riebeckite, but it is generally agreed that these minerals reflect both diagenetic and metamorphic overprinting: the primary iron minerals were most likely ferric hydroxide, greenalite, siderite, and amorphous silica. It is now generally accepted that the presence of ferric iron minerals in BIF is due to the metabolic activity of planktonic bacteria in the oceans' photic zone. Chemical oxidation of Fe(II) by photosynthetically produced O_2 is one possibility, allowing for the indirect biogenic precipitation of ferric hydroxide. Under an anoxic atmosphere, this O_2 could have been confined to localized "oxygen oases" associated with cyanobacterial blooms in coastal settings. It is also plausible that light, not O_2, may have coupled the carbon and iron cycles, via photosynthesis that used Fe(II) rather than H_2O as an electron donor, producing Fe(III) rather than O_2. Experimentally determined photosynthetic Fe(II) oxidation rates even suggests that such microorganisms could have accounted for all of the Fe(III) initially deposited in primary BIF sediment. If a biological mechanism was important in the initial process of Fe(II) oxidation in the ancient ocean water column, it is expected that biomass would have settled to the seafloor along with the Fe(III) minerals. This organic carbon would subsequently have served as an oxidizable substrate during diagenesis and metamorphism, but the relevant question is what terminal electron acceptors were present at the seafloor?. The paucity of O_2 would have meant minimal nitrate and sulfate availability. By contrast, there was abundant ferric hydroxide deposited as BIF, and given the presence of partially reduced iron phases such as magnetite, a microbial process coupling the oxidation of organic carbon to the reduction of ferric iron mineral phases seems very likely. Supporting evidence for an ancient Fe(III) reduction pathway comes from highly negative δ^{56}Fe values in early Archean BIF, comparable with the negative fractionations observed from cultures of dissimilatory Fe(III)-reducing bacteria. In addition to the settling biomass, inorganic nutrients in the form of major elements and trace metals would have been delivered to the seafloor as the result of adsorption and co-precipitation with ferric iron particles. In this regard, it is reasonable to argue that their concentrations in BIF provide important clues to ancient seawater composition and the potential primary productivity of the oceans. For instance, it has been proposed that low P concentrations in BIF indicate limited marine phosphorus availability, which would have reduced levels of photosynthesis and carbon burial, thereby limited the long-term oxygen production on the early Earth. Recently, it has also been shown that the nickel content in BIF (and by extension seawater) has changed dramatically over time, and that this drop in Ni availability in the oceans would have had profound consequences for microorganisms that depended on it, that being methane-producing bacteria called methanogens. These bacteria have a unique Ni requirement for their methane-producing enzymes, and crucially, these bacteria have been implicated in controlling oxygen levels on the ancient Earth as the methane they produced was reactive with oxygen and kept oxygen levels low. If we accept that BIF can serve as useful proxies for the composition of ancient seawater, the question then becomes what do other trace elements in BIF through time tell us about the ancient biosphere?. Prospectives for the future include evaluating marine trace element evolution as recorded by BIF in relation to trace element records from other lithologies, such as black shales or carbonates, as well as in relation to other biological proxies, such as stable isotope records.

Some frontiers of carbonate research

MARIA MUTTI

University of Potsdam, Germany

Research over the past decades has revealed how changes in climate and surface conditions can impact carbonate systems. Carbonate sedimentary systems closely track changes in Earth History. Changes in ocean circulation, sea floor spreading rates and climate have influenced temperature and seawater chemistry, including carbonate saturation state and nutrient availability, and as a result have determined the boundary conditions for the biota that form carbonate platforms. This biota determines accumulation rates and facies dynamics thus controlling the overall platform geometry and stratal architecture. Temperature and nutrient gradients in the modern ocean have an important influence on biotic associations. Calibrating modern assemblages to the boundary conditions provided by the oceanographic setting in different geographical settings offers the tools for relating past episodes of extreme climate changes to concurrent changes in the biosphere. Selected examples from the Recent, Paleocene/Eocene, Miocene and Cretaceous will be discussed to highlight the role of sedimentological, biogenic and geochemical proxies to reconstruct past temperature and nutrient fluxes and to constrain paleooceanographic controls over the distribution of carbonate associations.

Late Cenozoic glacigenic sediments in Patagonia and Tierra del Fuego

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Patagonia and Tierra del Fuego are the most extensive areas with exposed Late Cenozoic glacigenic sediments in the Southern Hemisphere. These sediments have been formed throughout the Late Cenozoic, as the Andes were rising and the Patagonian Mountain Ice Sheet expanded during many glaciations since the Late Miocene. There are a few examples in which glacigenic sediments formed in local ice caps, around volcano summits and isolated mountain peaks, clearly separated from the main ice sheet. The Patagonian Ice Sheet, at its largest extent during the Early Pleistocene, formed a single, unique, huge ice mass, more than 2,500 km long in a N-S direction, from latitude 35º S to its southernmost extreme at Cape Horn (latitude 56º S), following the axis of the Andes. These mountains were totally ice covered several times during the cited period. This was the largest Cenozoic ice mass in the Southern Hemisphere outside of Antarctica. The ice sheet was much narrower, 100-200 km at most, but it became wider south of Río Santa Cruz, where it expanded across the Patagonian lowlands to the present submarine platform several times during the Early Pleistocene and reached midway during several cold episodes in the Middle and Late Pleistocene. The lowlands of the Isla Grande de Tierra del Fuego were probably fully ice covered during the Early Pleistocene and, at least along the Bahía Inútil-San Sebastián depression, the ice reached then the present submarine platform. However, there are no outcropping glaciomarine deposits in Patagonia. In the Northern Patagonian Andes, the ice was restricted only to the mountain area, exceptionally overflowing over the adjacent piedmont areas. Further south, the ice became thicker and expanded over the piedmont areas to the east, at least south of latitude 41º S, and over the outer lowlands south of latitude 50º S. Along the western side, the ice sheet reached the present submarine platform, south of latitude 41º S and all the way to the Magellan Straits. It was probably calving in the Pacific Ocean along this side. This geographical distribution, together with varying bedrock characteristics for each portion of the glaciated area, controlled the nature, grain size and amount of the glacigenic sediments. The observed glacigenic sedimentary types are many different kinds of till, such as basal, melt-out, and flow tills, outwash gravels and sands, lake sediments, including lacustrine rhythmites, and marsh and bog deposits and organic peat layers interbedded within tills and outwash. Most commonly found sedimentary glacigenic landforms are lateral, frontal and ground moraines, crevasse-fillings, kettle moraines, lake and outwash plains, kames, kame-deltas and esker-like crests, and drumlins and drumlinoid features. In the Northern Patagonian Andes, tills are bouldery and massive, with Andean granites and intermediate volcanics as dominating rock types, with very coarse matrix. In the Southern Patagonian and Fuegian Andes, tills are highly enriched in finer sediments, mostly coming from the extensive Late Mesozoic and Tertiary marine sedimentary rocks, with much scarcer gravelly clasts coming mainly from the Triassic-Jurassic porphyritic rocks and Cretaceous-Tertiary granodiorites, and abundant silty-clayey matrix. In this area, the plentiful finer sediments in the matrix allowed strong subglacial deformation and modeling processes that generated the existing drumlin fields. The study of Patagonian and Fuegian glacigenic deposits may be also very useful in the understanding of ancient glacial sedimentary rocks of the Southern Hemisphere, such as those formed during the Permo-Carboniferous Gondwana glaciations.

Microbial carbonates

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Synsedimentary microbial carbonates include products of bacterially bio-induced precipitation that form within sediments (e.g., at cold methane seeps), at the sediment-water interface (e.g., in biofilm-mats), and as allochthonous water-column precipitates (e.g., biogenic whitings). They have a long record and wide distribution in aquatic environments. Microbial carbonate development particularly reflects: (i) environmental controls (e.g., carbon dioxide, light and nutrient availability; carbonate saturation); (ii) evolution of bacterial metabolisms that promote precipitation (e.g., sulphate reduction, oxygenic photosynthesis and carbon dioxide concentrating mechanisms, CCM); and (iii) interactions with eukaryotes (e.g., grazers, mat- and reef-builders). Key questions include microfabric and macrofabric development, controls on spatial and secular abundance, and the record of metabolic development and seawater carbonate saturation state reflected in microbial carbonates. Precambrian stromatolites reflect the rise of bacterial mats and metabolisms that influenced microfabric development, and progressive decline in abiogenic seafloor crust precipitation. Suggestions for investigation include: (i) millimetric dark-light couplets are seasonal alternations of abiogenic crust and lithified microbial mat (Hybrid Stromatolites); (ii) clotted-peloidal microfabrics increased with sulphate availability that promoted bacterial sulphate reduction; (iii) cyanobacterial in vivo sheath calcification was triggered by CCM induction in response to decline in carbon dioxide. These latter filamentous fabrics contributed to thrombolite development that transformed macrofabrics in the mid-Proterozoic. Phytoplanktic CCM induction at this time could also have increased whiting precipitation, contributing to carbonate mud substrates in which 'molar tooth' structures developed. In addition, increase in background sedimentation would have reduced stromatolite relative accretion rate, promoting late-Proterozoic diversification of digitate forms. In the Early Palaeozoic, cyanobacteria and other calcimicrobes contributed significantly to thrombolite-dendrolite formation. Domes and columns declined in the Ordovician as algal-metazoan reefs increased. Subsequently, these morphotypes only developed extensively in marine environments when or where skeletal encrusters were reduced, as in the immediate aftermaths of Mass Extinction events and in ecologic refuges. Reefs limited overall microbial carbonate habitats, but provided cryptic substrates where heterotrophic communities developed reefal microbial crusts, often with distinctive clotted fabrics. Late Devonian decline in carbon dioxide stimulated cyanobacterial sheath calcification, and also whitings that contributed to Late Devonian-Early Carboniferous carbonate mud mound formation. In addition to competition, episodic Phanerozoic decline in microbial carbonate abundance reflects fluctuating reduction in seawater carbonate saturation that slowed lithification and therefore accretion. Present-day thrombolitic stromatolites with weak initial lithification that largely accrete by grain trapping are grazing prone; but grazing probably has reduced influence on early-lithified mats. Present-day examples provide valuable insights. Cyanobacterial mat calcification is well-developed in calcareous streams and lakes but weak in marine environments, reflecting dependence on elevated carbonate saturation. Marine calcification is sustained better by sulphate reducers in more enclosed substrates, as in methane seeps and reefal crusts. Large marine domes are restricted to shallow wave-swept bays and channels, protected from reef encrustation by hypersalinity (Shark Bay) and/or mobile sediment (Lee Stocking Island). Their accretion relies on production of extracellular polymeric substances, stimulated by high illumination, that promote grain trapping and on heterotroph-dominated sub-mat lithification.

The Miocene transgression along the Brazilian coast

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The early/middle Miocene is well known as the time for a global transgression due to the eustatic rise in sea level related to the retreat of the Antarctic ice cap, an event that lasted until the Tortonian, when sea level experienced a major drop. This transgressive-regressive episode has been recorded in several continental areas worldwide. Miocene deposits are widespread along the Brazilian coast, extending from States of Amapá to Rio de Janeiro, in the northern and southeastern Brazil, respectively. The most expressive and well studied exposures are located in the north of the country, where they are bounded by unconformities marked by lateritic paleosols. Deposits between these unconformities include a late Oligocene to early Miocene carbonatic unit, corresponding to the Pirabas Formation, and a siliciclastic early to middle Miocene unit included in the lithostratigraphic term Barreiras Formation. The Pirabas Formation is well known by its rich fossil content that is typical of marine, mostly inner shelf to estuarine, environmental conditions. The overlying siliciclastic deposits, which are correlated to the Barreiras Formation that crops out in several other areas of the Brazilian coast, were traditionally attributed solely to continental environments. Several detailed faciological and ichnological studies undertaken in the last two decades have shown, however, that the Barreiras Formation in northern Brazil includes deposits formed chiefly in a variety of tidally-influenced estuarine settings developed in incised valley systems. Analysis of stratal architecture suggests that the estuarine valleys did not fill continuously, but they had a complex sedimentary evolution as a reflex of low amplitude/high frequency relative sea level fluctuations in the turnaround from an overall transgressive to highstand episode. Despite that the estuarine nature of Barreiras Formation in northern Brazil has finally reached a general consensus, this unit is still related to continental deposition elsewhere. If this was correct, then an intriguing question to be answered is why the Miocene transgression is well recorded only in northern Brazil, and not along the northeastern coast, where these deposits are also well represented? No answer is required in the light of new results derived from detailed facies characterization focusing the Barreiras Formation in many areas of Northeastern Brazil, which reveals pervasive strata with unambiguous evidence of sediment deposition mostly by tidal processes. These inedited data suggest that the early/middle Miocene period of worldwide marine transgression left a much more widespread sedimentary record along the Brazilian coast than previously regarded. In addition to sea level, intraplate tectonics during the post-rift history of Eastern South American Plate might have promoted fault reactivation, creating new space to accommodate the Miocene sedimentary pile after a long period of non-deposition and/or erosion. Sediment filled up the estuarine valleys until the Tortonian, when a renewed phase of drop in relative sea level resulted in subaerial exposure and soil formation. Pedogenesis extended well beyond the end of the Miocene, demonstrating that, in addition to the eustatic drop, there was a period of relative tectonic stability. The most likely is that the Miocence transgression recorded along the Brazilian coast reflects the combination of eustatic rise with subsidence between two prolonged tectonically stable phases, when the Eastern South American Plate remained mostly in quiescence.

The Late Cenozoic continental sedimentary record of central Argentina: characteristics, genesis and implications

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The Late Cenozoic continental sedimentary record of the extra-Andean region of central Argentina, between latitudes 31°S to 40° S, is vastly distributed across the Pampean plain, the eastern Andean piedmont and northern Patagonia. It covers a very heterogeneous basement overlying Precambrian-Mesozoic bedrock in the block areas and Miocene marine deposits in the tectonic basins. The sequence is discontinuously exposed, generally consisting of outcrops, few meters thick and several meters long; road cuts and quarries provide much thicker exposures useful for sedimentological analysis. Drilling information indicates that it composes a large and continuous sedimentary apron with an average thickness of around 100-200 m. The accumulation of the deposits started circa 12 Ma following the Miocene marine regression of the Paranense sea. The sequence is lithologically homogeneous, mainly consisting of sandy silts to silty sands of dominant volcanoclastic composition; significant percentages of andesitic and basaltic lithoclasts as well as volcanic shards are present, the latter sometimes forming discrete tephra layers. The Andean region is the provenance area of the bulk sediments with secondary sources corresponding to local rock outcrops (Ventania, Tandilia, Pampean and Lihue Calel ranges). The rather uniform lithology and the general massive appearance of the deposits were taken as evidence of an aeolian origin. However, primary loess facies are a minor component of the sequence, being mostly reworked either by aqueous transport agents (loess-like or loessoid deposits) or modified by pedogenesis (weathered loess). Paleosol levels and pedogenic features are very common throughout the succession. On the basis of the ubiquity of pedogenic features, the succession is interpreted as a pedosedimentary sequence; the occurrence of numerous paleosol levels documents an episodic sedimentation process. The presence of welded paleosols and intervals of accretionary pedogenesis suggest a variable balance of pedogenesis and sedimentation through time. Calcretes, carbonate nodules and concretions as well as massive accumulation of calcium carbonate are very common traits. Bioturbation structures of both invertebrates and vertebrates (burrows, caves, galleries) are outstanding features of the succession. The occurrence of several Miocene, Pliocene and Quaternary impactites levels (locally known as *escorias*) is a unique and remarkable characteristic. The sequence, accumulated in a very extensive and shallow foreland sedimentary basin, is subdivided into four main stratigraphic intervals, interpreted as subcycles of sedimentation on the basis of the stratigraphic relations, relative ages inferred from the vertebrate fossil assemblages, and numerical ages.

A B S T R A C T S

Glacial to Holocene paleoclimate reconstruction based on Laguna Las Ranas record in south-central Chile (39°S)

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Laguna Las Ranas is an small pond, surrounded by moraines formed during the LGM, located at the northern shore of lake Villarrica, Chile (39º11´S/72º05´W; 400m altitude). The local vegetation consists of moderate-disturbed temperate-rain forests. The 7 m-long core, characterized by six radiocarbon dates, shows laminated clay sediments on the base prior to 18.8 kyr BP and high deposition rate of gyttja for the rest part of the Holocene. Several tephra layers document the volcanic activity in the area; at least 2 major volcanic eruptions are recorded at 4 and 11.6 kyr BP, associated with Villarrica volcano. The pollen record reveals important paleoclimatic and vegetation changes during the last ~19 kyr. The deglacial warming trend in the area at 18.8 kyr BP, is characterized by Nothofagus dombeyi-type dominance, followed by a expansion of Myrtaceae tree-species at 15.5 kyr BP, Hydrangea and Aextoxicon increase at 14.2 kyr BP. Maximum of Weinmannia at 12.5 kyr BP is associated with high volcanic and fire activity. The climate during the early-Holocene (11.5-7 kyr BP) was warm and dry characterized by the expansion Nothofagus obliqua-type forests and the prevalence of high fire activity. A second warm, but humid pulse at the mid-Holocene (5 kyr BP) is recorded with the expansion of Eucryphia and Aextoxicon forest. A cold climatic trend is observed at 1.8 kyr BP with a new expansion of Nothofagus dombeyi- type. In conclusion the high resolution sedimentological and palynological record from Laguna Las Ranas allows reconstructing the climatic changes from the Late Glacial to the Holocene associated with changes of the most important atmospheric circulation system: the Southern Westerly Winds in south central Chile.

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The first result of cyclostratigraphic analysis of the Danien pelagic succession in Mudurnu-Goynuk Basin, Sakarya Zone, NW Turkey: a paleoclimatic approach

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The aim of this study is to understand the forcing mechanisms and changes in climatic/oceanographic conditions in the formation of the Lower Danien mudstone – limestone cycles in Mudurnu-Goynuk Basin, NW Anatolia. To achieve this aim, a high-resolution, 31 m thick, stratigraphic section (Okçular section) has been measured in detail and sedimentological, geochemical analyses have been carried out in all samples throughout the section. In total 89 samples were analyzed in terms of $\delta^{13}C$ – $\delta^{18}O$ and element compositions. Small-scale and large- scale paleoclimatic/oceanographic changes that took place in the basin were determined. In Okçular section mainly 2 different cycle patterns can be described: 1) thicker mudstone-thinner limestone cycles and 2) thicker mudstone – thinner marl cycles. From this 31 m thick Okçular section 40 cycles can be identified with various thicknesses (30 – 150 cm) and types. According to spectral analyses with respect to mudstone thickness, $\delta^{18}O$ content and abundances of certain elements, cycles correspond to Milankovich Cycles (mainly precession). The $\delta^{18}O$ values show 3 large-scale excursions (first increasing and then decreasing) along the first 17 m of the measured section. After this level, $\delta^{18}O$ values display a more stable trend. The $\delta^{13}C$ curve displays very similar trends in some parts of the section. Average $\delta^{18}O$ trend shows negative correlation with salinity and detritic influx sensitive proxy elements. Additionally, cyclostratigraphic analysis of the section revealed that $\delta^{18}O$ curve is inversely correlated with the Fischer plot curve indicating that increasing accommodation space is correlated with rising temperature trend. This relationship implies that the cyclic limestone-mudstone alternations along the sections are mainly controlled by climate-induced relative sea level changes. $\delta^{18}O$ values display a positive rise from mudstone to limestone, whereas the abundance of detritic elements decrease in each cycle in small-scale and large-scale. Decrease in $\delta^{18}O$ values and increase in detritic elements in mudstones can point out the effect of fresh water input and surface run off. Unlike the relationship between elemental abundances and $\delta^{18}O$, productivity sensitive elements do not display a positive correlation and show minor fluctuations along the section. As a consequence, cyclic pelagic succession in the Mudurnu-Goynuk basin were under the control of climate and sea level fluctuations in the Danien. Dry-cool and wet-warm climate alternation took place. This type of change also confirms the relationship between $\delta^{18}O$, detrital elements, and Fischer Plot analysis in small- and large-scale fluctuations in the basin. This study has been carried out for first time in Turkey and will be supported by more high-resolution stratigraphic sections in the future.

Expression of the Cenomanian-Turonian OA2 in shallow water sequence, insights from the North African Margin and Mexico

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The response of shallow-water sequences to oceanic anoxic event 2 (OAE2) and mid-Cenomanian events 1a and 1b was investigated along the west African margin of Morocco, north of Agadir (Azazoul), in Sinai, Egypt (Whadi El Ghaib) and in the Morelos carbonate platform located in southern Mexico and then correlated with deeper-water sequences based on biostratigraphy, mineralogy, phosphorus, trace- metals and stable isotopes. In the shallow environment north of Agadir as well as in Sinai, a fluctuating sea-level associated with dysoxic, brackish and mesotrophic conditions prevailed during the middle to late Cenomanian, as indicated by oyster biostromes, nannofossils, planktonic and benthonic foraminiferal assemblages. Oyster biostromes suggest deposition occurred in less than 50 m depths in low-oxygen, brackish, and nutrient-rich waters. Their demise prior to the $\delta^{13}C$ excursion is likely due to a rising sea-level. Anoxic conditions characteristic of OAE2 (for example, laminated black shales) did not reach into shallow-water environments until the maximum transgression of the early Turonian. Climate conditions decoupled along the western margin of Morocco between mid-Cenomanian event 1b and the Cenomanian–Turonian boundary, as also observed in eastern Tethys (Sinai). North of Agadir alternating humid and dry seasonal conditions prevailed, whereas in the Tarfaya Basin the climate was dry and seasonal. This climatic decoupling can be attributed to variations in the Intertropical Convergence Zone and in the intensity of the north-east trade winds in tropical areas. The Axaxacualco and Baranca el Cañon sections, located at the Guerrero-Morelos carbonate platform in southern Mexico, exhibit correlateable $\delta^{13}C$ curves. In the distal part of the carbonate platform at Axaxacualco, the maximum $\delta^{13}C$ positive excursion coincides with oligotrophic carbonate platform environments, characterized by abundant and diversified benthic microfauna and rudists, confirmed by low concentrations in Ptot. The impact of OAE appears slightly more significant in the proximal part of the carbonate platform at Barranca, characterized by the deposition of thick laminated microbialites indicative of mesotrophic conditions. The Morelos carbonate platform with oligotrophic to mesotrophic conditions was persistent throughout the entire OAE2 in Central Mexico despite the closeness to the Carribean plateau. The definitive drowning, marked by the deposition of black shale and turbidites, occurs therefore only in the lower Turonian (P. flexuosum), well above the end of the $\delta^{13}C$ shift.

3D seismic geomorphology of landslide debris flow deposits offshore Angolan margin

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3D seismic attribute analysis, including spectral decomposition and RGB blending and variance attributes, reveals extensive slope failure and slides along the Angolan margin that occur in close association with slope geomorphic features including NW-SE- and E-W-trending growth faults and salt-cored folds at a high angle to the regional dip of the slope. The most significant of the faults in terms of length (~ 35 km) and displacement (~1000 ms TWT) constitutes the headwall for the downslope transformation of precursor slide to sediment gravity flows. Evolution of both folds and faults significantly changes the dip and dip direction of the palaeo-seafloor which strongly controls the spatial distribution of the landslide associated geomorphic elements. In plan- view, the landslide is identified in the first instance as a gouging/scooping of the palaeo-seafloor marked with slide scars and debris flows. The features of the landslide are categorised into three seismic facies: (i) slide scars with intervening slide blocks that transform downslope to a streaky/lineated debris flow facies. The streaky debris-flow facies occur as an elongate dip-parallel features that become broader downslope and is associated with lineations that are parallel to the flow direction, (ii) chaotic debris flow facies which are also elongate and dip-parallel, are of similar-along strike dimension to the streaky debris-flows facies, and (iii) blocky, chaotic debris-flow facies which occur as discrete zones that are elongate to oval in geometry. The debris flow deposits extend along-strike over 15 km distance and vary in thickness from <20 ms TWT to >100 ms TWT. The landslide occurred on a basal decollement that is characterised seismically by a high amplitude reflection of high continuity that separates the discontinuous, chaotic, low-moderate amplitude reflection package of the overlying debris flow deposits and the more continuous and parallel reflection package of the underlying units. The slide scars are identified as elongate to arcuate geomorphic features that are up to 2.5 km wide and 5 km long. In cross section, the slide scars are approximately 100 ms TWT deep and occur as steep geomorphic features characterised by a basal erosional surface based on the nature of strata truncation within them. Some areas of extensive sediment failures on the slope are coincident with the widespread occurrence of palaeo-pockmarks along channels, growth faults and slope striations. These features suggest spatial coincidence of seismic- scale fluid flow phenomena and slope failure. The presence of gas in the slope sediments is interpreted to have facilitated their failure as a result of the high pore-fluid pressure. This coupled with the local steepening around growth folds and faults promoted mass downslope movement of upper slope sediments (i.e. landslides). The results of the present study give new insights into the likely causes of the landslide and deserve a careful thought in view of oil and gas exploration and production installations.

Environmental dynamic mechanisms for sedimentary structure formed by typhoon over coastal wetland: a case study from the "fung-wong" typhoon in 2008

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In order to understand the mechanisms of coastal wetlands erosion and accretion during typhoon events, in situ measurements of environmental dynamics, such as water level, tidal current speed and direction, wave height, wind velocity, and suspended sediment concentration (SSC), were carried out using velocimeters (Electromagnetic Current Meter, product of ALEC; ADV and ADP with wave directional data, products of Nortek), miniature pressure sensor (MkV/D, product of ALEC), anemoscope and Seapoint Turbidity Meter (product of Seapoint) sensor on coastal wetlands (including bare flat and salt marsh) in Luoyuan Bay of China, during the period when the typhoon "KAEMI" was passing through the region. At the same time, very shallower surficial sediments were collected. The analysis of the data obtained showed that the maximum wind velocity and wave height could reach 20 m/s and 2.11 m, respectively. Under the dropping and sorting of rainfall, the cohesive sediment on wetland surface was eroded and transported to the adjacent tidal creek, and the sedimentary structure with sediment coarsening and well sorting was formed. During typhoon event, the bottom shear stress on coastal wetland exceeded the critical shear stress for sediment motion, which induced the flat erosion during the tidal cycle. However, the bottom shear stress decreased to the values which were lower than the critical shear stress for sediment deposition after the typhoon landed, which induced the suspended sediment settled to bed quickly. Analysis of erosion and accretion showed that the Spartina alterniflora marsh bed was eroded always during the typhoon event; the plant roots snapped off at the flat surface under the influence of interactions among wind, wave and current, which carry off the sediment around the plant roots. After typhoon landed, the marsh bed was accreted.

Initiation and growth of Challenger Mound in the Pleistocene oceanographic resume in NE Atlantic (IODP Expedition 307): implication for the animal evolution in the stratified Neoproterozoic ocean

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IODP Expedition 307, the first attempt to drill throughout a modern deep-water coral mound, improved our understanding of the growth and internal life of these intriguing structures, which can be extended to reconsider the evolution of multicellular animals. From the summit of our drilling target, Challenger Mound at ~800 m deep in the Porcupine Seabight, south west of Ireland, we successfully recovered the whole mound section of 155 m long, which almost entirely consists of coral-bearing (mostly *Lophelia pertusa*) calcareous sediments and rests on the Miocene siliciclastics. The mound was initiated ~2.6Ma at the beginning of Pleistocene, when the modern circulation was established in Atlantic. The subsequent mound growth was sensitive to the amplitude of glacial/interglacial change, and appeared two stages; the relatively continuous lower mound (2.6-1.7 Ma) accumulated under the low-amplitude change, and the discontinuous upper mound (1.0 Ma to mid-Holocene) developed under the high-amplitude change. A key oceanographic feature for the mound coral communities is most likely the density gradient developed above the saline Mediterranean Outflow Water where organic particles from the sea surface persist for a longer time and fuel the filter-feeding coral communities. The history of Challenger Mound implies how the filter-feeding cold-water corals dependent on particulate organic matter (POM) in the density gradient. Because water temperature cannot be warm around the density gradient, many of heterotrophic corals including *L. pertusa* might have evolved to cold temperature. During the Earth's history, a substantial POM was suspended in oceanic water column after the Neoproterozoic glaciation, when the release of a substantial amount of buoyant ice-melted water resulted in oceanic stratification. Recent paleontological and biochemical studies have suggested that this was the time of evolution of non-bilaterian multicellular animals. This temporal coincidence evokes a hypothesis that the accumulated POM stimulated the evolution of animal multicellularity in Ediacaran ocean. The hypothesis controverts more popular idea that oxygenation of the ocean was the most important factor for the evolution of multicellular animals, but is consistent to the fact that the two most primitive animal phyla (Porifera and Cnidaria) are filter feeders. The POM was an oxygen consumer, but on the other hand could have provided a food source for filter-feeding animals, such as sponges and cnidarians. The evolved filter feeding ecosystems consumed the POM and may have contributed the ocean oxygenation in the terminal Neoproterozoic when animal evolution passed into the second stage, appearance of bilaterians. The establishment of the coral mound ecosystem, as observed in Challenger Mound, could be the modern analog to understand the crucial link between the sequence of animal evolution and extreme climate changes in late Neoproterozoic.

Revised age model for the upper mound section of Challenger Mound in the Irish offshore

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The Challenger mound, a deep-water coral mound in the Irish offshore drilled during IODP Expedition 307, has recorded its growth response to the enlarged amplitude of climate changes since the mid-Pleistocene transition (MPT). The age model of the 23.7-m-thick upper section was largely improved by successful evaluation of the open- system U–Th ages of corals. The corals collected above the Bruhnes and Matuyama boundary (0.78 Ma) were mainly assigned to a range of 0.5–0.6 Ma; the reliability of the age evaluation is supported by the appearance of a theoretically predicted covariance between $\delta^{234}U$ and $^{230}Th/^{238}U$. The U–Th ages, coupled with previous Sr isotopic chronology, foraminiferal oxygen isotopic records, and paleomagnetic variability, indicate discontinuous deposition of the upper mound, which represents a contrast to the continuous lower mound that developed under low-amplitude climate changes in the late Pliocene. Three recognized hiatus horizons subdivide the upper mound into four subunits. The thickest, Subunit B (9.5 m thick), was assigned to Marine Isotopic Stages 13–15 (0.62–0.50 Ma) where the isotopic signals display a relatively small amplitude as the post-MPT glacial–interglacial fluctuations. The conditions during low- amplitude climate changes were preferable for the growth of the Challenger mound. The mound growth could not have been sustained during high-amplitude glacial/interglacial changes, most likely because of the lower temperature (during the glacial period), erosion (during interglacial periods), and/or the dislocation of the density gradient where the corals would have benefited from food particles (during both glacial and interglacial periods). We predict that the mound growth response to climate changes is site-specific, and that each mound has its own growth history depending on its latitude, depth, and position in the regional oceanographic circulation.

Provenance of Tertiary siliciclastic rocks in the Tarfaya-Laayoune Atlantic Coastal Basin, SW Morocco

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Sandstone petrology, heavy mineral analysis and mineral chemistry of the sandstones of Tertiary in the Tarfaya–Laayoune Atlantic Coastal Basin, SW Morocco, show that the sandstones were derived from heterogeneous sources that lie in the western Anti Atlas and northern Mauritanides, in which, Mauritanides belong to the basement of this area. The sandstones are mainly carbonatic-arenites. They have average petrographic composition (QFL, 67:13:20), quartz content is medium to high, plagioclase is higher than potassium-feldspar and chert is present as rock fragments along with carbonate sedimentary grains, classified as, subarkose, lithic arkose, litharenite and feldspathic litharenite. These sandstones plot in the recycled orogen provenances on QFL diagram. Quartz-undulosity and polygonization analysis suggests a source of medium-to-high grade metamorphic rocks. Garnet minerals plot in the field A, B and D on ternary diagram, pyrope(Mg) +almandine(Fe),spessartine(Mn)+grosssular(Ca), which infer the low-to-high-grade metamorphic, meta-sedimentary and meta- carbonatic source rocks. Mineralogical analysis of amphiboles exhibits low grade green schist and medium grade amphibolite facies source rocks. Bulk rock geochemistry and U-Pb zircon geochronology will provide more information about the provenance. Key words: Provenance, sandstone petrology, heavy minerals, mineral chemistry, Tertiary, Morocco.

Pleistocene depositional rhythms in clastic successions of the Caspian Sea under climatic control

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Intensive orogenic movements in the vicinities of to the South Caspian basin folded areas and promoted submersion of the basin's central parts at the end of Pontian – (beginning of Early Pliocene) and led to a dramatic Paleo-Caspian Sea level fall (from 600 to 1500 m). Since that time sedimentation there took place under conditions of an isolated basin temporarily connected with the Black Sea in the Upper Pliocene (Akchagyl), and during some Pleistocene stages. Being the largest land locked basin in the world with hyper unstable sea level regime the Caspian Sea represents a beautiful model area for studying the dynamics of sedimentary basins development in short -term intervals. This study aims to define a relationship between climatic changes, high - frequency Caspian Sea level fluctuations and facies variations in the Pleistocene. The Lower Pleistocene (Absheron stage) and Middle Pleistocene (Khazar stage) exposures (Shikhovo outcrop) located on the Absheron Peninsula in the western flank of the South Caspian depression have been studied via application of multiple geological and analytical tools - sedimentology, paleontology, sequence-, bio-, chemostratigraphy, isotope and trace elements geochemistry. Lithologically these sediments are represented by shelly sandstones, coarse- to medium - grained sandstones, silts and silty shales. The Caspian Sea level fluctuations were recorded in the Pleistocene succession as depositional environment changes within shoreface -offshore facies zones. The full depositional cycles of a high order with low and high stands are clearly identified within Lower and Middle Pleistocene successions. Data on O, C isotope composition of ostracods shell carbonate as well as Ca/Mg, Sr/Ba ratios therein testify to significant climate and basin salinity changes through out the Pleistocene and provided us a unique opportunity for characterizations of short-term climatic cyclicity in Lower-Middle Pleistocene, which was the major lake-level control. The applied multi-component approach to the study of the sedimentary response to climate changes in the Caspian Sea demonstrated the strong influence of climatically driven rapid fluctuations of this closed basin level on the stratigraphic architecture and faunal assemblages in the Pleistocene succession.

Holocene Depositional History and Organic Carbon Cycle in the Delta of the Kura river, South Caspian basin

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The modern Kura delta is located in southwest Caspian Sea. The delta is the fluvial dominated, and distributes its sediment load through three channels oriented North, East and South. The north flank of the delta is composed of a barrier lagoon complex. The east and south flank of the delta are delta front marsh environments, typical for a fluvial dominated delta. The southern slope has a low gradient. Morphology of the delta slopes here demonstrates classic clinoform geometry. Several field campaigns in 2001, 2008 and 2009 were organised to acquire the necessary data. 30 offshore shallow sesimic profiles were shot in lines parallel and perpendicular to the delta contours, 40 hand augerings up to 7 m depth were made in the onshore delta, offshore 14 piston cores down to 3 m, 8 wells down to 20 m, and 2 wells down to 35m were drilled. A number of samples have been selected for different type of analyses. The offshore delta's Holocene sediments consist up to at least 20 m depth of thinly bedded silty clays and laminated dark grey clays underlain by reddened fluvial clays. Locally sand and shell-rich horizons occur. The data have given a concise insight in the development of the delta during the last ~10000 years. They show several phases of delta retrogradation during the Caspian Sea highstands, interrupted by erosional phases during lowstands, recognisable in the sesimic profiles as prominent reflectors. The first phase is represented by reddened fluvial clays (Sequence 1) possibly affected by soil formation during a lowstand at –90 m absolute depth dated at 12000 BP. These are overlain by several metres of laminated clays and silts, ^{14}C dated at 9240-5920 BP (Sequence 2). This succession is truncated by a prominent reflector bounding Sequence 3 (modern delta dated at 1400 BP consisting of thin laminated clays. Sequence 3 consists of four progradational and retrogradational phases of a higher order corresponding to: 1. a lowstand at about –48m absolute depth and correlated with the 11th century Derbent Regression, 2. laminated deltaic clays and silts, passing locally to organic clays with fluvial diatom assemblages; 3. an erosional event, related to a lowstand in the 16th century; 4. last 200 years deposited succession. Onshore delta consists of progradational sequences of channel-levee sands and floodplain silts and clays deposited during gradual sea-level fall and overlain by clays and silts reflecting the last phase of rapid sea- level rise since 1977. Overall sedimentation rates in the delta determined by ^{210}Pb methods range between 1.5-3.0 cm/year. The amount of Corg in the upper part of the section in the Caspian Sea adjacent to river Kura delta varies from 0.2 to 1.22 % with median values 0.6-0.8 %. It demonstrates that in the sediments deposited during Caspian Sea high stand in 1929 the minimum of Corg content is localised near the mouth of the active southern channel of the Kura River and coincides with minimum of clay fraction. At the same time the maximum of organic matter content locates near the mouth of eastern channel which was inactive that time. Further southeastwards and eastwards Corg content increases. In section corresponding to the Caspian Sea low stand in 1977 the area of minimum Corg is located at the north near the northeastern distributary. This indicates high activity of this distributary during Caspian Sea fall. The area of Corg minimum extends covering also the mouth of main channel and eastern part of the delta. Corg maximum shifts toward the basin coinciding with maximum clay fraction. During the Caspian high stand in 1995 the minimum of Corg contents is confined to the mouth of main channel. Distribution of organic matter in the early Holocene sediments of the Kura river delta also displays the strong time dependence reflecting depositional history of the delta.

Variable response and depositional products of fluvial-alluvial fan systems in pyroclastic-rich successions: Cerro Barcino Formation (Cretaceous) of the Cañadón Asfalto basin, Central Patagonia Argentina

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Pyroclastic input in continental depositional systems is an important extrinsic factor that plays a major role in defining alluvial geometries and fluvial styles. The now classical response of syn-eruptive fluvial systems in proximal aprons consist in widening of fluvial channels, braided pattern development, and occurrence of poorly-evolved palaeosols as a consequence of high aggradation conditions. Nevertheless, pyroclastic influence in distal continental settings remains until now poorly understood. This study includes the analysis of the La Paloma and Cerro Castaño Members of the Cerro Barcino Formation (Albian) in the Cañadón Asfalto Basin (Central Patagonia). The unit is currently outcropped more than 300 km away from the Cretaceous volcanic arc. The La Paloma Member is characterized by a well-developed pyroclastic floodplain, where primary ash-fall deposits were reworked on wide floodplains, very shallow water bodies and into fluvial channels. The overlaying Cerro Castaño Member consists of fluvial channels and a mudstone-rich floodplain, the later containing isolated thick strata (up to 2 m) of tabular, ash-fall deposits. This contribution analyzes the pyroclastic influence in the development of volcaniclastic lobes and fluvial channels. Twelve volcaniclastic lobes restricted to a 20 m thick interval located in the lowermost part of the La Paloma Member were described and interpreted. The bodies are characterized by lobate cross-section, plane to slightly erosional base and a convex-up top. Lobes are rarely simple and mainly consist of vertically-laterally stacked bodies. Simple or stacked lobes range from 0.6 m to up to 6.7m thick, and true width varies from 16 m to 273 m. The architectural analysis allows the recognition of three depositional zones: proximal, middle and distal. The proximal depositional zone is amalgamated with a feeder channel. Medial and distal zones were identified according to the shape of lobes and sedimentological features. Thin sections reveal ash-size pyroclastic material and flow-oriented cuspate shards, suggesting limited reworking. Volcaniclastic lobe complexes are interpreted as terminal zones of distributary feeder channels, representing the reworking of distal ash-fall material in areas proximal to intrabasin geomorphic thresholds. Lobe complexes were passively-buried during subsequent ash-fall deposition, showing local unconformities between ash-fall events. Influence of pyroclastic deposition was also evaluated in the Cerro Castaño Member, where the width/thickness ratio of fluvial channels was obtained in a 162 m sedimentary log. Fluvial bodies (n=11) are broad ribbons with a mean thickness of 1.7m and a mean W/t of 17. On top of a 2m thick tuff strata, a 4.5 m thick, poorly channelized body with narrow-sheet geometry is developed (W/t=45). The fluvial channel is characterized by well sorted, biotite-rich, medium-grained sandstones that show antidune bedding at base, low-angle cross-stratification and trough-cross stratification upward. Changes in external geometry and preserved sedimentary structures were imposed by the delivery of large sediment load and by the low-permeability conditions of the ash particles. Both volcaniclastic environments represent ash fall reworking and redeposition from dilute aqueous alluvial systems. Volcaniclastic lobes are associated to shorter transport distance than the poorly-channelized fluvial channels described above. Thus the geomorphic setting played a major role in syn-eruptive systems and their associated deposits. Pyroclastic effects are thought to be related to (1) increase in sediment load in channels, (2) increase in channel avulsion rate of channels, (3) decrease in floodplain permeability, that contribute to increase runoff. The observed differences between La Paloma and Cerro Castaño Member of the Cerro Barcino Formation seem to be the result of temporal decreasing in Cretaceous volcaniclastic input and local geomorphic changes.

Recognition of tectonic, climatic and geomorphic signals in a fluvial succession developed in an extensional setting: Los Adobes Formation (Aptian) in the Cañadón Asfalto Basin, Argentina

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The three-dimensional alluvial architecture reflects the interaction of fluvial systems with the major basin controls, such as climate, sediment supply, subsidence and geomorphic setting. Nevertheless, the evaluation and clear identification of the relative role of these factors is difficult to achieve. In fluvial sequences, signals recorded in channel bodies include variations in (1) external geometry, represented by the width/thickness ratio (w/t), (2) channel connectedness and (3) changes in fluvial patterns. The dataset for the study includes detailed sedimentary logs, architectural element analysis, palaeohydrological estimations, paleoflow data and fluvial style reconstruction of 78 fluvial channels of the Los Adobes Formation in the Cañadón Asfalto basin (Central Patagonia). The tectonic influence on the sedimentation was evaluated at the Paso de Indios depocentre of the Cañadón Asfalto basin, where 12 detailed sedimentary logs carried out at different positions in the depocentre allows to document spatial changes in the fluvial system over a *ca.* 35 km^2 area. A major NNW-SSE-trending normal fault defines an axial channel network that drained SW, and transversal tributaries that drained to NW-NNW. At the confluence zone, transversal tributary bodies mean thickness is 10 m and maximum bankfull discharge is 1314 m^3/s. Downstream of the confluence zone, axial bodies record maximum bankfull discharge values from 431m^3/s to 1535 m^3/s, instead its mean thickness increase from 7 m to 13 m. Fluvial bodies commonly show vertical decreasing in set thickness, normal grading and full preservation of waning-flow structures in upper reaches of the channels. Climatic signal is interpreted from cyclical repetition of set thickness trend in multi-storey channels, suggesting seasonal variations in discharge. Discharge values inferred from a multi-storey sandbodies range from 83 m^3/s to 1535 m^3/s, data comparable to those obtained in modern dryland fluvial systems. Additionally, macroform preservation at top of channel bodies is considered as an evidence of climatically-induced avulsion processes. Geomorphic influence on the fluvial system was evaluated from the analysis of a 330° Az striking valley-fill at Estancia Contreras (southern boundary of the Gorro Frigio Depocentre), where the fluvial succession rest on Jurassic rocks. In the deepest part of the valley (valley width: 250 m) fluvial channels consist of multi-storey braided channels up to 4.3 m thick with w/t of 20 and paleoflow direction of 351º. Upward in the section (33 m), near to the geomorphic threshold, valley width increases until 560 m. The fluvial system consists of low-sinuosity channels with alternate bars. A single-story, 4.3 m thick, low sinuosity channel body show w/t of 9 and mean paleoflow direction is 312º. Up-section (25 m), the valley width is at least 2.6 km, and meandering channels show a mean thickness of 5.3 m, w/t is 7.5 and mean paleoflow direction is 115º. The vertical variation in external geometry and channel styles are interpreted as related to valley width variation, which control the lateral migration of the channel belt. Channel style variations may be also a response to decreasing power stream during valley-fill. The deposition of the Los Adobes Formation seems to be related to the interplay of intrinsic and extrinsic forcing factors. According to the observations, three conditions favour the recognition of such factors: (1) The tectonic signal is better identified in high accommodation conditions, (2) the geomorphic control is better recognized in low accommodation settings, and (3) the climatic signal, although overimposed to others signals, can be identified from palaeohydrological estimations within individual fluvial channels.

Spatial variability in the external geometry (W/t ratio) of fluvial channels and its implications for basin analysis and reservoir characterization: Los Adobes Formation (Apitan) of the Cañadón Asfalto Basin, Central Patagonia

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The characterization of fluvial channels is based on defining their internal architecture and external geometry. The later parameter is established by the width/thickness ratio (W/t), which allows analyzing the balance among channel aggradation rate, reoccupation frequency, avulsion periodicity and bank migration rate. Such parameter is of relevance in the economic development of oil-bearing hydrocarbon reservoirs, basin modeling and well-to-well correlations, where prediction of channel-body geometry is essential to optimize the recovery of hydrocarbons and exploratory activities. Changes in W/t ratio of channels can be imposed by changes in extrinsic controls (eg. climate, base level, subsidence, sediment supply and geomorphic scenario) or intrinsic factors (eg. fluvial style, migration mechanism). The aim of this study is to compare and to evaluate the spatial changes in the W/t ratio of a fluvial succession within zones of variable rate of accommodation space (AS). The dataset consists in the analysis of 165 fluvial channels of the Bardas Coloradas Member of the Los Adobes Formation (Aptian) in the Cañadón Asfalto Basin. The unit was deposited coeval with an event of extensional reactivation of NNW to NNE striking normal faults. The study area covers 3500 km^2, and includes 7 study locations of the Paso de Indios and Gorro Frigio depocentres. Most of the fluvial channels are braided, with evidences of migration by avulsion processes. Studied outcrops at Paso de Indios depocentre are NNW-SSE oriented, roughly parallel to the strike of the mayor normal fault that bound the depocentre. The mean thickness of 114 fluvial channels (T) is 4.9 m (StD=3.4 m) and mean W/t ratio is 21 (StD=19.4). The overall architecture and paleoflow data reveal a transverse tributary system that join an axial fluvial system, and the occurrence of a regional trunk system basinward. The external geometry of channels changes downstream from a W/t ratio of 5 (StD=2.7) at Ea. El Comienzo, through 18 (StD=15.8) at Pje. El Calafate to 29 (StD=22.8) at Pje. El Pajarito. Transverse tributary systems show a mean W/t ratio of 18 (StD=17.5) and a maximum thickness value (T) of 4.4 m (StD=3.5), instead the regional trunk system has a W/t ratio of 30 and a T of 12.6 m. Four main study locations were selected in the Gorro Frigio depocentre. Relative high-accommodation conditions prevail at Co. Planchada and Co. Chivo areas. In the former area, fluvial channels have a mean W/t ratio of 17 (StD=7.4) and T is 8.5m (StD=4 m); the Co. Chivo area is located even closer to the depocentre, and channels show a mean W/t ratio of 43 (StD=48) and T of 3.1m (StD=2.4 m). Low-accommodation zones prevail in the southern margin of the depocentre (Ea. Contreras and Cañadón Asfalto areas), characterized by proximity of the Jurassic basement and overall thinning of the unit. Fluvial channels show a mean W/t ratio of 17 (StD=14.4) and T of 3 m (StD=2.1 m) at Ea. Contreras, instead in the Cañadón Asfalto area the fluvial channels have a mean W/t ratio of 17 and T is 19m. As climate must be similar due to proximity among studied areas, channel geometry and connectedness are governed by the rate of change in AS, linked to changes in subsidence rate and local geomorphic conditions. In areas of relative high rate of AS, regional avulsion and low reoccupation frequency are dominant. On the contrary, low AS zones are characterized by laterally-vertically stacked channels, whose wider external geometry is the result of low aggradation rate conditions and high reoccupation frequency. Either in high- or low-accommodation settings channel bodies are narrow sheets (mean regional w/t=23, StD=12.6). However, mean and maximum thickness values are noticeably different in both depositional settings. A mean regional thickness value of 8m represents an underestimation of up to 137% in relation to low-accommodation settings, and is overestimated in up to 50% in relation to high-accommodation setting.

Sedimentary response to the uplift of a inner structural high in a Neoproterozoic rift basin, Santa Bárbara Group, Southern Brazil

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Current models for the tectono-sedimentary evolution of extensional basins consider that tectonic reactivation results in instantaneous increase of subsidence rates, which in turn results in the deposition of finer-grained facies, followed by latter progradation of coarser clastic wedges due to the denudation of the reactivated topographic highs. These models are based on the tectonic activity of structural highs adjacent to the sedimentary basins, and thus do not take into account the particularities of the reactivation of intra-basinal structural highs. The Santa Bárbara Group in the Camaquã Basin (Ediacaran of the southern Brazil) shows evidence of the uplift of an internal structural high contemporaneously to the deposition of the unit. The Santa Bárbara Group comprises a more than 2,000 m thick succession of conglomerates, sandstones and siltstones deposited in continental environments, composing an initial fining-upward cycle followed by two coarsening-upward cycles. Provenance studies in the coarser deposits of the Santa Bárbara Group, combined with detailed facies and paleocurrents analyses, indicate a major shift in the provenance and paleoflow patterns during the first coarsening upward cycle, in a stratigraphic level correlated to the uplift of the Caçapava do Sul high, which divided the Camaquã Basin into a western and a central sub- basins. The identification of progradational deposits as the response to the uplift of the structural high implies particularities concerning the activity of inner structural highs that have been neglected in the current tectonic models, such as the possible increase in sedimentary input due to the erosion of unlithified sediments previously deposited on the uplifting area and a fall in the subsidence rates as consequence of doming in the early stage uplift.

Paleoecology, taphonomy and sequence-stratigraphic framework of postglacial fossil concentrations of the Late Carboniferous Hoyada Verde Formation, Argentinean Precordillera

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The Hoyada Verde Formation (Sierra de Barreal, San Juan) represents the Namurian glacial event and the subsequent postglacial transgresion. This unit is subdivided into four intervals: (1) the lower interval consisting of diamictite and mudstone in a glaciomarine environment; (2) the middle interval consisting of mudstone with dropstones and wave- rippled sandstone documenting the early transgressive systems tract; (3) the upper interval composed of a late transgressive package of shelf mudstone bounded at the top by a maximum flooding surface, and (4) interbedded offshore to shoreface sandstone and mudstone forming the highstand systems tract. The top of the Hoyada Verde Formation is truncated by an erosional surface and overlain by the Tres Saltos Formation. The third and fourth intervals, containing the *Levipustula* fauna, record the last stage of the postglacial transgression and climatic amelioration during highstand, respectively. This postglacial fauna has been systematically analyzed from paleoecologic and taphonomic standpoints within a sequence-stratigraphic framework. The mudstone interval was systematically sampled at every meter, also addressing lateral changes. Taphonomic observations were made for each sampled level. Integrated palaeoecological analysis reveals a pattern of vertical distribution of the benthic fauna, and allows recognizing three types of paleocommunities. Bivalve-dominated paleocommunities, mainly composed by the *Streblochondria sp*.-*Palaeolima retifera* association, are characterized by relative low values of biovolume and diversity. Bryozoans paleocommunities are dominated by *Fenestella sp*. and have the lowest diversity, but high values of biovolume. Brachiopod-dominated paleocommunities, characterized by the *Costuloplica leoncitensis, Kitakamithyris sp., Levipustula levis* association, show the highest values of biovolume and diversity. The bryozoan and brachiopod paleocomunities are well represented throughout the interval, meanwhile the bivalve paleocommunities are confined to the lowest levels. The replacement of bivalve paleocommunities by bryozoan communities suggests a decrease in sedimentation rate and current intensity as result of sea level rise during the last stage of the trangressive systems tract. Maximum depth, and minimum energy and sedimentation rate during maximum flooding are characterized by the development of bryozoan paleocommunities. The replacement of bryozoan paleocommunities by brachiopod paleocommunities represents an increase in food supply during the highstand. Towards the top of the section, the benthic faunal content decreases and finally a barren interval marks the uppermost part of the Hoyada Verde Formation. The last paleocommunity recorded is dominated by bryozoans, but with poor biovolume in marked contrast with those of the maximum flooding, reflecting more unstable conditions and probably an increasing sediment supply. This occurrence represents faunal restrictions as a response to shallowing. In short, the vertical pattern of community replacement follows closely changes in local environmental conditions, which in turn are mostly dictated by sea-level changes.

"Calizas del Queguay": stratigraphy, sedimentology and trace fossils

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The "Calizas del Queguay", originally named by Lambert (1940), outcrop mainly in the north-western region of Uruguay. These continental limestones, formed under arid to semi-arid climates, are part of the Paraná, Santa Lucía and Merín basins, overlying the Uruguayan shield. There are many controversies on its stratigraphy, age and paleoenvironment (Martínez and Veroslavsky, 2004; Tófalo and Pazos, 2010), which are the focus of our contribution. Deposits under or overlying the limestones, except for Guichón and Fray Bentos Formations, were studied in localities from the north-west and south Uruguay. The deposits can be divided in 6 units. -Unit 1: 5 m of coarse sands with interbedded fine gravels. At the top, the unit includes nodules and carbonates laminae and is partially silicified. -Unit 2: 1 to 3 m thick limestone beds, partially silicified, which include *Biomphalaria* gastropods, ostracods, charophytes, *Celliforma germanica*, *C. spirifer*, *Rebuffoichnus sciuttoi* and rhizoliths. Scarce dinosaur eggshell fragments. We name this unit "Queguay limestones-1". -Unit 3: 2-3 m of medium to fine sands showing prismatic structure and mottling. It is conformably overlain by the Asencio Formation. Units 1, 2 and 3 are part of the Upper Cretaceous Mercedes Formation. - Unit 4 (early Eocene Asencio Formation): 2 to 6 m thick. It is composed of red clayish sandstones, containing a great richness of trace fossils. It is utilized herein as a key-bed within the studied area. -Unit 5: up to 5 m thick. It consists of coarse to fine sands, with sparse larger clasts. Some of these clasts are sourced by the Asencio Formation. It is partially silicified and it grades to Unit 6. -Unit 6: 2 to 10 m thick. It consists of sandy silicified limestones. The limestones contain ostracods, charophytes, *Celtis* endocarps, *Biomphalaria*, *Physa*, and *Eoborus* gastropods, *Celliforma germanica*, *C. spirifer*, *C. rosellii*, *C.* ispp, *Rebuffoichnus sciuttoi* and rhizoliths. We consider this unit "Queguay limestones-2". Units 5 and 6, conformably overly Asencio and so are very probably Paleogene in age. The two units (2 and 6) of Calizas de Queguay constitute different stages of deposition of terrestrial carbonates over the Uruguayan shield. Both are separated by units 3, 4 and 5. During sedimentation of mostly fluvial clastic sediments in unit 1, the progressive rise of groundwater table, caused either the formation of groundwater calcretes or the emergence of the lake to form palustrine or lacustrine carbonates. Roots colonized both sand and limestone deposits to form laminar calcretes. Calcretes and palustrine limestones of Unit 2 constitute the characteristic deposits of Calizas de Queguay-1. Calizas de Queguay-2 are thicker palustrine limestones indicating a more persistent palustrine environment. Both units were deposited in a very flat landscape, evolving laterally and vertically from distal fan/fluvial environments to lacustrine ones. The features of the lacustrine/palustrine limestones indicate that these areas were also very flat and their water bodies very shallow.

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C-Sr-isotope values as environmental and stratigraphic indicators in Proterozoic carbonate rocks in the São Francisco Basin, Brazil

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An intriguing stratigraphic scenario is present in the base of the Bambuí Group concerning ages of sedimentation of the different carbonate facies. The São Francisco Basin includes a basal dominantly siliciclastic- carbonate sedimentary succession of the Paranoá Group (Meso- Neoproterozoic) and a higher pelitic-carbonate succession of the Bambuí Group (Neoproterozoic). The distinction of these two groups is clear when the glacial Jequitaí Formation is present, separating these two stratigraphic successions. Nevertheless, when the Jequitaí Formation is absent the carbonate facies of Paranoá and Bambuí groups can be in contact and due to their similarities it is difficult to determine their stratigraphic position. Isotopic evidences indicate two carbonate succession: one for the Bambuí and other for the Paranoá Group. These isotopic signatures distributed throughout the São Francisco Basin mark $\delta^{13}C$ excursions and $^{87}Sr/^{86}Sr$ ratios that can be tentative linked to environmental events of the Meso-Neoproterozoic. In the carbonates of the Paranoá Group the resulting $\delta^{13}C$ values are positive, ranging between +0.3‰ and +3.0‰. The $\delta^{13}C$ value along the Bambuí Group begins at -5‰, cap carbonate, and rise upward reaching+12‰. This $\delta^{13}C$ stratigraphic curve of the Bambuí Group can be correlated throughout the São Francisco Basin. The 87Sr/86Sr ratio for limestones of the Paranoá Group is 0.7056-0.7068, while the ratio for Bambuí Group, which is younger, is 0.7074-0.7075. These limestones have Sr > 500 ppm and Mn/Sr < 0.3, thus they reflect $^{87}Sr/^{86}Sr$ of coeval sea water. $^{87}Sr/^{86}Sr$ data for the Paranoá Group, which is stratigraphically older than the Bambuí Group, are consistent with an age older than 750- 800 Ma preceding Sturtian Glaciation.The isotopic results support and validate the carbonate stratigraphic reconstruction proposed for the São Francisco Basin and support the relative ages suggested for these two groups regarding Sturtian glaciation.

High resolution sequence stratigraphy: practice in Guiné Formation (Precambrian), Chapada Diamantina, BA, Brazil

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Chapada Diamantina East-Central portion (BA/Brazil) has been subject of studies of high resolution sequence stratigraphy (Raja Gabaglia *et al.*, 2006) due to the preservation of primary sedimentary structures and both lateral and vertical good continuity of outcrop exhibitions. The Guiné Formation (Espinhaço Basin) records a siliciclastic shelf/marine environment formed at the beginning of thermal-flexural subsidence stage of a rift-sag basin type (Statherian?). In this work we employed techniques of sequence stratigraphy to correlate episodes and describe depositional evolution in two large outcrops located along the highways BR 242 – outcrop 1 - and BA 148 – outcrop 2. Besides the facies associations and external definition of architectural elements, we also used gamma ray profiles and laser scan imaging for the establishment of their cyclic stacking pattern, independent of any time-scale relationship (Catuneanu, 2006; Catuneanu *et al.*, 2009). Preferentially we took in account the relative magnitude and/or nature of the architectural elements shifts. Using specific criteria, the aim was the characterization, in these outcrops, of two orders of sedimentary cyclicity, in terms of auto and/or allocyclic controls. Facies associations and architectural elements as defined in outcrop 1 indicated a tide-influenced deltaic origin. From the base to the top two subsystems were described: I) dominated by lenticular to tabular architectural elements - interpreted as formed by tidal processes (inlets); and II) characterized by tabular architectural, which correspond to delta front deposits, as a consequence of traction and suspension processes. The resulting stacking pattern is clearly progradational. In outcrop 2, facies associations and architectural elements mainly resulted from tidal processes. In this case, it is assumed the following vertical succession of associations of facies or subsystems - IHS deposits, subtidal/intertidal plains and tidal channels filling. The main tractive structures have both bidirectional and unidirectional character. The stacking pattern is agradational/retrogradational from the bottom to the middle, and progradational at the top of the section. The arrangement in subsystems, limited by key surfaces, suggests a 3rd order cyclicity. These 3rd order surfaces are candidates to be the MRS-Maximum Regressive Surface and the MFS-Maximum Flooding Surface. By the other hand, the very regular vertical alternating pattern of the architectural elements suggests the existence of a subordinated higher frequency and smaller amplitude cyclicity, here considered of 4th order, probably also linked to an allocyclic control (alternating pattern occurs inside the same subsystem). What seems to be clear is that in the northern portion of the studied area (outcrop 1) the sediment supply is related to a more effective fluvial activity (tide-dominated deltaic system), while in the southern portion (outcrop 2), tide was totally responsible for the sedimentary processes, with the development of a very large tidal plain and the incision of tidal channels. Nevertheless, the change of nature of architectural elements as well as their stacking pattern in both outcrops suggests, from the bottom to the top, a general decrease in the rate of rising sea level and the consequent reduction of water depth, typifying, in the 3rd order, respectively, the passage from a Transgressive to a Highstand System Tract.

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Morphosedimentary dynamics in beaches under estuarine inlet influences in the coast of Paraná, Brazil

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The coast of Paraná is in the southern region of Brazil (25°34'S/48° 21'W) and has two main estuaries named Guaratuba Bay, with nearly 50 km^2, and the Estuarine Complex of Paranaguá (CEP) with 600 km^2 and both have ebb tidal deltas at their inlets. Sandy beaches that make up the portion associated with these inlets have different features as the bathymetry and degree of exposure to wave and tidal currents energy. The study area is located at CEP's mouth where the exposed portion to SSE quadrant wich has oceanic features with effective wave and longshore current action and association with the ebb tidal delta. The beaches turned to NE have estuarine features that are mainly influenced by tide and longshore currents and by waves sometimes. The coastal stabilization works (rockfills, retaining walls, groins, and others.) can be seeing throughout the area. The aim of this work was to establish relations between the beaches morphological variations under inlet influence and the sedimentary transport processes in the adjacent coast. To achieve this objective topographic beach profiles were carried out in 2008/2009 on both portions. In general the segment exposed to SSE was erosive except in the portion near the inflection between the two sectors where deposition occurred. The bathymetric charts of the region show shallow areas settled along the coast that in this study were interpreted as a sandspur which develops to NE according to longshore current pattern. In the NE sector there was an intercalation between erosive and depositional points according to the arrangement of the engineering works built normal to the coast (groins or jetties). These works tended to trap sediments on the stoss side and caused erosion on the lee side. In an overview the longshore transport of beaches under mouth influence tends to be interrupted by tidal currents causing partial obstruction of the sediment transport. In this way the eroded sediments in the SW portion can be trapped, in part, in this inflexion area by the interaction among the present processes. In a second moment, the coastal transport flowing into the estuary shows capture of sediments by the hard structures in the NE quadrant. This portion responds directly to various anthropic modifications made in the area compromising the urbanization settled along the years.

Digital Outcrop Modeling of an inner carbonate ramp setting (High Atlas, Morocco) using LiDAR technology

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Capturing facies heterogeneities at different orders of magnitude in a digital outcrop model (DOM) is crucial for reservoir characterization and flow prediction. The present work focuses on the analysis of sedimentological features of a carbonate ramp at different scales of observation from lithofacies (metre-scale) to depositional environments (ten to hundred metre-scale) to system tracts (hundred metre-scale) and their integration within a DOM. The area chosen for this study, a Jurassic succession in the High Atlas of Morocco, offers outstanding outcrop conditions and a range of sedimentological features showing variability at all scales of interest. Situated 50 km toward the west of the city of Rich, the study window is located in the Assoul Fm. (Bajocian) and its dimensions are 700 m2 and 90 m thick. The methodology comprises field data collection, GPS mapping survey, LiDAR data, and facies modeling using PetrelTM software. A total of 12 lithofacies have been identified and grouped into four lithofacies associations, a marly open ramp, a semi-restricted ramp, a high-energy ramp and a reefal facies. The stratigraphic interval is composed of four fourth-order depositional sequences, which show the deposition of the marly open ramp during the transgressive phase, which evolves upwards to a lagoonal facies with Cayeuxia-type cyanobacteria, oncoids, and a significant amount of micritization and microencrustation. The highstand phase records the progradation of shoals toward the lagoon. According to the regional study of Pierre *et al.* (2010), the stacking pattern and facies evolution show an alternance from an ooid-free muddy ramp to an oolitic ramp related to fourth-order sea-level fluctuations. Showing two different depositional profiles, both ramp types need to be modeled to create a reliable DOM. For the system tracts, a deterministic approach is suggested by assigning a rock property (muddy/oolitic ramp) for each layer. Indeed, at this scale the strongly interpretative character of this rock property does not allow the application of any stochastic method. The modeling of depositional environments is carried out using a stochastic approach, particularly the Truncated Gaussian Simulation algorithm (TGSim). The advantage of this method is that the proximal-distal trend of the depositional environments can be correctly modeled. At the facies scale, a stochastic approach is also applied. Although commonly utilized by previous studies, the use of one unique algorithm is not adequate to model the spatial facies distribution and therefore, the modeling approach combines three different algorithms. The object-based modeling is used to model patch reefs and shoals by measuring their dimensions on the field. The TGSim and SISm (Sequential Indicator Simulation) algorithms are used to model the lithofacies distribution. The need to assign a lithofacies trend using TGSim algorithm is not necessary adequate for the facies modeling, especially within the lagoon environment. In this particular case, the SISim algorithm is used.

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Pierre, A., Durlet, C., Razin, P. and Chellai, E. H. (2010) Spatial and temporal distribution of ooids along a Jurassic carbonate ramp: Amellago oucrop transect, High-Atlas, Morocco. Geol. Soc. Spec. Publ., 329, 65-88p.

Spatial characterization of the metre-scale cycles variability in the Latemar platform (Dolomites, Italy) using digital outcrop modeling techniques

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The Latemar controversy is focusing on the understanding of the auto- or allocyclic origin of the metre-scale carbonate cycles and their temporal significance (Mundil *et al.*, 2003). Most studies so far have focused on the description and interpretation of the vertical stacking pattern of the carbonate cycles from metre to hundred metre scale. A fundamental contribution over the understanding of the mechanisms controlling carbonate deposition is acquiring a detailed knowledge of the lateral facies and cycle changes through the entire interior platform, across critical turning points in the stratigraphic evolution. This project aims at analyzing the lateral facies and carbonate cycles variability across a transect within the interior to outer platform of the Latemar platform in the Dolomites by collecting traditional field data supported by d-GPS and a digital outcrop modeling (DOM) using LiDAR technology. The 3D modeling is designed to help for the visualization of the spatial facies distribution and to assess quantitatively the geological data. One of the key aspect in this study is the building of a DOM through the mapping of key stratigraphic surfaces, such as subaerial surfaces or boundaries between units, closely-spaced stratigraphic sections, LiDAR data, and the Petrel software. Previous work (Peterhansel and Egenhoff, 2008) has focused only at the base of the Upper Cyclic Facies (UCF). This study provides a high-resolution dataset of the entire Cima del Forcellone outcrop spanning the Lower Cyclic Facies (LCF), the Middle Tepees Facies unit (MTF), and the Upper Cyclic Facies (UCF). The closely-spaced logging of this outcrop allowed the analysis of i) changes in the depositional profile of the interior platform between tepees and cyclic facies units and ii) the influence of topographic highs as tepees on the expression and frequence of the metre-scale cycles. The preliminary results focused on lateral cycle variability show an increase of the number of cycles (25 to 50%) along a transect from the lagoon to the tepees belt within the MTF unit. The tepees being interpreted as topographic highs, this observation could indicate that the autocyclic mechanisms seem to play a more important role within the tepees facies units than within the cyclic facies units, where only 25% of increasing has been documented (Peterhansel and Egenhoff, 2008).

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Revisiting the sedimentary record of a high-energy marine-inundation at Martinhal (Algarve, Portugal)

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The Holocene sedimentary infill of the Martinhal coastal lowland (southern Algarve, Portugal) has been reported in the literature (Kortekaas and Dawson, 2007) as hosting a sandy deposit attributed to the AD 1755 Lisbon tsunami event. In these studies the sedimentary succession consists of a basal medium-sand of marine facies overlain by ca. 2 m of brown to black estuarine/lagoonal mud, grading upwards into alternating laminae of terrestrial mud and marine sand of varying thickness, reflecting the present-day pattern of sedimentation in the coastal basin; the AD 1755 tsunami deposit is located between the lower mud and the top layered unit and occurs as a widespread layer of coarse to very coarse sand with many shell fragments, sand-armoured mud balls and limestone pebbles. Grain size characteristics of the sediments, their foraminiferal content and also the presence/absence of rip-up clasts and large pebbles were used to reconstruct distinct sedimentary sub-environments and to distinguish between coarser materials deposited by either tsunamis or storms within the more recent part of the sequence. An older episode of coarse sedimentation is embedded in the lower mud unit, which, though ubiquitous along the lowland and with an extension similar to the tsunami sand sheet, does not share compositional neither textural similarities with both the AD 1755 tsunami sand or the present-day sediments accumulating within this lowland and in the beach-dune confining system. We recently opened six exploration trenches at Martinhal, which allowed us to revisit the depositional history of this lowland. Samples were collected to produce large and small (2 mm) aliquot quartz OSL dating of sand laminae, lenses or layers representing the coarse sedimentation episodes present in all lithostratigraphic units of the Holocene infill in order to time-constrain and to complement the correlation between different sedimentation episodes. The observation and interpretation of the depositional architecture suggest a more complex picture for the sedimentation of the sandy units resting upon the lower mud unit, namely due to emphatic lateral changes in facies between trenches located at short distances from each other. In the back-barrier area, the marine deposits that we correlate to the tsunami unit exhibit only a planar lamination dipping seaward, indicating post- tsunami beach accretion by reworking of the sand originally emplaced by the high-energy marine inundation. Further inland, several wedging out sand units and small-scale sedimentary structures (lamination) suggest post-depositional reactivation of the tsunami deposit; such remobilization is associated with either marine- processes acting in the onshore direction or, in contrast, backwash activity, as indicated by directional features looking seaward. Field observations also suggest that the landward limit of the inundation was most probably located further inland than inferred from previous biostratigraphical and lithostratigraphical studies; the inundation invaded the small canyons outletting in the lowland and fluvial and colluvial sediments were moved into the lowland to build the topmost section of the high-energy deposit.

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Lake Van Drilling Project 'PaleoVan': a long and continuous sediment-based reconstruction of the climatic, volcanic and tectonic history of Eastern Anatolia

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Lake Vans annually laminated sediment-record covers several glacial-interglacial cycles and holds thus potentially 500'000 years of depositional history. It is considered a jewel for high-resolution paleoenvironmental, paleoclimatic and paleotectonic research. The sedimentary succession of the lacustrine subsurface will be recovered in summer 2010 by the ICDP (International Continental Scientific Drilling Program) project, 'PaleoVan'. Based on the high-resolution seismic data and multidisciplinary scientific work, it is planned to drill a series of sites in variable water depths. Lake Van is the fourth largest terminal lake in the world (volume 607 km3, area 3,570 km2, maximum depth 460 m), extending for 130 km WSW-ENE on the Eastern Anatolian High Plateau, Turkey. Therefore, Lake Van is a key site for the investigation of the Quaternary climate evolution in the Near East. The geochronological precision on a decadal or even annual scale will allow comparisons not only with astronomical cyclicity but also signals below the frequency of Milankovitch cycles, such as North Atlantic Oscillation, which may have also affected the past climate system of the eastern Mediterranean region. As a closed and saline lake, Lake Van reacts very sensitively with lake level changes to any alterations in the hydrological regime in response to climate change. These changes do affect water chemistry and water physics, which in turn alter the sediments so that they record these past fluctuations with distinct changes in lithology. Tephra layers originating from several volcanoes surrounding the lake were documented in previously collected cores and are also expected in the deep drill cores of Lake Van sediments, allowing reconstructions of larger volcanic events and environmental impacts. Furthermore, they offer through tephrachronology and radiogenic-isotope analyses the means to date the stratigraphic section beyond the range of radiocarbon. As the region is seismically very active, the short cores from Lake Van show strong evidence of earthquake-triggered deformation, such as microfaults. As these structures were mapped at several sites in the same stratigraphic horizons, they were confirmed to be seismites. Similar features are expected to be found in the deeper sections providing a sediment- deformation based paleoseismic record. The unique setting of Lake Van, which records simultaneously the volcanic as well as the earthquake history, will also allow establishing possible coincidence between larger earthquakes and volcanic events. Drilling will take place during three months during July, August and September 2010. We will be able to present the first initial results of this campaign during the meeting in Mendoza. This contribution is co-authored by the entire 'PaleoVan'scientific drilling party.

Travertines, climate and sea-level. Insights from central-southern Italy

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The Quaternary travertines of central and southern Italy, including a large part of thermal deposits, developed mostly during interglacial periods. In particular, they appear well related to specific warm-wet climatic intervals, characterized by increasing volume of the spring waters in the foothills of the calcareous mountains and by forest expansion. Formation of travertines takes place in the presence and with contribution of biota. The basic components are represented by incrustations (mainly on vegetable supports) with different porosity and permeability and mostly precipitated, with fast accretion rates, in (and around) aquatic organisms which are able to arrange the primary carbonate precipitates along their prevailing growth directions. So the porosity-permeability of these carbonates results from the interplay of their precipitation rate as well as size and related growth rate of the benthic organisms. In particular, thermal water travertines, displaying a stony firmness, tend to be less porous from the analogous ambient water deposits. Moreover their biotic component is limited to bacteria or archea, at least in the vicinities of the spring. Most of the thermal water travertines of central and southern Italy that prevailingly occur in active tectonic or volcanic areas is today almost inactive and is characterized by low to middle thermalism (e.g. Contursi near Salerno). We discuss here the case of thermal water travertines cropping out in the Acque Albule basin, near Tivoli (Rome). In the past years several studies have been carried out on these deposits that are well exposed in numerous active and inactive quarries, used since Roman times for the extraction of large blocks. These travertines accumulated between 115 and 30 ka B.P. from moderately warm waters. In particular, we have measured at a mm scale a 30 m bore-core drilled in the NW sector of Tivoli to sequentially analyse the vertical organization of depositional characteristics (textures and sedimentary structures) and to reconstruct the related environmental dynamics. The organization of the travertine lithofacies and lithofacies associations in general suggests (a) an upward increasing diffusion of very shallow lake environments, as well as (b) an upwards decreasing of both the inclination of depositional surfaces and related hydrodynamic energy. The observed lithofacies and their organization do not substantially differ from those of genuinely cold water deposits (calcareous tufas, according to other glosses) except for some of thermal related features (microbialitic and spongy textures). Moreover, the recurrence of the discontinuity surfaces implies a pulsation in the flowing-water volumes and/or calcium carbonate precipitation potential, where the bulk porosity decreases when the parent water temperature increases. As to the systematic (cyclic ?) alternation of periods of abundant deposition of calcium carbonate incrustation and periods of starvation, travertines appear to undergo to an allocyclic regulation of climatic origin, even if an autocyclic control that includes parent water temperature and/or tectonics cannot be excluded. Moreover, there is a close relationship between the travertine formation and high-sea level phases.

Diagenetic-metamorphic characterization of Paleozoic pelitic units of the Mojotoro Range, Eastern Cordillera, Argentina

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This contribution presents the diagenetic–metamorphic grade variations determined from the Kübler index (KI) measured in Lower Paleozoic pelitic units of the Mojotoro Range. The compositional studies of the field samples were carried out with a binocular magnifying lens, optic and scanning electronic microscope (SEM), and X-ray diffraction (XRD). In metapelitic facies, the <2 µm fraction was separated with a previous SrCl saturation and homoionization. In this fraction, oriented aggregates were prepared, glycoled in ethynel glycol treated during 48 hours at 60 °C and calcined at 550 °C. The KI were measured in the <2 µm fraction, and the data was corrected according to the CIS scale (Cristallinity Index Standard). The CIS standard samples (SW1, SW2, SW4, SW6) were prepared and radiated using the same technique employed for the metapelitic samples. Three clastic units were recognized in the basement of the Mojotoro Range. These units present different lithologies, structures and metamorphic grades but mineralogically, they preserve a Low-Middle Cambrian acid volcanism contribution in their mineral composition. The Chachapoyas Formation crops out in the western flank of the range. It consists of shales and greenish, very fine grain sandstones strongly folded and affected by a high anquizone–epizone grade (0.23– 0.32Δ°2θ). This unit is intruded by acid dikes, dated in 533 ± 2 Ma, therefore, it is the older formation in the Mojotoro basement. The upper unit is sandstone level, Alto de la Sierra Formation and consists of quartzose, lithic, and feldespathic wackes with a seriate texture and evidences of superimposed metamorphism. The wackes are interstratified with purple mudstone composed of illite and traces of illite/smectite mixed-layers. The measured KI indicates a metamorphism of very low grade, in the limit of low anchizone–high anchizone (0.31– 0.36Δ°2θ). The last unit is the heterolythic facies of Guachos Formation, and consists of wackes–metapelites with illite, chlorite and interestratified illite–chlorite. Based on the KI, these rocks were affected by a high anchizone–epizone metamorphism (0.25–0.32 Δ °2θ). Upper Cambrian metapelites from the Campanario Formation and ordovician units of San José, Floresta and Santa Gertrudis Formations, were also analyzed. The Campanario Formation is formed by purple limolites. The San Jose Formation (Early Tremadoc) is a gray and white pelitic unit. The Floresta Formation (Early Tremadoc – Late Tremadoc) is composed of coquinites, claystone and mudstone. The Santa Gertrudis Formation is made up of fine wackes and limolites. The clay mineralogy of these rocks consists of illite, chlorite (clinochlore) and glauconite, and their KI are 0.44 Δ °2θ; 0.5 Δ °2θ; 0.53 Δ °2θ; 0.58 Δ °2θ, respectively. Thus, these rocks were affected by deep diagenetic grade. In summary, the grade metamorphic determined by the KI have a direct relationship with the ages of the rocks, except for the Guachos Formation from the basement of the Mojotoro Range that has the highest metamorphic grade (greenschist facies) and it is the youngest stratigraphic unit of this basement.

Sedimentary facies analyses of rift initiation to rift climax stages on outcrops along the transnordestina railroad, Araripe Basin, Northeastern Brazil

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The origin of the Araripe basin and its tectonic evolution is linked with South Atlantic rifting. The basin records four major tectonic-sequences representing its filling. This paper discusses the research carried out to date, with the objective of mapping and describing the sedimentary facies and geometry of the rocky bodies found within the Brejo Santo, Missão Velha and Abaiara formations. These units represent periods which encompass the beginning of the rift stage climax during the Araripe Basin evolution. The aim of our investigation was to analyze the siliciclastic facies of these units in order to determine their reservoir potential within a possible Araripe Petroleum system as well as for analogous reservoirs that could be used for other Brazilian basins. Brejo Santo formation (Upper-Jurassic) shows the Fsc, Fl, Fr and Lc facies with the occurrence of red to brown shales, with well-developed laminations. Other lithologies are represented by intercalations of decimetric beds of green mud siltstones with centimetric beds of reddish shales, calcareous nodules and fine horizontally stratified calcareous sandstones. The characteristics of this formation are suggestive of a lacustrine depositional system for its origin such as a playa-lake. Brejo Santo shales grade laterally to sandstones of Missão Velha (Upper- Jurassic), which consists of Gp, St, Sp, Sh, Sl, Fsc and Fl facies. It is mainly composed of sandstone beds showing fining-upward sequences rich in silicified plant remains. These sandstones present colors varying from white to yellow and occasionally red. Grain size varies considerably, and the beds possibly reveal conglomeratic facies locally, with small and medium sized trough and planar cross-stratifications. Also load structures were observed represented by convolute laminations, thin siltstone and red shales beds intercalated within the sandstones layers. The characteristics listed above suggest deposition occurred in a braided fluvial system. The Abaiara formation (Lower Cretaceous) presents Gm, Gp, St, Sp, Sh and Fsc facies and is inferred to as a discontinuous intercalation of sandstones into shale bodies. The sandstone lithologies consist of quartzose sandstones, ranging from green to yellowish in color, with trough and planar cross-stratifications and convolute structures. The matrix presents subrounded fine to coarse grains. The pelithic facies of this unit are very similar to those found in the Brejo Santo formation. These facies are composed of red to green shales intercalated with calciferous sandstones thin beds. The coarse sandstone facies of this unit were interpreted as being deposited by a braided fluvial system, which graded to a shallow lacustrine system demonstrated by the pelithic facies.

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Sedimentologic and stratigraphic studies of lacustrine deposits associated with early (Aliança Formation) and middle to climax rift (Candeias Formation) phases in the Jatobá Basin, NE Brazil

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The sedimentologic and stratigraphic aspects of pre-rift and rift phases lacustrine deposits can be demonstrated using the interior Jatobá Basin, which occupies an area of approximately 5,000 km² along the Pernambuco and Bahia states of northeast Brazil. Smaller lakes are more susceptible to environmental changes, showing lateral and vertical variations of facies more abrupt than those demonstrated by facies in marine basins. Climate and tectonic factors control the lacustrine depositional system, including the physical-chemical characteristics of the water column and the production and preservation of organic matter within the sedimentary deposits. The lacustrine deposits found in Jatobá Basin show similar lithologies and age to those in the Araripe Basin (Brejo Santo Formation (Upper-Jurassic) – Abaiara Formation (Lower Cretaceous). Upon the Paleozoic pre-rift sequence, the rift onset to early rift phase of the Jatobá Basin comprises a sedimentary sequence deposited during the Upper Jurassic under an arid climate in a depression along the rifting line (African-Brazilian trough). These sediments are represented by eolian-fluvial cycles (Sergi Formation), which are intercalated with lacustrine red pelites (Aliança Formation). The Aliança Formation is composed essentially of calcareous argillite, red shales, and siltstones, locally intercalated with light green shales, interbedded with dm- to m-thick layers of fine- to medium-grained sandstones and clayey limestone beds. The presence of exclusively non-marine fossils indicates freshwater sedimentation. During the Lower Cretaceous (middle to climax timing of the rift event), the deposits belonging to the Candeias and São Sebastião Formations accumulated. These Jatobá stratigraphic units confirm the relative similarity of the basin infilling pattern along the Recôncavo-Tucano-Jatobá system. The Candeias Formation (less expanded compared to its correlative in the Recôncavo Basin) is undivided in the Jatobá basin, being represented by lacustrine shales intercalated with abundant deltaic sandstones and limestone beds. The Candeias and Abaiara Formations from the nearby Araripe Basin demonstrate a significant lateral and vertical facies variation. This allows a clearly distinction to be made in the stratigraphic record among the deposits associated with rift onset and those related to early to mid-rifting. Our preliminary analysis suggests that it is possible to characterize the Aliança and Candeias paleolakes and to construct a depositional model that allows a comparison to be made between the systems associated with the rift onset and the early rift stages (Aliança Formation) and with the middle rift climax phase (Candeias Formation) in Jatoba Basin.

Coastal processes and the effects of freshwater tidal influences within large-scale river systems: comparison of the Changjiang (Yangtze) and Amazon Rivers

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Problems can arise when standard models of tidally influenced estuaries and deltas are applied to large, tidally influenced rivers. The widely discussed tripartite estuarine model cannot be readily applied to systems such as the Amazon or the Changjiang (Yangtze), which do not exhibit a mud-dominated central basin. In such systems, the large freshwater flux can displace the turbidity maximum seaward onto the continental shelf. Thus, extensively mud-draped bedforms may not be formed, even in areas of strong tidal influence. Analyses of thickness variations of laterally accreted bedforms and vertically accreted laminae, however, may be used to detect tidal cyclicities. There are a variety of inland limits of marine and tidal influences that can be defined in large-scale rivers. Because such rivers tend to occupy low-slope basins and have a large cross-sectional area, marine and tidal influences can propagate for many 100s of km inland. During low-flow stage of the river, brackish-water intrusions can extend for 10s of km up into the fluvial channels. Similarly, flood-tidal currents can be detected for 100s of km inland and can have significant effects on bedform sedimentology. Even beyond the inland limits of flood-tidal currents, tidally induced changes in river-water levels can be detected. In the Changjiang (Yangtze) River, this inland limit of tidally induced river-level variations occurs 450 km upstream from the river mouth; in the Amazon, such variations can be detected 1000 km from the mouth. The recognition of tidal effects in the lower stretches of rivers is of great importance, particularly during the study of ancient systems. Recognition of the various marine and tidal effects is crucial to the proper unraveling the facies mosaic of incised valley-fill sequences (IVFs).

Diagenetic and depositional significances of the Miocene gypsified laminites and stromatolites, Red Sea Coastal Plain of Saudi Arabia and Egypt

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Field and petrographic examinations of active gypsum quarries in the Miocene evaporites of the Red Sea coastal plains of Saudi Arabia and Egypt have revealed the dominance of microbial laminites and stromatolites structures in secondary gypsum rocks. The microbial laminites and stromatolites have variable composition such as micritic and scalenohedral calcite, dolomicrite and rhombic dolomite, euhedral celestite and pyrite. Six petrologic types of gypsum are described; these are porphyrotopic, poikilotopic, granular, alabastrine and selenitic gypsum, in addition to satin spar gypsum veins. The porphyrotopic and poikilotopic gypsum increase towards the bottom of the sections and decrease towards the top. On the other hand, an increase in abundance of alabastrine, granular and selenitic gypsum is noticed towards the upper parts of the sections. Crystals of primary anhydrite and primary gypsum, or their pseudomorphs are scarcely present. A sequence of diagenetic stages could be recognized. This includes: (1) transformation of anhydrite into secondary porphyrotopic and poikilotopic gypsum during early exhumation; which is believed to had taken place through slow crystal growth on a volume for volume basis in an equilibrium condition, whereas the excess sulfate was deposited as satin spar gypsum veins; (2) dissolution and recrystallization of the porphyrotopic and poikilotopic gypsum into alabastrine and granular gypsum and limpid giant selenite crystals during late exhumation; and (3) late climatic dehydration of gypsum at the outcrop into felted and prismatic anhydrite. The hydration of anhydrite into secondary gypsum and their subsequent dissolution and recrystallization are believed to have taken place in the relatively late history of the rock by invasion of percolated meteoric waters, whereas the saline Miocene and later Red Sea waters had no effect on the diagenetic history of the secondary gypsum. The enrichment of microbial laminites and stromatolites in the secondary gypsum indicate that they were formed in very shallow salina and supratidal depositional settings. The stable tectonic setting of the studied areas, the continued restriction of the evaporite basin, the slight fluctuation in salinity and the prevalence of arid climate allowed the accumulation of the sulfate evaporites and the persistent flourishing of microbial laminites and stromatolites in the evaporite basin.

Sediment record of alternating wet and dry climate in lowland Central America since MIS3

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A suite of drill cores was retrieved from Lake Petén-Itzá, Peten, Guatemala, as part of an ICDP-sponsored program. An 85-ka sediment record from this lowland Central American lake was used to reconstruct hydrologic changes in the northern Neotropics during the last glaciation. Sediments are composed of alternating layers of clay and gypsum, reflecting relatively wet and dry climate, respectively. Moist conditions dominate Marine Isotope Stages (MIS) 5a, 4, and early 3, as shown by predominantly carbonate and clay sedimentation. The first gypsum layer was deposited at 48 ka and marks a shift toward drier hydrologic conditions and the onset of wet–dry oscillations. During the youngest section of MIS 3, Petén climate varied between wetter conditions during interstadials and drier states during stadials. The pattern of clay– gypsum (wet–dry) oscillations during the latter part of MIS 3 (48–23 ka) closely resembles temperature records inferred from Greenland ice cores and North Atlantic marine sediments, as well as precipitation patterns from the Cariaco Basin, off Venezuela. The most arid intervals coincided with Heinrich Events, when cold sea surface temperatures prevailed in the North Atlantic, meridional overturning circulation was reduced, and the Intertropical Convergence Zone (ITCZ) was displaced southward. A thick clay unit was deposited from 23 to 18 ka, suggesting deposition in a deep lake, and pollen accumulated during the same period indicates vegetation was dominated by temperate pine-oak forest. This finding contradicts previous claims that climate was arid during the Last Glacial Maximum (LGM) chronozone (21± 2 ka). At 18 ka, Petén climate switched from moist to arid conditions and remained dry during the so- called “Mystery Period” from 18 to 14.7 ka during the early deglaciation. Moister conditions prevailed during the warmer Bolling–Allerod (14.7– 12.8 ka), with the exception of a brief return to dry conditions at 13.8 ka that coincides with the Older Dryas and meltwater pulse 1A. The onset of the Younger Dryas at 12.8 ka marked the return of gypsum, reflecting dry conditions. The lake continued to precipitate gypsum until 10.3 ka when rainfall increased markedly during the early Holocene. Tropical forest decline started at ~4.5 ka, simultaneous with the onset of a circum-Caribbean drying trend that lasted for ~1.5 ka. This forest decline preceded the appearance of Maya-associated Zea mays pollen. Thus, vegetation changes in Petén during the period from ~4.5 to ~3.0 ka were largely a consequence of a climate shift to drier conditions. Furthermore, palaeoclimate data from low latitudes in North Africa point to teleconnective linkages of this drying trend on both sides of the Atlantic Ocean. Our results generally support the hypothesis that summer precipitation in the northern Neotropics was controlled by migrations in the meridional position of the Atlantic ITCZ during the stadial–interstadial events of late MIS 3 and the last deglaciation. The ITCZ was located farther south during cold periods when arid conditions prevailed in the northern Neotropics, especially during Heinrich Events. At some drill sites, the deeper part of the record, below a desiccation horizon, comprises an older lacustrine section that was dated with tephrachronolgy to 200,000 years. It is not yet clear whether these deposits represent the first lacustrine phase in the Peten Itza record and are thus related to basin formation, or whether even older deposits lie below.

Late Pleistocene and Recent stromatolites in lacustrine closed-basins of northern Patagonia (Argentina)

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Previous research in lacustrine settings has shown that fossil stromatolites often develop continuous shorelines that can be used to reconstruct contemporaneous lake levels in the past. Their potential bathymetric extension commonly ranged between 0 and 30 m water depth where microbial communities colonize hard substrates and precipitate carbonates in situ. At present there is a clear paucity of detailed studies on lacustrine stromatolites in southernmost South America particularly in regions confronted to extreme and variable environmental conditions. Laguna Cari-Laufquen, a closed-lake basin, is located in the eastern side of northern Patagonia and has a present catchment area of ca. 16,500 km^2. Mean annual precipitation is ~200 mm falling primarily during Austral winter months and annual temperature averages only 4 °C. As a result of this extreme hydrological regime today the lake is separated in two parts presenting rather distinctive sedimentation that witness their different salinity and organic matter production. A higher, permanent body – Laguna Cari-Laufquen Chica – is a dilute, sodium bicarbonate lake (pH 8.7 and ~283 ppm TDS). It usually overflows into a lower, intermittent body – Laguna Cari-Laufquen Grande – that is a brackish, sodium bicarbonate lake (pH 8.6 and 4000 ppm TDS). Well-developed shorelines indicate that the two lakes were formerly united and much more extensive. Two well defined shorelines located at ~25-30 m and ~15-20 m contain rather large stromatolites of ca. 1m diameter that have been radiocarbon dated at 19,120 ±165 yrs. BP and 15,790 ± 230 yrs. BP, respectively. Fine-grained lacustrine deposits underlying the upper two shorelines contain diatoms and ostracodes suggesting deposition in the shores of a deeper, saline and alkaline lake. The buildups are often coalescent forming continuous ridges. They display a cauliflower structure with a nucleus of black basalt that dominates the catchment geology. Microscopic observations show a pseudo columnar and rarely columnar micro lamination with interbedded micritic and organic matter laminas without evidence of trapping and binding structures. Thus, their texture more closely resemble to Precambrian stromatolites than do other modern marine and lacustrine examples and, therefore, they may be a more appropriate analogue for these early bioconstructions. Moreover, it appears that similar microbial carbonates are presently forming on Laguna Cari-Laufquen Chica shores providing us with a unique analogue to study ongoing formation of these lacustrine stromatolites using a modern geomicrobiological approach.

Organomineralization and ooid development in freshwater Lake Geneva (Switzerland)

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The latest Holocene shallow water sediments in western Lake Geneva, Switzerland, are >90% composed of ooid sands. Several hypotheses have been advanced to explain their formation such as increasing energy linked to enhanced winds and/or changes in biogeochemical conditions of the lake. In particular the presence of biofilms lining depressions on ooid surfaces has been previously appointed as starting sites for low-Mg calcite cortex formation. Recent field- and laboratory-based experimental results point towards a dominant role of biological versus purely physicochemical processes in the early stages of freshwater ooid development. A special device was placed in the ooid-rich bank of the lake. It contained frosted glass (SiO2) slides, since quartz (SiO2) is the most abundant mineral composition of ooid nuclei that acted as artificial substrates to favor microbial colonization. Microscopic inspection of the slides depicted a seasonal pattern of carbonate precipitates, which were always closely associated with biofilms that developed on the surface of the frosted slides. They contain extracellular polymeric substances (EPS), heterotrophic and photosynthetic organisms such as cyanobacteria and diatoms. Carbonate precipitation peaks during early spring and late summer, and low-Mg calcite crystals mostly occur in close association with filamentous and coccoid cyanobacteria. Further SEM inspection of the samples revealed low-Mg calcite with crystal forms varying from anhedral to euhedral rhombohedra, depending on the seasons. In situ biofilms communities were harvested and cultivated under laboratory conditions. Liquid and solid cultures corroborate the field observations and demonstrate that under the same physicochemical conditions the absence of biofilms prevents low-Mg calcite precipitation. The lack of evidence for the presence of sulphate-reducers further indicate that photosynthetic activity through increasing pH in EPS is the main factor triggering the early precipitation of low-Mg calcite. Hence, these results support the hypothesis of organomineralization of low-Mg calcite as the main mechanism involved in the early stage of ooid formation in freshwater Lake Geneva. Total DNA extractions on natural ooids, biofilms harvested from the in situ glass slides, and cultured biofilms in the laboratory indicate a comparable microbial diversity supporting this model. Ongoing investigations in a series of short cores retrieved at different sites within the bank provide a unique opportunity to reconstruct early diagenetic processes associated with microbial activity throughout depth. These results are combined with the outcome of a downscaled water circulation model for the section of the lake containing the ooidal bank, and further help to clarify the factors controlling its morphology. Finally, these data will help to better understand the mechanisms behind the development and spatial distribution of freshwater ooid deposits at different geographical and temporal scales.

Eolian and fluvial system of the Anacleto and Allen Formations, Neuquén Basin, in the south of Paso Córdova, Río Negro, Argentina

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In the province of Rio Negro, south of Paso Córdova area, there are excellent outcrops of the Anacleto (Neuquén Group) and Allen Formations (Malargüe Group). The detailed sedimentary analysis with description of lithofacies and architectural elements of these Upper Cretaceous continental deposits, allowed establishing the paleoenvironments and the stratigraphic evolution for the eastern margin of the Neuquén Basin. In this contribution four eolian lithofacies (SpE1, SpE2, ShE and SrE) and five fluvial lithofacies (StF, SpF, ShF, SrF and FlF) were defined. The lithofacies association allowed the identification of eolian and fluvial architectural elements: Dunes transverse (DT), Dunes barchans (DB), Wet Interdune (WI), Dry Interdune (DI), Channels Element (CH I y CH II), Lateral Accretion (LA), Downstream Accretion Macroforms (DA), Crevasse Splays (CS), and Floodplain (OF). The spatial distribution of these architectural elements and the analysis of discontinuity surfaces allowed interpret an eolian – fluvial system (FES) for the Anacleto Formation and an eolian system (ES) for the Allen Formation. The eolian-fluvial system is defined by channels with multiepisodic fill (CHI), with the development of simple and complex transverse bars (DA I). The presence of lateral accretion elements (LA) suggest high sinuosity for system and the crevasse splay (CS I) isolated in flood plain (OF) imply numerous overflow events due to marked climatic seasonality. In addition, this FES is constituted of ephemeral fluvial channels (CH II), associated with Wet Interdune and Dry Interdune deposits (WI - DI) and Barchans Dunes (DB). The WI deposits have desiccation cracks, burrows, root structures and bioturbated surfaces. The DI deposits are dominated by wind ripple strata and granule lags related with deflation processes. The barchans dunes are characterized for the presence of grainflow strata indicates dunes with well-developed slipfaces. This dune type show difference of paleocurrent data and set thickness variations, suggesting that smaller superimposed dunes have migrated on top of the main dune. The eolian system is composed of wet interdune (WI) deposits and transverse dunes (DT) with well-preserved slipfaces and grainflow deposits. In addition this system presents granule lag deposit associated with reactivation surfaces suggesting deflation process due to strong wind and the growth of eolian megarripples in the upper and middle section of the flank dune. This type of lag deposits is also present at the base of the system associated to wet interdune deposits. The WI areas show high preservation because has several trace surfaces indicating the fast migration of the dune. This sedimentological study suggests an eolian – fluvial system for the Anacleto Formation and an eolian system for the Allen Formation. Both systems are in contact through a significant discontinuity surface that suggests an important subsidence event that allowed the installation of a great system of dune transverse dunes (Allen Formation) on the eolian – fluvial system of the Anacleto Formation.

Pliensbachian paleoclimatic changes recorded in the geochemistry of belemnites from Asturias (Lower Jurassic, northern Spain): regional or global signal?

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One of the most severe and better-known Jurassic paleoenvironmental crisis is the lower Toarcian Oceanic Anoxic Event (~183 ma), which resulted in major global carbon cycle perturbations and widespread organic facies development. However, other worse-known events of black-shales development exist during the Pliensbachian (Lower Jurassic), which effects have been underestimated due to the scarcity of high-resolution geochemical records from this period. Good examples of those events are recorded in the Basque–Cantabrian and Asturias basins (northern Spain) (Aurell *et al*., 2003). In this study we have generated new high-resolution geochemical data from two sections of Asturias of Pliensbachian age. They represent relatively expanded and continuous successions of hemipelagic deposits and tempestites deposited in the outer area of a storm-dominated carbonate ramp (Bádenas *et al*., 2009). In order to analyze regional changes of composition and temperature of the marine waters in relation to the onset of Pliensbachian black shales in this area, we have examined in detail the Lower-Upper Pliensbachian transition (davoei to margaritatus ammonite Zones). To address this issue, high-resolution chemostratigraphic records of geochemical and isotopic parameters ($\delta^{13}C$, $\delta^{18}O$, Mg/Ca ratios) have been performed in well-preserved belemnite rostra. Oxygen and carbon stable isotope values from well- preserved specimens throughout the succession reveal significant negative $\delta^{18}O$ and positive $\delta^{13}C$ excursions related to the black-shale development within the margaritatus Zone. The running average values for $\delta^{18}O$ vary from –0.6 ‰ in the davoei Zone to –2.4 ‰ in the margaritatus Zone. The $\delta^{13}C$ mean values show a positive trend from –0.4 ‰ in the davoei Zone to +1.4 ‰ in the margaritatus Zone. The Mg/Ca data are consistent with relatively low and constant seawater temperatures before the development of the black-shales (minimum mean value of 8.7 mmol/mol), and experienced a prominent warming (maximum mean value of 16.6 mmol/mol) directly linked with the onset of black shale deposition. The records show an excellent negative correlation between $\delta^{18}O$ and Mg/Ca ratios (r = –0.94). This good inverse correlation supports the notion that these belemnite calcites are recording real paleotemperature signals. Combination of these records with other published regional isotope and sedimentary data (Aurell *et al*., 2003; Rosales, *et al*., 2004) indicates that the termination of these black shales is associated with a progressive cooling and sea-level fall, which culminate in the spinatum Zone. Cooler conditions could be the effect of inverse greenhouse conditions as a result of the drawdown of CO2 due to organic matter burial in the oceanic basins during this anoxic episode. In conclusion, the obtain data provide relevant information about the existence of paleoclimatic and paleoenvironmental changes related to the development of organic facies during the Lower-Upper Pliensbachian transition in Asturias. The data are consistent with warming of seawater during regional anoxia and deposition of black shales (margaritatus Zone), followed by a cooling phase and sea-level fall (spinatum Zone) after black-shale deposition. These paleoenvironmental events may be associated to global climate changes and should be considered in future research of Jurassic OAEs.

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Pre-avulsion levee and post-avulsion channel evolution: Niger Delta Continental Slope

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Channel avulsion is fundamental in defining submarine fan morphology, yet as a process is poorly understood. The post-avulsion evolution of five channel-levee systems, documented from both the shallow subsurface and the seafloor, is marked in the early stages by relatively wide axial channel belts containing sinuous channel elements. The axial channel belt in each system narrowed through time in association with levee aggradation, which resulted in increased channel confinement. Of the five systems studied, four avulsed from a radial avulsion node at the mouth of the basin feeder-channel complex. Only one avulsion occurred at an avulsion node downflow of the mouth of the feeder-channel complex associated with a rapid change in channel-levee system orientation. The degree of channel instability in three of the four systems prior to an avulsion event was increased by channel-floor aggradation, caused by the back-filling of turbidity current deposits. Channel-floor aggradation reduced the confinement relief, the distance between the channel floor and the levee crest, of the systems, thereby increasing the probability of avulsion during an outsized flow event. The back-filled deposits in the channel belts display relatively high seismic-reflection amplitudes inferred to be coarser-grained (more sand-rich) than their surroundings, i.e., out-of-channel deposits. Overbank cyclic steps are exceptionally well preserved on subsurface levees and their potential role in promoting an avulsion event is considered. Whilst outsized flows are the likely trigger of avulsion, depending on the degree of confinement relief in the channel, multiple small flows could be responsible for levee breaching, resulting in avulsion. Here we consider the interaction of flow dynamics with the morphodynamics of the levee. Levees display an increase in taper with a diminishing rate prior to abandonment (updip avulsion). This evolution of levee morphology is modeled using an advection-settling scheme which produces estimates for the vertical sediment concentration profile, mean current velocity, and current thickness. These results are then used to interpret flow conditions prior to avulsion.

Stratal architecture of highly-confined and poorly-confined deep-marine sinuous channel systems – an outcrop perspective

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During the past decade, deep-water clastic depositional systems formed on and at the base of passive continental margins have become one of the most promising global exploration plays. Currently areas like west coast Africa, offshore Brazil, Gulf of Mexico, and the North Sea contribute about 20-30% of global petroleum production, and all from reservoirs hosted in deep-water turbidite systems. Much of this resource is contained with channelized systems, but because of their great depth of burial and a relatively impoverished, but steadily growing database in the ancient (outcrop) geological record, knowledge of their composite stratal architecture is still poorly known. In rocks of the Neoproterozoic Windermere Supergroup (WSG), and particularly at the Castle Creek study area, a collection of geologically fortuitous conditions (2.5 km thick x up to 8 km wide, vertically dipping, recently deglaciated strata) have superbly exposed a succession of two end-member kinds of (deep-marine) base-of-slope sinuous channel fills – poorly-confined and highly confined. In both poorly- and highly-confined channel systems coarse-grained channel deposits are flanked on both sides by levee deposits, however the make-up of these latter deposits are starkly different. In poorly- confined channels, the outer levee, at least in its proximal reaches (<400 m from channel margin) tends to be sand rich, and was constructed by flow overspill and inertial run-up. The contact between coarser-grained channel deposits and sandy levee strata is erosive. On the inner-bend side, by contrast, channel strata grade laterally into finer, thinner levee deposits, suggesting continuity of the flows that deposited in the channel and over the inner-bend levee. In highly-confined channels the outer bend is similarly erosive, but everywhere in contact with fine- grained levee deposits (thin-bedded turbidites) related to an older (underlying) channel. Sandstone injection complexes are locally well developed. On the inner-bend side of the channel, a distinctive obliquely- upward interfingering pattern of coarse-grained channel deposits terminating abruptly where they onlap fine-grained levee deposits is observed. This intercalation suggests episodes of fine- and coarse- grained sediment deposition on the inner-bend levee related to recurring variations in local flow and/or channel conditions. Many of the differences in stratal architecture between highly- and poorly-confined deep-marine channels is interpreted to be related to differences in structure of the channelized turbidity currents, specifically the degree of (vertical) density stratification. In the case of highly confined channels, throughgoing channel flows were highly stratified, which is manifest in the abrupt lateral and vertical facies changes, particularly in the upper part of the channel fill. The more gradational facies changes observed in poorly confined channels reflect the more subdued nature of the vertical density gradient. Such density stratification also controls the position of the flow velocity core, which in the case of unconfined channels lies above or close to the top of the channel-bounding levee, but in confined channels lies at all time below them. Fundamentally, these differences in flow structure are controlled by changes in sediment supply from the up-dip sediment staging area. Moreover, unconfined systems appear to form preferentially during lowstand and into the early transgressive systems tract whereas highly confined form mostly during the late transgressive and/or highstand systems tract.

High frequency cycles in tectonically modified areas. Lower to Middle Jurassic river and tide dominated deltaic systems, Neuquén basin, Argentina

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The Neuquén Basin is a retroarc basin located in the southwestern convergent margin of the South American continental plate. The subsidence of the basin, under a complex arrangement of basement terranes, had a particular behaviour in different regions, especially during the first marine incursion in Upper Triassic to Lower Jurassic times. The southern section of the basin is associated with the "Patagonia Terrane" (Mosquera and Ramos, 2005) that was accreted from south to north with a southwest-northeast dominant fabric, at Permian Times. The studied area located in the southern margin of the Neuquen Embayment is characterized by the presence of a large (300 km), complex, and tectonically active positive lineament known as "Dorsal de Neuquén". Its morpho-structural and sedimentary behavior is strongly inherited from the basement fabric and was conditioned during the complete history of the area. The Picun Leufú Anticline is the westernmost part of this structure where are exposed an extensive river and tide dominated Lower to Middle Jurassic system that lithostratigraphically comprises the Los Molles and Lajas formations. Based on the hierarchical classification methodology proposed and developed by Catuneanu (2006) and Gabaglia *et al.* (2006) two third order and five fourth order stratigraphic sequences were recognized in the Lajas Formation. Synsedimentary tectonics recognized by Freije *et al.* (2001) in third order cycles for Lower to Middle Jurassic times also produces interference in high frequence cycles and it is identified (in fourth order), according to the observations made by the authors, by the following criterias: 1- subtle changes in dip, 2- abrupt shifts of facies and 3- abnormal presence of thick fine deposits. The areal extension of the three and fourth order sequences was estimated based on analogies with 3-D seismic information complementing the 2-D outcrops observations. The use of this methodology allows the creation of more realistic subsurface geological models using analogies obtained from surface exposures.

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Textural recognition by Transmission Electron Microscopy of detrital origin for clay-sized material from anquizone-grade rocks in low-grade diagenetic marls (Basque-Cantabrian Basin, Spain)

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The discrimination between detrital and authigenic origin of clay mineral phases that coexist in a rock is fundamental for a correct interpretation of diagenetic grade, and, in particular, the hydrocarbon potential in the basin. A textural study of the clay mineralogy of marly samples using TEM has been carried out to investigate diagenetic evolution of the Upper Cretaceous materials from the Alava Block (Basque Cantabrian Basin). These materials are especially suitable for studies of diagenetic prograde transformations due to the exceptionally thick sequence of sediments (more than 4000 m), homogeneity of lithologies and no major tectonic overprint. The investigations have been focused in the textural characteristics, origin and provenance of some detrital phases from anquizone-grade clastic rocks. This study complements the previous research about the layer charge characteristics of the I/S mixed layer expandable component using n-alkylammonium method (Arroyo *et al.*, 2006) and the diagenetic microtextural changes observed in the samples by TEM (Arroyo *et al.*, 2007). Specimens have been prepared with L.R. White resin following the procedure of Kim *et al.* (1995) to avoid complete collapse of smectite-like interlayers in the vacuum. Identification of mineral phases was based on SAED patterns, lattice fringe images and microanalyses. TEM images show that marls are composed of large calcite and quartz crystals (>2µm) with the phyllosilicates randomly distributed throughout the matrix. The same heterogeneous clay mineral suite previously identified by XRD studies was recognized in lattice fringe images: smectite, R1 and R≥3 order illite/smectite mixed-layer, micas, kaolinite, chlorite and chlorite/smectite mixed-layer. TEM research has allowed us to distinguish various chemical varieties of micas: discrete illite, muscovite and Na-K mica. Illite packets (5-15 layers thick) have been observed in all the studied samples. They coexist with Na-K mica crystals and chlorite-mica stacks showing evident textural characteristics of a detrital origin. All of them are typical materials from very-low grade rocks and a Na-K mica grain wrap up a quartz crystal, showing that they were sedimented as detrital material. Therefore, a source area with anquizone-grade clastic rocks supplied all these typically incipient metamorphic materials. The possible authigenic origin of illite packets as a deep diagenetic product can be discarded. The correct identification of these phases as non-neoformed material is very important to avoid their misinterpretation as phases indicative of a more mature stadium in the smectite to illite diagenetic transformation.

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Subglacial landforms, sedimentary facies and paleo-ice flow in the Permocarboniferous San Gregorio Formation, Chacoparanense Basin, Uruguay

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A very well-exposed glacial surface sculptured on Precambrian crystalline rocks occurs below the glacial succession of the San Gregorio Formation in the eastern border of Chacoparanense basin in Uruguay (Estancia Las Moras – ruta 7). Remarkable is the presence many NNW/SSE asymmetric streamlined bedrock features (10-30m long, 5-10m wide and 1-3m height), interpreted as whalebacks because all sides are abraded surfaces, lacking the typical plucked (quarried) side that characterize moutonnées. The gentle slope exhibit striated surfaces, sometimes polished, covered by a 10-100 cm thick layer of coarse-grained sandy tillites. The presence of these subglacial facies suggests glacial abrasion produced mainly by subglacial till sliding. Tillites themselves were ice-molded since flutes and grooves are present at their top. Flutes and grooves with amplitudes of up to 30cm are meso-scale streamlined features superimposed on larger whalebacks. Rippled sandstones can be found in some grooves revealing the presence of meltwater. The association of these features makes sense because the ice may well have slid over the whalebacks on a thin film of meltwater. The whaleback's gentle slopes face towards NNW pointing out to ice flow from SSE to NNW. This direction of ice movement is corroborated by striations preserved on gentle slopes and paleocurrents measured in associated rippled sandstones. Subglacial facies are overlain by fine-grained facies with dropstones indicating an association of grounded ice-sheet and subaqueous environment. Medium-grained sandstones end the deglaciation sequence in the studied area, showing the permanence of glaciers in the depositional setting. Soft-sediment striations oriented N25E, present in discontinuous and concave surfaces between sandstone beds, may be considered ice keel scour marks produced by floating ice. The occurrence has great importance in terms of paleoglaciological and paleogeographical reconstructions in the Southwestern Gondwana from Late Carboniferous to Early Permian. Ice paleoflow and meltwater paleocurrents are directed towards south Brazil where similar trends are observed in the glacial Itararé Group, portraying a geographic scenario in which an ice shelf advances northwards in a great marine embayment.

Stratigraphic switching in the Proto-Andean margin (western Argentina) during the late Paleozoic: implications for development of contrasted sedimentation and climates

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Analysis of the Paganzo basin in central and western Argentina (between 27º-32º SL) incorporating new stratigraphic, isotopic, provenance and structural data provides the basis for an integrated model of evolution for the southern Central Andes from Late Devonian to Late Permian. Tectonic switching in the Terra Australis peri-Gondwanan accretionary orogen can be related to the following sequence of events: 1) collision of Chilenia (~385 Ma), including the deformation of previously deposited Early Devonian foreland basin successions; 2) post-collisional Mississippian rifting (370-335 Ma) associated with slab break-off and back-stepping of subduction; 3) growth of an accretionary prism (~340-325 Ma), mainly recorded along the Chilean coast; 4) retroforeland basin development (~305-290 Ma) including a foredeep and a broken foreland with involvement of basement in deformation toward the craton; 5) strong compression in an Andean-type setting (San Rafael Orogeny) with I-type magmatism along the arc (along present Frontal Cordillera) and progressive shallowing of the subducting slab and sedimentary blanketing across a long-wavelength foreland (290-270 Ma); and 6) final slab break-off or crustal delamination (~260 Ma onwards) related to the Choiyoi magmatic province and grabens from the Cuyo-Ischigualasto basins. A chronologically constrained stratigraphic revision of the rifting stage predicts a strong asymmetry with an E-dipping detachment between two mayor coeval domains recognized within the Paganzo basin. In the western domain (WD: Cordillera Frontal and Western Precordillera) a thick succession of Mississippian continental to shallow-marine fossiliferous rocks is developed, but in the eastern domain (ED: Eastern Precordillera and Sierras Pampeanas) no Mississippian sedimentary record is preserved. Early Pennsylvanian (~325 Ma) glacial rocks form a marker horizon for both domains indicating a common history across the region. In the ED this event is preserved as deep "U" shaped valleys carved into basement on a regional peneplain surface; in the WD the rocks of this glacial horizon covers the thick Mississippian record. Provenance and paleocurrents indicate an eastern source for glaciation, and suggests the development of regional epeirogenesis triggering a mayor glaciated plateau. While the ED was being uplifted, rifting progressed in the WD and is recorded by massive alluvial-fan conglomerates associated with partly inverted normal faults giving way to shallow-marine strata. Magmatism accompanied asymmetric rifting after initial faulting and crustal thinning. This is indicated by bimodal volcanism along the WD and by A-type granites with mantle signature intruding the early Paleozoic basement rocks in the ED which is compatible with crustal asymmetric underplating. This extensional episode in the back-arc of the Gondwana margin was aborted sometime after subduction renewal to the west that initiated the Pennsylvanian foreland. The Mississippian rifting event appears to be related to an "extensional mode" within a largely convergent margin. Our model suggests that lithospheric extension in the aftermath of the Chilenia collision can explain sedimentary and magmatic distribution whithin a strong asymmetry inherited from basement fabric (east-dipping slab). Delay between Mississipian A-type and Pennsylvanian-to Early Permian I type and outboard migration of the site of magmatism is consistent with the suggested evolution. In our case-study in the Central Andes, tectonic switching processes can be closely matched with the climate signatures recorded in the stratigraphic evolution of the Gondwana margin and may considered as an independent factor distinct from global circulation patterns. Moreover, recurrent glacial activity, major glacial expansion and progressive aridization in the study area seem to relate to topographic barrier effects and climate restrictions that do not need to correlate with other regions in Gondwana.

Carbon and strontium isotopic variability across the Ediacaran Polanco Limestone Formation (Río de la Plata craton, Uruguay)

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Well preserved C- and Sr-isotope data obtained from marine carbonates can provide a detailed record of isotopic variation in seawater through time and have proven to be a valuable tool for correlating these isotopic changes worldwide. Negative carbon isotope excursions in the Polanco Limestone Formation, Uruguay, have been interpreted as recording post-Gaskiers glacial events in the Río de la Plata craton. However, the available evidence do not support this model and an alternative hypothesis is required. The record of both deep- and shallow-water settings in the Polanco Limestone Formation provides an opportunity to examine $\delta^{13}C$ variability across the platform (i.e. varying depositional depths) and evaluate whether the carbon isotope signatures are the result of processes intrinsic or extrinsic to the basin. High-resolution $\delta^{13}C$-chemostratigraphic profiles, Sr-isotopic data and trace-element composition, including REE+Y, are presented from stratigraphic sections comprising proximal and distal settings of the platform. Carbon isotopic values became slightly negative up section in deep facies (ranging from -2 to -3.5‰), whereas a transitional variation between deep- and shallow-water settings, with $\delta^{13}C$ values rising from -2.7‰ to +2.5‰, is recorded. Hence, the carbon isotopic data reveal a previously unrecognized increase trend, and a tentative scenario to invoke that the deposition of Polanco carbonates occurred across a stratified ocean basin in which $\delta^{13}C$ decreases significantly at depth. Furthermore, $^{87}Sr/^{86}Sr$ and $\delta^{13}C$ chemostratigraphy coupled with new radiometric data allowed a more precise age determination for the Polanco Limestone Formation. The comparison of the new strontium isotopic data with the strontium isotope age curve indicated to the Neoproterozoic suggests that the middle Polanco carbonates were deposited somewhere between 590 and 580 Ma. Given the available data, whether associated $\delta^{13}C$ variations were produced by glacially-related conditions or the dynamic of the basin itself remains unresolved.

Lacustrine sedimentary archives as complementary paleoseismological tools; a case study along the Boconó Fault, North-Western Venezuela

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As lacustrine sediments appear to represent reliable archives of earthquakes (in Beck, 2009) several high altitude lakes developed after the L.G.M in the Merida Andes (North-Western Venezuela) have been investigated. In this area, a significant part of the South-Caribbean active transform boundary is accommodated along the (seismogenic) Boconó Fault, which active traces crosscuts the sedimentary fill of these lakes. From detailed investigations based on field surveys (Los Zerpa paleolake) and coring (Mucubají lake) we could extract a 16 kyr paleo-environmental archive (Carrillo *et al.*, 2007). Detailed sedimentological investigations (textural parameters, mineralogy, organic matter) and AMS ^{14}C dating permitted to disentangle, at different scales, the influence of climatic modifications (rainfall and temperature), and the impact of seismic activity. Concerning the latter, we could separate major sedimentary abrupt changes related to direct co-seismic displacement across the lakes, from sedimentary disturbances (or specific deposits) associated to regional shaking and not necessarily to local displacement of the Boconó fault itself. Two active traces had been investigated through trenching (Audemard *et al.*, 1999, 2008) at less than 10 km from the lacustrine fills, and we could compare both series of results. One trench concerns the trace crossing the two investigated lake fills, the other, parallel, is located at 0.6 km from Lake Mucubají's northern shore. Taking into account the dating error intervals, we checked the coincidence of the different events respectively detected in the four situations. Older events (Late Glacial and pre-Late Glacial) are only present in Lake Mucubají's and the proposed comparison concerns the last 10 kyr (almost the entire Holocene). Possible correlations are the following: 13 events in two sites, 3 events in 3 sites (within a 24 events total); 9 correlations concern separate traces while 4 concern the same trace, may be indicating relays of rupturing. A possible hierarchy between events is discussed. Thus, we tentatively consider that this combination of surveys both reinforce and complete the trenches results, leading to a better assessment of local to regional seismic risk. Sedimentological observations better assess the co-seismic origin of a disturbance, and their dating may be more direct and precise (e.g. final settling of re- suspended organic particles). Reversely, their potential for recording is not constant through time.

These investigations are part of a wider general project concerning natural hazards assessments (earthquakes and related phenomena, debris flows) funded through FONACIT, CNRS-INSU, and an ECOS- Norte grant.

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A continuous transition from the Pampean into the Famatinian orogeny? Provenance implications from quartz and zircons of the Cambrian Mesón Group, NW Argentina

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Although quartz is the most common mineral in most sandstones, it usually is not considered in provenance studies. We use provenance information from both detrital quartz and zircon grains to infer source rocks and transport paths to the western Gondwana margin. The shallow-marine Cambrian Mesón Group in NW Argentina is mainly composed of sandstones. Due to weathering, sorting and diagenesis, the sandstones are mineralogically and chemically mature, with > 90 % quartz, < 10 % feldspar and < 2 % rock fragments in the framework as well as with Th/Sc ≥ 1.8 and Zr/Sc > 30. In provenance research, such compositions often are taken as evidence for input of large amounts of recycled detritus transported from the interior of a craton into a depositional basin, which was situated along a passive continental margin. For the Mesón Group, such an assumption is in disagreement with provenance information from detrital quartz and zircon grains presented here. In the Mesón Group sandstones, cathodoluminescence (CL) colour wavelength spectra of quartz are typical for red, violet and bright blue luminescent quartz. Zircons mainly are oscillatorilly zoned. The quartz colours and zircon zoning point to a dominance of magmatic source rocks. In the stratigraphically oldest unit (Lizoite Fm.), volcanic quartz grains are common (> 30 %; red and violet luminescent). In addition, ca. 40 % of the zircon grains are euhedral and yield U-Pb ages of 510-600 Ma. These ages correlate with ages of exposed magmatic rocks proximal to the depositional basin. Input from local and regional igneous complexes, as well as from the Sierras Pampeanas in northwest and central Argentina suggests direct detrital transport paths of 100-1000 km. The geographic position of the source areas suggests main transport in marine currents within the Mesón Group basin itself. The short transport, the low degree of abrasion and a dominance of zircons formed during one single growth stage suggest that the arenites may represent first-cycle sand. In the stratigraphically upper parts (Campanario and Chalhualmayoc fms.), the majority of quartz grains are of plutonic origin, whereas few are volcanic. Here, subangular to subrounded zircon grains of 550-700 Ma age are dominant. The abrasion, ages and origin of quartz and zircon grains indicate a stronger influence of reworking and more far-travelled detritus than for the older sandstones. The material partly can be traced to igneous rocks that are exposed in the Sierras Pampeanas. Considering the detrital zircon ages, presently unexposed or eroded rocks around the depositional basin may have contributed further detritus. Alternatively, the Goiás Massif of the Brasília belt in central Brazil may have been an important source area. In that case, the additional presence of Transamazonian-aged grains (ca. 2 Ga) suggests that the zircons passed the Río de la Plata Craton. A higher degree of roundness and multiple growth zones in zircon grains with inherited Transamazonian age suggest that these arenites represent multi-cycle sand. Detrital zircon U-Pb ages from the Mesón Group (and depositional ages of the underlying Ediacaran to Lower Cambrian Puncoviscana Fm. and the overlying Upper Cambrian to Ordovician Santa Victoria Group) are in accordance with a mainly Upper Cambrian age of the sandstones. This is younger than the assumed cessation of the Pampean Orogeny and older or similar to most estimates of the onset of subduction related to the Famatinian Orogeny along the west Gondwana margin. The initially high input of volcanic detritus may mirror initial Famatinian volcanic activity. We assume most of the volcanic detritus to be nearly syn-sedimentary, as reflected in the zircon ages. Therefore, the quartz and zircon data from the Mesón Group provide the first indications of a Cambrian magmatic arc in northwesternmost Argentina related to the Famatinian Orogeny. Magmatic bodies of this arc are not exposed or have not yet been identified.

The use of cathodoluminescence colours of quartz in provenance research revisited

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Quartz is the most common mineral in sandstones. In spite of this, it is rarely used in provenance studies. We have established a provenance scheme for cathodoluminescence (CL) colour wavelength spectra of quartz. CL light is produced when quartz is bombarded with electrons. This causes electrons in the quartz to jump between different energy levels if lattice defects occur. Due to the kind and frequency of defects, CL spectra of quartz from volcanic, plutonic and metamorphic rocks are significantly different. This has been known for decades, but is now viewed with scepticism by many researchers. Therefore, the use of CL colours of quartz to reveal source rock types of sediments is worth more attention. For this study, we analysed > 1000 quartz crystals in > 50 samples from different magmatic and metamorphic rocks of varying age and from different tectonic settings to determine their typical CL colour wavelength spectra. CL spectra were measured to avoid the subjective optical colour identification. We used identical operative settings for all measurements (10 kV, 3.5-4.0 µm at the sample, 50 s. analytic time) and tested the results for colour changes during the analysis. With the settings used, no changes in the CL spectral shapes were observed. The measurements prove that volcanic quartz luminesces in red and violet, and plutonic quartz usually have blue CL colour shades. A metamorphic overprint mostly leads to an alteration of the original CL colour into brown or dark blue. CL spectra of quartz usually are dominated by two emission bands. These are situated in the blue and red wavelength intervals (apparent peak positions at ca. 470-490 nm and 600-640 nm). The peak intensities vary with CL colour. For example, bright blue (plutonic) quartz is dominated by the emission band in the blue colour interval and red (volcanic) quartz has a higher peak in the red interval. This difference causes variations in two easily measurable parameters. (1) The apparent wavelength positions of the peaks vary slightly with CL colour. This is accentuated by a larger variation in the position of the trough between the two peaks. Therefore, the variation is most distinct when the apparent peak position is compared to the position of the trough, here called “relative peak position”. Accordingly, the bright CL colours of volcanic and plutonic quartz (red, violet, bright blue) have lower relative peak positions (ca. < 0.9 for the blue peak and < 1.15 for the red peak), than have the darker CL colours of metamorphic quartz (dark blue, brown). (2) Also the relative heights of the peaks vary, here defined as the peak intensity compared to the intensity in the trough. This is a better measurement of the peak intensity than the absolute height of the peaks, because the shape of a spectrum, rather than the absolute intensities of the peaks, causes the different CL colours. The relative peak heights for plutonic quartz (bright blue; > 1.5 and < 1.5 for the peaks in the blue and red wavelength interval, respectively) can be discriminated from both volcanic (red and violet; > 1.5 for both peaks) and metamorphic quartz (brown and dark blue; < 1.5 and > 1, respectively). Hence, the criterion, which is most useful for provenance discriminations, is the relative intensity of the peaks. So far, some studies already use the above presented scheme for CL colours of quartz. They successfully discriminate between source areas dominated by different rock types. It is also evident that provenance-indicative data from quartz are in accordance with roundness and U-Pb data of detrital zircon grains. This has been shown for sandstones of the Cambrian Mesón Group in NW Argentina, a study which also will be presented at this congress. Finally, we conclude that the measurement of CL colour wavelength spectra of detrital quartz is a fast and straightforward method to determine quartz-bearing source rocks of sandstones.

Provenance analysis of Paleogene sandstones from the northwestern Maracaibo Block: the link between local drainages and tectonic events

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Paleogene sedimentary environments in northern South America are marked by the transition from marine to continental environments and the formation of several sin-orogenic basins. A multi-proxy sandstone provenance analysis was carried out on Paleogene sandstones along five sub-basins within the Maracaibo block in northeastern Colombia and western Venezuela, in order to trace the relationship between sandstone compositional shifts, drainage patterns, orogenic uplift and Caribbean-South American plate tectonic interactions. Upper Cretaceous sandstones are mainly quartz-rich. U-Pb detrital zircon geochronology shows predominantly Meso and Paleoproterozoic ages. Considerable and variable diachronous changes occur during Paleogene in studied sub-basins. Lower Paleocene sandstones are sublitharenites to quartz-arenites in the northern basins and feldespatic litharenites in the southern ones. Grain size is very fine to fine. Middle Paleocene sandstones are coarser (medium grained) and composed mainly by sublitharenites in all sub- basins. U-Pb detrital zircon geochronology shows predominantly Proterozoic ages (similar to Upper Cretaceous sandstones) but older ages (Paleoproterozoic) are less abundant. Upper Paleocene units are characterized by major changes in stratigraphic thickness between sub-basins and include feldespatic litharenites, mainly with low-grade metamorphic and volcanic fragments. Sandstones are mainly fine-grained. Detrital zircons show Cretaceous- Paleocene, Jurassic and Permo-Triassic ages, with minor Proterozoic signature. Lower to Middle Eocene sandstones are medium to coarse grained and have higher quartz and sedimentary fragments content when compares with metamorphic fragments. Detrital zircon patterns changes towards a mixing between Proterozoic and younger ages. Eocene rocks lie unconformable over Late Paleocene rocks in most studied areas. Similarities in the Early-Mid Paleocene sandstones and the distribution of siliciclastic and carbonate facies suggest the existence of a main river system draining from the south, and a single regional basin involving all studied sub-basins. Major changes in Late Paleocene sandstones provenance suggest the existence of a main orogenic event, with local variations between sub-basins related to the uplift of proximal massifs and the segmentation of in several sub-basins, with the former broader river system only surviving at the southeast. Whereas the Early Paleocene record can be related to oblique Caribbean-South America collision, subsequent Late Paleocene to Early Eocene provenance record with contemporaneous sin-depositional magmatism may be link to a new subduction setting and associated block uplifting with associated tilting.

Animal-sediment relationships and neoichnological distributions across the delta front and prodelta of the asymmetrical, tide-influenced Fraser Delta, Canada

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Distinct ichnological and sedimentological characteristics define the updrift and downdrift delta front and prodelta of the tidally influenced Fraser River Delta, Canada. Net sediment transport is to the north, where the main channel divides the updrift and downdrift sides of the delta. Across the delta front and prodelta, seventeen cores (up to 12 m in length) were acquired and x-radiographs were taken. Sediments deposited on the delta front, downdrift of the main channel, are mud-rich with a low diversity of traces (BI 0-3). In contrast, sediments on the updrift delta front grade seaward from sand in the upper delta front into heterolithic beds in the lower reaches. There is a high diversity of burrowing in these sediments (BI 4-6). The prodelta is sedimentologically and ichnologically similar on both sides of the main channel. Mud-rich sediments with a high diversity of traces (BI 4-6) characterize these deposits. Grab samples were also collected from the delta front and prodelta, enabling correlation of infauna with traces observed in the sediment cores. Distinct traces are correlated to the burrowing behaviours of holothurians, spatangoid echinoids, bivalves, polychaetes and nemerteans. Holothurians and bivalves produce large, vertical burrows that may or may not have re-equilibration spreite below their living chambers. Holothurians produce *Skolithos*-like traces, and bivalve structures are best described as *Siphonichnus*. Spatangoid echinoids produce horizontal, backfilled structures including *Laminites* and *Scolicia*. Nemerteans and some polychaetes construct simple vertical and horizontal burrows with similar morphologies to *Skolithos* and *Planolites*. Other polychaete species are noted to produce *Cylindrichnus* and *Thalassinoides*-like traces. Infauna diversity is high on the updrift delta front, where traces attributable to all of the above infaunal organisms were recognized. The trace suite is robust, and includes: *Asterosoma, Cylindrichnus, Laminites, Planolites, Rosselia, Siphonichnus, Skolithos* and *Thalassinoides.* In contrast, on the downdrift delta front, only spatangoid echinoids and polychaetes were recovered. The trace assemblage preserved on the downdrift delta front is a mixture of simple horizontal and vertical traces, dominated by *Skolithos, Planolites* and *Laminites.* The prodelta on both the updrift and downdrift sides of the main channel exhibit a high diversity of traces, and an assemblage similar to that of the updrift delta front. The distinct sedimentological and ichnological characteristics of the updrift and downdrift delta front reflect the asymmetry in tidal flow across the delta. Given that this asymmetry is tidally derived, the Fraser River Delta provides a modern analog for tidally asymmetrical deltas.

Do bedforms in mixed sand and mud record flow history?

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The majority of sediment on Earth consists of mixtures of cohesive clay and cohesionless sand and silt, but our knowledge of sedimentary bedforms within such deposits is poor. The results of flume experiments on mixed-sediment bedform development from flat bed conditions will be presented. The experiments compared the effect on bedform development of cohesive forces in the substrate and within the overlying flow. For this purpose, one series of experiments simulated waxing-to-steady flows over substrates with different sand-mud ratios, while another series of experiments simulated waning-to-steady flows, in which bedforms were generated after rapid deposition of mixed sediment from these flows. The main input variable for both series of experiments was the ratio of cohesive to non-cohesive sediment, thus simulating differences in cohesive strength of flow and sediment bed. The experimental results showed that the growth rate, equilibrium size, morphology and internal stratification of bedforms are highly dependent on the flow history. In the waning-to-steady flows, where cohesive forces in the flow dominated dynamic bed changes, the size of the bedforms increased with increasing clay concentration. In contrast, bedform size decreased with increasing clay concentration in the waxing-to-steady flows, where cohesive bed forces were dominant. Winnowing of clay from the bed during bedform development was important in both series of experiments, but this process was more efficient when cohesive bed forces dominated bedform development. Diagnostic sedimentary structures for the range of boundary conditions investigated in this study will be discussed with the aim to define criteria for the process-based interpretation of natural, mixed-sediment bedforms.

Experimental research on wave ripples in mixed cohesive sediment

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Wave tank experiments were conducted to determine how the size of wave ripples changes as a function of yield strength in mixtures of non- cohesive sand and cohesive clay. These experiments focussed on cm- scale rolling-grain and vortex ripples at constant maximum orbital velocity, but increasing clay-to-sand ratio of the bed sediment. The results showed that the first appearance of wave ripples on a flat bed is delayed progressively longer as the clay-to-sand ratio is increased, and above a threshold clay-to-sand ratio wave ripples are entirely absent after a period of 2 hours. However, in the experiments where the wave ripples were able to reach equilibrium size, their height and length were independent of the clay-to-sand ratio in the sediment bed. This is in contrast to current ripples in mixed cohesive sediment, which were found to decrease in size with increasing clay-to-sand ratio. It is inferred that this difference is caused by a more efficient clay winnowing process for the wave case, leading to bed segregation into sandy bedforms "floating" on original, unaffected mixed sediment. The size of the sediment within the winnowed bedforms was similar to that of the wave ripples formed in a clay-free control experiment, thus explaining the equilibrium ripple size similarity. The implications of the laboratory research for wave-generated bedform size predictors and sedimentary facies in wave-dominated environments will be discussed.

Non-magnetic indicators of pedogenesis related to loess magnetic enhancement and depletion from two contrasting loess-paleosol sections of Czech Republic and southern Siberia during the last glacial-interglacial cycle

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We searched for non-magnetic proxies of the intensity of pedogenesis in loess/paleosol sections from two different climate settings, Dolní Vìstonice, Central Europe, and Krasnogorskoye, southern Siberia. The work was performed to overcome the problem of two opposite scenarios of magnetic susceptibility (MS) patterns in these two profiles, the "Chinese" model with magnetically enhanced paleosols and the “Siberian/Alaskan” model with magnetically depleted paleosols. Age constraints of the Krasnogorskoye section were inferred from independent correlation with the well-dated Dolní Vìstonice section, based on MS and sediment colour (CIE L*), and with the MS log from the Lake Baikal. Pedologic description of the loess/paleosol sections and their correlation potential was considerably improved by using Vis spectral proxies (CIE L*, reflectance in the red band) while their weathering intensity can be effectively characterised by diffuse reflectance spectroscopy (DRS) and geochemical (CEC and Rb/Ca) proxies. While the MS is strongly dependent on the type of soil (chernozems vs. brown soils) the geochemical proxies, in particular CEC, proved to be relatively independent on the soil type. These parameters are less affected by region-specific conditions than the MS signal. Even the non-magnetic proxies indicate relatively dissimilar climatic trends for the two sites during the last glacial-interglacial cycle. A long-distance correlation, based solely on the MS signal, can be adversely affected by switching between the Chinese and the Siberian/Alaskan magnetic modes, which was observed at the Krasnogorskoye section. In general, no single universal proxy of weathering or pedogenesis intensity exists, which would be applicable across wide regions or across considerable climatic gradients. Palaeoclimatologic interpretations across wide regions should always be based on a carefully designed, multi-proxy approach.

Outcrop gamma-ray logging related to modal composition of sandstones: case studies from foreland-basin turbidite systems of the Grés d´Annot, France and Moravice Formation, Czech Republic

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Outcrop/wire-line spectral gamma-ray (GRS) logging has been established as a suitable stratigraphic technique for long-distance correlation and sequence-stratigraphy. The GRS signal (concentrations of K, U and Th) is usually related to facies (net-to-gross ratio, carbonate-shale ratio) but it can be considerably influenced by modal composition of the rock (heavy minerals, clay minerals, micas, K-feldspars). Variation in modal composition of sandstones may therefore indicate changes in siliciclastic provenance, which, in turn may impair possible interpretation of facies from wire-line data. We studied facies, modal composition (point-counting, CL microscopy and XR diffraction analysis), mineral and bulk-rock chemistry (electron microprobe analysis, XR fluorescence analysis) and GRS concentrations of K, U and Th (both field and laboratory) in sandstones and mudstones of two foreland-basin turbidite systems: Grés d´Annot, France (Eocene-Oligocene) and Moravice Formation, Czech Republic (Lower Carboniferous). The aim was to filter out provenance-related GRS signal from transport/facies-related GRS data. In Grés d´Annot, which has relatively uniform source throughout the stratigraphy, we traced the GRS signal in proximal-to-distal section from channel facies (St. Antonin section, Annot composite section) through to channel-lobe transition (Chalufy and Grand Coyer sections). The K, U and Th data are strongly dependent on facies and there is a distinct proximal-to-distal trend. However, variation in K/Th and U/Th ratios between individual sections indicate that this trend is rather complex, related partly to the net-to-gross ratio, hydraulic sorting of heavy minerals and partly to clast composition of conglomerates. In contrast, there is a distinct compositional trend in the Moravice Formation, which indicates decreasing contribution from volcanic/low-grade metamorphic sources in favour of increasing supply from plutonic/high-grade metamorphic sources up-section due to unroofing of deep crustal parts in the source area. The modal composition of sandstones suggests recycled-orogene geotectonic provenance. The GRS signal is strongly dependent on facies (mainly grain size), but there are visible positive shifts in K and Th concentrations in thick-bedded, coarse-grained sandstone facies at several stratigraphic levels, which coincide with shifts from quartzolithic to quartzofeldspathic and quartzofeldspatholithic sandstones. Similar shifts were observed in mudstones. They are interpreted as switching between sediment sources. Interpretation of GRS data in siliciclastics clearly requires detailed knowledge of facies and sediment composition. However, once this is done, the rapid acquisition of GRS data and their statistical processing may significantly contribute to the knowledge of sediment dispersal patterns in the basin.

High-frequency cycles in hemipelagic successions driven by climatic changes: evidences from facies and stable isotope analysis (Pliensbachian, North Spain)

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The Lower Jurassic succession of Asturias (northern Spain) was deposited in an epicontinental platform developed westwards to the Basque-Cantabrian Basin, a seaway that connected the Boreal and Tethys oceans throughout the Jurassic. Hemipelagic Pliensbachian successions were studied in two logs (PV and PL), separated 20 km apart along the Asturias coastline. They are characterized by the presence of decimetric-scale elementary cycles that do not match with the marl-limestone profile (Bádenas *et al.*, 2009). These elementary cycles were formed from rapid deposition during several storm episodes (bioclastic facies) followed by periods of pelagic sedimentation combined with dilute suspended clouds lofted by successive storm-density currents (laminated facies). This laminated sediment could be later colonized by infaune being partly to completely bioturbated (bioturbated facies). The elementary cycles are arranged in 9 decimetre to metre-thick bundles including an average of 4.3 elementary cycles in PL log and 3.7 in PV log. The lower interval of bundles shows decreasing bioturbation and frequent and thicker laminated facies up to a middle interval characterized by scarce traces of medium and small Chondrites. The upper interval has high diversity of traces and/or intensely bioturbated intervals. There are significant lateral facies changes between the relatively shallow to deep outer carbonate ramp domain represented by the PV and PL logs, respectively. The lower interval of bundles with decreasing bioturbation is characterized in the deeper PL log by cycles with thicker laminated facies. Isotopic data obtained from well-preserved belemnite specimens (PL log) reveals the existence of different isotopic trend across the bundles, depending on the facies in which the belemnites were collected. In particular, the isotopic evolution obtained from the specimens included in the laminated facies, shows negative $\delta^{18}O$ excursions across the lower interval of each bundle, with overall trend toward more negative values up to a minimum in the middle laminated interval. The origin of the bundles is explained by cyclic variation of shallow carbonate production and resedimentation to the hemipelagic domain by the storm-density currents. Sea level changes, affecting the carbonate production, could have been controlled by climatic variations, as indicated by the existence of negative $\delta^{18}O$ excursions across the lower interval of the bundles. The average duration of the 9 bundles, developed at the upper part of the ibex Zone and during most of the davoei Zone, points towards climatic cycles driven by the short-eccentricity orbital cycles.

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A comparative analysis between the Iberian carbonate ramp and the Swiss Jura platform (Kimmeridgian-Tithonian): key factors for facies and high-frequency sequence development

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During the Late Jurassic, the Western Tethys was characterized by shallow epicontinental seas that covered extensive areas. Both the Jura platform and the Iberian carbonate ramp developed on its northern margin being situated some 1200 km apart. Over the last decade, these two areas were subject to detailed studies that led to a high degree of understanding of development of facies patterns and high-frequency sequence architecture in each area. This unique data set offers the opportunity to compare two shallow marine carbonate-dominated depositional systems that have significant differences on their overall geometry and distribution of facies belts. The slightly sloping Jura platform developed around the emerged areas of an island archipelago and was bounded by more or less continuous bioclastic and oolitic sand barriers, with widely developed tidal flats and lagoons in the interior platform areas. The Iberian platform, in contrast, was a low-angle carbonate ramp system dominated by tropical storms, with a well-developed high-energy oolitic, oncolitic, or peloidal facies shallow belt, and only a limited extent of the lagoonal and peritidal facies. Comparative analysis between these two time-equivalent (Kimmeridgian–Tithonian) shallow marine carbonate-dominated depositional systems has proven useful for filtering out local versus regional effects. The presented long-distance correlation is based on a sequence-stratigraphic, biostratigraphic and chemostratigraphic framework. The detailed analysis of facies indicates that the shallow areas of the Iberian carbonate ramp saw a significant change at the Kimmeridgian-Tithonian transition, from oolitic shoal and coral reef facies belt development to the widespread presence of oncolitic rudstones in the Lower Tithonian. At the same time, the Swiss and French Jura platform also experienced a major change-over in sedimentary architecture as the thick-bedded, lagoonal deposits of the Upper Kimmeridgian were replaced by Lower Tithonian tidalites. Moreover, this shift is usually marked by a characteristic marly interval (upper virgula marls) on the Jura platform that can be correlated over large distances. At that time, climatic conditions between Spain and France were probably different. The interaction between internal and external controls on facies distribution and hence the generation of high-frequency stratigraphic sequences is discussed, specifically against a background of palaeoclimatic change and regional tectonic events. The sequence-stratrigraphic framework supports the development of a widespread discontinuity recorded in both the Jura and Iberian platforms at the onset of the Late Kimmeridgian and at the end of the Early Tithonian. The number of high-frequency cycles recorded on both platforms is similar within the study window of 2.7 Myr duration, but not exactly identical. Medium- and small-scale sequences were mainly controlled by sea-level changes formed in tune with the long and short-term eccentricity orbital cycles, respectively. The contrasting number of high-frequency sequences preserved around the Kimmeridgian/Tithonian boundary in both areas is likely to reflect a regional tectonic event that affected the Jura and the Iberian platforms differently. Our comparative analysis also shows how shallow-water carbonate platform systems may react differently to similar palaeoclimatic or tectonic events depending on their sensitivity in recording environmental change. This can be a handicap when aiming for high-resolution correlations over long distances.

Low-temperature zircon growth related to hydrothermal alteration of ironstone concretions in Lower Carboniferous shales, Scotland

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Zircon growth at relatively low temperature is well documented in the literature. It is, for example, widespread during low-grade (prehnite- pumpellyite and greenschist facies) regional metamorphism, with growth commencing at temperatures of ~250°C. Hay and Dempster (2009) have argued from the presence of dissolution features and outgrowths on the margins of detrital zircon in clastic metasedimentary rocks that zircon can crystallize at temperatures as low as 100°C. Here we describe low- temperature zircon growth in siderite concretions, the first record, we believe, of such an occurrence. Ironstone (mainly sideritic) concretions occur in the Lower Carboniferous Wardie Shales, which crop out north of Edinburgh (Scotland). The shales were deposited in a large freshwater or brackish water lake. Siderite precipitation was induced by the degradation of fish remains, which are preserved in the centers of the concretions. Authigenic zircon has been found in the center of one concretion as tiny veinlets and separated nests. The veinlets cut through phosphate fish remains and do not propagate near the rim of the concretion. Zircon is one of the last phases to form in the veinlets predating or contemporary with kaolinite. Veinlets are up to 10 μm thick and usually a few hundred μm long. They are filled with zircon as either a solid or porous phase. Nests are usually porous. HR SEM images reveal the detailed structure of the phase. Porous zircon displays ovate and spherical shapes composed of small (usually below 500 nm long) elongated "crystals" with fairly well developed faces. Vitrinite reflectance examination shows that organic matter from the concretion containing zircon and the surrounding shales has been matured at temperature between c. 200 and 230°C. This temperature is significantly higher than paleotemperatures calculated from stable O isotope compositions of the concretionary siderite, which are between c. 30 and 60°C. This suggests that the concretion grew under moderate temperature burial conditions, but was subsequently affected by much higher temperatures. Organic matter from siderite concretions and shales from outcrops situated several hundred meters away, showed much lower maturity (c. 70-90°C). Therefore, we suggest that the source of the heat which affected the zircon-bearing concretion could not have been deep burial, because that would have promoted more pervasive metamorphism. Instead, the temperature increase was a local phenomenon. Thin dolerite sills occur in the section where the concretion with zircon was collected and are the most probable heat source. Biomarker analysis reveals di- tetra- and hexahydro- products of polycyclic aromatic hydrocarbons (PAHs) in the highly mature samples. These compounds do not occur in typical sedimentary organic matter but can form in high temperature aqueous media (McCollom *et al.*, 1999). The presence of high amounts of these compounds in the zircon- bearing concretion suggests unique conditions where hydrothermal fluids played a crucial role. Thus, localized precipitation of authigenic zircon occurred under "normal" diagenetic conditions related to moderate depths of burial.

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Rockfalls risk reduction and redesign of rock slopes using rockfall program

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Constructing mountain roads in harsh terrains is a challenge to the engineering and the development of south-western Saudi Arabia. As this part of the country is characterized by high-rising and steep slope rock masses, it is full of terrain and engineering problems. Al-Baha mountain road of almost 32 km long is an example where many rockfalls incidents were experienced. A 100 m long portion of such mountain road, in this study, lie along a sharp cliff suffers from frequent rockfalls on the road, mainly in rainy seasons, in addition to various types of slope failures. The rock masses are mainly igneous rocks of medium to low quality. The rock slope-cut along the road has no bench for 10m. Such dip of the man-made rock slope cut is 70°-90° directly on the road, and reaches up to 30 m on natural slopes height behind it. Accordingly, such dangerous slope cut suffer from many events of rockfalls from upper slope elevations, which are potentially source areas. Absence of ditches and support systems aggravates the daily road conditions under such conditions. In this research, the dominant geotechnical properties of the rock masses were studied in order to identify the decisive parameters of rockfalls. The Rockfall computer program was utilized to perform the risk analysis on such steep man-made and natural rock slopes behind such problematic part. Parameters such as 1) block size, 2) seeder points of blocks falls, 3) slope angle, 4) restitution coefficients, and 5) slope roughness. These input parameters were used to measure properties of the potential and fallen rock blocks such as: 1) bounce height, 2) kinetic energies (total, translational, and rotational), and 3) translational and rotational velocities. The program modeled the 1) proposed location and energy of the rock blocks barriers heights and locations, collectors, and 2) proposed safer redesign of the slope height and slope angle, which would give a reasonable factor of safety. The results of such a study provide a solution to prevent the rock blocks from reaching the road at such rock slope cut, and could be applied at other locations with similar conditions.

The February 27, 2010 Chile Tsunami – First results of a sedimentological study of tsunami deposits between 34° and 39°S

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Considering past tsunami events, respective deposits may be the only observable evidence, even though their preservation potential is limited. To understand how tsunami deposits form and how they can be identified in the geological record, it is of paramount importance to undertake detailed studies in the wake of such events as they occur. Here we report initial field data of a sedimentological post-tsunami field survey undertaken in Central Chile between March 31 and April 18, 2010. On February 27, 2010, at 3:34 am local time, an earthquake with Mw 8.8 occurred off the town of Constitución and caused a major tsunami. Most affected were coastal towns between Duao in the north (c. 35°S) and Concepción/Talcahuano in the south (c. 36.45°S). Maximum runup heights of up to 10 m were measured on broad coastal plains. The cliff coast at Tirua (c. 38.20°S) recorded a runup height between 30 m and 40 m, indicated by eroded vegetation and soil. At Callipo beach (c. 38°S) c. 20 m high dunes on a spit separating the Paicavi river from the sea were overflown by the tsunami, which then inundated the river's floodplain. At selected localities we measured detailed topographic profiles including runup heights and inundation distances, and recorded the thickness, distribution, sedimentological structures and facies of the respective tsunami deposits. Field data will be combined with high resolution grain size analyses, the latter of which will be used to derive hydrodynamic conditions of transport and deposition. We found the most instructive and complete sedimentological record of the February 27 tsunami at the northern tip of Isla Mocha, a small island off the Chilean coast at c. 38.15°S. Runup distances vary between 400 m and 600 m, the flow depth exceeded 3 m at ca. 100 m from the coast. In a rare sedimentological case, deposits of tsunami runup and backwash could be distinguished. The runup phase was mainly documented by fields of boulders extending c. 200 m inland. Boulders had maximum weights between 15 t and 20 t. They were oriented with their long axis parallel to the wave front which indicates their transport by rolling. Algal veneers and barnacles on the boulder faces give evidence of entrainment in intertidal water depths. The boulders are now embedded in mostly structureless coarse shelly sand of up to 30 cm thickness. These sands were entrained at least in parts during near shore supratidal erosion by the tsunami and transported inland during runup. At the maximum runup position thin veneers of sand were deposited. To the best of our knowledge ours is the first report of transport of sand to and its deposition at maximum runup. Flow structures indicate that the sands were then re-deposited during backwash. Downcurrent of terrace steps the tsunami backwash produced large erosional gullies which supplied additional volumes of coarse grained shelly sand from older terrace deposits. Downcurrent, i.e. seaward from the gullies the backwash sands form fan-shaped braided deposits prograding over denuded soil surfaces. At Bucalemu bay (c. 34°40°S) the tsunami inundated the coastal plain and redeposited boulders with weights around 0.7 t. The boulders had been transported there from nearby quarries prior to the tsunami event for construction purposes. The redeposited boulders are runup deposits, showing two depositional clusters that may be related to transport by different waves, and are associated with thin veneers of silt and clay most likely deposited during maximum inundation.

Why in dubio pro tsunami deposits does not work: two examples from northern Chile

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The recognition of tsunami deposits in the geological record is hampered because there are no unique sedimentological criteria that clearly define tsunami sediments, and tsunami deposits have a very limited preservation potential. We present observations on two alleged tsunami deposits exposed at the Chilean coast north of Antofagasta, at Caleta Herradura and Hornitos, of Miocene and Plio-Pleistocene age, respectively. These we interpret to be in fact mass flow sediments unrelated to any kind of tsunami depositional process. At Caleta Herradura, Cantalamessa and Di Celma (2005) interpreted mass flow deposits arranged in a Lower and Upper Unit as the product shallow marine tsunami backwash. However, the deposits in question occur in a coeval graben as intercalations between shoreface deposits. Tracing the deposit across the downthrowing graben margin faults, we did not find any evidence of described "abrupt" lateral changes in depositional facies. When the Lower Unit is traced towards the graben margin it increases in thickness and the association to synsedimentary downthrowing faults becomes evident. The Upper Unit is described as being "distributed more widely than the Lower Unit and, where the Lower Unit is absent, it succeeds directly the lower shoreface deposits." We disagree. The Upper Unit tapers out eastward against the inclined upper depositional surface of the Lower Unit. We interpret the Lower Unit as a debris flow alluvial fan and fan delta deposit of the graben margin which was itself affected by synsedimentary downthrow activity. If the debris flow deposits are restored for the downthrows realized along the numerous faults, it becomes apparent that the alleged tsunami backwash deposit of the Lower Unit represents the distal part of a physically continuous coarse alluvial wedge thinning westward and towards the graben center. The Upper Unit represents a debris flow deposit at least the matrix of which was derived from marine sediments within the graben. There is no evidence permitting an interpretation of both units as tsunami deposits of any kind. At Hornitos, a very conspicuous, coarse clastic unit is exposed along a c. 1.5 km long cliff section at the foot of the Coastal Cordillera. The unit is less than 15 m thick, has an erosive base, lacks internal stratification, and is intercalated between shallow marine sandstones. The deposit consists of abundant clasts of highly variable diameter set in a sandy matrix. Clasts are mostly angular and diameters vary between a few centimeters and c. 50 m. Oblong clasts are oriented either subparallel or at high angles to the bedding. Clast lithologies are basalt, granodiorite, shist and sandstone, which were locally derived from the nearby Coastal Cordillera and coastal region. The deposit is generally chaotically mixed, although large clasts may display local grading and are sometimes concentrated near the base of the unit. It was previously interpreted as a shallow marine backwash deposit of a giant tsunami. The largest clast size previously reported was 10 m. The characteristics of the deposit, and particularly the presence of the giant clasts and rock slabs (50 m long axis length!) makes deposition by a tsunami highly unlikely. We interpret the deposit to be the product of catastrophic rock avalanche processes connected to a mountain collapse in the nearby Coastal Cordillera. Shell debris may have been incorporated into the matrix in the same way entire blocks of the underlying shallow marine lithologies were embedded in the deposit during emplacement of the unit.

Microbialite occurrences in the Cretaceous Codó Formation – Northeast Brazil

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Located in the Parnaiba and São Luis Basins, the Aptian-Albian Codó Formation is one of the best-preserved Mid-Cretaceous sequences found in Northeast Brazil. The formation has been recently correlated to the new major petroleum discovery in the deep waters offshore Brazil, called the Pre-Sal. This stratigraphic section is interesting for its value to exploration, but also because it records the history of the early stages of the opening of the Equatorial Atlantic Ocean. We report on the preliminary results of our recent studies of the sedimentological, stratigraphic and geochemical aspects of the Codó Formation, which have been carried out to characterize the paleoenvironmental conditions of deposition. We also report similar results for samples from the nearby Araripe Basin (Santana Formation), which provides a context for our results. Samples from the Codó Formation contain diverse microbialite facies, including parabolic, wavy and domal stromatolite features, and planar, wavy and discontinuous laminae and spherulites. The mineralogy consists of calcite (70-80%), dolomite (10-25%) and quartz (10-15%). In contrast, the Santana Formation of the Araripe Basin contains only wavy and discontinuous laminae and spherulites, and is mainly composed of calcite (80-90%) and quartz (10-20%). To evaluate the growth temperatures of carbonate constituents of these samples, carbonate clumped isotope thermometry was applied to selected Codó Formation samples from outcrop and drill core from the Parnaiba and São Luis Basins (500 and 600 meters deep), and drill core samples from Araripe Basin (30 to 60 meters deep). The paleotemperatures derived for dense stromatolitic fabrics drilled from outcrop samples of the Codó Formation vary between 29 and 33°C. In contrast, the micritic matrix of the drill core samples range from 30 to 48°C. The lower values for the outcrop samples may indicate a primary or early diagenetic temperature signal preserved in the rock. Moreover, matrix micritic material from the Araripe Basin drill core samples indicate paleotemperatures ranging from 40 to 68°C, which are slightly higher than for all measured samples of the Codó Formation. We propose that the higher paleotemperatures for all drill core samples represent a diagenetic effect that occurred with sediment lithification processes during burial; that is, isotopic reequilibration at depth is reflected in the increased measured paleotemperatures. This effect is likely present in some carbonate fabrics of the outcrop samples of the Codo formation (which also underwent lithification), but was avoided by our ability to micro-sample primary or early diagenetic stromatolitic fabrics. Assuming that the outcrop samples of the Codó Formation preserve an original stable isotope signal, the $\delta^{18}O$ values of the bulk carbonate (- 5.8 to -1.5 ‰ PDB) suggest precipitation from water with calculated $\delta^{18}O$ values ranging between approximately -2.5 and 1.5 ‰ SMOW, possibly reflecting precipitation from a variably modified Cretaceous sea water. The $\delta^{13}C$ values of the bulk carbonate (-9.5 to -7.2 ‰ PDB) indicate a significant input of carbon derived from aerobic or anaerobic respiration of organic matter, suggesting precipitation in a semi-enclosed or isolated water body. These preliminary results demonstrate that a combination of petrographic and geochemical approachs can provide a realistic evaluation of the paleoenvironmental conditions during primary carbonate mineral precipitation and subsequent rock formation. A more in-depth study of the Codó Formation microbialite is in-progress.

Discrimination of fluvio-eolian deposits of the Sergi Formation (Reconcavo Basin, Bahia, Brazil), using a portable gamma-ray spectometer

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Fluvio-eolian deposits are found in many basins around the world, and they consist of excellent reservoirs of oil, gas and water. Generally these deposits form amalgamated sand bodies and are characterized by a high degree of complexity and internal heterogeneity. However, individualization of these deposits in subsurface is extremely difficult due to the complex depositional architecture and the fact that they show similar signatures in wireline logs. This work aims at discriminating fluvial-eolian deposits of the Sergi Formation, the main reservoir the Recôncavo Basin, using spectral gamma-ray profiles (K, U and Th). The Sergi Formation comprises three depositional sequences bounded by regional unconformities. Sequence I is composed of fine- to medium-grained sandstone related to eolian dune and sand sheet and ephemeral fluvial stream deposits. Sequence II comprises coarse-grained to conglomeratic sandstones deposited in a braided channel-belts. Sequence III comprises bimodal sandstones related to eolian dune and eolian sand. Outcrop analyses performed with a portable gamma ray spectrometer were integrated to quantitative petrography in order to identify the mineral that are the main sources of K, U and Th radiation, with the purpose of discriminating the different sequences and facies associations in the Sergi Formation. The eolian dune and eolian sand sheet deposits of Sequence I were discriminated through the U and Th channels, being monazite the main mineral phase. However, the differentiation between ephemeral fluvial and eolian deposits was not possible, as they show similar values of K, U and Th. This fact is related to the similarity in the detrital composition of these deposits. The discrimination between the eolian deposits from Sequences I and III is clear. Eolian deposits from Sequence I show higher K, Th and U values, which are related to the larger amounts of detrital K-bearing minerals and of infiltrated clays. The fluvial deposits from Sequences I and II were discriminated through the multi-spectral signature pattern, although for a certain overlap of the values occur. Sequence I fluvial deposits show a smooth and constant signature, while Sequence II deposits display a more serrated pattern with peaks related to high U and Th values. The use of portable gamma ray spectrometer has proved to be a practical and useful tool in the discrimination of eolian-fluvial deposits. The integration of multi-spectral signatures with petrographic analysis was quite relevant to understanding the results, since it allowed us to identify which minerals directly controlled the channels of K, U and Th in the studied rocks.

Fluvial braided overbank facies and paleosols in Paleogene rift basins of Southeastern Brazil

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This study aims to integrate sedimentological and paleopedological analyses of the Paleogene fluvial deposits that fill Resende and Volta Redonda basins. These basins correspond to adjacent hemigrabens located at the central segment of the Continental Rift of Southeastern Brazil, in western Rio de Janeiro State. The sedimentary filling of these basins presents alluvial fan deposits near the respective master faults and braided fluvial deposits in distal areas. Fluvial deposits are typically characterized by a succession of greenish to grayish weakly consolidated arkoses, siltstones and claystones, related to a litostratigraphic unit known as Resende Formation. Sandstones are massive or stratified, occasionally conglomeratic, with variable quantities of post-depositional mud matrix. Mudstones show a variable intensity of animal and root burrows, which produced mottled and variegate patterns. This work aims to contribute to the use of paleosols or pedofacies in architectural characterization of braided river floodplain deposits in order to improve the depositional model interpretation, discussing the possibility of autocyclic and allocyclic controls in their genesis. The methodology of this study included: sedimentary logs (1:20); photomosaic outcrop analysis for depositional architecture interpretation; granulometric, clay mineralogy, petrographic and micromorphologic analysis. The main sedimentary facies described corresponds to: i) tabular to lenticular beds of arkoses with weak horizontal lamination; ii) fine arkosic massive sandstones with tabular geometry; iii) bioturbated massive mudstones; iv) high bioturbated claystones. Two pedofacies were recognized: Pedofacies 1, with grayish background, yellowish mottles (goethite), blocky structure, variable grades of bioturbation, slickensides and silty to sandy texture; Pedofacies 2, characterized by brownish-reddish background, with grayish depletion halos with reddish rims, strong blocky to crumby structure, elevated grades of bioturbation, abundant slickensides, iron nodules, manganese rizoconcretions and muddy to clayey texture. Both pedofacies show abrupt contacts in the top and diffused contacts in the basis. Micromorphologic evidences points to intermediate do distal segments of floodplains to the formation of these pedofacies, seasonally saturated by groundwater or covered by water flows. Mottled and variegate features are attributed to subaerial changes of alluvial sediments under different hydrologic conditions, denominated pseudogleization or surficial water gleization, and groundwater gleization. Pedofacies 1 is interpreted as ancient stacked gley soils, under autocyclic controls. Pedofacies 2 is interpreted as vertic paleosols developed in paleoterraces free of steady sedimentation of the floodplains, being formed by allocyclic factors. Facies and pedofacies are interpreted as overbank architectural elements as sheet flow or splay fan deposits related to channel avulsion in floodplain, submitted to differential rates of pedogenetic, hydrologic and sedimentary conditions. Depositional model for those continental rift basins suggests the development of extensive floodplains adjacent to axial braided fluvial system with stable margins.

The sedimentary record of Bansko brdo hill (NE Croatia): from Badenian marine environment to Pleistocene eolian sediments

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Baranja region is located in the eastern part of Croatia. It is bounded from east and south, by the Dunav and Drava rivers and by Hungary from the north/north-west. Baranja is mostly covered by Pleistocene sediments, with some local outcrops of Miocene sediments. Pleistocene sediments are dominantly loess, loess-like sediments (marsh loess), fluvial, alluvial and marsh sediments, covering Baranja plains. Only high ground in Baranja is Bansko brdo hill (244 m), situated in the northern part of region, stretching in south-west to north-east direction, about 20 km. Geological basement of Bansko brdo hill is made of sandstone limestone, marl, andesite, riolite and andesite breccias, which are of Miocene age. Due to faults, which are normal, outcrops of Miocene sedimentary and igneous rocks are present at the northern slopes of the hill. Southern slopes are covered completely with loess. Sedimentary rocks represent sea level fluctuations during Badenian and Sarmatian period in Central Europe and transition from sea water to brackish water. Fossils found in marls are typically marine. Igneous rocks are determined to be Badenian age and they are intruded into sedimentary rocks, during upper Badenian magmatic events in Panonian basin. During Pliocene and lower Pleistocene, last remnants of Paratethys disappeared. Plains in central Europe were covered by marshes and newly formed rivers. During middle and Upper Pleistocene climate in northern hemisphere was influenced by glacial/interglacial periods. During that time, loess was formed, mainly from moraine material, and transported by winds to the plains. Total estimated thickness of loess on Bansko brdo hill is about 30 m. Oldest loess sections at Bansko brdo, at Zmajevac profile is 121 ka, which is base of upper Pleistocene. This age represents last glacial period, which is called Würm, in Alpine division of Pleistocene. Paleosoils visible in 3 layers are present in loess. Loess is eolian silt. Bulk samples of loess were taken for mineralogical and paleontological analysis. Mineral composition of loess, from Bansko brdo hill reveals the origin of that eolian sediment. In light mineral fraction quartz and feldspar are dominant. In heavy mineral fraction amphibole, epidote and garnet are dominant. Complete mineral assemblage indicates that source material for loess was the Alps. Loess at Bansko brdo hill is rich in fossil mollusc fauna, land gastropods. Gastropod shells from 3 most abundant fossil species were analysed on stable isotopes ΔO18 and ΔC13 in IAMC-CNR in Naples. Isotope results from loess sections, suggest a slight arid/humid and cold/warm variations in climate, during upper Pleistocene. These variations reflect stadial/interstadial climate changes in upper Pleistocene. Warmer and more humid periods, during last glacial are marked by 3 paleosoils which are inbeded in loess. Stable isotope data do not provide absolute numbers, just relative differences of Pleistocene and recent temperature/humidity. Due to that problem, shells of recent gastropods, collected from meadows, fields and loess sections were also analysed (ΔO18 and ΔC13). Numbers obtained from stable isotope results are matched with data of average annual temperature and humidity, at Bansko brdo for year 2009. (Beli Manastir meteorological station). These matched and calculated results, provide a certain standard, which can be used to determine (with caution) absolute temperature/humidity during upper Pleistocene. Results from recent gastropod shells and fossil gastropod shells, indicate significant difference in recent and Pleistocene climate (for Baranja region, which can be applied for southeast Europe). In general, in upper Pleistocene, climate was much more colder, than today, and also more arid. In some periods (interstadials) climate was more alike recent climate, but main trend was cold and arid climate, with average annual temperatures more than 7°C lower than today.

Calcium carbonate distribution in sediments of Sueste Beach and Mangrove, Fernando de Noronha Island, Pernambuco State, Brazil

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The Fernando de Noronha Archipelago is composed by 21 volcanic islands (26 km^2) located in the South Equatorial Atlantic (4°S/32°W), 540 km from Recife, Pernambuco State, Brazil. It is an extinct volcano top whose base of 74 km in diameter rests on the oceanic floor at an approximate depth of 4,200 m. Modern sedimentary biogenic deposits are present on beaches at the northern island side (Mar de Dentro) as well as in its southern portion (Mar de Fora), where the Sueste beach system is located. The Sueste Beach is 450 m in length and its width varies from 80-100 m in the western side to 30-50 m in the eastern side. A mangrove (8,900 m^2), associated to the Maceió river drainage, is isolated from the beach by a vegetated dune system (2.5 m in height), except in a portion adjacent to the Maceió River inlet, located in the west beach side. This study evaluates the carbonate contents distribution in surface sediments from the Sueste beach, mangrove, and dune system. Eighteen sediment samples were collected in January of 2010 and research methods included calcium carbonate and total organic matter (TOM) analysis. Grain size was analyzed by sieving and pipette-method, and the calcium carbonate and total organic matter were determined by the weight difference prior to and after acidification with 1N HCl and 1N H_2O_2, respectively. The collected samples are bioclastic, presenting high carbonate contents that vary from 73.8 to 96.0%, as observed in previous studies performed on samples from the island. TOM ranges from 1.0% to 5.6%. The results show a spatial distribution pattern characterized by the presence of sandy and granular terrigenous components (fragments of higher plants and heavy minerals), lower $CaCO_3$ and TOM contents in the west side of the beach. On the other hand, in the east side, the sediments are well sorted and mainly composed by sandy carbonate fragments and higher organic matter contents. This distribution is directly related to the presence of terrigenous sediment sources in the west side, due to wave action in the adjacent volcanic rock cliffs and the Maceió River local sporadic sediment input. A higher exposure of the western side of Sueste's beach to the wave action and prevailing trade winds, added to a parallel current convergence process induced by refraction and diffraction of SW/S/SE/E waves in the Sueste Bay entrance, also contributing for the observed spatial sedimentary pattern distribution, sediment composition and beach morphology.

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Holocenic sedimentary processes and the organic matter behavior in cores of the Cananéia-Iguape Lagoonal-Estuarine System, São Paulo State, South-Eastern Brazil

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Sedimentary organic matter (SOM) is a good tool for environmental evaluation where the sediments are deposited. We determined the elemental C, N and P and $\delta^{13}C$ and $\delta^{15}N$-isotopic compositions of 296 sub-surface sediment samples from 14 cores (ranging from 18 to 171 cm), collected in the Cananéia-Iguape estuarine-lagoonal system. The aim of this research is to evaluate the environmental variations of this subtropical coastal micro-tidal system over the Holocene, through SOM distribution. According to ^{14}C data this study represents about the last 3.0 ka BP in the region. The studied parameters show differences between the cores located in the northern (sandy, sandy-silt, sandy-clay to silty-clay sediments), central (sandy) and southern (sand, sand-clay, clayey-sand and silty-sand) portions. In general, the elementary organic contents in the cores present low to medium contents (organic C: < 2.0%, total N: < 0.2% and total P: < 15.0μmolg-1), when compared to other tropical and subtropical estuarine environments in the world. The whole area presents a mixed organic matter origin signature (local mangrove plants: < -25.6‰ PDB and phytoplankton $\delta^{13}C$ values: -19.4 ‰ PDB). The C, N, P, $\delta^{13}C$, $\delta^{15}N$, CaCO3 and elemental C/N, C/P e N/P ratios, observed in sediments, added to grain-size and coarse fraction analysis results, allow the identification of the prevailing influences in sedimentation processes in the different sectors of the estuarine-lagoonal system. A greater marine influence is observed in the southern sector, while from its central portion toward the north, especially within the Valo Grande inlet (ST-20 core), a markedly terrigenous influence is dominant. The northern and central cores, which are submitted to high modern sediment deposition (0.77 and 0.50 cm year-1, respectively), are more homogenous, presenting lower $\delta^{13}C$ (< -25.2 ‰ PDB) and higher C/N (> 14) and C/P (>200) values, directly related to the terrestrial input from Ribeira de Iguape River (24,000 km^2 basin). The southern portion presents lower sedimentation rates (0.32cm year-1) and is associated to a small river basin (1,340 km^2), presenting values of $\delta^{13}C$: -25.0 to -23.0 ‰ PDB and of C/N ratio: 11 to 15 and C/P (< 200). Although a greater marine influence is observed in the southern system portion, the majority of the cores present an elevated increase of continental deposition, most likely related to the strong silting process that the area has been subjected to since the 1850s, when an artificial channel was built linking, directly, the Ribeira River to the estuarine-lagoonal system. The increase of OC, TN and especially TP contents are also observed in the majority of the top cores, indicating temporal changes of the land-derived input material for the whole lagoonal system, and may also indicate a gradual eutrophization process directly associated to agricultural activities and urbanization growth in the area over the last 50 years. On the other hand, an increase in SOM of terrigenous origin, in sediments more ancient than 2690±40 years-1, may be related to a natural climatic behaviour associated to wet periods as a collection of rainy years, in the Holocene.

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A potential petroleum system in the flexural margin of the Rincón Blanco rift, San Juan, Argentina

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The Triassic Rincón Blanco Sub-basin is an elongated, asymmetric rift located in the Precordillera fold and thrust belt. The infilling consists of almost 3000 m of non-marine Triassic coarse conglomerates interfingered with sandstones, shales, rhyiolitic tuffs and basalts. The master fault is a north striking down-to-the west fault which dips at 70º but at depth it is lystric. Fault blocks and transfers created isolated depocenters and, despite the overall stratigraphic similarity among them, the active and flexural margins seem to have evolved independently up to late post rift stages. Three depositional sequences associated with the extensional events were observed. They are part of the lithostratigraphic units which from base to top are Agua de Los Pajaritos, Monina, Hilario, Alcázar and Cepeda formations (Sorocayense Group). Field and seismic data have been integrated to interpret the petroleum system. The main source rock has not been identified in the flexural margin; instead a new potential source rock, the Monina Formation, has shown good chemical features (Zamora *et al.*, 2008). This unit corresponds to a lake environment with IH values over 700 mg/g/TOC that suggest type I kerogen (Zamora *et al.*, 2008). Small fluvial streams from the flexural margin and from the transfers drained the lake in a muddy, low energy shoreline. These sandstones display poor reservoir quality because they are texturally immature and reduced in porosity and permeability properties. There might be occasionally local seal potential in the mudstones. The overlying Hilario Formation comprises low energy fluvial system that proved to be mostly impermeable, however migration could have taken place via fractures and faults that leaked and charged upper sandstones. El Alcázar Formation, developed during the post-rift, started as a series of palustrine to lacustrine environments with marls and limestones occasionally deposited in the shoreline of areas of minimal detrital input mainly on top of the shallowly submerged fault blocks. The shallow water environment prevented the accumulation of large source rocks, however TOC values of 4% and IH higher than 600g/g/Toc, but the Ro, IP and Tmax values indicates that these rocks are inmature in outcroops (Zamora *et al.*, 2008). The potential reservoir rocks of this unit are mostly associated with fluvial deposits of the upper facies whose clastics are texturally mature as they originated outside the rift. The burial of the organics under the charge from the Cepeda Formation clastics (Upper Triassic) (Barredo y Ramos, 2010) and the Tertiary synorogenic sediments may cause the shales to approximate the thermal maturity (Zamora *et al.*, 2008). Traps are associated with the development of thrusts and mild inversion of the previous extensional structures during the Tertiary. Finally, the seals, if any, should be associated with the overbank mud deposits and tuff accumulations of the Hilario Formation and with the post-rift deposition of the El Alcázar Formation.

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Syn-tectonic controls over the Alto de Kauffman petroleum system, Cuenca Neuquina

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The Neuquén Basin, one of the fifth hydrocarbon producing basins in Argentina, started during the Jurassic as a back-arc rift system composed of a series of sub-basins with different evolutionary histories. Among them, in the region of "Alto de Kauffman", in the western part of Río Negro province, the Estancia Vieja fault system constituted the border fault of an asymmetric halfgraben. It was composed of a series segments and transfer zones whose kinematic evolution impinged on sedimentary signatures. On the basis of seismic and sequence stratigraphy tools, each distinctive expression of the characteristic depositional system and the potential petroleum system could be recognized. The infilling consists on the Precuyo and Cuyo clastics and pyroclastics rocks which developed the thickest levels close to the master fault but specially associated with the transfers faults and lineaments. It is considered here that the tectonic evolution has had important impact on the development of the source rocks. Rapid subsidence during rifting and the humid climate favoured the development of sediment starved depocenters with deep lakes which permitted a good preservation of organic material. Additionally, during climax and initial post-rift the basin displayed high levels of productivity via internal nutrient recycling. However, each simple depocenter was characterised by its own sedimentation rate which induced dispersed potential source rock distribution. Reservoir rocks are associated with lenticular sand bodies of peripheral fluvial systems mostly developed in the flexural margins of the sub-basin to the southwest. Seals are practically limited to mudstones of the lake marginal facies and to the interbedded primary tuffs. An inversion related uplift occurred in the southeast portion of the sub-basin during Jurassic times while the basin was still evolving to the post-rift stage. It is proposed here that locally and mildly inverted depocenters, with restricted areas of uplift along the faults, could have developed good anticline traps where the potential hydrocarbon developed in the neighbouring depocenters could have migrated, being only constrained by the relationship between timing of trap formation and petroleum charge. The potential reservoirs rocks are most abundant in the post-rift succession especially of the inverted troughs and included fluvial sandstones developed in high to medium energy environments mostly controlled by the rate between uplifting and local base level variation. Good seals are associated with the existence of mudstones and evaporites of the late post-rift stage, however, the regionally extended inversion which affected the whole sub-basin later might have given place to penetrating structures with the lost of pre-existing hydrocarbons.

A new stratigraphic synthesis of the Agua de Los Pajaritos depocenter, flexural margin of the Rincón Blanco Sub-Basin

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This analysis provides new insights into the stratigraphy of the flexural margin of the Rincón Blanco Sub-basin and its relationships with the Triassic tectonic events. This sub-basin is a north-south elongated and asymmetric rift located in the Precordillera fold and thrust belt. The infilling comprises non-marine Triassic coarse conglomerates interfingered with sandstones, shales, rhyiolitic tuffs and basalts of the Sorocayense Group. A recurrent problem in this region is the incomplete preservation of the Triassic record along the Barreal-Calingasta-Rincón Blanco area. Field studies suggests that the extensional geometry of the sub-basin is characterized by fault blocks and transfers that created isolated depocenters which lead to a separate evolution of the active and flexural margins at least up to the late post rift stages. An attempt has been made to infer the temporal relationships and the distribution of depositional systems in each through as far as was possible. Accordingly to these results, the stratigraphic order could be revised. From base to top the Sorocayense Group is composed of: Agua de Los Pajaritos, Monina, Hilario, El Alcázar and Cepeda formations, succession which is quite similar to that proposed by Baraldo and Guerstein (1984). The older extensional units comprise predominantly alluvial-fluvial and lacustrine settings with subaerial volcanic and volcaniclastic rocks. They are Agua de Los Pajaritos, Monina and Hilario formations, developed in an Early Triassic phase of limited crustal extension, which led to the formation of a series of areally restricted, north-south elongate half-grabens. The Monina Formation, has been identified as good source rock with similar lithological and geochemical characteristics of the Carrizalito Formation of the active margin (Barredo *et al.*, this congress). It passes laterally into predominantly fluvial deposits that, from their geometry, are interpreted to have been developed in a still extensional subsiding basin. El Alcázar Formation is locally unconformably overlying the extensional suit and it is widely extended all over the flexural margin, for it has been interpreted as part of the post-rift stage. Furthermore, recently surface and subsurface information indicates that it is in fact equivalent to the sag phase related Casa de Piedra Formation, in the Rincon Blanco active margin. In all previous interpretations of the Sorocayense stratigraphy, this formation has been considered part of the early extensional phase and has been assumed to be coeval with the synrift facies of the active margin. It started as a series of palustrine to lacustrine environments with marls and limestones occasionally deposited in the shoreline of a muddy shallow lake which is gradually replaced by low energy fluvial systems, sourced from outside the rifted basin. A renew of the extensional regime gave place to a deposition of the fan derived clastics of the Cepeda Formation lateral equivalent of the Marachemill Unit (Barredo y Ramos, 2010).

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Chalky deposits of the Rio Quinto basin, San Luis, Argentina

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The Rio Quinto basin is located in the east-central region of San Luis province and develops on the crystalline basement in the south of the San Luis Range. The sedimentary rocks study in this paper fill the basin and they are covered by a typical alluvial-eolian succession Late Pleistocene to Holocene in age. The outcropping sedimentary rocks in the ravines of the Quinto River and affluents are continental red clastic deposits including: silty sandstones and sandy siltstones interbedded with clayey siltstones, laminated, desert rose gypsum and calcretes. Calcrete profiles are characterized according to Netterberg (1980) and Machette (1985) by macroscopic and microscopic descriptions. The base and top of the succession are identified as Paso de las Carretas formation and Río Quinto formation, respectively. The mammal fossil assemblage of the last one allows assigning the interval to the Late Miocene-Middle Pliocene, fossil traces and paleobotanical remains were also identified. In Paso de las Carretas formation four lithofacies were identified: C1, fine polymictic orthoconglomerate with carbonate cement and calcretization levels of Glaebular Calcrete, Calcrete Honeycomb and Calcrete Hardpan types; A1, medium to fine sandstones with chalcedony and the calcrete types: Calcareous Soil, Calcified Soil, Glaebular Calcrete, Calcrete Honeycomb and Calcrete Hardpan; A2, silty sandstones with carbonate cement and a level of Calcareous Soil; P1, calcretized mudstones of Calcifield Soil type. In Río Quinto formation three lithofacies were recognized: A3, silty sandstones with carbonate cement, the calcrete level is a Calcrete Honeycomb type; A4, fine sandstones with conglomeratic levels; P2, mudstones with carbonate cement and nodules, and gypsum. The macroscopic description of the calcretes suggests that the predominant structure is medium to fine bedding, planar to lightly wavy with scarce massive levels interbedded with sandstones and siltstones levels. The microscopic description shows a predominance of the micritic cement with little veins of chalcedony, clay illuvial and eroded grains of quartz and feldspar. The depositional paleoenvironment is a fluvial environment with subenvironments of piedmonts and shallow and temporary flooded depressions, where the flood plains underwent edaphic processes with eolian contributions and vegetation. The abundance of carbonate in the sequences leading to the formation of laminar calcretes, epiclastic calcretized rocks and calcareous nodules constitutes a clear evidence of the change in climate conditions during the Neogene, suggesting high temperatures and geochemical precipitation in epiclastic successions saturated in water with a high phreatic level.

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A new insight of deep-water turbidity flows: laboratory experiments and numerical modelling

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Turbidite successions have long been an important target of petroleum production and exploration on the Norwegian Continental Shelf. The sequence-stratigraphic analysis of these successions requires a good knowledge on possible allogenic vs. autogenic changes in turbiditic depositional systems, which entails major implications for spatial reservoir predictions and geological models. It is still known relatively little about the hydrodynamics of naturally diverse turbidity currents, their varied responses to seafloor topography and the resulting autogenic variation in a turbiditc system and its deposits. The collaborative research outlined here, combining laboratory experiments and numerical CFD simulations, addresses some of the crucial issues related to the topic of autogenic factors and their stratigraphic effects. Computational fluid dynamics (CFD) is a tool for numerical solution of the physical equations describing fluid flow and sediment transport. The method has been widely applied in the engineering branches of fluid mechanics, but has thus far been little used in sedimentological research and reservoir studies. Novel CFD software, called MassFlow-3D™, has been developed and successfully used to construct a three-dimensional model for the simulation of turbidity currents. All principal hydraulic properties of the flow (velocity, density, sediment concentration, apparent viscosity, turbulence intensity, bottom shear stress) and its responses to topography can be continuously monitored in three dimensions over the whole duration of the turbidity current. The model has been calibrated and verified against laboratory flows and can readily be up-scaled to natural conditions. A combined set of laboratory experiments and CFD simulations have been carried out in order to gain a better understanding of the following issues: (1) the affect of slope gradient on flow behavior (including the determination of equilibrium slope, where net deposition equals net erosion); (2) the affect of initial sediment concentration on flow behavior; (3) the affect of initial discharge on flow behavior; (4) flow structure at channel bends in relation to the channel/current relative dimensions; (5) the pattern of sand dispersal at a channel outlet in relation to the location of hydraulic jump – whether outside or within the channel – and for a range of grain-size mixtures. Another series of CFD numerical simulations has been focused on the broad, system-scale response of turbidity currents to basin-floor topography and its effect on differential stacking of consecutive deposits, by flow ponding or spill-over, which bears direct implications for the succession's primary heterogeneities (lateral and vertical facies changes, sediments distribution, sand net/gross variation, sand pinch-outs). Such up-scaled preliminary 'real-world' studies included flows in the Monterey Canyon system, the Ormen Lange field and the Peïra Cava Basin. The CFD simulations in combination with the palaeogeomorphological seafloor maps provided by modern 3D seismics may thus offer unprecedented new insights in the spatial development of hydrocarbon-hosting turbidite successions.

Response of ostracods to abrupt climate changes in the Western Mediterranean (Gulf of Lions) during the last 30 kyrs

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Global climate changes attract the attention of researchers working with paleoceanography proxies for reconstructing past ocean circulation modifications and the physico-chemical parameters that control the environmental conditions. Moreover, recent studies have shown that the effect of climate change on deep sea benthic biodiversity ought to have an increasing scientific attention. Deep sea benthic fauna is not isolated from atmospheric processes and climate changes controlling the life at surface of the oceans, for benthic assemblages fluctuate synchronously with the prevailing climatic conditions as well. Substrate and physico-chemical characteristics of bottom waters have particularly strong influence on ostracod species distribution in all marine settings making them excellent environmental indicators. Here, we present the results of the study of ostracod assemblages from core MD99-2348, located on the continental slope of the Gulf of Lions. It belongs to the western sector of the Mediterranean Sea, where abrupt and short-time scale climate changes play a major role in oceanic circulation. Our results show that species as *Henryhowella* and *Echinocythereis* can be a useful indicator of the surface dense water sinking due to intensification of NW winds (Tramontane and Mistral) during the acme of HEs, when high latitudes bodies of cold air (Mobile Polar Highs) reach the Mediterranean area. Thus, cold, oxygen and nutrient-rich dense waters sink down to the continental rise providing environment suitable for opportunistic benthic ostracods. The concomitant high abundance of *Krithe pernoides*, which proved to a very sensitive to oxygen content variability and it probably records even shorter (millennial to centennial scale) climate oscillations. In addition, major change in environmental conditions is clearly marked by the shift of two different groups (*C. testudo-Loxoconcha* vs *Pseudocythere-Macrocypris*) that reflect detrital input/productivity changes in the Mediterranean since the LGM.

Estuarine infilling processes interpreted from surface sedimentary facies distribution (Vitoria Bay, southeast Brazil)

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Modern estuaries were developed during the last postglacial marine transgression, when river valleys and lowlands were flooded. In general, estuaries are infilled by fluvial and marine sedimentary processes, leading to the development of a coastal delta plain. Overall, an estuarine facies model can be described as a function of distinct hydrodynamic domains, such as: fluvial domain with coarse sand/gravel fluvial facies; tidal-low energy portion with estuarine muddy facies and wave/tide marine domain with flood/ebb delta sands. Variations on facies characteristics may occur as a function of the interplay between different hydrodynamic forces (river flow, tides and waves) acting within the system. In Brazil, several estuaries have been studied in order to understand the sedimentary infill processes along a regressive coast. Established relative sea-level curves for the eastern Brazilian coast suggest that a regression in the order of 3 to 4m have been occurring during the last 5,000 years. In order to understand the Holocene evolution of estuarine infilling processes, an investigation combining surface sediment samples, seismic profiles, seabed sonographic imaging, shallow cores and radiocarbon dating has been carried out along Vitória Bay, southeast Brazil. Vitoria Bay is a 20km long estuary, morphologically narrow with a microtidal regime. The estuarine bed morphology is characterised by a main natural channel limited by tidal flats with developed mangroves. An integrated analysis allowed the recognition of four regions associated with distinct processes: the upper estuary is dominated by fluvial input and estuarine processes; a large portion of the central region of the system showed erosive characteristics and morphological adaptations related to the increase in currents caused by the man-induced narrowing of the bay, providing the formation of bedforms; the port navigation channel, which shows high rates of sedimentation and is clearly modified by dredging and the estuarine mouth which is dominated by marine processes. Considering only the inner parts of the bay, where dredging did not take place, a complex bed sedimentary facies distribution was observed, which may indicate that the surface sediment distribution is not entirely related to modern sediment supply and redistribution. High-resolution seismic data have revealed that the main channel is an erosive feature that exposes transgressive deposits at the bottom. These deposits have been dated as 3900 cal yrs BP. The present channel morphology represents a tidal scouring surface or a tidal diastem, eroding and truncating regressive facies, and exposing relict sediments (transgressive facies). The sediment distribution in the inner parts of Vitoria bay is characterised by a regressive muddy facies along the tidal flats and channel margins and a mix of transgressive muddy facies with modern sedimentation within the channel. Thus, it is very important to interpret the significance of surface estuarine sedimentary facies within the concepts of sequence stratigraphy, in order to get a better understanding of prevailing sedimentary processes and infilling patterns.

Topographic control on the morphology and distribution of modern microbially induced sedimentary surface structures (MISS): Case Studies from Saudi Arabia and Egypt

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Recent supratidal sabkha and solar salt works in Saudi Arabia and Egypt are dominated with gypsified microbial mats. These microbial mats modify sediment behavior and result in a variety of microbially induced sedimentary surface structures (MISS). Common structures include: gypsified loose mats, knobby surfaces, blisters, domes, pinnacles, cones, ripples and folds (petee structures). In general, the height and thickness of the MISS increase with increases in the depth of the brine. Migration of subsurface gases from decayed sub-recent microbial mats, together with physical environmental factors such as waves and winds, are responsible also for the modification of the MISS. Transition from one type of MISS to other types may occur within few meters, depending mainly on local topography of the sediment surface because the degree of inundation is the primary controlling factor for the mat growth and resultant MISS. Therefore, the morphology and distribution of the microbially induced sedimentary structures in sabkha and solar salt works can be potentially helpful in interpretation of the topography of paleodepositional surfaces and delineating the direction of wind and wave actions.

Clay mineralogy of the kaolin-rich sedimentary deposits from the Weald facies in the Iberian Range (NE Spain)

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The aim of this study is to characterize the clay mineral associations from the sedimentary deposits of the Lower Cretaceous (Weald facies) in Maestrazgo basin (Teruel, NE Spain). The deposits, that are rich in kaolin minerals, are actively mined by the ceramic industry. Most of these materials (claystones, siltstones and sandstones) display red colors although there are also greenish and grey levels. They constitute the Camarillas Formation (Barremian) and represent a fluvial system of multiple low sinuosity channels, evolving towards the top to a delta plain, with tidal influence. A systematic sampling (45 samples) has been performed in two sections in the Maestrazgo basin: in an open pit nowadays mined close to Galve (Galve section) and in other outcrop at 50 km (Miravete section). The X-ray diffraction analysis indicates claystones and siltstones have similar mineral composition in both sections. Claystones have ~50% quartz, ~40% phyllosilicates (kaolinite, micaceous phases and rare chlorite), and very low amounts (<5%) of feldspars (K feldspar and plagioclase), carbonates (calcite, dolomite, siderite) and hematite. The mineralogical composition of siltstones is similar to that of claystones although with lower contents in phyllosilicates (~30%). Sandstones of both sections have high quartz content (~75%), and minor feldspars (K feldspar and plagioclase, ~10%), phyllosilicates (<10%) and carbonates. The analysis of fine fractions of claystones reflects that the major phyllosilicates are micaceous phases (mostly illite) and kaolinite, with minor chlorite. The kaolinite/micaceous phases ratio ranges between 0.3-0.7. In sandstones most of the fine fractions are formed by kaolinite (and minor dickite) with accessory micaceous phases and chlorite. The kaolinite/micaceous phases ratio ranges between 2-5.The kaolin minerals of sandstones have higher crystallinity (0.19º 2θ, FWHM) than those of claystones (0.33º 2θ). In addition, the 7 Å peak in claystones enlarges with the ethylene glycol treatment indicating the presence of interstratified smectite layers in the kaolinite. No variations have been observed with the same treatment in sandstones. Scanning electron microscopy study reflects striking textural differences between sandstones and claystones. Secondary electron images show that sandstones contain abundant booklets formed by subhedral to euhedral hexagonal plates of kaolin minerals; these booklets are absent in claystones. The kaolin plates are 5-20 µm in diameter and the aggregate thickness along the c axis is up to 35 µm. In these rocks, highly altered K feldspars have been also observed. Backscattered images also display kaolinite growing between cleavage sheets of pre-existing mica. In contrast, claystones are mainly formed by subhedral to anhedral flakes of kaolinite and illite with particle size <10 µm. These flakes have random orientation. The differences in crystallinity, morphology and texture of clays from claystones and sandstones probably suggest that they have different origins. Kaolinite from claystones may be mostly inherited phases and their anhedral shapes would be a consequence of sedimentary processes. The delicate and fragile shapes of kaolin booklets represent an authigenic origin as response to diagenetic processes.

Late Eocene-Pliocene basin filling patterns of the Llanos foreland basin of Colombia: local to lithospheric scale tectonic and eustatic controls to continental foreland deposition

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The Llanos basin of Colombia records a complete Upper Eocene- Pliocene sedimentary succession that document the growth of the adjacent Eastern Cordillera of Colombia. The effects of tectonic and eustatic factors were evaluated using 170 wells distributed in an area of 342 x 470 kms. Well cuttings, core descriptions and electric logs were used to define vertical patterns of sedimentation and stratigraphic surfaces of correlation; major surfaces were followed in a network of 11000 km of seismic profiles. The age and marine influence of stratigraphic units/surfaces were calibrated by palynological reports of 95 wells. Tectonic subsidence analyses and flexural geometry was evaluated with two-dimensional geodynamic models. Chronostratigraphic diagrams of the basal unconformity of the Upper Eocene-Lower Miocene succession indicate southward and eastward increasing depth of truncation. The onset of deposition in the proximal foreland began in Late Eocene in the southern and central Llanos, in mid-Oligocene in the northern Llanos, and in early Miocene in the distal Llanos. The topography of the unconformity in the southern Llanos and normal faulting in the northern Llanos controlled the irregular onset of Oligocene deposition. We interpret that migration of the forebulge controlled the eastward increase of the lacuna, but intraplate faulting in the south increased the depth of truncation. Two coarse-grained successions overlie the unconformity. The Upper Eocene – Lower Oligocene clastic wedge covered the proximal segment of the southern and central Llanos basin and extended 80 km from the present leading thrust fault of the Llanos foothills. The mid-Oligocene – Lower Miocene clastic wedge covered uniformly 250 kms of the middle to distal segments of the Llanos basin. Lithological associations of the second wedge changes westward to siltstones and mudstones, and it conformably overlies the first clastic wedge in the proximal Llanos basin. The eastward migration of theses continental clastic wedges is associated to the eastward migration of loading in the Eastern Cordillera. During late Early to Middle Miocene, the basin extended eastward more than 150 kms and the basin-filling processes shifted up-section from continental, to fluvial-deltaic, and to lacustrine. This retrogradational trend initiated at ca 20-21 Ma as recorded by a thin, but laterally continuous, shaly unit with marine fossils in the central-proximal segment can be followed in wells and seismic reflection profiles. Upward-coarsening successions of fluvial-deltaic origin overlies this unit indicating a short period of progradation. This sandy unit is covered by a thick silty to shaly unit with an aggradational pattern. Lithological associations of this fine-grained lacustrine unit are more sandy rich to the west, to the north, and to the east. The retrogradation documented in the Llanos basin is explained by onset of regional subsidence by mantle-driven processes, onset of vertical uplift of the Eastern Cordillera, and sea-level rise. Thickness patterns of the youngest and thickest coarse-grained continental clastic succession in the Llanos foreland basin suggest a rapid subsidence at the northwestern corner of the basin, associated to the conjugated vertical uplift of the Eastern Cordillera and Merida Andes. The thin record in the southern Llanos and provenance analysis indicate a shift pattern of provenance from cratonic, to internal uplifts, and finally to sediments derived from the Eastern Cordillera. The Llanos foreland basin developed as result of multi-phase growth of the Eastern Cordillera of Colombia, as depicted by the foreland-type stratigraphy and flexural geometry. Mantle-driven processes and eustasy also played a role in controlling the widespread deposition and retrogradation of Lower to Middle Miocene strata. Intraplate uplifts and normal faulting also controlled restricted continental deposition.

Tectono-sedimentary evolution of the Atuel depocenter of the Neuquén basin, Southern Central Andes, Argentina

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The Atuel depocenter of the Neuquén basin originated as an Upper Triassic to Lower Jurassic rift system, later inverted during the Andean contractional deformation. In order to study the tectono-sedimentary evolution of this depocenter, we integrated a large set of stratigraphic, sedimentologic and structural data into a multidisciplinary approach. We used data from facies and thickness distribution of the synrift units, provenance studies on sandstones, palaeoslope and palaeocurrent field measurements, kinematic data from outcrop scale normal faults, and angular and progressive unconformities within synrift strata. Regarding its structural architecture, the Atuel depocenter has a NNW trend, showing a bimodal distribution of NNW and WNW major faults. The general orientation of this depocenter was controlled by the development of two first order faults of NNW trend and western hanging-wall, the La Manga and Alumbre faults. From kinematic indicators measured on outcrop-scale faults, we found a mean NE internal extension direction, which is oblique to the general trend of the sub-basin. Taking these particular characteristics into account, we interpreted the Atuel depocenter as an oblique rift system. The Upper Triassic to Lower Jurassic infill of the Atuel depocenter consists of siliciclastic marine and continental sedimentary rocks, grouped in the Arroyo Malo, El Freno, Puesto Araya and Tres Esquinas Formations. The Rhaetian to Early Sinemurian period was characterized by deposition of slope-type fan deltas in the western sector, while in the eastern sector a coeval braided fluvial system developed. By the end of Early Sinemurian period, an intermediate- type fan delta prograded over the slope-type fan deltas in the western sector, while in the eastern sector the fluvial systems increased their lateral migration. Later, during late Early Sinemurian to Toarcian times transgression of a marine shelf and a marked increase in the marine depositional area took place. We interpret the Rhaetian to Lower Sinemurian sediments as deposited during the synrift phase of the Atuel depocenter. The La Manga and Alumbre major faults controlled most of the basin subsidence, the distribution of the sedimentary environments and the drainage patterns during this stage. While the braided fluvial system characterizes the synrift infill in the hanging-wall of the La Manga fault in the eastern sector of the depocenter, coetaneous deposits to the west of the Alumbre fault were deposited in the slope-type fan deltaic environment. The La Manga fault was the eastern border of the Atuel depocenter. To the east of this fault, there is no record of Upper Triassic to Lower Jurassic synrift deposits neither in outcrops nor in wells, while more than 1500 m of continental synrift deposits are registered in its hanging-wall. The fluvial deposits show outcrop scale normal faults and angular unconformities, indicating syntectonic sedimentation. On the other hand, the Alumbre fault maintained a nearly fixed position of the coastal line from Hettangian to Early Sinemurian times, restricting the marine sedimentation to the western sector of the depocenter. Fan-deltaic deposits in the hanging-wall of the Alumbre fault show a marked cuneiform geometry, with strata thickening towards the structure. This synrift sequence also shows angular and progressive unconformities indicating a progressive eastward tilting of its hanging- wall. The decreasing accommodation observed by the end of the Early Sinemurian was previously related to the start of the sag phase. However, we observed outcrop scale faults affecting Pliensbachian sediments in the southeastern sector of the depocenter, suggesting that the extensional deformation continued for some more time, or that a second rifting stage took place. In this context, it will be necessary to review the tectonic setting during the Sinemurian to Toarcian marine transgression.

Direct measurement of co-seismic fault activity through associated sedimentation: an example within the Lesser Antilles Arc

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In addition to climatic hazards, the Lesser Antilles Volcanic Arc is facing volcanic and seismic risks, and subsequent phenomena as tsunamis, and aerial or subaqueous landslides. Here, seismic hazard is both related to deep subduction ruptures and to more superficial faulting. The latter encompasses faults orthogonal to the Arc, and a left lateral strike slip system parallel to the arc with associated normal faulting. Relationships between these intra-arc deformations and volcanism are the focus of investigations combining tectonics and tephrachronology (Feuillet *et al.*, 2002, 2004; Boudon *et al.*, 2008). The GWADASEIS project was dedicated to identify the network of recent fault scarps (multibeam, SAR and chirp) and their deeper roots (multichannel airgun), and to reconstruct the distribution of major tephra for the Late Plesitocene and Holocene (pinger profiles and cores). As sedimentological studies may also yield paleoseismic data along active faulting systems (Beck *et al.*, 2007), 17 coring sites were chosen in order to provide: i) continuous records of Late Quaternary pelagic production and major volcanic events, ii) seismicity imprint. Different profiles display transparent homogenous layers overthickening towards the deep intra-arc basins or furrows. This geometry is supposed to result from the transfer of hemipelagic/holopelagic sediments from high ridges down to deeper floors. According to preliminary interpretations and cores contents observations (Beck, Feuillet, Reyss *et al.*, 2009) this transfer results from huge instantaneous events of gravity reworking (mass wasting evolving into turbidite). When these sedimentary bodies show thickening alongside ongoing faulting, we supposed they could represent co-seismic deposits which, thus, compensate the vertical component of the successive offsets. If so, they enable to directly measure the vertical component of each co-seismic offset and their recurrence time interval. In order to confirm the specific character of these sedimentary "events", we cored the most recent one, displayed by very high resolution profiles. We observed a structureless sandy- silty layer (up to 1.5 m thick) overlying fine-grained sediment. As the top of the underlying hemiplagic sediments strongly resembles the classical RedOx interface, i.e. the latest cm of sediments with early diagenetic transformations, we sampled this interval for short-live radionucleids detection and measurement. ^{137}Cs activity clearly displays the Atmopsheric Nuclear Experiments peak (also confirmed by 241Am) below the homogenous layer (“sedimentary event”). The 210Pb decay curve indicates that this major sedimentary event is not older than 1970 AD, and could likely represent the Mw 6.4 Nevis March 16th 1985 earthquake. Applying a sedimentation rate for the normal (back ground) sediment permits to estimate local recurrence time intervals, at two different scales: millennial (high resolution seismic profiles), and decadal (core data).

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Study of the water circulation patterns using Landsat imagery in San Blas Channel, Argentina

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San Blas channel (40º34´S, 62º11´W), located at the SW of Buenos Aires province (Argentina), is the southern portion of a large embayment (Bahía Anegada, 2371 km^2). The channel is 3-km wide and 27-m deep with a SE-NW orientation. Winds and tides are the main forcing agents that influence the water circulation in the channel. Data recorded by a meteorological station installed at San Blas channel coast since December 2007 show prevailing N and NNE winds and stronger NNE (39.5 km/h) and S (38.8 km/h) winds. The channel is affected by a mixed tidal regime with a semidiurnal predominance. Recently performed ADCP velocity profiles showed maximum values of 2.0 m/s during flood tide and 1.8 m/s during ebb tide (Cuadrado, pers. comm.). This investigation deals with the application of satellite images to characterize the water circulation in San Blas channel during a theoretical tidal cycle. Turbidity, a parameter detectable by Landsat reflective bands, was used as a natural tracer of water circulation patterns. Although the Landsat visible channels do not penetrate much in the turbid water, reducing the utility of turbidity patterns in dynamic studies to surface waters, the well- mixed San Blas channel, characterized by prevailing homothermal and homohaline vertical profiles and intense tidal currents, is considered an appropriate environment for the application of this approach. Six Landsat TM and ETM images acquired under clear-sky conditions during the warmer months of the year (November – March) and representing different tidal stages were selected from a pool of Landsat images provided by CONAE (National Commission on Space Activities). Geometric and radiometric corrections were performed on the visible and near-infrared bands. An atmospheric correction based on the COST method was applied. Terrestrial areas were masked and an ISODATA unsupervised classification was performed. TM3 and ETM3 bands were chosen for this study. Turbidity patterns have close relation with some morphological features of the channel bed. Tidal deltas located at both ends of the channel were evidenced by turbidity plumes during ebb and flood tide, respectively. Sediment transport by ebb currents (2 hours before low tide) was observed along the northeastern coast of the channel (Isla Gama and Banco Nordeste) which is characterized by fine-grained sediments (Cuadrado, pers. comm.). Sandy sediments along the southwestern coast were also carried by ebb currents, apparently feeding the ebb-tidal delta. These banks were also reworked by flood currents. From the elongated shape of the turbidity plumes, general tidal circulation patterns were identified in San Blas channel: a) in the external area seaward from the channel mouth, the flood current direction is nearly S to N due to the tidal wave coming from the south. This fact generates the re-transport of sediment from the banks closed to the shore, b) in the inner channel, flood currents cause sediment transport mainly on the south coast, c) in contrast, ebb currents trigger turbidity mostly over the northern flank, and d) as they reach the channel mouth, ebb currents flow in a wide spread direction into the open sea, showing a northward and southward transport of suspended sediment.

Mass-Wasting Events and related morphology along a coastal portion of Nahuel Huapi Lake Bed (Patagonia)

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A bathymetric survey using a Phase Measuring Bathymetric Sonar System ("GeoSwath Bathymetry System Plus", GeoAcoustic Ltd.) (CONICET-IADO) was carried out at selected coastal areas of Nahuel Huapi lake on April 2007. The equipment records the bed morphology and sedimentology with a high (submetric) resolution up to 100m depth approximately (Gómez and Maraschin, 2006).The aim of the survey was to study the origin of the tsunami that hit the coasts of S. C. de Bariloche on 22 May 1960, destroying the pier of San Carlos harbour. Analysing bathymetric data acquired at the vicinity of the harbour, a large subaqueous landslide and recent mass-wasting deposits were identified below 70- 80m water depth (Villarosa *et al*., 2009). Through sedimentary core information and high resolution seismic profiles, the authors linked the mass-failure and consequent tsunami to the 1960 Valdivia earthquake, suggesting that the failure was probably induced by the presence of a non-cohesive surface (tephra layer?) that acted as a sliding surface. Based on these previous results, a hypothesis about the probable existence of landslide-prone areas in the lake bottom was established. These areas, with steep slopes and/or materials prone to fluidization below, could be destabilized during a high magnitude earthquake, causing an extraordinary wave that would affect vulnerable coasts. The aim of this work is to present preliminary results of a landslide susceptibility study on costal areas of Nahuel Huapi lake, particularly at the urbanized coasts of S. C. de Bariloche, Dina Huapi and adjacent zones. Subaqueous morphology along a 9-km coast from Playa Bonita to the vicinity of Ñireco stream outlet (S. C. de Bariloche) was studied. Digital elevation models (DEMs), slope maps, bathymetric maps and bathymetric profiles were performed. Stream outlets were located and mapped. Steep slopes, subaqueous landslides, debris flow channels and probable mass- wasting deposits were found. The general areas affected by mass-wasting events were identified and related to slope ranges. In order to verify the hypothesis about the presence of potentially unstable areas in this portion of the lake bottom, next step will be collecting sedimentary cores at selected sites to determine the characteristics of the subjacent sediments.

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Ichnological and paleoclimatic analysis of weakly developed paleosols: Punta San Andrés Alloformation (Plio-Pleistocene, Buenos Aires province, Argentina) as a case study

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The Plio-Pleistocene continental deposits of the Punta San Andrés Alloformation that crop-out in the marine cliffs of Mar del Plata City (Buenos Aires Province, Argentina) show the development of different kinds of paleosols (Protosols, Vertisols and Calcisols) and a variety of trace fossils related to them. The presence of structures related to biological activity in these deposits has been pointed out by several authors, but they have never been properly described. Amongst the variety of traces related to invertebrate activity, burrows are the most abundant and three different morphologies can be recognized. The first group consists of un-lined meniscate burrows. They are slightly sinuous and their orientation is predominantly vertical to oblique. The burrows are 10 mm in diameter and 10 to 15 cm long. Secondary successive branching may occur, but true branching is absent. The absence of lining makes this ichnofossil assignable to *Taeniduim* isp. and they have been interpreted as produced by earthworm activity. These burrows are developed in Protosols with an index of bioturbation estimated in 4 or 5. The second group consists of variably orientated burrows with also a characteristic backfill meniscae but this time, lining is present. This burrows, interpreted as *Beaconites* isp., are found mainly in Protosols, more rarely in Vertisols, and their estimated index of bioturbation is between 3 or 4. Finally, the last burrow morphology is that of vertical to oblique orientated, un-lined, essentially cylindrical, straight to slightly sinuous burrows with active filling. They are 6 to 10 mm in diameter and 10 to 15 cm long and are found in calcic Protosols. The index of bioturbation for strata containing this kind of burrows is between 4 and 5 and they tend to be the only ichnofossil present in this silty to sandy strata. Another kind of trace fossil that can be found in these paleosols is multi-layered, spherical chambers 15 to 20 mm in diameter assigned to *Castrichnus incolumnis*. The chamber walls are 1 mm thick and they are built with imbricated pellets. Some of these chambers are connected to meniscate burrows assigned to *Taenidium* isp. Abundance of this ichnofossil is very low, less than 5%, and they have been interpreted as earthworm aestivation chambers. They are found in Protosols. The presence of chambers and burrows associated with earthworm activity provides valuable paleoclimatic and paleoecological information. Most earthworms can´t survive in water logged soils and need water to be confined to films on soil aggregates surfaces or in pore spaces. In those soils affected by seasonally strong dry periods, earthworms build aestivation chambers. Protosols are immature paleosols that characterize levees, crevasse splays and proximal floodplain deposits and they show, for the studied deposits, micromorphological evidence of a well-drained area. Calcic Protosols in the study area show micromorphological evidence of seasonally dry periods and Vertisols show evidence of water logging. The fact that the burrows and chambers described here were found mostly in Protosols and calcic Protosols, and that merely none of them were found in Vertisols confirms the prior paleoclimatic interpretations made on the basis of the micromorphological and sedimentological work.

Lacustrine cyanoids from freshwater limestones in the Triassic Cerro Puntudo Formation (Cuyana Basin, San Juan, Argentina)

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In order to better refine the paleoenvironmental analysis of the lacustrine succession in the Triassic Cerro Puntudo Formation (Anisian) located in the Cuyana rift basin of Argentina, a half-meter thick limestone was studied. This carbonate layer contains two tuff and two silty clay laminae about 1 cm in thickness that allows for the differentiation of three units. All three units are characterized by the presence of cyanoids (oncolites containing cyanobacteria and algae), silty carbonate and siliciclastic matrix, and charophyte remains, and are classified as algal wackestones. The cyanoids have concentric laminae and range in diameter from 0.5 to 8.0 cm. They have irregular margins and multiple laminae in the cortex coating of one or more nuclei. In some cases the nuclei consists of charophyte thalli and reproductive structures (gyrogonites). Transversal sections of the thalli measure between 0.2 and 0.6 mm wide with longitudinal sections of gyrogonites 600 µm long with an approximate diameter of 400 µm. Both structures are replaced by spar and can be seen in longitudinal and transverse sections. Between the laminae algal filaments of cyanophytes have been preserved as tubules of 10 to 20 µm long with micritized external walls. The matrix is composed of carbonate and siliciclastic silt grains as well as cyanoid coated grains. These limestone units are interpreted as deposits of a marginal lacustrine paleoenvironment that has undergone diagenesis within subaqueous conditions, no subaerial exposure or pedogenic features are evident. The process that gave rise to the cyanoids involved the growth of microbial mats above the thalli of charophytes while they were in situ in the littoral zone of the Cerro Puntudo paleolake. The existence of moderate energy currents and agitation may have promoted the formation and growth of the concentric cyanoids in this Triassic nearshore environment.

An exceptional record of shelf sediment export from the Uruguayan Margin

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The direct study of shelf sediment export behaviour through time requires well preserved but as proximal to the shelf as possible records. Outer shelf sedimentary patterns are too dynamic to give the full temporal evolution. On the other hand as soon as the sediment is transported over the shelf break it is affected by sorting processes (e.g. by contour-parallel or downslope transport), which overprint the slope sediment records. Sedimentary traps directly below the shelf break would make the perfect location for studying shelf sediment export. Off Uruguay a 20-km long morphological terrace right underneath the shelf break (shelf break in about 200 m water depth, mean water depth of the terrace: about 250 m) has been discovered. This exceptional morphological feature of the Uruguayan margin gives the rare opportunity to directly record shelf export variations through time and thus gain insights into the genetic evolution of the shelf-system and into process-oriented shelf – slope linkages. During the R/V Meteor expedition M78/3a in 2009 three up to 10-m long gravity cores from this exceptional location have been recovered. We employed sediment-acoustic (Parasound) profiles, radiocarbon dating and detailed lithologic core description to set the stratigraphic time frame, identifying four main depositional units. The upper three units have been sampled by coring and thus we could assign their lithologies. The lowermost cored unit (U3) is associated with sea-level lowstands prior to and during the Last Glacial Maximum (LGM) and records sensitively rapid changes in the neighbouring shelf environment; the overlying unit (U2) spans the following deglacial time interval of transgression during which thick coarse-grained beds of reworked shelf material have been deposited on the terrace; the youngest, uppermost unit (U1) represents the very close to and modern sea-level highstand sedimentation on the terrace. Clastic sedimentation on the terrace is on larger scale primarily controlled by sea-level variations. However, grain size proxies and benthic foraminifera assemblages indicate additional major oceanographic changes over the study area since the LGM. On the one hand, the energy conditions on the outer shelf have strongly changed through time and are recorded by overall grain-size trends as well as the preservation of numerous time-concentrated event beds. On the other hand, the general oceanographic circulation pattern in the upper levels of our study area is dominated by the Brazil-Malvinas Confluence (BMC) arising from the conjunction of the northward-flowing cold and nutrient-rich Malvinas Current (MC) and the southward-flowing warm and saline Brazil Current (BC). The varying presence of selected benthic foraminifera with certain water depth and temperature range preferences indicate a change from pronounced warm water influence towards stronger cold water influence on the terrace through time.

New approach for reservoir assessment using geochemical analysis: Case Study

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Geochemical studies provide information on the concentrations and distributions of some geochemical constituents for the purpose of reservoir quality. It may reveal constituents origin; help classifying reservoir rocks and assessing the evolution of petrophysical properties (porosity and permeability). Geochemical constituents; such as K_2O, CaO and MgO and their concentration have an important impact not only on the pore space, and its geometry, but also on the generation of secondary porosity. Thus, reservoir characterization is related to mineral type, dissolution, and precipitation, since the host minerals are partially or totally changeable chemically and physically. This occurrence is own mainly to subsurface variation of thermodynamic conditions. The main objective of this study is determination of reservoir quality based on specific geochemical constituent's evolution. This investigation will lead to determine the potentially net pay zones. The geochemical method based on the suitable constituents can be applicable in formation zones, where appropriate cutoffs are established. Sustainability of this study comes from the use of Geochemical Logging Tool logs (G.L.T), which can be coupled with geochemical analysis to gain reservoir relevant information on petrophysical characteristics.

Characterization of the Oxfordian coral-reef types, at Portada Covunco, Neuquén Basin

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During the Oxfordian coral-reefs flourished at mid-palaeolatitudes on the Neuquén epicontinental shelf. The reef facies of the La Manga Formation extending along the southernmost part of the Sierra de la Vaca Muerta, at Portada Covunco, have been studied to identify and characterize different types of coral reefs. Sedimentological and paleoecological observation lead to the reconstruction of a coral reef tract in a shallowing-upward succession evidenced by the associated microfacies which show a coarsening upward trend from peloid mudstones to bioclastic wacke/pack/floastones and finally grain/rudstones. The fauna is dominated by scleractinian corals. Additional benthic faunal elements are siliceous sponges with calcareous preservation and coralline sponges, brachiopods, bivalves and some cidaroid echinoids. An encrusting and boring fauna composed by serpulids, bryozoans, and lithophagid bivalves occurs on the undersides of corals and, partly on sponges. Microbial crusts overgrow the sponges or the skeletal hardparts. Seven generic reef types are recognized in the vertical ecological zonation: 1) platy microsolenids (Microsolena?) associated to peloidal mudstone matrix; 2) reefal framestone of tall dense phaceloid colonies developed in pure carbonate muds; 3) mixed coral-siliceous sponge (hexactinellids and "lithistids") reef with echinoids in marly facies; 4) branching ramose coral (Actinastrea?) developed in marly facies; 5) coral- microbial crust reef dominated by thamnastero-meandroide massive colonies (Australoseris radialis?), ramose corals and brain corals, and some small siliceous sponges in microbial-peloidal packstones with dense micritic crusts; 6) platy- microsolenid corals associated with bioclastic wackestone with abundant and diverse skeletal material (cidarid echinoids, bivalves, gastropods, brachiopods, coralline sponges, bryozoans, serpulids, Tubiphytes); 7) tall dense phaceloid colonies (organ-pipe corals) developing among sand-shoal and coral debris channels. Such succession is repetitive. The microfacies model implies an oolitic shoal in the highest energy zone at the base of the coral facies.The intersticial material between corals is a bioclastic-pelecypods-wackestone matrix with serpulids. Towards the top, tabular-platy corals are replaced by tall, dense phaceloid colonies associated to lithoclastic-grainstones which point to shallower depositional conditions of this upper Jurassic coral reef. This reef facies can be remarkably usuful in local and regional stratigraphic correlations and for a better paleoenvironmental interpretation of the basin during this time. This reefal succesion can be correlated with the "global carbonate reef event", which occurred widespread within the epicontinental seas bordering the northern Tethyan Ocean and the marginal basins of the young North Atlantic Ocean.

Microfacies and paleoenvironments from the carbonate shelf of the southwest Laurentia border, Pozo Nuevo Formation, Lower-Middle Ordovician (Central Sonora, Mexico)

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This work shows the results of the facies/microfacies and paleoenvironmental analyses of the Pozo Nuevo Formation outcropping at the Cerro Salazar, nearby the Rancho Las Norias (Central Sonora, Mexico). The formation corresponds to the deposits of a continental carbonate shelf that developed in the southwestern extreme of Laurentia in the Lower-Middle Ordovician. The microfacies enables identifying different sub-environments within the carbonate shelf from shallower to deeper: beach coastal, formed by quartz sandstone and laminated quartzite with desiccation cracks; internal shelf supratidal constituted by dolomitized wackestone and intertidal-subtidal lagoon characterized by diffusely laminated microbialites, oncoid mudstone, pelloid packstone grading to biopelloid and bioclastic packstone with foraminifera and ostracods; intertidal-subtidal frontal bar complex composed by grainstone and packstone with crinoids and algae (Nuia) and detritic quartz and bioclastic packstone with briozoans. In the lagoon as well as in the bars environment, there are intraclastic-bioclastic packstone levels intercalated. They are interpreted as proximal storm events. The main fauna components are orthid and strophomenid articulate brachiopods, trilobites, nautiloids, crinoids, archaeogastropods (Macluritids), bryozoans, calcareous algae, ostracods, foraminifera and conodonts. The facies vertical variation indicates a marked trend toward shallowing with quartz sandstone and dolomite from the top of the carbonate section. At the base, fine micrite was deposited in a shallow lagoon. A crinoid bar complex in intertidal environment was developed in the middle part. Over these bars fine laminated sediments were deposited in a shallow intertidal environment. New crinoid and briozoan bars developed toward the upper part. Towards the top there is an increased participation of detrital quartz with deposition of quartz sandstone from a coastal environment, recording the migration toward the basin interior of the coastline. The section culminates with a significant dolomite thickness from vadose environment. The depositional model shows a gradual shallowing from low-energy carbonates to beach facies of quartz sandstones.

Stratigraphic signature of sea-level and climate changes during the last 500 kyr: The Gulf of Lions deltaic margin in the western Mediterranean

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High-resolution seismic investigations of continental margins around the world reveal that Quaternary sea-level changes had a strong impact on their architecture; to some extent, these investigations fuelled the conceptual models of sequence stratigraphers, because Pleistocene sea-level changes are better known than those of the geologic records. However, very little chrono-stratigraphic constraints were available, especially for those seismic sequences few tenths meter thick that typically constitute the building blocks of many deltaic margins; consequently, the processes and time-scales at their origin remained largely speculative. The sites drilled by the European Community-funded PROMESS 1 project in the Gulf of Lions and in the Adriatic provide the best-documented examples of the impact of Quaternary sea-level changes on margin evolution. In the Gulf of Lions, seismic profiles display sediment wedges thickening seaward, with shelfal regressive units bounded by unconformities, and their correlative conformable sequences. Two sites were drilled, one within the prograding clinoforms on the outer shelf (PRGL2), and a second one on the upper slope where sediment record is continuous (PRGL1). The latest provides an expanded and continuous record of the last ca. 500 kyr that has been precisely dated through a multi-proxy approach. We present here a revised and refined seismic interpretation, based on the confrontation of (a) the interpretation of about 10,000 km of seismic profiles at various vertical resolutions and (b) the multi-proxy analysis of hole PRGL1-4. It shows that the most distinct seismic reflections along the upper slope are maximum flooding surfaces (mfs) associated to the warmest interglacials, corresponding to the top of condensed intervals formed at a time when deltas migrated about 70 km landward. They display distinct amplitude anomalies, often underlined by pockmarks, and toplap and onlap terminations. The most pronounced transitions between stadials and interstadials are at the origin of similar seismic surfaces. For instance, the transition between Heinrich Event 5 and Greenland Interstadial 12 is characterized by a major seismic surface traceable throughout the shelf edge. Sequence boundaries (sb) associated to major glacial periods are only recognizable on shelf seismic profiles, where they are represented by high-amplitude truncation surfaces (polygenic in origin). They match the very coarse-grained intervals, with a mixture of cold and warm mollusk faunas described on borehole PRGL2-2. The long-lasting and major sea-level drawdown during Marine Isotope Stage (MIS) 12, and almost as pronounced MIS10.2 had a major impact on shelf architecture, removing a large amount of sediment and providing accommodation for ensuing deposits. In particular, thick sandy delta fronts deposited at the transition between MIS 9.1 and MIS 8.2 were almost entirely preserved. Finally, our results demonstrate that a new approach, named “seismic paleoceanography” by R. Schneider (pers. comm.) is possible on deltaic margins, allowing for identification and characterization of a large spectrum of paleoceanographic and paleoclimatologic events. This approach, as any other, suffers limitations that will be discussed.

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Transport trajectories of "smart" pebbles on an artificial coarse-grained beach at Marina di Pisa (Italy): implications on beach morphodynamics

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The definition of pebble transport and movement along the shore has been subject of revived interest lately mainly because of significant advancement in the technologies that enable to trace such coarse sediments. The chance to improve the understanding of a topic sometimes neglected in the past has been favoured by recent refinements on the Radio Frequency Identification (RFID) technology, which has proved to be a reliable tracing technique, perfectly suitable for pebble-sized sediments. The RFID technique allows to couple the pebbles to small, discoidal transponders (tags). These "smart" pebbles are detected back by an antenna (reader), which transmits low frequency (125 KHz) radio signals. The choice to opt for the low frequency was suggested by its capability to better transmit and receive the radio signals even underwater. The research was performed on an artificial pebble beach at Marina di Pisa (Tuscany, Italy), a small village located on the Pisa coast, which has been subjected to serious erosive processes since 1850. The original sandy beaches could not be preserved, thus prompting local authorities to plan coarse replenishments. The artificial beach, named Barbarossa, was set up in its final configuration in 2007. Presently, it is 110 m long and 20-to-35 m wide. It is bound laterally by two groynes, which impede longshore sediment movement. One-hundred and two pebbles were sampled on the beach and carefully prepared for the installation of the transponders, which univocally identify the pebbles because each tag possesses an unambiguous code. The tracers were injected on the beach along cross-shore transects, three pebbles each (on the fair-weather berm, on the beachface, and on the step crest). The release position of each tracer was recorded with a total station. The recovery campaign was carried out after three storms, which all came from the same direction (SW). Fifty-three smart pebbles were found back, which is not a negative outcome considering the high rates of sediment reworking on the backshore of Barbarossa due to the intense wave energy this beach is subjected to during the storms. The recovery position of the pebbles was recorded as well. The analysis of the tracer displacement pattern highlighted a tendency of the sediments to move towards the storm berm, where 55% of the smart pebbles was detected. This movement is probably related to the energy of the incoming waves, hardly dissipating in the surf zone of Barbarossa. The waves unload their energy almost entirely on the beachface, where they force a sediment onshore movement rather than offshore. In addition, the smart pebble transport pathways outlined the presence of two distinct convergence area at Barbarossa. The tracers showed the tendency to converge to two separate sectors along the beach. A topographic survey of the sea-bottom fronting the beach was carried out prior to the recovery campaign by means of a single-beam echo-sounder. Data processing showed the presence of two portions of the sea-floor characterized by shallower depth. These shoals are just opposite to the two convergence areas pointed out by the pebble movement. These features of the sea-bottom might imply refraction and diffraction processes of the incoming waves, which in turn are responsible of the generation of convergent fluxes on the beachface. The convergent pattern of these fluxes leads to the transport trend of the smart pebbles. These results confirm the existence of a tight connection between the sea-bottom morphology and sediment transport on a beach. In-depth considerations about pebble movement on a coarse-grained beach might be useful to an optimization of future coarse replenishments, since they are frequently used as a form of coastal protection. In addition, a better definition of the dynamics acting on this environment might support studies on similar, ancient depositional settings.

Limited influence of sediment grain-size on elemental XRF core scanner intensities

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XRF core scanning is increasingly used to generate high-resolution geochemical records from sediment cores. This technique is non-destructive and it provides bulk sediment chemical data, expressed as elemental counts, or peak areas. Although XRF elemental counts mainly depend on the concentration of the element, they are also influenced by the characteristics of the X-ray source (energy level, nature of the tube) and detector (count time), by core surface topography, and by a series of sediment physical properties such as density, water content, organic matter content and grain-size. Since these physical parameters frequently vary with depth in sediment cores, it is crucial to understand their effect on XRF intensities to improve data interpretation. Here, we investigate the influence of grain-size on elemental XRF intensities by comparing ITRAX XRF data and ICP-AES measurements from two sediment cores with variable grain-size. For both cores, we compare the XRF intensity / ICP-AES elemental concentration ratio to the sediment grain-size, which was measured on the organic-, carbonate- and opal-free fraction by laser diffraction. The two cores cover a series of sediment grain-sizes from 15 to 120 µm, with the first core showing abrupt transitions between sub-glacial sand deposits (100-120 µm) and fluvio-glacial silts (~20 µm), and the second core showing a gradual evolution from fine to medium silt (15-25 µm). Both cores provide evidence for a very limited influence of sediment grain-size on XRF intensities. This influence is negligible for elements that are not strongly partitioned by grain-size, such as Ca, and it appears minor (~10%) for elements that are regularly associated with a specific sediment grain-size fraction, such as Zr and Ti. Because of their strong partitioning by grain-size, these elements also show large variations in concentration in the studied sediment cores, and we argue that the observed changes in the XRF intensity / ICP-AES elemental concentration ratio are mostly due to the absence of blank and/or matrix correction of XRF core scanner intensities (i.e., calibration equations never pass through the origin). These observations therefore demonstrate that the influence of sediment grain-size on elemental XRF core scanner intensities is negligible for most elements. However, our results also show that there is a need to develop rigorous calibration equations for geochemical data obtained by XRF core scanning. Further studies should focus on assessing the influence of other sediment physical properties on XRF intensities.

Holocene glacier variability in Northern Chilean Patagonia reconstructed from the glacio-marine sedimentary record of Golfo Elefantes (Chilean Fjords, 46°S)

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Several recent studies have demonstrated that the Holocene climate of Northern Chilean Patagonia was more variable than previously thought. In parallel, several authors have demonstrated that the outlet glaciers of the Northern Patagonian Ice Cap (NPI) have re-advanced several times during the Holocene. However, the link between glacier variability and past climate changes in Northern Patagonia remains unclear. Here, we investigate the mid and late Holocene variability of Gualas Glacier, one of the northernmost NPI outlet glaciers, by a multi-proxy sedimentological and geochemical analysis of a 15m long fjord sediment core from Golfo Elefantes, Chile. Radiocarbon measurements obtained on shell debris (reservoir age: 500 years) and terrestrial plant remains demonstrate that the core covers the last 5400 years. Our multi-proxy approach combines high-resolution geochemical (XRF core scanning at 2 mm resolution) and magnetic susceptibility (MS, 1 cm resolution) measurements with lower resolution (2-10 cm) grain-size, organic (TOC, C/N, $\delta^{13}C$) and inorganic (ICP-AES) data. Our results show that the core can be sub-divided into three main units that were deposited under very different hydrodynamic conditions. Between 5400 and 3700 cal. yr. BP and from 750 cal. yr. BP to the present, sedimentation in Golfo Elefantes was characterized by the rapid deposition (~ 10 mm/yr) of fine silt, which was most likely transported by fluvio-glacial processes similar to those currently occurring in front of Gualas glacier. By contrast, sediment deposited between 3700 and 750 cal. yr. BP is composed of poorly sorted and shell-free sand, most likely representing sub-glacial sedimentation. This coarse unit, which is particularly marked by high magnetic susceptibility values and Zr concentrations, was deposited at an average rate of 1 mm/yr, and it likely reflects a major advance of Gualas glacier into Golfo Elefantes during the Neoglaciation. In addition, several thin silt layers observed in the upper part of the core are interpreted as minor advances of Gualas glacier during the Little Ice Age. This interpretation is supported by the historical data available for the nearby San Rafael glacier. Our interpretation of the Golfo Elefantes glacio-marine record in terms of glacier variability is in excellent agreement with the regional glacier chronology based on terrestrial (moraine) deposits. By comparing our results with regional precipitation and sea surface temperature records, we demonstrate that the major advance of Gualas glacier at 3700-750 cal. yr. BP was most likely caused by a combination of low temperature and high-precipitation following the end of the Holocene climatic optimum. However, our results also provide evidence that the retreat of Gualas glacier during the Medieval Climate Anomaly (MCA, 800-1300 AD) was most likely due to a decrease in precipitation, rather than an increase in temperature. Similarly, it appears that the minor glacier advances during the Little Ice Age were driven by increased precipitation in the Patagonian Andes. These results therefore suggest that NPI glacier variability during the mid and late Holocene was mainly driven by precipitation in the Andes, which is in turn controlled by the strength and latitudinal position of the westerly wind belt.

Roofing and Unroofing inferred from sandstone compostion: case studies of the Shimanto Supergroup, Kii Peninsula, Southwest, Japan

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Multi-approach combining with modal, heavy minerals and garnet composition analyses of sandstones were carried out for the Late Cretaceous Terasoma Formation and the Palaeogene Otonashigawa Group that belong to the Shimanto Supergroup of the Kii Peninsula, Southwest Japan. The Terasoma Formation (Turonian – Early Companian) is divided into three members: the Lower member being composed mainly of mudstone and mudstone-dominated alternating beds of sandstone and mudstone; the middle member consisting of sandstone with intercalated mudstone; and the upper member comprising mudstone. The Terasoma Formation has been believed to be deposited in a forearc basin. Modal composition of the sandstones of the Terasoma Formation shows upward change in a rock type from feldspathic wacke to lithic wacke rich in felsic volcanic fragments in the lower part of the middle member. Composition of heavy minerals also changes upward from the assemblage rich in zircon and garnet associated with epidote, titanite, allanite to the assemblage of minor amounts of garnet and anatase. These changes suggest that violent felsic magmatism took place in Coniacian in the hinterland and lavas and pyroclastics thickly roofed granitic rocks. The Otonashigawa Group (Paleocene – early Late Eocene) is lithologically divided into the Uridani and Haroku Formation, in ascending order. The Uridani Formation is composed of grey mudstones accompanied with green or red mudstones. The Haroku Formation is mainly composed of interbedded sandstone and mudstone, and conglomerate beds; they are arranged, as a whole, into thicken-and coarsening-upward motif. The Otonashigawa Group has been interpreted as submarine fan deposits accumulated at the mouth of a submarine canyon debouched to the trench basin. The modal composition of the sandstones of the Haroku Formation shows upward change from lithic wacke rich in felsic volcanic fragments to feldspathic arenite rich in monoquartz grains. The heavy mineral assemblages of the lower part are rich in greenish-brown hornblende.On the other hand, the uppermost part contains abundant epidote, allanite and titanite. The chemical composition of detrital garnets also shows from the lower to upper parts a decrease in the pyrope-rich almandine (intermediate P/T type garnet) and an increase of spessartine-rich almandine (low P/T type garnet). A few Grossular garnets are extracted from the upper most part. These data indicate that the source rocks for the lower and upper parts of the Haroku Formation were different. During Palaeocene to earliest Eocene time, the provenance of Otonashigawa Group was chiefly composed of felsic volcanic rocks, pyroclastics, intermediate P/T metamorphic rocks, and glanulite-facies metamorphic rocks. Due to unroofing, granitic rocks and low P/T metamorphic rocks which were situated below the felsic volcanics, were exposed and their detritus were transported into the trench basin in Middle Eocene time. Calcareous metamorphic rocks were also exposed,as suggested by the presence of Grossular garnets. The existence of pyrope-rich almandine (Ig2 type garnet) and so-called Purple zircon suggests that there were also Precambrian granulite-facies metamorphic rocks and sedimentary rocks in the source of the Otonashigawa Group. The change in sandstone composition in the Terasoma Formation suggests that the roofing rapidly took places. In contrast, moreover , the change in the Otonashigawa Group shows that the unroofing gradually progressed. These events suggest fast lapping by the lavas and pyroclastics, and slow denudation of them.

Aeolian dust in the semiarid Argentinean Pampas. Source of 2009 Dust Storms

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The semiarid region of the pampean plains is located in eastern Argentina, and comprise part of La Pampa and Buenos Aires provinces. This region is mainly an extensive plain grading to the Atlantic Ocean with several longitudinal and enclosed topographic depressions. Late Pleistocene-Holocene sandy loess and very fine sand sheets cover most of the landscape. This region is located in a temperate climate zone, with mean annual temperature of 15.3°C and annual rainfall of 610 mm. Prevailing wind directions are N and NW with mean speed of 24 km/h. Particularly, during the two-year drought of 2008 and 2009 -annual rainfall of 340-400 mm- the strong dry N-NW winds (35-70 km/h) blowing over fine-grained aeolian sediments have led frequent dust storms in the region, mainly during springtime. The purpose of this paper is to explore the provenance and transport of dust storms during 2009 in southwestern Buenos Aires Province, by combining dust flux, particle size, petrographic and SEM analyses of dust storm materials. The composition of these materials was compared to those of regional loess and topsoils of Chilean Atacama Desert (1800km to the NW of study region), in order to evaluate local and distal potential source areas of dust storms. Dust materials were sampled during 8 dust storm events from July to November 2009. Dust samples were collected at 10. 5 and 1 m over the soil surface using three types of traps. A special trap was used to capture airborne materials for SEM analyses. Grain size distributions of dust storm samples show that about 80% are silt-size particles. However, SEM images of this material show that silt-size aggregates are very frequent. Several coarse and medium silt-size grains are in fact aggregates of 1-10 µm particles. Other discrete particles of 10-50 µm have a great amount of ultra-microparticles (<0.5 µm) filling hollows or surface irregularities. These features could indicate that not all particles <10 µm were transported as discrete particles in long-term suspension -at high altitude- travelling thousands of kilometres. Probably, part of them could have moved as silt-size aggregates in short-term suspension episodes at lower levels in the atmosphere over short distance from the source (<30-50 km) Petrographic analyses show that the light fraction of dust -in decreasing order of abundance-, is composed of 1) unaltered acidic glass shards –scarce basic shards-, 2) opal phytolyts, vegetal tissue fragments and aggregates of biological and terrigenous material, 3) phyllosilicates mainly those of chlorite group, with biotite as a subordinated component, 4) fresh and altered K- feldspars (sanidine and microcline) and plagioclases, 5) carbonates, mainly calcite. Heavy fraction is represented by 1) hornblende and lamprobolite, frequently fresh and euhedral, 2) Fe-hypersthene and augite, frequently fresh and euhedral, and, as a minor component, 3) Rounded and unaltered olivine. Furthermore, SEM images show abundant halite cubic crystals of 0.5 to 15 µm of size. The petrographic composition of dust is similar to those of sandy loess and very fine sand of the Southwestern Buenos Aires Province, suggesting that these materials could have been a local source of 2009 dust storms. Halite crystals have been probably emitted from the local topographic saline depressions of the region. The higher contents of chlorite and biotite, opal phytolyts and fresh and euhedral K- feldspar, amphibole and pyroxene of dust are also found in topsoils of Atacama Desert. Recent satellite images observations of the Puna region, show dust plumes emerging not only from saline lakes of Atacama Desert but also from those of Argentinean Puna. The migration of this dust plumes is downwind, i.e. NW-SE, consistent with the wind circulation of 2009 dust storms in semiarid pampas. This behaviour and the dust mineral composition suggest that Chilean Atacama Desert topsoils could have been one of the distal sources of 2009 dust storms.

Quaternary evolution of alluvial fan systems: an example from the Gastre Basin, Argentina

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The Gastre Basin is an intermontane topographic depression located in central Patagonia, Argentina. It has a NW-SE main trend and extends over an area of 4,200 km2 which has arid climate conditions. The basin formed during the Middle Miocene and suffered minor structural reconfigurations during the Pleistocene. The heights of the NE bounding mountains (1800 m) are higher than the ones in the SW (1200 m), both composed of pre-Miocene basement. The basin floor has a minimum height of 830 m. The drainage network is transitory and endorheic, defining a bolson. The record of this basin is 400 m maximum, with a maximum of 150 m of Quaternary deposits that include alluvial, fluvial and lacustrine deposits that interplay with a volcanic field 0.3-1 Ma old. Detailed geological, geomorphological and hydrological mapping, together with trial pits and sedimentary cores were performed in order to analyze the sedimentological characterization of the quaternary geomorphological units. Two distinctive stages of accumulation were recognized for the Quaternary fill of the Gastre Basin. Stage I (lower to middle Pleistocene) is characterized by remnant fans and bajadas of an area around 50 km2, which are incised by the modern drainage systems. The surface of these units is characterized by the development of mature soils that include argilic and calcic horizons, and varnished gravels. The slopes of the remnant fans and bajadas range from 1° to 3°. These units are mainly composed of pebble to cobble-grade conglomerates with abundant fine- to coarse-grained sandy matrix. In some cases, these deposits are clast-supported. Internally, they are mainly massive although a faint horizontal stratification and clast imbrications can be registered. These facies can be associated with fine- to coarse-grained sandstone lenses with planar cross-bedding. Subordinated facies of matrix-supported, cobble to pebble-grade conglomerates with a clay matrix are also registered. The younger stage (Stage II) is related to the upper Pleistocene- Holocene and is composed of three large alluvial fan systems, around 170 km^2 in area, and by many inset fans with less areal extension (45 km^2). The record of Stage II incises deposits of Stage I, causing topographic ridges up to 50 m high near the mountain front. The fans end in playa lakes and are connected to the recent drainage systems. The catchment area of the large fans ranges from 400 km^2 to 1,300 km^2, and from 27 km^2 to 240 km^2 for the inset fans. The slopes of the alluvial fans and inset fans of Stage II range from 0.1° to 1°. They consist of pebble to cobble-grade conglomerates with fine-to coarse-grained sandy matrix. Clast and matrix-supported textures are registered with planar cross-bedding, horizontal stratification and clast imbrication as the most common sedimentary structures. Lenses of coarse-grained and pebbly sandstones with planar cross-bedding are also recorded. The overlapping of alluvial fan lobes over playa lake deposits and the presence of remnant elevated coast lines are indicate episodes of base level fall during the development of Stage II. All the geomorphic units exhibit evidences of streamflow processes. Minor debris flow facies are observed in Stage I. The marked differences in slopes between the two identified stages and the presence of debris flow deposits only associated to Stage I indicate a change in depositional conditions between these two evolutionary stages. Despite neotectonic activity inside the basin (indicated by aligned volcanic cones), there is no evidence of tectonic control over the quaternary sedimentary record. The development of large, streamflow-dominated alluvial fan systems is most likely associated with more humid conditions recorded towards the end of the Pleistocene. Therefore the actual configuration of the Gastre Basin reflects processes that took place in the Pleistocene-Holocene boundary and little modifications have occurred since then.

High-frequency evolution of Cap Lopez area (Gabonese margin) from annual bathymetric data (2004-2009)

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The Cape Lopez, located on the Gabonese coast (South Western African Margin) is a very large, NW-SE orientated sand bank, characterized by a rapidly changing coastline due to the complex alternation of erosion and sedimentation. Most of the sediments deposited in this area are transported by the littoral drift (sedimentary flux: 300,000 - 400,000 m^3/year; Bourgoin *et al.*, 1963). Recent Mono and Multibeam data in this area reveal for the first time the detailed morphology of the Cape Lopez Canyon and Pointe Odden. Georeferenced digital elevation models performed each year between 2004 and 2009 were analyzed to determine changes in bathymetry and describe short-term sedimentary processes. Substantial rapid changes in the morphology have been observed in both areas between 2004 and 2009: - In the Cap Lopez Canyon, an important lateral migration of the thalweg is observed (mean: 30 m, locally up to 55 m). The absolute migration is linked to back-and-forth movements of the thalweg, inducing significant evolution of the sinuosity (up to 0.2/year).The lateral migration is characterised by sediment accumulation on the inner-bend (mean deposit: 3m) and erosion on the outer-bend (mean erosion: 6m). - On the Pointe Odden, erosive patterns (up to 6m) are observed between 2004 and 2005, leading to the formation of a new gully located close to the coast. In 2005, a submarine slide occurred between 5 and 50m water depth. The estimated volume of the corresponding slump scar is 2.5 x 106 m^3. The upslope migration of the gully head between 2004 and 2005 probably contributed to the destabilisation of an important volume of sediment. These results show that the Cap Lopez is a very dynamic sedimentary environment. High frequency study of this area provides new elements of understanding about submarine channels and slides dynamics. However, the important sediment movements observed on the bathymetric data represent only a part of the real sediment flux that occurs through repeated sediment supply and sediment removal.

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Transport of terrestrial particulate organic carbon in the Ogooué deep sea turbidite system (Gabon)

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In order to define the nature and distribution of the organic matter preserved in the recent Ogooué deep sea turbidite system (Gabon), bulk geochemical techniques (Rock-Eval, elemental and isotopic analyses and palynofacies) were applied to three cores collected both on the continental slope and in the Cape Lopez canyon and lobe. Particulate organic carbon (POC) accumulation in the study area is strongly controlled by the combined influence of Cape Lopez canyon and littoral drift. In the canyon and lobe, terrestrial organic material is predominantly deposited. Hemipelagites show constant POC contents (~ 3%). Gravity-flow deposits are generally low in POC (0.5 %) and organic matter is oxidized. These low values are attributed to the capture of the littoral drift by the canyon head during high energetic mechanisms, leading to the dilution of the organic carbon signal by the detrital fraction. Transport by long-shore currents and/or gravity flows probably leads to the oxidation of the OM. However, high POC content is found in the lobe deposits and could be related to a direct transport of the OM from the river mouth by gravity processes generated during Ogooué flood events. On the continental slope north of the canyon, hemipelagites (~ 3 % POC) contain a mixture of terrestrial higher-plant debris and oxidized phytoplanktonic material. High amounts of terrestrial organic matter (up to 14 % POC) are observed in turbidites due to the low dilution of organic matter by the detrital fraction, which is preferentially channeled by the canyon. POC content variation within turbidite laminations can be explained by the burst and sweep deposition process affecting the boundary layer of the turbiditic flow. This study provides new information about transport of terrestrial POC in the Ogooué turbidite system. We show that mass gravity flows are an important process for the formation of organic-rich sediments in deep water settings and that the Ogooué turbidite system may form a potential depot-centre of organic matter.

Deep-shelf cool-water bryozoan mounds from the Early Paleocene at Stevns Klint, Denmark

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A laterally extensive lower Danian deep-shelf bryozoan mound belt is exposed over 14 km of near continuous outcrop in the coastal cliff Stevns Klint in eastern Denmark. Formation of the bryozoan mounds was initiated shortly after the K/T boundary in a NW–SE oriented seaway covering the Danish Basin. Individual mounds are oval in plan view, internally asymmetrical, and were 5–11 m high, and 45–110 m long on the seafloor in NNE–SSW oriented dip sections parallel to the direction of mound migration, and 50–300 m long in strike sections. The southern flanks are steep and dip 15–30° mainly towards the SSW whereas northern flanks have gentle dips of 0–15° towards the NNE. The mounds were dominated by small benthic suspension-feeders that generally occur as non-abraded fragments set in a carbonate mud matrix. The main skeletal contributors are delicate branching bryozoans with minor contributions of bryozoan sheets, and nodular/arborescent bryozoans. Locally abundant octocorals occur on the mound crests and upper parts of the steep flanks. Echinoids are present in minor amounts, but are locally abundant. Serpulids, crinoids, asteroids, brachiopods, bivalves, massive calcareous sponges, and benthic foraminifers are minor contributors to the benthic mound fauna. Influx of planktonic foraminifers, coccoliths and other planktonic organisms was high and was probably a major source of nutrient supply to the mainly suspension-feeding benthic fauna. Four facies associations are distinguished: 1) The initial mound association, consisting mainly of bryozoan packstone–rudstone; 2) the steep flank – mound crest association, consisting of bryozoan rudstone with subsidiary octocoral and encrusting bryozoan rudstone and bryozoan grainstone; 3) the gentle flank association characterized by bryozoan packstone, and incipient to fully developed hardgrounds; and 4) the intermound association consisting of echinoid rudstone, packstone and minor occurrences of bioclastic grainstone and argillaceous wackestone–packstone beds and laminae. Facies analysis and mesoscale mapping indicate that the bryozoan mound complexes were formed in relatively deep cool water below the photic zone and storm wave base. Deposition was influenced by along-slope currents, with prominent seasonal and long-term variations. Mound growth was governed by primarily in-place benthic carbonate production of mainly delicate branching bryozoans which baffled and trapped pelagic and detrital benthic carbonate mud. Gentle bottom currents rich in particulate nutrients flowing towards the WNW resulting in up-current biogenic mound migration towards the SSW. High production in the surface waters combined with an effective mixing of the water column was important for transporting particulate nutrients to the bottom waters. Periodical intensification of the bottom current system resulted in winnowing and erosion of the northern mound flanks. Long-term periodical waning or cessation of bottom currents and possibly stratification of the water column resulted in strongly decreased benthic carbonate production and mound growth associated with formation of extensive Thalassinoides burrow galleries mirrored by the rhythmic occurrences of flint nodule bands. Mound development thus reflects the delicate balance between biogenic growth towards nutrient-carrying currents, current winnowing and erosion.

Flow over and under gravel beds: does hyporheic flow control the generation and morphodynamics of coarse-grained bedforms?

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Many studies have quantified the morphology, generative mechanisms and stability conditions of subaqueous bedforms generated in a wide range of sediment types. However, most of this past work has not considered interactions between the free-flow and flow within the bed (hyporheic flow). Yet, as the sediment size (and thus bed permeability) becomes greater, it may be expected that flow into, and out of, a non-cohesive sediment bed may significantly modify the resultant flow field. This paper presents results from laboratory experiments that investigated interactions between hyporheic flow and flow above the bed, and made possible by development of new techniques for measuring flow within the pore-space of a simplified gravel bed. These results demonstrate that flow in the leeside of a 2D bedform is significantly influenced by topographically-induced hyporheic flow, resulting in a flow field that is radically different to traditional views of leeside flow. These results have significant implications for the formation and two-dimensionality of coarse-grained bedforms. Experiments were conducted in a recirculating water flume 2.40 m long, 0.35 m wide and 0.60 m deep. We considered a flat porous bed comprising six layers of uniform spheres (D = 0.04 m diameter) arranged in a cubic packing. An idealized impermeable 2-dimensional bedform (akin to a finer-grained bedform moving over a gravel surface) was placed on top of this gravel bed, and was 0.41 m long and 0.056 m high (bedform height: flow depth ratio = 0.31), and had a leeside angle of 27°. Flow above the bed and within the permeable matrix was quantified using two types of particle imaging velocimetry (PIV). Standard PIV was used to quantify flow above the bed (flow Reynolds number = 25,000; Froude number = 0.1), using illumination by a pulsed laser and digital imaging through the side of the flume. This system yielded whole-flow field quantification at a rate of 10 Hz. Flow within the second pore space below the bed-freestream interface was quantified using a novel endoscopic PIV (EPIV) technique. In EPIV, the laser illumination and camera imaging are provided by boroscopic optics mounted through the side and base of the flume, allowing high-resolution flow data collection within the pore space, at a rate of c. 15 Hz. The results show that hyporheic flow significantly modifies the structure of flow in the leeside, as compared to that detailed in past studies. Jets of flow, driven by pressure gradients across the bedform, cause i) flow into the bed upstream of the bedform, and ii) intense, pulsating, upwelling flow at the toe of the leeside. The result of this hyporheic flow upwelling is that leeside flow reattachment is entirely absent, and the recirculation bubble usually associated with bedforms is replaced by a mechanism of alternate vortex shedding. Hyporheic flow thus controls the dynamics of flow in the leeside and near-wake region. These results have significant implications. If flow in the leeside of coarser-grained bedforms is changed, then the high shear stresses that are usually present in the region of reattachment may be absent. Three corollaries may thus arise: 1) the distinct region of leeside scour, which eventually leads to bedform crestal three-dimensionality, may be absent or minimal. This provides an explanation for the greater two-dimensionality of coarser-grained bedforms that has been observed in past studies; 2) if flow reattachment is prevented and higher shear stresses are reduced in the bedform leeside, then flow separation may not play a role in regulating bedform wavelength, hence also explaining the more irregular spacing of some coarse-grained bedforms, and 3) the formation of bedforms may be more likely due to flow field accelerations/decelerations and particle interference, rather than flow separation dominated dynamics, thus pointing to the importance of different processes generating bedforms in different sized-sediment.

Statistical analysis of mineralogical characters of potentially prospective titanium-zirconium placers

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This paper devotes to statistical and lithological-facial investigations of Oligocene complex of sediments in order to single out the most perspective on titanium-zircon placers areas in Khanty-Mansiisk administrative region, in particular – in the Mansiisky area. This research is concerning to the territory of West Siberia adjacent to Ural Mountain System (west part of Khanty–Mansiisk administrative region). Researched placer bearing area (Mansiisky area) has intermediate location between east piedmont of Ural Mountain System and west setting of Siberian plain that determine special features of regional stratigraphic scales. The Mansiisky area locates on the regional zone of shoreline of Oligocene sedimentary basin. From the west–northwest to the southeast on the Mansiisky area are consecutive allocated faces of paleo delta, beach and submarine delta zone, zone of shallow sea and zone of absence of wave influence. The beach drift is focused from the south–southwest to the north–northeast. The most perspective faces is represented faces of beach and submarine delta zone and Zone of shallow sea with moderate hydrodynamic activity. For the Mansiisky area two relative factors for first three zones have been calculated: the relation of the sum of titanium minerals to zircon (K1) and the relation of heavy mineral fraction in a class 0.25-0.1 to heavy mineral fraction in a class 0.1-0.01 (K2). The character of ore Ti-Zr assemblage at change facial complexes delta – beach – sea shoal varies slightly: the average relation of the sum of titanium minerals to zircon on a zone varies the within 12–14. Some increase of this indicator in a beach zone, connected, first of all with content increase in heavy mineral fraction rather larger ilmenite, explains the general increase of grain size of detrital material in this zone. The zircon content goes down from delta to beach and raises from beach to shoal. It explains that there is material separation on border of delta and beach. Factor K2 behaves according to classical representations about separation and redeposition of a sandy material: the greatest value is characterized in paleo delta, the least – in a shallow zone. On the Mansijsky area statistical researches on the basis of a method of MPC have been conducted, allowing not only to curtail multicomponent space and to allocate the most ordered mineral assemblages, but also to reveal the most perspective sites of prospective placer. The analysis of structure of mineral assemblages of Oligocene sediments, which was carried out by MPC has shown that analyzed Oligocene complex is characterised by well-ordered mineral assemblages, into which structure enter ilmenite, rutile, zircon, leucoxene, sphene, anatase. High "weight" of 1st Principal Component (1PC), and also its structure show us that there was effective ore-forming process, capable to create concentration of ore minerals close to industrial level. It confirms by comparison of calculated "weights" of 1PC (62-65 %) with the similar parameter which has been counted up directly for ore bed of industrial titanium-zircon placers (70-78 %). Also MPC has proved on revealing various paleofacial zones. Done grain-size, mineralogical analyses, and also studying of structures and textures of investigated thicknesses have confirmed the received results by MPC.

Carbon-isotope anomalies of the Ediacaran Tamengo Formation (Corumbá Group, Brazil)

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The Corumbá Group, cropping out in the southern Paraguay Belt in Brazil, is one of the most complete Ediacaran sedimentary archives of palaeogeographic, climatic, biogeochemical and biotic evolution in southwestern Gondwana. The unit hosts a rich fossil record, including acritarchs, vendotaenids (Vendotaenia, Eoholynia), and skeletal fossils (*Cloudina, Corumbella, Titanotheca*) within the context of a rift and post-rift sedimentary succession. The Tamengo Formation, in the upper part of the Corumbá Group, is characterized by black limestones (mudstones, grainstones, and rudstones), and carbonaceous shales. These shales are locally arranged in rhythmic successions with mudstones, in which *Cloudina* and *Corumbella* may be present in abundance. High-resolution carbon isotopic analyses are available for six sections of the Tamengo Formation including two sections in the Paraguay Belt, in carbonate rocks previously assigned to the Cuiabá Group. Samples were obtained using a dental burr after petrographic analysis. The results show (from base to top): (1) a positive $\delta^{13}C$ excursion to +4 ‰ PDB above post-glacial negative values, (2) a negative excursion to -3.5 ‰ associated with a marked regression and subsequent transgression, (3) a positive excursion to +5.5 ‰, and (4) a plateau characterized by $\delta^{13}C$ around +3 ‰ associated with occurrence of *Cloudina*. A U-Pb SHRIMP zircon age of an ash bed in the upper part of the $\delta^{13}C$ positive plateau yielded 543 ± 3 Ma, which is considered as the depositional age. The positive plateau in the upper Tamengo Formation and the preceding positive excursion are ubiquitous features in several successions worldwide, including the Nama Group (Namibia), the Dengying Formation (South China) and the Nafun and Ara groups (Oman). This plateau is constrained between 542 and 551 Ma, thus consistent with the age of the upper Tamengo Formation. The negative excursion of the lower Tamengo Formation may be correlated to the Shuram-Wonoka negative anomaly, although $\delta^{13}C$ values do not fall below -3.5 ‰ in the Brazilian sections. Sedimentary breccias occur just beneath this negative excursion in the lower Tamengo Formation and were interpreted as the result of glacioeustatic sea-level fall, but a tectonic interpretation cannot be ruled out. The isotope studies presented here support the return original definition to the stratigraphy of Corumbá Group, in which the folded carbonate rocks and phyllites, defined as Cuiabá Group, are interpreted as distal equivalents of the upper part of the Corumbá Group (Tamengo and Guaicurus formations). The isotope data correlate with he global isotope curve, with the possibility that the negative excursion, at the base of Tamengo Formation, may be associated with the Shuram-Wonoka anomaly and the characteristic positive plateau ($\delta^{13}C$ around +3 ‰), associated with *Cloudina* , with other sections beneath and near to the Precambrian-Cambrian limit.

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Clastic dike swarms induced by seismic activity in an intracratonic basin: example from Permian-Triassic sedimentary deposits of Paraná Basin, Brazil

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Clastic dike swarms occur in the upper part of the Corumbataí Formation, Permian-Triassic of the Paraná Basin, São Paulo State, Brazil. The Corumbataí Formation consists mainly of interbedded sandstone and siltstone related to a shallow epicontinental sea deposits. The clastic dikes intrude siltstones and are composed of very fine to silty sandstone. Three outcrops of clastic dikes were analyzed in road and railroad cuts. A total of 273 measurements of structural attributes of dikes were obtained in four different stratigraphic levels. Dikes are centimetric to decimetric in thickness, metric to decametric in lenght, and with metric height in outcrops, being mostly subvertical and with tabular forms, sometimes with ptigmatic folds caused by latter compaction. The origin of the dikes is related to upward forced injection of fluidized sediment. Observed features supporting this conclusion are upward ramification, drag folds in the host rock, sediment extrusion structures over the upper termination of feeding dikes, host rock intraclasts in the dikes and the vertical fabric of the grains which parallels the dike walls. Fluidization of the sand was most likely caused by seismic activity, and therefore the studied dikes are considered as seismites. Other evidence support this interpretation, such as their association with other types of liquefaction features found in the coeval Corumbataí and Pirambóia formations, the broad area of occurrence of the dikes (tens to hundreds of kilometers), the confinement of the dikes to specific stratigraphic levels, and their spatial relationship with tectonic structures of the basement. Despite the great dispersion of dike directions, there are preferential orientations with strikes varying from NNW to NE, the NNE-trending direction being the most common. Admiting that hydraulic fracturing was the main mechanism of dike generation, the prevailing NNE direction would indicate the maximum horizontal stress during the intrusion, related to an WNW-ESE extension. The great dispersion in dike orientations can be interpreted as the consequence of low differential stresses during the fracturing and injection of fluidized sediment, which is common in shallow intrusions. The interpreted earthquakes were the result of reactivation of a Precambrian basement fault, as indicated by the geographic alignment of the Permian-Triassic seismites following the ENE-trending direction of the Jacutinga Shear Zone. The dikes which are closest to the shear zone are the most closely spaced and the thickest of all occurrences, indicating the fluidization of larger volumes of sediment, probably due to proximity to the epicentral zone of the paleoearthquakes. The stress field interpreted from the dike orientations implies in a left- lateral reactivation of the Jacutinga Shear Zone during the Permian- Triassic seismic events in the Paraná Basin. These events are possibly related, in a broader scenario, to the far-field propagation of the compressional stresses of N-S direction originated in the southern border of Gondwana in the Late Paleozoic, recorded in the Cape Fold Belt of South Africa and Sierra de La Ventana in Argentina.

Thermal burial history in the Chaco-Paraná Basin, Argentina

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The Chaco-Paraná basin (locally knon as the Pampas) between 64˚- 61˚ WL constitutes the modern foreland system of central Argentina. Accommodation of deposits in this region has been related to a combination of tectonic loading of the Córdoba ranges and dynamic topography by subduction of the flat slab. According to present-day temperature measurements, the geothermal gradient is nearly normal. But the sedimentary record is as old as Late Paleozoic, when the subsidence mechanics and ancient geotherms were distinctly different than today. The Upper Paleozoic and Mesozoic were largely associated to extension, within the cratonic scenario of the Gondwana supercontinent. The stratigraphy is mainly known from oil industry borehole cutting (Yacimientos Petrolíferos Fiscales, YPF during the 60' and 70') and patchy exposures along and across the Córdoba ranges. Upper Carboniferous and Lower Permian diamictites form the Upper Paleozoic, which rests unconformably on crystalline basement. Cretaceous strata rest on a major discordance on Upper Paleozoic and locally basement. On top Cenozoic alluvial strata, interlayered by two shallow marine horizons, lay conformably on Mesozoic. In this contribution we present a new basin thermal study along the Josefina borehole YPF.SF.J.es-1 (Santa Fe Province), ~100 km eastward of the Córdoba ranges, in order to understand the burial history of the Pampas since the Late Paleozoic. We assumed neoformed clay mineralogy is close related to subtle temperature changes during the ancient burial/exhumation of the basin and might assist to solve the thermal history of this region. We followed the laboratory protocol treatment recommended by Moore and Reynolds (1997) and analyze the samples with an X-Ray Diffratometer X PANalytical X Pert PRO. The samples analyzed are: (a) the metamorphic basement located at ~4500 meters below the surface (mbs); (b) Upper Paleozoic located from the surface between ~4000 and ~2780 mbs; (c) Cretaceous rocks located between 2130 and 590 mbs; (d) a Cenozoic sample located at ~285 mbs. Two samples from Cretaceous exposures were collected along the western flank of the Córdoba ranges to compare the borehole results. Kübler Index from Upper Paleozoic to Lower Cretaceous (KCIS between 0.54 and 0.36 $\Delta°2\theta$) suggests temperatures between 175° and 215°C in the ~3000-4000 mbs interval. The clay mineral assemblage of the Upper Cretaceous samples, between ~2100 and 2800 mbs, are dominated by R0, R1 and illite with absence of R3 ordering suggesting for these levels temperatures around 100-120°C. Samples between ~1200 and 300 mbs (Cretaceous to Cenozoic) are dominated by R0 and illite, with absence of R1 and R3 orderings and temperatures between 50-120°C. Modern geotherm in the Pampas is higher than in regions further west, which support the hypothesis that flat subduction affects deeply the thermal structure of the lithosphere. These preliminary results suggest two cycles of burial interrupted by an exhumation. The first burial (or alternative higher ancient geotherm) affected the Paleozoic sections. The strong exhumation would have occurred previous to the Cretaceous sedimentation. This exhumation episode is consistent with apatite fission track cooling ages recorded in basement rocks along the Córdoba ranges. Temperatures of ~100-120°C recorded at the base of the Cretaceous strata (~2800 mbs) suggests a geothermal gradient between 33 and 40°C/km, although a second exhumation episode with significant thickness loss should be also considered.

Filling and excavation of an intra-montane basin in a tectonically active fold-and-thrust belt: the Agua Amarga basin (Neuquén Andes, Argentina)

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In the Southern Neuquén basin (Argentina), the roughly N-S-trending Chihuidos anticlines (38°S, 69°40W) form the outermost crustal orogenic front of the Southern Central Andes. Their late Miocene to present uplift led to the compartmentalization of the foothill into two basins namely the Agua Amarga intra-montane basin to the west, confined between the Agua Amarga crustal thrust and the Chihuidos anticlines, and the current foreland basin that begins with the Añelo basin located at the eastern toe of the folds. In this work, we document the timing, cyclicity and sedimentary processes that led to the filling and reexcavation of the Agua Amarga basin and to its reconnection to the current foreland. The 250 m thick Miocene continental deposits of the Agua Amarga basin form a coarsening-up sequence that varies from lake to lateral alluvial fans and fluvial environments. Tilting of the earliest Miocene deposits along the basin borders is accompanied by regressive erosion that entrenched deep canyons in the uplifting barrier (Chihuidos anticlines) and by a sudden and deep incision of the Agua Amarga basin. The excavation of the Miocene deposits led to the development of a 50 km- long E-W-trending alluvial fan at the basin outlet above the Añelo basin. This 140 m thick fan widens from 5 km-wide in the eroded limb of the Chihuidos anticlines to 7 km-wide at the anticline outlet. It is characterized by several coarsening-up sequences composed of mass flow deposits with plurimetric angular blocks of Cretaceous sandstones resulting from the destabilization of the flanks of the valley. Abandonment of the alluvial fan is marked by the deposition of a 30 m thick Plio-Quaternary volcanoclastic level illustrating a drastic change in the drainage network and sediment supply. This alluvial fan may have created a new temporary sedimentary dam at the catchment outlet which could have delayed the basin excavation. This has been followed during the Quaternary by an episode of incision and by the entrenchment of several stepped terraces in the whole area. These observations show that the uplift of the Chihuidos anticlines disturbed the mass transfer from the inner part of the orogen towards the eastern foreland basin. Even if the Agua Amarga basin acted as an important storage area, it is still difficult to assess the relative importance of tectonic uplift with respect to bedrock resistance and climate changes.

Fluvial base level variations in the Lower Triassic Katberg Formation, Karoo Basin, South Africa

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The main Karoo Basin (South Africa) was characterized by widespread fluvial sedimentation during the Late Permian-Early Jurassic. Subsequent to the Permo-Triassic ecologic crisis, a pronounced change in the fluvial style from meandering to braided systems is well-documented. The Lower Triassic Katberg Formation consists of fairly regularly interbedded tabular sandstone and vertically accreted mudstone units. The overall architecture of the laterally extended sandstone stories shows lateral to downstream accretion of channel marcroforms with intraformational mud-pebble and pedogenic carbonate-nodule conglomerates. The high amount and relatively large, cm-size in-channel, reworked carbonate nodules contrast the mostly mm-size *in situ* pedogenic carbonate accumulations in the mudstones. The latter are either parallel-bedded with mm to cm thick intercalations of bioturbated, very fine sandstones or are non-bedded sandy-clayey siltstones. The mudstones contain shallow and smooth erosional surfaces up to a few dm deep and few m wide, as well as laterally continuous surfaces with sand-filled desiccation cracks at several levels. The mm-size *in situ* carbonate accumulations with calcified rootlets and small nodules (that are locally coalescent and may form thin calcic laminae), suggest calcisols that formed above the palaeo-water table. Climatic signal of the Permo-Triassic palaeosols and carbonate nodules is rather controversial in the Karoo literature (see Pace *et al.* 2009 for review). Pace *et al.* (2009) assigned all *in situ* carbonate concretions to groundwater origin. We explain the distribution and abundance of *in situ* and redeposited carbonate concretions in terms of temporal fluctuations in the fluvial base level. On short term, fluvial base level changes are chiefly influenced by fluctuations of the palaeo-water table, which in turn are climate dependent. Lateral variability of the water table is a function of the distribution of groundwater discharge and recharge areas, local topography, differential aggradation and compaction rates of channel vs. floodplain sediments. At a given time, in areas adjacent to the channel belts, the water table was locally higher, allowing the growth of relatively denser vegetation shown by numerous calcareous rhizoliths and colour mottles. In these less drained soil profiles, the development of *in situ* carbonate nodules was present, but somewhat limited. Contrastingly, further away in slightly elevated floodplain rises, the water table was deeper relative to the land surface, and calcisols were better protected from unconfined sheetfloods allowing the development of larger pedogenic carbonate nodules. Changing fluvial base levels controlled both the lateral shifts (avulsions) of channel belts as well as degradation of the floodplain via land- wasting processes and incision. With the onset of relatively wetter intervals, as the palaeo-water table rose, aggradation of the channel fill led to channel overfilling and eventually surpassing of the avulsion threshold. Subsequently, as base level fell, the newly positioned channel systems incised and the degradation of the topographically high areas accelerated, affecting the larger *in situ* concretion-bearing calcisols as well. This way, the virtual absence of calcisols with larger *in situ* carbonate concretions in the succession is mainly due to base level fall induced land-wasting of the floodplain rises, and less commonly due to scavenging of the floodplain during infrequent, large sheetflooding events. The higher abundance of calcisols with smaller *in situ* carbonate concretions is explained with their higher preservation potential, being common in less emergent areas with higher burial rates.

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Devonian shale microfacies in the Paraná Basin (Brazil)

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Expressive shale formations occur in the Devonian strata in the onshore cratonic Brazilian basins (Solimões, Amazonas, Parnaíba and Paraná basins), where they are usually recognized as potential source rocks, but not evaluated so far as effective sealing rocks or gas reservoirs (shale gas) The present microfacies analysis of Devonian shales from the Paraná Basin (Ponta Grossa Fm), based on petrographic thin section descriptions (allied to TOC and XRD analysis), involves challenging procedures (difficulty in obtaining good thin sections and in making the appropriate microscopic observations), that are, when overcome, rewarding due to low costs and good results in characterizing reservoir/seal quality. Moreover they provide adequate process– paleoenvironment interpretations, particularly relevant if data are tied to a well known stratigraphic context. Based on a previous detailed sequence stratigraphic study (Bergamaschi and Pereira, 2001), we chose two outcrop areas in the Eastern border of the basin (Paraná State), where a HST (São Domingos Mb) and a TST (Jaguariaíva Mb) were well defined in a 3rd order depositional sequence framework, and where smaller T-R cycles are identified. Complementary data also come from other outcrop sites, in the Northwestern border of the basin (Mato Grosso State) and even from the same Eastern border. The Ponta Grossa Fm microfacies reveal mainly clayey-silty shales (high silt:clay ratio), illite/kaolinite composition with abundant continental palynodebris, and varied physical and biogenical microstructures (microscours, microload-casts, silt/mud ripples, silt laminae, micrograded laminae, microbiolaminations and bioturbations), deposited from offshore to prodeltaic marine paleoenvironments (interpretations supported by biogenic/trace-fossils observations). Unlike HST microfacies, the TST ones reveal smaller TOC (~0.5%), chaotic microtexture and the absence of physical microstructures, resulting from intense wave reworking and bioturbation, particularly during the early TST phase. The HST microfacies suggest strong current reworking of the bottom, revealed by the varied identified physical microstructures, probably resulting from hyperpycnal flows, which would be responsible for higher TOC values (~0.8%), associated to continental palynodebris in silty shales. These shale microfacies altogether show a fair potential as unconventional reservoirs (gas shale), which may eventually reduce their effectiveness in sealing the Tibagi Mb sandstones of the Ponta Grossa Fm, or the underlying Furnas Fm sandstones (Lower Devonian), in eventual speculative petroleum systems.

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Rift sequence stratigraphy in the Aptian of NE Brazil

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Aptian strata in the Brazilian basins are not only significant as the transition phase between rifting and post-rift phases during the formation of the South Atlantic, but also by containing the reservoirs of the "pre-salt" petroleum discoveries along the SE Brazilian continental margin. However, many tectonic (rifting vs. sagging) and stratigraphic uncertainties still need to be clarified. Among a series of onshore Cretaceous rift/pull-apart basins in NE Brazil, the Araripe Basin offers a good geologic example of these Aptian strata, here discussed on a detailed outcrop and core study of facies. We focus on the lower siliciclastic interval of the basin (Rio da Batateira Fm) characterized by fluvio-lacustrine paleoenvironments, which is underlaid “conformably” by a mixed, carbonate/evaporite/siliciclastic succession of lacustrine (marine influenced?) paleoenvironments (Santana Fm). Rift lake stratigraphy is itself a matter for debate since the modern sequence stratigraphic template has not been suitable to depict fully its filling history. Proxies for the understanding of the rift lake stratigraphy are being elucidated by Prosser (1993), Bohacs *et al.* (2000), and more recently by Martins-Neto and Catuneanu (2010). Prosser (1993) established the idea of four-fold tectonic phases (rift initiation, rift climax, immediate post-rift, and late post-rift) with particular stratal patterns (seismofacies type) and depositional systems, but no sequence boundaries were proposed. Bohacs *et al.* (2000) elaborated a three-fold depositional system tract scheme for high potential accommodation rift lakes under different climates, that yielded distinct facies associations (underfilled, balanced-fill and overfilled phases), but no stratigraphic boundaries were proposed. Martins-Neto and Catuneanu (2010), based on these tectonic models, proposed sequence boundaries at the “flooding surface” splitting the “rift initiation” phase (of low potential accommodation), below, from a conformably overlying “rift climax” phase (high potential accommodation), within an “overfilled” rift with a constant climate. This sequence boundary, as we understand it, may be correlative of an unconformity close to a ‘maximum denudation surface’, which may be not operationally suitable for other climatic-controlled models. The facies succession cycle in the Rio da Batateira Fm. points to (i) ‘wandering’ fluvial sandstones, (ii) meandering fluvial sandstones and reddish sandstones, and (iii) lacustrine dark/organic shales and calcilutites and microbialites; whereas the whole studied interval points to a balanced-fill rift with low potential accommodation (usually understood as sagging), where sequence boundaries can be positioned at the base of the “rift initiation” phase (i), close to an ‘onset denudation surface’, which unconformably overlies the “rift climax” phase (iii). Finally, we propose the use of the term "limnosequence" to contrast with the marine "depositional sequence", as the latter is historically allied to the sequence stratigraphy paradigm established for the continental margins, and also address the need for a unified, rift lake stratigraphy, intrinsically distinct in tectonic and climatic control mechanisms.

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The stromatolite–thrombolite–oncolite plex of Lagoa Salgada (coastal lagoon), SE Brazil

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Microbialites are organosedimentary deposits formed mainly by the activity of cyanobacteria, which involve biofilm/algal mats, stromatolites, thrombolites, oncoids/oncolites, leiolites and a collection of microbially induced sedimentary structures (MISS). They've been part of the geological records since the Archean until the present. Among many recent occurrences around the world, in distinct geological environments, microbialites can also be seen in a series of hypersaline coastal lagoons in the Rio de Janeiro State (Brazil), including the present study case (Lagoa Salgada). The studied microbialite occurrences show a complete evolutionary spectrum from biofilms to algal mats to a stromatolite–thrombolite–oncolite plex (STOP), here defined. Algal mats vary morphologically (bubble, film, gelly, smooth, polygonal, pustular and tuffed), and contain Ca/Mg-carbonate grains (clots, peloids and micro- oncoids); whereas the STOP shows a peculiar microstratigraphy, characterized petrographically by an association of stromatolitic (convex up, crenulated to flat and fibrilar thin laminae), thrombolitic (micritic coagules and peloids, dissolution cavities and borings) and micro-oncolitic microfacies, despite its overall external 'stromatolite' morphology. Dissolution (micro-caves) and bioerosion (serpulid and vermitid borings) are responsible for the enhanced STOP porosity, mapped by XR microtomographic techniques (micro-CT), which also allows a 3D 'architectural element' approach to the STOP, besides the microstratigraphic characterization. Terrigenous clastics (micro- and macroclastics) and allochemical grains (foraminifera, ostracods and microgastropods) are also present in varying proportion in some of the microfacies. Wind regime, tides, rainy seasons, freatic level, water chemistry and their own microbiocoenosis are the controlling factors analyzed in the studied lagoon. At last, this study points to the necessity of a new approach in describing and classifying these microbialites, for paleoenvironmental interpretations and facies modeling.

Impact of fluvial acid waters on REE concentration in estuarine sediments (SW Spain)

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The Huelva estuary receive the Tinto and Odiel acid river inputs, characterized by extremely low pH values (< 3.5) and high Fe, heavy metals and REE contents (Borrego *et al.*, 2005) . The fluvial and marine water mixing cause an important pH and chlorinity gradient in the estuarine mixing zone that originate two processes (Braungardt *et al.*, 2003): the saline dilution and the acid neutralization. In this context, the mean content on total REE in sediments for the Tinto estuary is 59.25 ppm and 86.65 ppm for the Odiel estuary, with an average of 74.47 ppm for the whole system. The greatest absolute REE concentration takes place at the marine estuary and the estuarine mixing zone, followed by the sediments placed in the fluvial estuary end-members of the Tinto and Odiel rivers, where the absolute REE content is of 66.94 ppm and 78.98 ppm, respectively. The longitudinal evolution of the absolute concentrations of La, Gd and Yb throughout the Odiel and Tinto estuary shows a different behavior for each group of REE in relation with the hidrochemical conditions of the system. The sediments corresponding to the fluvial estuary end-members display a La:Gd:Yb concentration ratio of approximately 7:2:1 and 9:2:1, respectively. At the upper sector of the estuarine mixing zone (pH ~ 4.5 and Cl ~ 3 $g \cdot l^{-1}$), the Gd and Yb concentrations in sediments remain quite constant while the La content decreases. The La depletion in sediments is probably due to LREE tend to remain in dissolved phase when pH is lower than 6, whereas the HREE have a greater affinity for the solid phase. The great pH influence on the estuarine mixing zone causes that LREE remain dissolved until pH of 5.7 at the low chlorinity zones (< 6 $g \cdot l^{-1}$) while in other estuaries unaffected by AMD they are removed during estuarine mixing (Lawrence *et al.*, 2006). The acid neutralization process (pH ~ 7) takes place at the lower estuarine mixing zone where sediments experiment an increase in the absolute La concentration, due to LREE are removed from solution to the suspended matter. The transference of dissolved MREE and HREE to suspended matter also occurs but in a lesser extend. The REE fractionation in the sediments of the Tinto and Odiel estuary could be synthesize in three NASC-normalized patterns according to the environmental conditions prevailed in the areas where they were deposited: - The fluvial estuarine sediments under pH < 4 and Cl < 2 g l^{-1} conditions show a slightly MREE enriched NASC-normalized pattern. - The estuarine mixing zone involves steep gradients characterized by pH ranging from 5 to 7 and chlorinity from 2 to 10 g l^{-1}. In such conditions, the sediments display a fractionation pattern LREE depleted but nearly flat for MREE and HREE. - Once the acid neutralization has finished at the outer estuary and pH increases above 7 and chlorinity above 10 g l^{-1}, the sediments of the marine estuary show a LREE and MREE enriched pattern with a slight negative Ce anomaly typical of marine conditions (Elderfield *et al.*, 1990; Nath *et al.*, 1997; Lawrence and Kamber, 2006). The strong relationship between pH and REE content indicates that pH is the key variable controlling REE geochemistry in estuarine systems affected by acid mine drainage. The recognition of these patterns in the sedimentary record could help in the identification of acid dominated periods in environments related with acid waters.

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Primary versus secondary volcaniclastic deposits

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The classification of unconsolidated deposits related to volcanic activity is a very important part of the current volcanology due to the implications of each one in terms of the hazard evaluation. However many terms, most of them generated in English language, differ from country to country when they are translated to Italian, French, Portuguese or Spanish language mainly. In the last one language, the localisms have made that the terms vary, not just in their translation, but also in their meanings. An example, lahar deposits have a lot of distinct denominations for the same type of deposits as: volcaniclastics (the more extended name), fluviatil volcaniclastic, epivolcaniclastics, secondary volcaniclastics, sediment flows, volcaniclastic debris flows, etc. Besides, also there are many problems to use the terms in old the deposits and when they are not associated to current volcanic activity. A revision of a lot volcanic deposit studies in Latin America and Spain, those published in English language, and the application in personal academic studies, allow us to present a basic classification of volcaniclastic deposits and the particles that compose them. This proposal is based in the necessity of unify the terms, in addition of to frame them within genetic processes. The proposed classification is intended to make applicable the terminology for present and old deposits, and to speak in the same way at the moment of perform volcanic deposit studies and hazard evaluations. The term "volcaniclastic" is an expression used to define deposits which include a total spectrum of clastic deposits formed partial or totally by pyroclastic, hydroclastic, hialoclastic, autoclastic or epi-volcaniclastic particles, generated them by mechanical fragmentation due to primary volcanic or erosion processes. The adjectives "primary" and "secondary" are defined by the kind of the events associated to volcanic activity without temporal implications. In this way, primary volcaniclastic deposits make reference to deposits generated by pyroclastic falls, pyroclastic density currents and peperites, and they are composed by particles that contributes with variable amount of heat to the formation of the deposits; and secondary volcaniclastic deposits make reference to deposits formed by debris avalanches and lahars, mainly derived from remobilization of primary and/or secondary volcaniclastic deposits and reworked by geomorphic processes. In each one of them, there are subdivisions that respond to the eruption type, the generator/trigger mechanism, or the deposition facies. In a wide spectrum, these subdivisions are: Pyroclastic falls with ballistic projectiles or pyroclastic falls sensu stricto. Pyroclastic density currents with pyroclastic surges (ground, ash cloud, basal and blast) or pyroclastic flows (block and ash, rock fall, pumice/ash/ignimbrite and scoria/ignimbrite). Debris avalanches (Bezymianny, Banday and Unzen types). And lahars (sin-eruptive, post-eruptive and no-eruptive) with lahars sensu stricto (debris flows) or diluted lahar/lahar run-out (hyperconcentrated flows or stream flows). We present our proposal as a flow diagram in a poster in order to discuss the repercussions of this classification, within the spectrum of the sedimentary deposits.

Microscopic and field characterization of microbial mats in the Bahía Blanca Estuary

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Microbial mats and their associated sedimentary structures (Microbially Induced Sedimentary Structures - MISS, Noffke, 1997) have been recently identified in the Bahía Blanca Estuary, being this the first mention of modern microbial mats in Argentina. Since then, a number of studies have been conducted to characterize morphologically these structures, and to determine their implications for the fossil record. Results from field observations, and sedimentologic and petrographic analyses are presented herein. The study tidal flat is located in Puerto Rosales, in the central area of the estuary, where a wide variety of MISS occurs. These sedimentary structures show a distributional pattern related to tidal inundation, which is determined by the micro-scale topography of the tidal flat that controls the moisture content of the substrate. Therefore, in the highest zone of lower supratidal areas, frequently exposed, desiccation cracks are well developed. Toward lower zones, mat cracks with curled edges (mat curls), and polygonal oscillation cracks, usually associated with mat chips and flipped-over mats, occur. Frozen ripples are widespread over the flat, being often subtle due to ripple leveling. Gas domes has also been observed, showing different sizes, and being sometimes cracked at the top and collapsed due to gas escape. Erosional remnants and pockets occur in the lower intertidal zone, most likely in relation to higher hydrodynamic conditions, especially during winter months. Besides, multidirected ripple marks are also common in this intertidal zone. Undisturbed samples were taken with tube corers and sectioned in millimeter-thick intervals in order to characterize them as a function of depth. Granulometric distributions, moisture, and organic matter contents have been measured. Grain size analyses show predominance of silt-sized sediments (20-40 µm)) in the upper 0.5 cm of the profile, which corresponds to the layer with microbial mat. This layer usually has more than 6% of organic matter and elevated values of water content, exceeding the 30%. These parameters tend to decrease with depth. Also, below this upper layer, there is a distinctive change in colour, from light brownish to dark, indicating the presence of an anoxic horizon. Petrographic analyses of thin sections revealed the presence of fabrics resulting from trapping/binding and post-burial processes. The first includes matrix-supported grains (silt- fine sand sized) incorporated in the fibrillar meshwork of the mat, arranged with their long axes parallel to the sediment surface. Orientation of grains in association with this biolaminite type is a common signature in the analyzed sections. Also, framboidal pyrite (or greigite) was observed, mostly in the reduced, lower layers of the sections. Geochemical changes resulting from the activity of the microorganisms are essential for precipitation of early diagenetic minerals, which in turn may enhance the preservation of the modern sedimentary structures in the studied tidal-flat. These actualistic analyses will help to recognize and characterize microbially induced sedimentary structures occurring in fossil tidal-flats.

Noffke, N. (1997) Mikrobiell induzierte Sedimentstrukturen (M.I.S.S.) in siliziklastischen Wattablagerungen, PhD thesis. University of Oldenburg, 127p.

Characterization of an Aptian carbonate platform margin using digital outcrop models (western Maestrat Basin, E Iberia)

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Outcrop-scale reconstruction of depositional geometries and facies distribution of carbonate systems improves our knowledge on their heterogeneity distribution, stacking patterns and stratal architecture. The collected data and derived models can be used as analogues for characterizing and modelling potential subsurface reservoirs. Traditional sedimentological analyses in cropping out carbonate systems have limited accuracy depending on exposure conditions, accessibility or past erosive processes. On the other hand, there is a need to complement classical sedimentological approaches with quantitative characterizations and models of sedimentary bodies. In this respect, processing of three-dimensional (3D) point clouds captured by terrestrial LIght Detection And Ranging (LIDAR) technology combined with real-time kinematic global positioning system offers to field geologists the possibility to construct virtual 3D digital outcrop models (DOMs), which allow for more accurate analyses, reconstructions and quantification of the outcropping facies distribution than conventional digital terrain models. We present a LIDAR 3D DOM of an Aptian flat-topped non-rimmed carbonate platform margin from the western Maestrat Basin (Spain). The DOM served as a departing point to perform a 3D reconstruction that shows the relationship between depositional architecture and facies distribution of the carbonate system. The reconstruction not only highlights the value of digital outcrop models to characterize virtual attributes not observable in the outcrops due to the limitations of the 2D views of the exposures, but also allows to refine outcrop-scale sequence stratigraphic analyses. In addition, the 3D sequence stratigraphic approach obtained together with the 3D facies distribution model generated can be used as an analogue for the characterization of subsurface carbonate reservoirs with similar depositional profiles. The workflow of this study followed these steps: (i) Acquisition of the outcrop 3D point data set using a ground-based terrestrial Laser Scanner ILRIS 3D Optech Inc. equipped with a differential GPS Top Con with a receiver GB 1000 and an antenna PG-A1. During this process, 44 overlapping scans were shot covering the totality of the exposure of the flat-topped non-rimmed carbonate system characterized due to the physical limitations of the scanner and in order to obtain the resolution desired. ii) Mapping stratigraphic surfaces and pseudowells describing 5 lithofacies onto each individual scan using projection of 2D digitalizations in a CAD software over 3D Laser scan data. iii) Locally georeferenced individual scanners were later globally georeferenced by means of the UTM coordinates of the scanner. iv) Reconstruction of the surfaces bounding stratigraphic units. v) Population of the internal facies distribution conditioned to the pseudowells. The result is a high- resolution 3D geological model displaying the stratal architecture and facies heterogeneity of sedimentary bodies, confined within a 3D sequence stratigraphical framework.

Deciphering late Early-Middle Aptian relative sea level fluctuations in the northern Maestrat Basin (Iberian Chain; E Iberia)

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Sequence stratigraphic analysis of the late Early-Middle Aptian strata cropping out in the northern Maestrat Basin (Morella sub-basin) revealed records of three depositional sequences: A, B and C. The transgressive systems tract (TST) of Depositional Sequence A corresponds to basinal marls containing ammonites, which allow us to constrain the top of this marly unit within the Dufrenoyia furcata biozone (late Early Aptian). Above, a carbonate platform dominated by corals and rudist bivalves constitutes the highstand systems tract (HST) of Depositional Sequence A. As a result of a late Early Aptian fall in relative sea level, which according to the literature could have had a Tethyan-wide significance, the aforementioned carbonate platform was subaerially exposed. The sequence boundary between depositional sequences A and B is situated at the top of these platform carbonates and is distinguished by an unconformity surface with palaeokarst. During relative sea level drop owing to a deceleration of base level fall, a forced regressive carbonate platform with rudists and corals flourished basinwards. This latter platform displays downlapping geometries and is underlain in some areas by meter-thick cross-bedded calcarenite deposits. The carbonate platform established in a basinal position during base level fall was finally subaerially exposed and shutdown as relative sea level continued to drop. Consequently, palaeokarst features and incipient laterization processes characterize its top, which corresponds to the most seaward portion of the preserved sequence boundary between depositional sequences A and B. Since current erosion affects basinward settings, no basinal forced regressive wedges containing allochthonous debris resulting from the collapse of the former carbonate systems or lowstand deposits were recognized locally. The subaerial unconformity between depositional sequences A and B is superposed by a hardground, which conforms the maximum regressive surface. Above, meter-thick marly deposits with gastropods, brachiopods and bivalves, constitute the TST of Depositional Sequence B. The aforementioned composite sequence boundary is occasionally overlain by a centimeter-thick calcarenitic transgressive lag. The subsequent HST is marked by the establishment of a large carbonate platform with abundant rudists and corals. The upper part of this highstand platform exhibits thin (up to few meters thick) parasequences indicating reduced accommodation as a consequence of the slowing of the relative sea level rise to a near standstill. The subsequent relative sea level drop, probably of Middle Aptian age, exposed subaerially the latter HST, resulting in a broad palaeokarst development, and induced an incision of approximately 90 meters. This subaerial unconformity surface corresponds to the sequence boundary between depositional sequences B and C. A maximum regressive surface, which is characterized by a hardground, superimposes this surface with palaeokarst features giving rise to a composite sequence boundary. The subsequent TST of Depositional Sequence C is characterized by cross- bedded calcarenites, marls, mudstones and wackestones containing oysters, which onlap the composite sequence boundary between depositional sequences B and C, completely filling the incision. At the upper part of the preserved Aptian sedimentary succession, these transgressive strata also onlap the carbonate deposits of the highstand platform of Depositional Sequence A. This scenario, when compared to that proposed for the same time interval in the western Maestrat Basin (Galve sub-basin) is an example of differential response to relative sea level fall within a basin. In this respect, in the Galve sub-basin, no forced regressive carbonate platforms were formed during the widespread late Early Aptian relative sea level drop, and no subaerial exposure features were identified during the Middle Aptian substage.

Quaternary reactivation of basement faults in NW-Germany: interplay of ice-sheet advance, glacial lake formation and sediment loading

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The Emme delta is a small glacilacustrine delta, which developed on the southern flank of the Wesergebirge Mountains in NW-Germany (Winsemann *et al.*, 2010). Shallow shear wave seismic surveys allow a detailed assessment of the structural style of the delta body (Brandes *et al.*, 2010) and indicate two different fault systems developed within the delta, both showing syn-sedimentary activity. Special emphasis was placed on reconstructing the geometry of pre-growth and growth strata. The seismic sections display the geometry of normal faults, related offsets and the lateral evolution of the deformation style. The faults have planar to slightly listric geometries and show vertical offsets in a range of 2 to 15 m. They form small graben and half-graben systems, which locally show roll-over structures. The fill of the half-grabens has a wedge-shaped geometry, with the greatest sediment thickness close to the fault. The fault system in the upper portion of the Emme delta is restricted to the delta body and probably gravity induced. In the lower portion of the delta normal faults occur that originate in the underlying Jurassic basement rocks and penetrate into the delta deposits. The grid of seismic sections shows that the normal faults are trending E-W. This fits to a late Triassic – early Jurassic deformation phase in the Central European Basin System. It is very likely that the basement coupled deformation in the study area was caused by the advance of the Early Saalian ice-sheet. The advancing ice-sheet caused far field extension, as described in the model of Stewart *et al.* (2000). This might have reactivated pre-existing normal faults. The advance of the ice-sheet induced a transfer of the stress-front through the upper lithosphere. Pre-existing basement faults were probably reactivated due to the varying stress conditions. A similar model was presented by Sirocko *et al.* (2008) for ice advances in northern Germany. The growth of the Emme delta created a local load that might have enhanced the reactivation of normal faults in the basement. The water pressure could have reduced the friction along the faults and supported the slip process. Though a reactivation of pre-existing basement faults due to loading and related effects is very likely, a neotectonic component along the Wiehengebirge flexure cannot be ruled out.

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Common earth model of folded Lower Carboniferous turbidites, NW Harz Mountains, Germany

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Static 3D models have been widely used in the last decade to visualize the subsurface geology. Especially in the mining industry, this technique was successfully applied. Common earth models are subsurface models, which integrate all available geological data of a study area. They allow a holistic insight into the geological situation of a target area and help to indentify economically interesting locations. The study area is located in the Harz Mountains in northern Germany. Lower Carboniferous successions reach a cumulative thickness of more than 2000 m and are characterised by turbiditic sandstones, which were shed from an active margin. Individual turbidite beds have thicknesses between 3 cm and 2 m. The analysed succession is organized into thinning and thickening upward cycles with thicknesses between 3 and 10 m. The common earth model presented here is largely a 3D structural model, based on numeric and graphical data. Outcrop analyses were carried out to get the necessary structural and sedimentological data. The orientation and geometry of structural elements such as faults and folds was measured in the field. The structural data was implemented into the geological modelling software SURPACTM to generate a large scale static 3D model of the deformed beds. Stereographic projections were added to key outcrops to visualize the small scale deformation and paleocurrent directions. The topography of the model is derived from digitised maps and SRTM data to give a realistic impression of the study area. The model displays the typical asymmetric northwest vergent fold style of the Harz Mountains. Small folds in outcrops in contrast, are symmetric and characterized by steeply southwestward plunging fold axes. The geometry and position of structural elements, such as faults and folds in this succession, are largely controlled by the lithology and initial architecture of the basin-fill. A multi-layered stratigraphy and the occurrence of weak décollments have a strong impact on the deformation style. Flat and laterally-continuous turbiditic beds (i.e. mechanical stratigraphy) favoured the development of the folds and detachments parallel to the bedding contacts. The integration of multi-scale data in a comprehensive common earth model helps to visualize the structural style of the study area and the thickness distribution of the depositional units in great detail. It provides insight into the distribution of the structural elements. Together with the stereographic projections it shows the relationship between large-scale and small-scale features. The resulting common earth model is more suitable for exploration campaings than conventional maps. It shows the true subsurface geometries of the target area in 3D, together with the topography and allows to calculate the volume of potential hydrocarbon reservoirs in one work-flow. It can be directly used as input for reservoir simulations. In addition, the 3D visualization gives the opportunity to quickly plan well paths. The implementation of small scale features like joints can help to visualize the orientation of the principle normal stress in the area, which is necessary for planning a frac campaign. Joint orientations are also crucial for the fluid flow in a sedimentary basin and have therefore a strong impact on the hydrocarbon potential.

Processes and patterns of chlorite authigenesis in deep reservoir sandstones of the Santos Basin, offshore eastern Brazil

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Upper Cretaceous, deep marine, shelf and deltaic sandstones are the main clastic hydrocarbon reservoirs of the Santos Basin, offshore eastern Brazilian margin. Some of these sandstones exhibit more than 20% of porosity at depths greater than 4000m. As for other deep reservoirs with anomalously high porosity, porosity preservation in deep Santos sandstones has been ascribed to the inhibition of quartz overgrowth cementation and pressure dissolution by the conspicuous occurrence of authigenic pore-lining chlorite. The positive effect of pore-lining chlorites on porosity preservation is, however, usually accompanied by permeability reduction due to blocking of the pores throats, and by resistivity decrease, owing to the irreducible water saturation within the microporous rims. The indicated role of pore-lining chlorite on porosity preservation of the Santos Basin sandstones justifies a specific study of its habits, spatial and time distribution, paragenetic relationships, and genetic conditions. Ongoing and previous studies in these sandstones suggest that chlorite precipitation is favored by the presence of eogenetic smectitic clay coatings that may be controlled by primary compositional, depositional facies, and/or sequence stratigraphic surfaces. This is supported by the presence of cryptocrystalline chlorite coatings beneath the dominant pore-lining chlorite rims, as well as of smectitic clays along tight intergranular contacts and in areas cemented by syn-compactional calcite. Nevertheless, the presence of a smectitic precursor is clearly not the only factor controlling chlorite distribution in these sandstones. Primary compositional seem to exert an essential control on chlorite authigenesis. The chlorite enrichment of lithic arkose sandstones rich in volcanic rock fragments (VRF), which commonly are extensively dissolved and replaced by chlorite, suggests that these grains are a significant source of ions for chlorite cementation in the sandstones. Besides VRF, a series of detrital constituents seem also to have acted as sources and/or substrates for chlorite authigenesis, such as unstable detrital heavy minerals, biotite, and mud intraclasts. The chloritization of VRF, biotite and heavy minerals has resulted in the precipitation of abundant, microcrystalline, authigenic TiO_2 minerals. Mud intraclasts eroded from fine-grained, delta-plain, delta-front, outer shelf or slope deposits, as well as the pseudomatrix derived from their compaction, are another important substrate for chlorite precipitation. In addition to primary compositional, burial and thermal history, as well as fluid flow patterns, certainly played a role on chlorite authigenesis and reservoir quality evolution of the sandstones. Potential sources of ions for chlorite authigenic external to the sandstones include volcaniclastic materials within the surrounding mudrocks, and the thick Aptian evaporitic section. Therefore, compelling petrographic evidence indicates that there are multiple processes of chlorite authigenesis in the Santos Basin sandstones, which patterns and impact on the quality and heterogeneity of the reservoirs are very complex. The recognition of such patterns and their control parameters is essential for the development of models for reservoir quality prediction, which may effectively contribute to the reduction of exploration risks in the Santos Basin.

Boring polychaetes on oyster shells from the Upper Cretaceous of Patagonia: A possible case of commensalism?

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The oyster *Pycnodonte (Phygraea) vesicularis* (Lamarck) is recorded in the Maastrichtian mudstones of the Jagüel Formation. This species was free-lying and inhabited muddy bottoms in a shallow marine shelf with low sedimentation rate. Therefore, the shells of these oysters offered relatively stable habitats for the settlement of a diverse hard substrate community. The most conspicuous components of this community are boring polychaetes. The fossil traces recognized in the shells belong to the ichnogenera *Maeandropolydora* Voigt, 1965 and *Caulostrepsis* Clarke, 1908. The aim of this work is to assess possible paleoecological relationships existing between oysters and polychaetes. Ninety two specimens were studied and presence/absence data were recorded on standardized maps of the valves. These maps show different areas established on the basis of morphological differences likely to influence polychaete settlement. Most of the borings are parallel to the hinge-ventral margin axis of the valves. Ninety percent of the boring apertures open along the ventral margin of the left valves. Location of the borings suggests that the oysters lived with the left valve resting on the mud. The position and number of polychaete borings close to the ventral margin of the valves sugest that the worms probably took advantage of the inhalant current generated by the oysters. Although the borings weaken the valve and reduce shell strength, this does not seem to be lethal for the oysters because there is no evidence of borings reaching the interior of the valve from the external surface. This suggests that probably a symbiotic relationship existed between *Pycnodonte (phygraea) vesicularis* and polychaetes and that it could be classified as inquilinism, a particular case of commensalism.

Migration of Banded Travertine during the evolution of the tectonically controlled Çukurbag fissure-ridge (Pamukkale, Denizli Basin - Turkey)

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Banded Travertine, is a distinctive lithofacies consisting of crystalline carbonate laminae vertically grown within a fissure-ridge which is a morphotectonic feature developed along the traces of brittle structures in many thermal systems. In particular the Banded Travertine is deposited on the walls of the fissure during its progressive opening and enlargement, by upwelling thermal waters that afterwards outflow at the top of the ridge building upwards and laterally an epigean Travertine system. In this view the Banded Travertine represents an useful tool to understand the mechanism of fissure-ridge development as well as the relationships between tectonic activity and carbonate sedimentation in a thermal system. An excellent example of the evolution of a fissure ridge and associated deposits is exposed in western Anatolia (Turkey) on the northern shoulder of the Neogene-Quaternary Denizli Basin. Close to the Pamukkale area, the Çukurbag fissure-ridge, about 360 m long and 10 m high, formed as a consequence of the activity of a minor normal fault development in the hangingwall of the regional normal fault system. The ridge is flanked by bedded Travertine forming steep marginal slopes ranging from near-vertical up to 5°. Its profile resulting from the neotectonic activity, shows a marked asymmetry mainly in its central part where the northern slope is about 3 m higher than the southern one. The crest is affected by fractures/fissures which are partially to fully filled by Banded Travertine. Quarry cuts of Roman times, occurring in the central portion of the ridge allow to investigate the internal part of the Çukurbag fissure-ridge which is characterized by several sub- parallel, meter-spaced fissures running along its long axis. Bedded Travertine along the flanks of the ridge consists of superposed lenticular bodies bounded by angular unconformities attesting successive depositional events. They are composed of a variety of lithofacies (fan ray, feather like crystalline crusts, shrubs, paper thin rafts, bubble) reflecting the irregular shifting in time of the depositional conditions corresponding to waterfalls, terraced or fans/smooth slopes, cones, shallow pools, drainage channels. The analysis of the relationships between Bedded Travertine and Banded Travertine suggests that the fissures and related Banded Travertine were not synchronous and migrated through time. Fissuring affected progressively the northern half of the ridge producing its asymmetric growth. The resulting network of Banded Travertines, coupled with the sedimentological features of the Bedded Travertine, indicate that the growth of the Çukurbag fissure-ridge was strictly influenced by the progressive development, in a substratum composed of continental, semi-lithified Neogene sediments, of deformation bands, probably starting with a single band and ending with a full zone.

Origin and significance of soft-sediment deformation in aeolian sandstones of the Lower Jurassic Navajo Sandstone of the Colorado Plateau, USA

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The Early Jurassic Navajo Sandstone of the Colorado Plateau is a classic example of the deposits of an aeolian sand sea (erg) palaeoenvironment. Cross-bedded aeolian sandstones are associated with interdune deposits and regionally extensive bounding surfaces that have been interpreted in terms of episodes of climatic change. Aeolian dune cross-bedding is deformed in places by zones of complex, large- scale soft-sediment deformation structures (convolute bedding) up to 30 metres thick and 100s of metres in lateral extent. Recent field studies in Utah, Colorado, Nevada, and Arizona, including previously undescribed sections, have focused on these zones of complex deformation, with the aim of clarifying their origin and improving the understanding of soft- sediment deformation processes in general. New data are presented on the areal and stratigraphical distribution of zones of soft-sediment deformation, their lithological and facies associations, and the orientation of structural elements. Comparisons are made with features elsewhere, including subsurface features imaged in seismic studies related to petroleum exploration. Particular emphasis is placed on understanding the deformation mechanisms (the roles of liquefaction and fluidization), triggering agents (earthquakes, groundwater movements, floods, storms or waves) and the relationship between subsurface deformation and the surface palaeogeomorphology of desert dunes, as well as the relationship of the timing of deformation events to episodes of palaeoclimatic change. The findings have significance for (1) understanding soft-sediment deformation processes, particularly the development of criteria for discriminating triggering agents and the significance of different deformation mechanisms (liquefaction and fluidization); (2) palaeogeography and palaeoenvironments of the Early Jurassic of the Colorado Plateau, including the relationship between processes in the subsurface and palaeo-dune topography; and (3) geohazard analysis, in particular relating to the identification of proxy indicators of earthquakes, floods or storms and the construction of temporal records of their occurrence.

Trace fossils from a prodeltaic channel and lobe complex, Aberdeen and Kenilworth members, Upper Cretaceous, Book Cliffs, Utah: Ichnologic signatures of turbidites and hyperpycnites in deltaic systems

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Exceptional outcrops of shallow-marine clastic wedges of the Campanian Blackhawk Formation prograding onto a shelf represented by the Mancos Shale are exposed in the Book Cliffs of Central-East Utah. In particular, the Aberdeen and Kenilworth members record deltaic progradation and significant by-pass through channels, leading to the deposition of muddy-sandy lobes emplaced seaward in a prodelta setting. Deposition involved a complex interplay of sedimentary processes, including turbidity currents (classical and wave-modified), storms and hyperpycnal flows. An ichnologic study in an area between Tusher Canyon and Hatch Mesa allows documenting the trace-fossil content of the different subenvironments represented in this channel-lobe complex. Upper Aberdeen Member channel-fill deposits exposed near the northwest entrance to Tusher Canyon are characterized by sandy and muddy hyperpycnites. The lowermost channel-fill is essentially unbioturbated, but trace fossils occur in the upper half. Sandy-fill channel deposits showing evidence of combined flows are dominated by *Protovirgularia* and *Phycosiphon*, with *Lockeia*, *Phycodes*, *Helminthoidichnites*, *Skolithos* and *Rosselia* as secondary elements. *Protovirgularia* in these deposits mostly reflect escape behavior (fugichnia). Muddy-fill channel deposits only display sparse occurrences of *Protovirgularia*. Kenilworth lobe deposits (parasequence 2) exposed near the southern entrance to Tusher Canyon consist of wave-modified turbidites and represent emplacement far from the lobe axis. With the exception of a few specimens of *Ophiomorpha*, trace fossils are restricted to the top of the lobe. This assemblage includes *Curvolithus*, *Gyrochorte*, *Palaeophycus* and *Lockeia*. Lobe deposits of parasequence 2 are also exposed in the Hatch Mesa area and consist of a complex facies mosaic of classic turbidites, sandy hyperpycnites, wave-modified turbidites and storm-generated beds. These deposits were emplaced near the lobe axis. Trace fossils are patchily distributed. This assemblage includes *Protovirgularia*, *Palaeophycus*, *Skolithos*, *Gyrochorte*, *Phycosiphon* and large specimens of *Rosselia*. The Aberdeen and Kenilworth ichnofaunas reveal a complex interplay of stress factors, including sedimentation rate, hydrodynamic energy, water turbidity, degree of substrate consolidation, and fluctuating salinity. The overall paucity and patchy distribution of trace fossils suggest high sedimentation rates and hydrodynamic energy. This is particularly evident during the main phase of channel fill and, to a lesser extent, lobe deposition. High rates of sedimentation are further supported by *Protovirgularia* escape structures. Although energy conditions were high, vertical burrows of suspension feeders are uncommon, pointing to high turbidity in the water column. Scarcity of biogenic structures in muddy channels may also be linked to soupy substrates. In addition, a wide variety of morphologies of *Phycosiphon* and *Protovirgularia* has been observed, mostly reflecting various degrees of substrate consolidation. The overall low diversities, simplicity of structures and small size (*Rosselia* being an exception) are also consistent with fluctuating salinities. Interestingly, the association present in lobes of parasequence 2 is remarkably similar with the so-called "*Curvolithus* ichnofacies" of previous authors. Documentation of the Aberdeen and Kenilworth ichnofaunas may yield insights into the paleoecologic conditions in prodelta settings strongly affected by hyperpycnal, turbidity and storm flows.

Landscape evolution of the Valle de Barrancas Blancas (Nevado Ojos del Salado Massif, Atacama Andes) driven by the entire spectrum of geomorphological processes

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The Valle de Barrancas Blancas represents a remote closed basin situated at elevations above 4850 m, west of the Ojos del Salado Massif (6893 m) and east of the Nevados Tres Cruces Massif (6748 m), in the High Atacama Andes of Chile (68°39' W, 27°02' S). Based on observations during a mapping expedition in 2002, in the spring times of 2008, 2009 and 2010 the Institute for Cartography and the Chair of Physical Geography/Regional Geography of Central Europe at the Dresden University of Technology in Germany carried out field campaigns. Some initial results are presented here. The study area contains a series of well preserved landforms resulting from a unique combination of slope, aeolian, lacustrine/ litoral, fluvial, glacial and periglacial regimes. They permit reconstruction of the full range of geomorphological processes within this isolated catchment of approximately 160 km². Environmental evolution deduced from such archive combinations as in the Valle de Barrancas Blancas may be also representative for other regions of the High Atacama Desert. Such a spectrum of geomorphic processes has not yet been described from the entire area. Further, these preliminary studies reveal modern subsurface features, which were not documented before and are presumably crucial for e.g. water management within the area and beyond. Particular features are intercalations of volcanoclastic material, presumably both *in situ* and redeposited by aeolian and gravitational forces, with some few to approximately 200 cm thick firn and ice layers, which do not contain any sediment. Though stratigraphic relationships remain uncertain yet, there exist some datings of volcanoclastic material by the Servicio Nacional de Geología y Minería de Chile and one own K- Ar dating of 135 ± 18 ka BP. Not all tributary valleys of the Valle de Barrancas Blancas are glacier-fed. Nevertheless, they are similarly deeply incised as the snow-fed ones. The processes responsible for this homogeneity are still under examination. Prominent shore line features with distinctive pedological properties suggest a palaeolake succession with up to 12 stages. They were surveyed in different GPS elevation profiles and raise questions about the impact of climatic changes on the environment. Thus, they may yield information about landscape evolution of the wider Andean Region which no other archive can provide. Stone pavement-covered, loess- like deposits of different habit indicate several periods of aeolian activity. The stratigraphic sequences of all the aforementioned geomorphological phenomena call for further studies. Presumably the entire catchment exhibits permanently frozen ground at an average depth of 37.5 cm, covered by mostly dry, partially water- saturated sediment. This finding, based on extensive avalanche-probe soundings, may lead towards a better understanding of water sources, flow paths and, hence, water management strategies in the High Atacama regions outside the Valle de Barrancas Blancas catchment. This is important for both mining and general water supply.

Environmental indicators in Marília Formation's Paleosols - Quintana, SP, Brazil

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The Marilia Formation (Maastrichtian, 72-65 Ma), according to Soares *et al.* (1980) is a unit formed by coarse to conglomeratic sandstones, "occurring in regions of average thickness between 1m and 2m" and "rare discontinuous layers of red mudstone and limestone". Is the Bauru Group's upper part, which consists of very fine to coarse sandstones, mudstones and siltstones (Neto et al, 1978). The described outcrop has a serie of paleosol profiles in a north-south cut between the municipalities of Quintana and Herculândia. It is about 13m high and was divided into five sequences of paleosols, which add up to 11 horizons, two of which (341-510 cm and 734-1114 cm) represent whitish, thick and very hard calcretes. The remaining horizons have reddish marks, roots, and krotovinas bioturbations filled by material from the overlying horizon and calcium carbonate. Wax is present associated with prismatic structures and well preserved slickensides associated with contraction cracks on its surface. The most recent soil profile corresponds to an Alfisol and consists of 1Bt1, 1Bt2, 1Bt/C1 and 1C horizons. Alfisols are characterized by low amounts of organic matter in its uppermost layer, an argillic horizon, where water remains at a tension around 1500kPa for at least three months per year. Below it, formed by a 2Cca(m) horizon there is a petrocalcic horizon from an Aridsol, a soil formed in a hot, dry climate. It is related to a stable surface for a long period of time. From the third soil, an Inceptisol, it only the 3Cg horizon is preserved. Inceptisols are formed in humid and semi-humid climates, with mild to hot temperatures within either poor or well drained settings and usually related to relatively active landscapes. In the profile this horizon has hydromorphic characteristics. 4Bss and 4Ahorizons are part of a Vertisol, a clay soil with expansive clay, which swells when wet and shrinks when dry, presenting cracks on the surface and slickensides. Below, is preserved an Aridisol's 5Cca(m) horizon with pedogenetic origin and formed in a very dry period. Finally, at the base of profile, and therefore, outcrop's oldest preserved soil, there is an Alfisol, consisting of 6Bt1 and 6Bt2 horizons. The calculation of molecular weathering ratios showed that the salinization process is negligible at all horizons. The calcification is almost negligible at all horizons, except in 2Cca (m) and 5Cca (m), indicating the driest times throughout the sequence. The relationship Al_2O_3/SiO_2 shows that the proportion of silica increases significantly just over the horizon associated with an Inceptisol, indicating an obstruction of drainage on this horizon, associated with waterlogging conditions. The loss of bases undergoes reduction at three horizons. In both calcretes -associated to conditions of aridity, semi-arid and gley horizon- hydromorphic processes with poor drainage can be inferred. It can be said, therefore, that there is an oscillation between semi- arids/arids conditions during the soils formation alternating with wetter conditions toward a tropical humid, with well marked wet and dry seasons. This means that significant greenhouse conditions that dominated the period led to intercalations between wet and dry times, apparently with temporal predominance of the first.

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Distribution, composition and provenance of hydrocarbons in Zechstein evaporites in central Poland

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Rock salt formations are regarded as weakly permeable lithologies that prevent hydrocarbon (HC) migration from underlying reservoir rocks. However, HC have been evidenced both in flat-bedded and diapiric salt structures worldwide, which raise questions concerning their origin in evaporites, whether they are primary or secondary. This study presents results of investigations on distribution of HC, host rock petrography as well as geochemical characteristics and provenance of HC in Zechstein evaporites that make up the Klodawa Salt Structure (KSS) in Poland. The KSS is a diapiric salt ridge situated in the central part of the Polish Zechstein Basin, where the most complete terrigenous-evaporitic sequence of Zechstein 1 to Zechstein 4 (Z1-Z4) cycles was deposited. Constituents of all 4 cycles are exposed in salt mine excavations that cut the uppermost portion of KSS. The analysis of HC occurrence implies that their distribution is primarily controlled by the associated stratigraphy. They were evidenced in Z1 rock salt (Oldest Halite), in the shale-carbonate-sulphate sequence separating Z1 and Z2 salts (Upper Anhydrite/Stinking Shale – Basal Anhydrite) as well as in the lowermost portion of the Z2 rock salt. The Oldest Halite rock salt in KSS is dynamically and statically recrystallized, as implied by euhedral-to-irregular grain shape, variable fabric and presence of subgrains within the halite. However, despite tectonic deformation and postdiagenetic alteration, the original sedimentary facies of Z1 salt can be restored. Variable content of less soluble minerals (anhydrite, clays) and of organic matter in rock salt enabled reconstruction of six rock salt types: (i) white and (ii) gray salts without distinct bedding, (iii) thickly and (iv) thinly bedded salts with distinct anhydrite laminae, (v) white salt with gray, anhydrite-rich laminae, and (vi) irregularly speckled salt. These lithotypes are indicators of the alternation of oxic and anoxic conditions during salt deposition. The speckled salt represents redeposited sediments, providing evidence for significant dynamic variation of the sedimentary environment and variable bathymetry of the basin. The anoxic conditions prevailed during deposition of the shale-carbonate-sulphate sequence until sedimentation of the upper member of the Z2 Basal Anhydrite, when alternation of oxic-anoxic cycles was resumed. The transition between shales, carbonates and sulphates is gradual, however, this sequence remains poorly recognized due to strong tectonic reduction of bed thickness and their discontinuity. White Z2 rock salt is monotonously layered with darker anhydrite-rich laminae. Both fluid and gas HC were documented in KSS. Geochemical investigations of about 50 samples collected throughout the salt structure were carried with use of GC-MS. The analyses show that they are characterized dominantly by n-alkanes (n-C8 – n-C4) and the presence of alkylcyclohexanes. In some locations, apart from n-alkanes and alkylcyclohexanes, hopanes, arylisoprenoids, mono- and triaromatic steranes as well as various aromatic and alkylaromatic compounds also are present. The bitumens depict significant variation in the maturity of organic matter throughout the salt structure. MS-analyses of gas entrapped in evaporites also show variation in composition throughout the structure. Preliminary results show that inclusions contain: CH_4 (0.84 to 2.13%), N_2 (from 66.58 to 71.27%), O_2 (from 23.71 to 30.73%), Ar (from 1.87 to 2.41%), He (from 0.02 to 0.13%) and, locally, H2S. Geochemical studies indicate that there were at least two sources of HC: organic matter accumulated under hypersaline conditions in Z1 and the lowermost Z2 cycles and an external source. The latter and mixed composition of HC at some localities demonstrate that both gas and fluid phases can migrate through salt. Allochtonous HC most probably migrated from underlying rocks.

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Controls in the erosion and deposition rates of a semiarid basin: natural and human factors. Tapia - Trancas Basin, Tucumán, Northwestern Argentina

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Tapia - Trancas Basin is a semiarid basin located in Tucumán province, in Northwestern Argentina. The basin supplies Celestino Gelsi reservoir, the biggest reservoir in the Tucumán Province. Since 1966, sediment deposition and loss of impoundment capacity of the reservoir were documented and referred as consequences of mismanagement practices, on agricultural lands and, deforestation in the Tapia – Trancas upstream area. We applied RUSLE model, (Renard *et al.*, 1997) combined with GIS technology to estimate soil erosion in the watershed. Satellite images (Landsat 5 TM from1988/08/15, 1997/08/24 and 2007/07/19) were classified by Support Vector Machine, supervised classification technique, to generate land cover maps and to analyse land use changes. Lack of complete rainfall data series made it necessary to applied alternative methods to obtain rainfall runoff erosivity factor - R- factor - (Renard and Freimund, 1994). Monthly and annual data series of rainfall amount were analyzed. R factor values show an increasing tendency from 1935 to 1990. This should be related to greater amounts of annual rain from 1967. Minetti and Gonzalez (2006) and Piovano *et al.* (2002) also detected increasing amounts of rainfall, for the second half of 20th century, in Northwestern and Central Argentina, respectively. Increased amounts of discharge entering into Celestino Gelsi Reservoir were also registered for the period 1967 to 1996, according to the database from Hydrologic Resources Department (Dirección de Recursos Hídricos of Tucumán). The increment in surface area of agricultural lands was observed mainly in lowland areas along the Salí River basin and in the east region of the basin (piedmont areas of the Sierras de Medina). Also changes in river morphology at the delta, sediment deposits and stabilization of deposits with vegetation were documented comparing Landsat 5 TM for different years. Changes observed could be related to both, natural and anthropical factors. First, change in base level due to the presence of the reservoir and the adaptation of the fluvial system to the new base level, also increased rainfall amount an its consequent rise in sediment yield. In second place mismanagement practices related to land use could have affected the balance of sediment leaving the basin area.

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Petroleum System Modeling of Continental Shelf Area, Southeastern Korea

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Petroleum system modeling was performed to analyze the petroleum generation and migration history of the continental shelf area, offshore southeastern Korea. The continental shelf area is located in the southwestern part of the Ulleung back-arc basin, which was formed in the early Miocene by southward pull-apart extension of the Japanese arc away from the Korea plateau. The continental shelf has largely bipartite petroleum prospect groups called Dolgorae (means dolphin) and Gorae (means whale). The Dolgorae prospects are present in the structurally deformed zone consisting of complex thrust faults and associated folds, whereas the Gorae prospects are in the relatively less deformed and stratified zone, where natural gases have been produced commercially since 2004. 1D modeling indicates that all the wells studied have essential elements of petroleum system, including potential source rocks, reservoirs, seals, and overburden rocks. Hydrocarbons are generated in the potential source rocks present at depths of wells. However, no expulsion of hydrocarbon occurs from the potential source rocks. It suggests that effective source rocks be situated in deeper levels than total depths of the wells. The depth of the effective source rock was inferred from the carbon isotope data and the modeling result. Maturity Ro was calculated from the carbon isotope ratio of ethane to postulate the depth of effective source rock. The calculation indicates that natural gases are migrated from the source rock present at a depth of 5,000 m. 2D model was made on a cross section that is traversing from deformed to the less-deformed zone in the area. The mode of migration is envisaged from the results of the 2D model. 2D modeling shows that thermogenic gases generated from the effective source rocks commonly move upward to sandstone reservoirs at shallower levels, even though some portion of the gases migrate updip toward the structurally deformed zone and often seep away along faults.

Evolution of the Middle and Late Jurassic lacustrine systems in the Fossati Depocenter, Gan Gan area, Chubut, Patagonia (Argentina)

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The objective of this contribution is the presentation of the facies evolution of the lacustrine Jurassic Fossati Depocenter (Gan Gan area) of the Cañadón Asfalto Basin. The sedimentation in this pull-apart basin begins early in the Middle Jurassic, accompanied by effusions of olivinic basalts. The lower lacustrine, Las Chacritas Member, of the here outcropping Cañadón Asfalto Formation is composed by 28 m of laminated micritic limestones, alternating with tuffs, covered by 36 m of stromatolitic limestones, alternating with subordinated tuffs and some fluvial channels. The upper, Puesto Almada Member, of the Cañadón Asfalto Formation (in this area not in contact with the underlying Las Chacritas Member) is composed by an alternance of 128,52 m of tuffites, tuffs and several intercalations of dark shales bearing assemblages of palynomorphs indicating the presence of wetlands characterized by planctonic coccal green algae (Botryococcus), bentonic Zygnematacean algae and the presence of conchostracans, ostracods and insects remains. The prevailing vegetation of the lowlands was characterized by widely distributed conifers (Cheirolepidiaceae), represented by high percentages of the pollen genus Classopollis, indicating well drained soils and warm climatic conditions. At topographically higher positions Araucariaceae and Podocarpaceae were frequent, as demonstrated by the presence of Callialasporites spp., Araucariacites and Podocarpidites. The palynologic assemblages identified in the wetlands allow interesting environmental conclusions, but the species present are of a wide Jurassic and Cretaceous distribution. The invertebrates identified for the Puesto Almada Member consist of "conchostracans" assigned to Congestheriella rauhuti Gallego and Shen, and specimens related to the families ?Euestheriidae and Palaeolimnadiopseidae (Asiolimnadiopseinae,? Eosolimnadiopsis Chen). Ostracods recognized correspond to the Darwinulacea Penthesilenula sarytirmenensis (Sharapova) and Cytheracea Theryosinoecum barrancalensis minor (Musacchio *et al.*); unidentified remains and fish scales. This association indicates the presence of not very profound benthonic faunas, well oxygenated environment and associated vegetation. The known radiometric age of the upper part of the Puesto Almada Member at the type locality is 147.1±3.3 Ma (Tithonian). In three cases paleosoils developed at the top of the wetland deposits. Levels of gravity flows could be observed in the middle and upper part of the here outcropping Puesto Almada Member. The thickness of these fining upward lobes is varying from 1.5 to 15.0 m. Evolution of the lacustrine system: The facies evolution within the Las Chacritas Member corresponds exclusively to littoral lacustrine environments. The sub-environments are profound (the lower part), shallow (the middle part) and eulittoral (the upper part of the section). The profound subenvironment is characterized by laminated micritic limestones. The shallow subenvironments are represented by wackestones and packstones, with tempestite levels and fluvial channels. The eulittoral subenvironment is characterized by domal and bulbous stromatolites. The evolution of the body of water during the deposition of the Puesto Almada Member is as follows: 1. Reduction of the water body. 2. Beginning of the filling of the basin with pyroclastic material. 3. Installation of three successive wetland episodes with palustrine environments. 4. Final filling with pyroclastic material and associated gravity flows.

Temporal constraints on sedimentation in the Jurassic Cerro Cóndor Depocenter, Cañadón Asfalto Basin, Patagonia, Argentina: U-Pb radiometric ages from pyroclastic facies

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The extra-andean Jurassic region of Chubut, between Cerro Cóndor and Sierra de Pichiñanes, is characterized by a magmatic-sedimentary association, the Cañadón Asfalto (CA) Formation, whose sedimentation took place in a pull-apart basin. It is composed by Las Chacritas and Puesto Almada Members. The first is characterized by lacustrine carbonatic and siliciclastic facies associations, interfingering with volcanic deposits grading from lavic in the base to predominantly pyroclastic towards the top. The carbonatic facies/microfacies are represented by mudstones, wackstones, packstones, grainstones and microbialitic limestones indicating littoral/marginal and palustrine environments. The tuffs, tuffites, shales and sandstones of the Puesto Almada Mb. represent the silting facies of the basin. The age of CA Fm. is limited by the ages of the volcano-sedimentary sequences in contact at the base and the top of the Formation. A K/Ar age of 173.1±9.4Ma (Aalenian) (Silva Nieto, 2005) was obtained for the Lonco Trapial Fm., at the base of the CA Basin, representing the beginning of the first depositional cycle of the basin. The CA Fm. is overlain by the Cañadón Calcáreo Fm., assigned by palynologic evidence to the Early Cretaceous (Volkheimer *et al.*, 2009). Furthermore, earlier dating, by K/Ar, of the basal olivinic basalts of the Las Chacritas Mb., indicates an age of 170.9±4.4Ma (Aalenian-Bajocian) for the basal part of the CA Fm. (Salani, 2007).The objective of this contribution is the presentation of new U-Pb radiometric ages from CA Fm, obtained from a middle part of the Las Chacritas Mb. and from the base of the Puesto Almada Mb. One sample from a gray pyroclastic level about 20 cm in thicknesses with rests of plants and pomez up to 2 mm of diameter, for Las Chacritas Mb., and one sample from a fall deposit of about 40 cm from Puesto Almada Mb. were sampled for U-Pb analyses by LA-MC ICP-MS on zircon grains. The zircons are clear, prismatic, up to 100 µm. A U-Pb concordia age of 167±4Ma (Bathonian) for Las Chacritas Mb. and a U- Pb concordia age of 161±3Ma (Callovian-Oxfordian limit) for Puesto Almada Mb. were obtained. The new ages obtained for the Las Chacritas and Puesto Almada Mb., permit to delineate the sedimentary cycles of the basin. According with the new data the sedimentation of Las Chacritas Mb. would extend from 171±5Ma (Bajocian) to, at least, 167±4Ma (Bathonian). The Puesto Almada Mb. would extend from 161±3Ma (Callovian-Oxfordian) to 147.1±3.3Ma (Tithonian) (Cabaleri *et al.*, in press,), embracing most of the Late Jurassic.

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An outcrop-based comparison of facies modelling strategies in fan-delta reservoir analogues (Sant Llorenç del Munt complex, Eocene, NE Spain)

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The study, characterization and modelling of outcrop analogues have become a very useful and efficient method to provide a source of information on architecture, geometry and connectivity, and a means to test and compare modelling strategies in cases where the geology is well constrained. This study aims to develop and compare modelling strategies for simulating facies belt distribution in a very well understood outcropping fan-delta, the Eocene-aged Sant Llorenç del Munt complex, deposited in the SE margin of the Ebro Basin (NE of the Iberian Peninsula). The reservoir-scale facies models developed cover an area of approximately 10 km2, and concentrated in the three-dimensional architecture of a transgressive-regressive succession within the fan-delta, the Vilomara composite sequence. A close-to-deterministic modelling strategy was developed based on the sequence stratigraphically defined, hierarchical scales of heterogeneity that control facies belt distribution in the Vilomara sequence. This strategy consisted of two main steps: a) a deterministic reconstruction of maximum flooding and maximum regression surfaces that subdivide the sedimentary package into a series of transgressive and regressive systems tracts at scale of high-frequency fundamental sequences; and b) modelling of the stacking of the facies belts and the detailed geometry of the boundaries between them (i.e. interfingering) using a geostatistical algorithm based on the truncation of the sum of a deterministic expectation trend and a Gaussian random field, and conditioned to five stratigraphic wells. This strategy resulted in a very detailed model that faithfully reproduces the facies belt distribution in the Vilomara composite sequence. Data from outcrops and from the close-to-deterministic model of the Vilomara sequence were used to test a variety of stochastic modelling strategies, in which well conditioning degree, level of stratigraphic subdivision, modelling algorithm and trends were all varied. The results were compared against themselves and against the close-to-deterministically built model using a series of static measures including the distribution of fan-delta front reservoir facies (i.e. the potential reservoir rock), directional connectivity and reservoir-to-well connectivity. The results highlight: a) how well conditioning improves the reproduction of the depositional architecture in the different modelling approaches; b) stratigraphic subdivisions including the maximum flooding surface of the composite sequence to separate two grids for modelling independently the transgressive and regressive sequence sets of sequence can actually be detrimental unless additional constrains are included; c) an algorithm combining a linear trend and a Gaussian field is the most suitable algorithm for reproducing this type of architecture, but requires defining a three-dimensional trend; and d) the need for using trends to properly reproduce the architecture when well data are sparse. The results of the close-to-deterministic strategy developed and the stochastic modelling strategies tested provide guidelines for modelling analogue reservoirs in the subsurface and reflect the requirement of using constraints in this type of depositional systems.

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Geochemical background of stream sediments of Santiago island, Cape Verde

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The island of Santiago is the largest of the Cape Verde archipelago, covering an area of 991 km^2, and with a length and width of 54.9 km and 29 km respectively, and reaching an altitude of 1392 m. Climatic conditions and erosion are some of the natural problems of the Cape Verde archipelago. Furthermore, human influence on the surface environment has often proven to be inappropriate and pollutant. These factors cause innumerable consequences in terms of contamination of soil and both surface and subterranean water. Knowledge of the natural geochemical variability is essential for the proper resolution of economic, environmental, planning, medical and legal issues. The need for building a database of georeferenced geochemical information that comprises the surface environment of the island of Santiago was the prime motivation for carrying out this study. A geochemical survey of 337 of stream sediment samples from the island of Santiago was conducted, following the guidelines of the International Project IGCP 259 not only at the sampling stage, but also in the subsequent stages of preparation, analysis, data treatment and mapping. Levels were determined, in the fraction < 2mm, of 36 elements: 9 major elements (Al, Ca, Fe, K, Mg, Mn, Na, P, Ti) and 27 trace elements (Ag, As, Au, B, Ba, Bi, Cd, Co, Cr, Cu, Ga, Hg, La, Mo, Ni, Pb, S, Sb, Sc, Se, Sr, Th, Tl, U, V, W and Zn). Granulometric analyses were also carried out, and the mineralogical composition of about 25% of the stream sediments samples was studied. 83 rock samples taken from various formations on the island of Santiago were also analysed, the levels of K_2O, Na_2O, Fe_2O_3(T), MnO, Sc, Cr, Co, Zn, Ga, As, Br, Rb, Zr, Sb, Cs, Ba, Hf, Ta, W, Th and U having been determined. The geochemical patterns obtained from spatial distribution maps were correlated with the nature of the parent rock, and some of contamination. The interpretation of the results was carried out not only by observation of the geochemical maps, but also after statistical analysis of the data gathered, and supported by a wide range of available information. The use of Principal Component Analysis allowed associations between chemical elements to be perceived, whether geogenic or anthropogenic in origin. Spatial distribution maps of various multi-element indices of environmental importance were also drawn up, such as the Al/(Ca+Mg+K) Acidification Index, the Combi Index, the Environmental Risk Assessment Index, and the Enrichment/Contamination Indices for several groups of elements considered primary pollutant metals.

A preliminary characterization of the wasted metals enriched sediments in the abandoned mining treatment plant La Poma, Salta, Argentina

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In the northwest of Argentina, abandoned mines as well as mineral treatement plants where metals as Pb, Ag and Zn were extracted and concentrated, represent a potential risk of acid mine drainage (AMD) generation. The mineral treatment plant La Poma is located in Chorrillos, 17 km from San Antonio de los Cobres village, Los Andes department, in Salta province. The old plant concentrated the ore using a flotation chemical method. In 1986 the plant stopped working and the waste from flotation process was left exposed to weathering. Furthemore, both infrastructure and machinery were abandoned without any planning for its closure. Nowadays a huge volume of mining tailings are present surrounding the closed plant. This material has been eroded by the Tajamar river, which pass through the abandoned place. Near the river, light and yellowish salts precipitate. By X-ray diffraction, a secondary sulfate dietrichite (Zn0.6Fe2+0.3Mn2+0.1Al2(SO4)4•22(H2O)) and sulfides such as smythite (Fe2+6.75Ni2.25S11), galene and pyrite were determinated. Tailings are composed of medium-fine grained sand, grey-yellowish and green color, with friable consistency. None sedimentary structure is observed. Quartz, feldspar and biotite were recognized as main minerals, and zircon, hornblende, hematite and pyrite are abundant accessory minerals. Some sediments deposited by the Tajamar river after crossing the tailings were described. Three leves were recognized. The upper level, 5 cm thick, is fine grained sand, gray- greenish color. The minerals identified are quartz and feldespar, hornblende, magnetite, pyroxene, zircon and tourmaline as accessories. Pyrite is absent. The second level, 6 cm thick, is fine grained sand, dark green color. Rock fragments, quartz, feldespar and altered biotite are present, the accessory minerals identified are similar to the upper level. Pyrite is poor and it is oxidized, which is coherent with the higher rate of weathering in this transported materials insted of the static sediments in the tailings. The lower level is composed of fine grained sand. Zircon, brownish hornblende with magnetite, poor altered biotite, tourmaline and pyroxene were determinated. Pyrite is absent. The occurrence of secondary minerals on tailings surface is the result of dissolution of primary sulfides, transporting and precipitation of salts due to evaporation. These soluble salts stay on the surface until next rainy season, when they are dissolved again.

Geomorphologic features of the Chaco alluvial fans and megafans

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Spreading on more than 840,000 sq km in Argentina, Paraguay and Bolivia, the Chaco is one of the more extensive Quaternary alluvial flat areas on Earth and extends from N to S on the eastern Andes foothills along ~1,200 km. The largest megafans of the planet were built in this huge flat plain. The apexes of the megafans are found at the foot of the Andean mountains. We have been studying and mapping the general hydro-sedimentologic and morphologic characteristic of the fans that generate by rivers debouching from the Andes into the Chaco plain, such as the Pilcomayo, Bermejo, Juramento and other minor rivers. We estimated as well a budget of sediment for all the region identifying source and sinks areas that are playing complex morpho-sedimentary interactions in the coupled system Andes-Chaco plain. To perform the geomorpholoical maping we use a GIS environment (ENVI), geological and soil maps, middle-to-high-resolution satellite images (SRTM, Landsat 5 and CBERS2) and historical cartographies. The Bermejo's fan area is 112,000 sq km, the Juramento's fan area is 150,000 sq km and the Dulce's fan area is 40,000 sq km. The Pilcomayo River megafan is the largest one, spreading on an area of 217,000 sq km (610 km in radius, with a base length of 720 km). The megafans show an avulsive distributary pattern of alluvial belts, with different generations of Quaternary belts and paleochannels spreading on the plain surface; slight differences in altitude between these belts and the recent active lobes occur. The relationship between fan areas (Af) and drainage areas (Ad) for the Chaco is Af = 1.52 Ad (exp 1.04), with r2 = 0.92. Near the apexes the channels are braided but they become meandering and straight at the distal zones. The change of channel patterns from the apex to the distal area is not abrupt. Transitional reaches of wandering rivers (a mixture of meandering and braided channel pattern) is founded in some fans. The changes in channel patterns respond dominantly to changes in slope and the average morphologic responses are a decrease in channel width of near 30%, increasing sinuosity (~20%) and an increase of the specific stream power. Modern river channels do not reach the distal parts of the fans because spill out on the surrounding plain generating large swamps and pounded areas that are located on previously abandoned Holocene channels or older paleochannels. Our estimations indicated that the sediment yield of the Andean source catchments is 1,750 T/yr/sq km, providing 380 M T/year to the Chaco plain. From this total amount just ~90MT reach today the main collector system that means, the Paraguay/Paraná river axis.

Towards the stratigraphic anatomy of the Motril-Salobreña coastal aquifer (S. Spain). Information from well cuttings and logs

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The dynamics of the recent uplift of the central sector of the Betic Cordillera (S Spain), together with the regime of torrential rains and scarce vegetation cover in the mountains led to the development of a series of rapidly accreting coarse-grained deltas along the entire southern coastline of the Spanish Mediterranean during the Quaternary. In this context, the Guadalfeo River produced a large delta fed by water and sediments from the highest reliefs on the Iberian Peninsula (Sierra Nevada). The alluvial and deltaic sediments that accumulated at the mouth of this river on the Mediterranean comprise the Motril-Salobreña aquifer. This system is extremely interesting as it is one of the few aquifers on the Spanish Mediterranean coastline not affected by marine intrusion. At the same time, it is currently undergoing a series of human-induced changes whose repercussions on the aquifer are bound to include a decrease in its water resources. The first foreseeable effect will be groundwater salinization due to marine intrusion. Since this aquifer has a very long border along the coastline in relation to its volume, it is crucial to have a detailed understanding of the overall distribution of permeabilities in the aquifer and, more specifically, in the proximity of the coastline boundary. We drilled three research boreholes 300 m far from the coastline, obtaining a record of around 250 m of cuttings and electric logs. A comparison with Neogene examples cropping out in the sedimentary basins of the Betic Cordillera indicates that the boreholes cut an ancient delta lobe (probably Gilbert-type). The upper section (13 to 63 m), dominated by sands and dark sandy silts with bivalve and gastropod bioclasts and organic matter, has an irregular, tight gamma ray log. It may represent a delta plain with a dominant restricted lagoonal environment that may rarely have received storm-tossed sea gravels laid down as washover fans. The second column section (64 to 85 m) has a resistive log depicting two bell-shaped, serrated decametric sequences corresponding to two more poorly defined funnel-shaped serrated sequences in the gamma ray log. These are interpreted as two fining-upward sequences dominated by well-rounded, very heterometric clasts that may correspond to the amalgamation of distributary channels. The next section (86 to 140 m) reveal superimposed coarsening-upward sequences primarily consisting of coarse detritus embedded in a clay matrix that may derive from debris flows on the delta front. The deepest 110 m are dominated by azoic clay with thin gravel intercalations. The resistive and gamma ray logs show quite linear, blocky geometries with some sections that are egg-type smooth concave and funnel smooth concave. We are inclined to conclude that this is a foredelta deposit of probable continental origin arising in a setting of low sea level. An examination of the planktonic microfauna in the cuttings indicates that the delta lobe was deposited during the Gelasian. In some sections, we have also been able to accurately establish sedimentation rates of nearly 1.8 m Kyr-1. This rapid sedimentation is typical of a delta system dominated by fluvial activity, in which sedimentation at the delta front occurs mainly during violent flooding events. Reconstruction of the horizontal and vertical distribution of sedimentary facies in this aquifer is providing more accurate knowledge of the distribution of permeabilities and the identification, thereby, of the most transmissive zones, which will offer possible pathways for the salt-water intrusion threatening this system.

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From chronostratigraphy to paleogeography: multi-aspect tephra studies from the Hadar region of Ethiopia

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The geochemical and geochronological analyses of volcanic tephra deposits have a long history at paleoanthropological sites in East Africa. For decades, tephra studies have been used to establish correlations and chronostratigraphic frameworks not only for intra- and inter-basinal sequences, sometimes greater than 1000 km apart, but also between terrestrial basins and marine cores. The Hadar and Busidima Formations of Ethiopia contain a record of hominin evolution and archaeological remains spanning from approximately 3.8 to 0.16 Ma and serves as a recent example of a systematic, inter-project tephra correlation study. Numerous tuffaceous deposits exist within the Busidima Formation, but are often spatially limited, fine-grained and reworked. While previous research attempted to assign correlations without geochemical analyses, recent work by geologists in the region have constructed a new tephrostratigraphic framework that ties together the four main project areas of Hadar, Gona, Dikika, and Ledi-Geraru. At Hadar alone, at least 12 distinct vitric tephra are preserved in the Busidima Formation (ca. 2.7-0.81 Ma), which are represented by no less than 20 chemical modes. These analyses have been used to construct the first tephrostratigraphic-based sequence for the highly complex and discontinuous Busidima Formation deposits preserved at Hadar and establish correlations between Hadar and neighboring project areas, specifically Dikika and Gona. Interestingly, despite their close proximity, tuffs associated with some of the world's oldest stone tools from Hadar and Gona were not identified outside their respective project areas. Moving beyond simple correlation, these tephra studies have also helped elucidate significant differences in sedimentation rates and sediment preservation between the Hadar and Busidima Formations and within the Busidima Formation across the region. The pattern of tephra preservation and the absence of correlatable tephra may be equally informative as those that do correlate, particularly in regards to the depositional/post-depositional histories and paleogeographic models that have been developed for the Hadar Basin and Busidima Half-graben. Because of their unique chemistry and composition, tephra deposits have also been useful for tracking lateral facies change across the greater-Hadar landscape (e.g., channel-fill to proximal floodplain to distal floodplain). A prime example of this is demonstrated by the ~2.95 Ma Bouroukie Tuff 2 (BKT-2) Complex, an important regional marker bed with an extent of at least 600 km2. The correlation of BKT-2 exposures in the region, substantiated by detailed stratigraphy, major element glass composition, and Ar/Ar dates have been used to construct a high-resolution record to interpret paleodepositional variations during the last major lacustrine phase of the Hadar Formation. For example, exposures of thick, coarse-grained tephra deposits encased in diatomite are preserved in the east, grading to thinner, fine-grained tephra deposits reworked with gastropods in the west. Our interpretation of lithofacies organization and variation across this region indicate a paleolake depocenter located in eastern Ledi-Geraru and shows a westward expansion of the lacustrine system ca 2.96 Ma, followed by eastward regression initiated sometime prior to ca. 2.94 Ma. Additionally, physical investigations of the BKT-2 Complex, including deposit thickness and grain-size distance relationships, suggest a Plinian style eruption and allow for preliminary column height and erupted volume estimates.

Rheological and sedimentological characterization of cohesive sediments erodability

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Erosion and deposition of cohesive sediments play a key role in coastal and deep-sea ecosystems. Morphological evolution of sedimentary systems results from the residual balance between erosion and deposition. Clay rich sediment cycles constrain the way nutriments and contaminants may be mobilized, transported and trapped/stocked in estuarine and marine environments. Fine sediments re-suspension may reduce the thickness of euphotic layer and hence reduce primary production in the water column. Benthic communities are sensitive to sediment quality, deposition or erosion. The erosive action of hydrodynamic forcing is usually quantified by the turbulent shear stress induced at the sediment-water interface. As a result, erosion is computed by a sediment erosion flux if the turbulent shear stress overcomes an erosion threshold or a critical shear-stress for erosion. The way turbulent shear stress relates to erosional sediment flux and critical shear-stress for erosion depends on the sediment erodability and hence on sediment properties that have not been easy to identify. One may identify a priori many factors such sediment granulometry, consolidation state, mineralogy, organic content, bioturbation, the presence of biofilms at the sediment-water interface, the nature of interstitial waters, among others. The aim of the present work is to determine the erodability of natural cohesive sediments (in terms of erosion fluxes and thresholds) under quasi-stationary hydrodynamic forcing (e.g. tidal currents) from sediment properties and rheological characteristics. In this study, as a first step, sediment properties are described in terms of dry sediment concentration, microgranulometry and organic matter content. A special attention to mineralogy will be paid in a near future. The mechanical behaviour of sediment deposits were characterized by Atterberg limits and creep and oscillatory rheological tests. Natural muddy sediment cores were collected in seven French coastal sites (British channel, French Atlantic coast and Mediterranean sea). Six sites are located on tidal flats. The Mediterranean site is subtidal. A pair of twin cores were obtained per site. One core of each pair were dedicated to erosion tests carried out in the Ifremer erodimeter. Erosion tests consist in a controlled closed-circuit stationary flow that induces a measured turbulent shear stress on the surface of the testing cores. The control of increasing suspended sediments concentration provides a quantitative estimation of erosion critical shear stress and sediment erosion flux. The second core of each pair was used for rheological tests. Good correlations were found between the critical shear-stress for erosion, obtained by erosion tests, and the rheological parameters. Therefore, rheological tests showed to be useful to easily determine and model sediment erosion threshold. However, the erosion tests protocol still needs improvement to enhance precision. Results also confirm and quantify the strong dependence of critical shear-stress for erosion on sediments dry concentration and organic matter. Furthermore, results demonstrate that the plasticity index should be a good alternative to the organic matter content for the determination of erosion critical shear-stress; this implicitly highlighting how organic content influences sediment plasticity. Correlations were also checked between sediment erosion, rheometry- deduced characteristic shear stresses and parameters characterizing sediments. Erosion fluxes present a significant dependence on dry sediment concentration, on one hand, and organic and mud contents on the other hand. A relation is proposed for the estimation of erosion threshold for natural cohesive sediments from these two parameters, easy to measure.

On earthquake-triggered landsliding and slope denudation

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It is well known that moderate and strong earthquakes can trigger from hundreds to tens of thousands landslides over broad regions. However, the effects of earthquakes on landslide activity, and on slope stability in general, are not restricted to a brief period of intense seismic shaking. Indeed, in some cases delayed landsliding has occurred hours or even days after an earthquake. Furthermore, the destabilizing effects of earthquake shaking can have longer-term impact on hillslopes. In particular, landslides initially induced by seismic shaking can be re-activated or enlarged as a result of other instability factors. For instance, several landslides triggered by the 1980 Irpinia, Italy, earthquake (Mw 6.9) continued to experience seasonal movement and associated erosion following periods of intense or prolonged rainfall. The data from the very well documented case of the Mw 7.6 Chi-Chi 1999 earthquake (that triggered 25,000 slope failures) in Taiwan indicate that rates of landsliding and erosion in the epicentral area increased few times in the years following the earthquake (Dadson *et al.*, 2004) and the most recent rates still remain significantly higher than the background values before the 1999 event (Lin *et al.*, 2009). Similar enhanced post-seismic landslide activity is being observed in the case of the Mw 7.9 Wenchuan 2008 earthquake, Sichuan, China (Tang et al, 2009), which triggered several tens of thousands landslides. Thus erosion and sedimentary processes in seismically active mountainous regions are significantly influenced by both co-seismic slope failure triggering and increased post-seismic landslide activity. To highlight the importance of earthquake-induced landsliding to long-term slope erosion we apply the quantitative approach by Keefer (1994) to the case of the 6.9 Mw Irpinia earthquake, Italy. Depending on the estimated earthquake return times and assumed average landslide depths the calculated erosion rates for the epicentral area of 130 km2 vary from about 0.05 to 0.14 mm/yr. Despite some data variability, these results imply that, along with other non-seismically induced erosion/sedimentary processes, earthquake-induced landsliding is an important agent controlling slope denudation in the Southern Apennines.

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Gravel antidunes in fluvial systems

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Antidunes may occur in river gravels for given hydraulic conditions. However there is little published experimental data to assist in determining the hydraulic conditions under which these classes of bedforms might develop. In addition there are few published examples of putative gravel antidunes in rivers. Some examples of putative gravel antidunes in rivers are presented and the preliminary results from recent flume studies provide new and additional insight into gravel bedform hydrodynamics. Flume studies have involved imaging the flow field above a series of fixed-bed sinusoidal fine-gravel antidunes that are of progressively steeper amplitude until incipient breaking of the standing wave occurred. Videos of wave behaviour have been processed to indicate fluid particle trajectories and ADV data show the turbulence characteristics of the flow as waves progressively steepen. Video of mobile beds of mixed sand and gravel in accretionary settings demonstrate how the stratigraphy develops and examples of the latter are presented.

Biostabilization vs. bioturbation: the analysis of biogenic structures associated with modern microbial mats in the Bahia Blanca estuary

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Studies of recent environments with microbial mats increased considerably during the last years, not only due to their unique sedimentologic and ecologic characteristics, but also because they provide important implications for the understanding of fossil environments and paleocommunities. Microbial mats were widespread during the Proterozoic times, but with the increment in bioturbation during the Cambrian, they were largely restricted to extreme or stressed environments (Seilacher, 1999). Field studies in a mesotidal flat in the Bahia Blanca estuary, Argentina, reveal the presence of extensive areas with microbial mats, covering the upper-intertidal and lower-supratidal areas. Different microbially induced sedimentary structures (MISS) have been recognized in this estuarine setting (e.g. multidirected ripple marks, mat chips, polygonal oscillation cracks, and gas domes). The main purpose of this study is to characterize the biogenic structures associated to this biostabilized mat ground. In the lower supratidal area, grazing traces of the small gastropod (*Heleobia australis*) occur, mainly in areas with ripples and places with relatively thick microbial mats. Additionally, undermat mining of diptera larvae produces horizontal burrows few millimeters below the sediment surface, just along the oxic-anoxic boundary. Footprints of shorebirds are also common. The anoxic sediments preclude the presence of other biogenic structures within the substrate. So, in the upper zones of the tidal flat, biogenic activity is restricted to the uppermost tiers. However, this situation changes in the intertidal area, where abundant decapod burrows of *Neohelice* (=*Chasmagnathus*) *granulata* occur. These burrows were previously restricted to the lower parts of the intertidal zone, although in the last year there was a significant expansion of these organisms to the upper zones of the intertidal flat, and even to the lower supratidal area. These decapods produce reworking and overturning of the sediment, oxygenating the substrate in the deep, and affecting the whole sedimentation and geochemistry of the tidal flat. Growth and development of microbial mats depends mostly on the ability of the benthic cyanobacteria to cope with the background sediment deposition. As the presence of these large bioturbators is changing the sedimentary dynamics of the tidal flat, removing large amounts of sediment (up to 5.9 kg. m-2. day-1, Iribarne *et al.*, 1997), their activity is having outstanding effects on the studied environment, and thus, the occurrence of microbial mats is largely dependent upon these deep-penetrating burrowers. This modern example helps us to understand the role of bioturbation in the decline of matgrounds and the onset of mixground in the early Phanerozoic.

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Identification of relict sediments in the Superagüi Channel (Paraná, Brazil): preliminary results

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The Superagüi Channel is located in the northern coast of Paraná State as part of the Estuarine Complex of Paranaguá, located between an estuarine environment (Bay of Pinheiros) and the Atlantic Ocean. In general, its shape will be elongated 20 km long and 1.5 kilometers wide with occurrence of mangroves and intertidal plains. The mouth of this channel has a small ebb tide delta (8 km^2 wide), if compared to the others verified on Paraná coast. These regions are composed by shallow areas interspersed with deep channels that dominate the local coastal dynamics. The adjacencies are formed during the Quaternary period and where can be observed extensive plains of beach ridges, with environmental protected areas (National Parks) delimited. The aim of this study was to characterize the bottom sediments along the Superagüi Channel, defining and interpreting sedimentological sectors. In this sense, 83 samples of bottom sediments were taked along the length of the channel, which were subject to grain size analysis with quantification of carbonates and organic matter contained in the sediments. Thus, the results were organized in thematic maps (Grain size, Sorting, Skewness, Kurtosis, percentage in coarse sediments, carbonates and organic matter %) through GIS methods. The characteristics of the sediments were analyzed by visual similarities among the products of GIS applications, the curves of the histograms and cumulative frequency of particles. So, the distribution of grain size along the Superagüi Channel showed variation between coarse sands and medium silts, moderate to very poorly sorted on the mouth of the channel and the Bay of Pinheiros respectively. The sediments with unimodal histograms are grouped in the southern region of the channel near the channel mouth, where coarse sediments prevailed. For bimodal distributions, two factors must be considered and may contribute to this attribute, they are: the presence of shells and concretions of mud (silt + clay), which may contribute to the deformation of the curves. Sedimentological sites were detected with unimodal and coarse sediments in the portion of the mouth, being homogeneous in a grain size sense. The central region of the channel has populations of bimodal sediments, poorly sorted with abundant shells and concretions of mud, mainly on a set of polymodal sediments. The northern portion of the channel presents bimodal samples due to the presence of shells, and large amounts of silts and clays. Thus, the inner and outer portions of the channel are formed by sediments influenced by present biological activities. In the other way, the central portion of the channel has good prospects for the identification of relict sediments, since it has sedimentological characteristics distinct from others. Nowadays, the work concerns in the statistical comparison between the sedimentary groups, as well as the combination of these results in the spatial integration on GIS. Hereafter, we are planning subsequent coring and dating of the sedimentary bedding in order to foster the present coastal Quaternary evolution models of southern Brazil.

Provenance of the Lower Cretaceous Marizal Formation, Northeastern Brazil: implications for paleogeographic reconstruction of post-rift fluvial deposits

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The Marizal Formation is the best exposed unit that crops out along the Recôncavo-Tucano-Jatobá aborted rift, localized in the northeastern region of Brazil. It is mostly surrounded by Neoproterozoic rocks of the Sergipano Belt at the north and of the São Francisco Craton at the southwest. The unit is mainly composed of sandstones and conglomerates, with a minor contribution of siltstones and limestones, interpreted as fluvial, alluvial fan and lacustrine depositional systems formed during the upper Cretaceous. The unit records post-rift subsidence, and overlies a major unconformity with the syn-rift deposits. In spite of being deposited during an interpreted thermal subsidence phase, the Marizal formation is dominated by coarse-grained sediments. We present the results of lithology counting of more than 3,000 pebbles, as well as paleocurrent analysis carried out in outcrops from different areas of the Tucano Central Basin, mostly from the post-rift Marizal Formation. Our data reveal that the provenance and texture of pebbles of conglomerates and pebbly sandstones of the post-rift stage are markedly distinct from those of the syn-rift deposits. Clasts in the Marizal Formation are mainly rounded to subrounded, and are more varied than those in the sin-rift deposits, being composed of gneiss, leuco-granites, garnet-chlorite-schists, quartzites, metaconglomerates, sandstones, phylites, and acid volcanics, with a distinctively lower content of vein quartz and quartizite than the sin-rift deposits. The paleocurrent analysis carried out on cross-bedded sandstones indicates transport towards SW and SE, which suggest a mean paleoflow from north to south. The combination of these methods allows the interpretation of local sources for the Marizal Formation, localized less than 40 km in the Sergipano Belt, and in the Paleozoic rocks preserved in the east. The lower compositional maturity of the post-rift stage indicates that there was no major reworking of syn-rift clasts, and suggests less chemical intemperism of the sources, possibly due to a dryer climate.

Geological Model of La Rosa and Misoa in the North-Central Maracaibo Lake

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In this study, the structure, depositional system, and the stratigraphy of the area were interpreted using seismic data, cores, lithology samples and well logs to characterize structural and depositional settings of the Misoa-La Rosa interval. To interpret depositional system of the Misoa interval, the C7-B7 intervals and La Rosa formation were studied based on well logs and lithofacies, as well as electrofacies maps were prepared. The results of this part of the study show that the sandstones of the Misoa Formation are delta front and fluvial /distributary channel facies of delta system. The net sand thickness map of the C4 interval also exhibits southwest northeast contour patterns reflecting depositional axes in the area. It also shows that the Santa Bárbara interval of La Rosa formation was interpreted as a delta with fluvial/continental influence. To demonstrate structural settings of the study area 3 -D seismic data were interpreted. The most dominant structure in the area is the Lama-Icotea Fault which was interpreted as a strike -slip reverse fault due to its behaviors as a reverse fault in cross sections. The Lama-Icotea Fault is the eastern limit the area, subdividing the field into two main structural blocks, a downthrown block in the western part and the upthrown block in the eastern part of the fault where the hydrocarbons were trapped. Several subsequential normal and reverse faults were located along the both sides of the area. The most relevant intervals economically are Basal La Rosa of La Rosa Formation and C3/C4 of the Misoa Formation due to the homogeneity of their chemical and physical characteristics and their performance as producer fields.

On the internal flow structure of high-density turbidity currents in both aggrading and non-aggrading conditions

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Here we present an experimental dataset on the internal structure of high-density turbidity currents. This study focuses on the transition between aggrading and non-aggrading flows as a function of sediment concentration, discharge and slope. High-density turbidity currents were first mentioned in the nineteen-fifties. Later experimental studies showed that the structure of these flows were characterized by two-layers of different densities. This layering is interpreted as an effect of hindered settling or as a consequence of a change in sediment support mechanisms. Such high-density turbidity currents would then consist of a low-concentrated top layer, where sediment is supported by turbulence, and a high-concentrated bottom layer in which the particles are dominantly supported by grain-to-grain collisions or by hindered settling. Experimental work on the dynamics of high-density turbidity currents is rare and often only considers aggrading flows. The lack of experimental data on non-aggrading flows might overemphasize the stratification of the flow and the roll of hindered settling therein. The aim of this research was to study the structure of high-density turbidity currents in both aggrading and non-aggrading conditions. A series of runs were made in a 4-meter long and 0.07-meter wide flume in the Eurotank laboratories. A 1 cubic meter mixing tank was filled with a mixture of fine sand (160 μm) and water. From this tank the mixture was pumped to the flume through a discharge meter. At three meters from the inlet a velocity profile was measured by a non-intrusive ultrasonic Doppler velocity profiler and a high-speed camera was used to study the dynamics of the flow. During 24 runs discharges (2.5 -5.5 l/s), sediment concentrations (5-26%) and slopes (6-11 degrees) were varied. In this parameter space we have mapped the boundary between the non-aggrading and aggrading flows.

Microbial mat preservation of dinosaur tracks from the Sousa Basin (Lower Cretaceous, Brazil)

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Fossil tracks are preferably found in fine-grained rocks, such as calcilutites and mudstones, what induces to the idea that only low energy environments are adequate for footprint preservation, despite frequent macroclastic deposit (high energy) findings. The recent recognition that some physical sedimentary structures (particularly mudcracks and bedforms of moderate to high energy environments) have an enhanced preservation potential due to the stabilizing character of biofilms and microbial mats also offers an alternative way for vertebrate trace-fossil taphonomic interpretations. These organosedimentary deposits of benthic microbial communities are constituted of multi-layered sheets of micro-organisms, mainly of cyanobacteria, that grow on any type of submerged sediments (since adequate ecologic conditions are achieved), and also on moist terrestrial sediment surfaces. Microbial fabric stress resistancy, sediment particle baffling/bindind nature of the EPS associated to the biofilm/mat, and induced precipitation of cementing minerals are all biosedimentologic (taphonomic) factors that enhance the dinosaur track preservation potential (cf. Marty *et al.* 2009), here discussed. The occurrence of microbial sedimentary structures in the Sousa Basin was first characterized by Silva Filho (2009), who identified them in marls, sandstones, siltstones and mudstones, all presenting dinosaur tracks. The large amount of dinosaur tracks in this basin, described by Leonardi (1989) and Carvalho (2000), seems to be strongly related to the role of biofilms and microbial mats in their fossilization, including its early lithification, preventing from initial current reworking (desintegration) before burial. The existence of an abundant vertebrate ichnofauna, consisting of footprints and tracks of theropods, sauropods and ornithopods, is one of the leading characteristics of the Sousa Formation, but they are rare in the underlying Antenor Navarro and in the overlying Rio Piranhas formations, deposited in alluvial fan/fluvial braided (Antenor Navarro Fm), fan-delta/lacustrine (Sousa Fm), and fluvial (Rio Piranhas Fm) paleoenvironments, during the Early Cretaceous (Neocomian). Despite the pervasive reddish colour in the Sousa Basin, typical of sediments that accumulated in oxidizing partially subaerial environments, there are some greenish shales and mudstones, where body-fossils are found. These body-fossils consist of fish scales, plant fragments, palynomorphs, ostracods and conchostracans. Paleoecologicaly, conchostraca allow to infer the ancient lakes waters as shallow, temporary, warm and alkaline (pH 7–9), according to Carvalho (1993). The dinosaurian footprints and tracks occur in 37 known localities, consisting of at least 585 dinosaurs individuals represented by their tracks, and includes a wide megatracksite named as Borborema Megatracksite (cf. Carvalho and Leonardi, 1992; Carvalho, 2000).

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The rise and demise of South Montserrat: Evolution of the South Soufrière Hills

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On the southern extent of the volcanically active island of Montserrat, West Indies, is an interesting but poorly understood volcanic centre called the South Soufrière Hills (SSH) volcanic complex. Eruptions from the SSH centre are dated at ~125-130 ka (Harford *et al.* 2002). Whereas most of Montserrat is made up of andesitic lavas and pyroclastic deposits, the subaerially exposed outcrops of the SSH volcanic centre are composed predominantly of basaltic lava flows. This study focuses sediment cores from the submarine deposits sourced from the SSH. Recent studies have shown that 80 to 90% of volcanic material erupted from the currently active Soufriere Hills volcano on Montserrat ends up in the sea (Le Friant *et al.* 2009). This illustrates that a better insight into the volcanic history of the SSH can be gained from looking at the marine stratigraphy as deposits on land are commonly eroded or buried by subsequent eruptions. We have discovered new evidence which suggests that there has been a large flank collapse of the SSH edifice into the sea. Sedimentological analysis on stacked graded beds of varying grain-size proportions in the marine sediment cores suggest that the deposit was formed by large retrogressive flank failures of the subaerial SSH edifice. This is supported by evidence from shallow seismic surveying off the southern Montserrat shoreline, which has identified hummocky morphology interpreted as debris avalanche deposits, the result of volcanic flank collapse, on the sea floor (Le Friant *et al.* 2004). Chemostratigraphy has been used in this study to provenance clasts to their source regions, to assess the chemical evolution of the magmas, and as a correlative tool to follow the deposits between cores. The geochemical analyses of samples taken from the submarine SSH deposits (trace element, $^{87}Sr/^{86}Sr$ and high precision double-spike Pb isotopes) coupled with SEM images illustrate that the SSH volcano contains a record of complex magmatic activity. The activity includes multiple injections of mafic magma followed by magmatic differentiation and episodic explosive eruptions of andesitic pumice, which were triggered by mafic pulses, after this were eruptions of poorly vesiculated basaltic scoria. Significantly, the chemostratigraphic correlations of the subunits within the submarine SSH deposits confirm that the SSH edifice suffered multiple retrogressive collapses of the subaerial edifice. The volcaniclastic turbidites in the cores sample chemically heterogeneous sub-units as the failures successively cut back through older subaerial volcanic deposits from the SSH edifice. Much of this key information would have been obscured in the on-land record by erosion and burial by later volcanic activity. Therefore the record in marine sediment cores provides the best means with which to reconstruct these events.

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Growth and decline of Holocene lagoons in the Quiaios region (central littoral Portugal). Natural and anthropogenic influences

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Geophysical, sedimentological, biological and chronological data are combined to establish the evolution of the Holocene coastal lagoons of the Quiaios region. The geological framework based on geophysical data was completed by the execution of 20 boreholes from which approximately 200 sediment samples were collected. Sedimentological, biological and chronological data were obtained from these samples. The upper Pleistocene to Holocene coastal succession north of Cape Mondego (Central Littoral Portugal) is organized in 6 facies that are interpreted as non-podzolized aeolian, podzolized aeolian, wet interdune, fresh-water lake, brackish lagoon and beach-shoreface deposits. The lagoon deposits are less than 2 m thick, cover beach-shoreface sediments and are covered by aeolian sediments. The geophysical results indicate that the lagoon unit has concave-up and sub-horizontal basal and top surfaces, respectively, and extends for about 1000 m inland from the present-day coastline, wedging out into resistive sediments (interpreted as aeolian sands). The fauna of mollusks collected in these sediments indicates low-energy, rather restricted ecological conditions, but always with a significant influx of sea-water. Pollen content demonstrated that the area around the lagoon may already have had cereal cultivations. The ^{14}C calibrated ages of the lagoon deposits range between 4145±35 and 3215±40 years BP. These dates are consistent with other similar lagoon deposits from central west Portugal, both north and south of Cabo Mondego. The aeolian units that show signs of pedogenetic evolution, found to the east, are older (> 5590±45 years BP). Our results indicate that during the extensive Flandrian transgression the existing coastal deposits were truncated while the marine environments progressed eastwards. The coastline reached its easternmost location around 4500 years BP, some 1500 meters east of the present-day position. Development of the brackish lagoon resulted from reworking of coastal sediments and formation of a discontinuous barrier island that did not entirely prevent the entrance of sea water. Later, a phase of intense aeolian activity promoted lagoon silting up. By this time, human activities, through deforestation, may have facilitated aeolian processes and sediment erosion in the watershed feeding the lagoon. The older aeolian units were probably further eroded due to wind deflation during this period.

Petrography and geochemistry of Permo-Triassic Trinity Peninsula Group, Antarctic Peninsula: Implications for provenance and tectonic setting

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Petrographical and Whole-rock major, trace and rare earth elements data are combined in a provenance study of a Permo-Triassic turbidite in the Antarctic Peninsula: the Trinity Peninsula Group. Sandstones and mudstones from seven localities (from north to south: Joinville Island, Hope Bay, Cape Legoupil, Bone Bay, Spring Point, Wildermina Bay and Paradise Harbour) and clasts of conglomerate from View Point have been analyzed to characterize its source and depositional tectonic regime. Furthermore, garnets, an abundant heavy mineral in sandstones at all sampled localities, were analyzed by an electron microprobe. Sandstones modal composition is dominated by quartz and, in smaller proportions, by feldspar, and according to the discrimination scheme of Dickinson *et al.* (1983) is consistent with being the product of erosion of the plutonic roots of a magmatic arc. Moreover, the clasts of a conglomerate from View Point, northeast of Antarctic Peninsula, are mainly granitoids. Major elements on sandstones and mudstones show that sediments underwent low chemical alteration in the source area or during transportation (Chemical Index of Alteration range between 52 and 66), so compositions accurately represent their source areas. The chondrite-normalized REE distribution patterns show an enrichment of LREE relative to HREE and have a negative Eu anomaly (average Eu/Eu* of 0,78 and 0,67 in sandstones and mudstones respectively). Furthermore, ratios of immobile trace elements suggest a felsic igneous source (Th/Sc>1 in sandstones). Sandstones and mudstones show a systematic grain-size-related geochemical contrast which reflects a higher content of clay minerals in mudstones than in sandstones, and a higher proportion of quartz, feldspar, and heavy minerals in sandstones than in mudstones. Heavy mineral fraction comprises only a very small part of the rock. However, this fraction offers a more reliable qualitative indication of the source rock composition. For the Trinity Peninsula Group heavy mineral assemblage consists mostly in zircon, garnet, titatine, apatite, etc. Zircons are mostly igneous and its U-Pb ages (from three samples: Hope Bay, Cape Legoupil and Paradise Harbour; Castillo *et al.*, 2009) show a large narrowly defined population on late Paleozoic (about 270 Ma). Chemical analyses of detrital garnets show they are mostly Almandines types (average Alm68Py25Sp6) and they could be either igneous or methamorphic, but because of the high proportions of igneous zircons the most probable source is igneous. In summary, textural, framework compositions and geochemical data point towards a relatively proximal felsic volcanic arc source. The plutonic roots of this arc must had been exposed by erosion. Furthermore, this arc is likely to have been located at an active continental margin. These results show also that there are strong chemical and chronological similarities between the Trinity Peninsula group, the Duque de York Complex (Patagonia), the Rakaia Terrane (New Zealand) and the LeMay Group (Alexander Island, Antarctic Peninsula). These similarities suggest that these successions derive from the same active continental margin.

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Silting rates in the Paranaguá Bay estuary (Brazil): a bathymetrical approach

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The complex sediment dynamics in coastal regions is a result of the coexistence of fluvial, estuarine, deltaic and shelf depositional environments, as well as the relation among the processes of sediment transport. In the same way, the morphology of the coast has been driven by sediment budget and interactions with hydrodynamic forces. The Estuarine Complex of Paranaguá (CEP; 25°15'S/48°35'W) has an area of 601 km² and presents different characteristics along E-W axis, containing areas of port activity. The aim of this study was to identify critical areas of estuarine sedimentary infill, determining their rates and relationships regarding the estuarine environment features. So we used 38 bathymetric surveys, conducted between 1999 and 2008 and arranged from the head of the estuary to the shallow continental shelf. First, these surveys were grouped chronologically and according to their areas of overlapping. Later they were divided according to grain size and physical parameters (temperature, density and water turbidity, suspended particles and turbidity maximum zone) in four sectors. At the headlands, the sedimentation rates were around 0.60 cm/month/km², whereas in the Turbidity Maximum Zone (TMZ; middle portion) were around 0.06 cm/month/km ² and in the Mouth of the Estuary were around 0.08 cm/month/km². On the Inner Continental Shelf was observed a critical point of silting on the terminal lobe of the ebb tidal delta, where the rate was quantified around 0.56 cm/month/km². The differences among silting rates along the CEP are related to the sediment supply for each sector of deposition, as well as the hydrodynamic forces acting. The highest rates found in the inner portion of the estuary may be the result of the advance of river deltas at the Head of the Estuary, associated to shallow depths and low energy in tidal currents. In TMZ, silting occurs heterogeneously, with erosion areas associated to rock formations. The portuary dredging activities conducted on the mouth of the estuary may have altered the results obtained, since they resulted in erosion rates along the axis of the bathymetric surveys. On the Inner Continental Shelf, the silting critical point concern in sediment dynamics of tidal delta, located at the mouth of the CEP, which reduces the energy waves from the S-SE quadrant and amplifies the power of sediment transport for this area.

Sedimentological and sequence stratigraphic characterization of the transitional-marine reservoirs of the Centenario Formation at the Rio Colorado Heavy Oil Belt, Neuquén Basin, Argentina

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The NE edge of the Neuquén Basin, northward from the Colorado River, was poorly known due to a paucity of well-bore data (less than 1 well per every 75 km^2) and the absence of economic discoveries. The recent discovery of more than 400 million barrels of oil in place (19°API) in the Centenario Formation (Hauterivian-Barremian) trigged aggressive exploration and development activities. A new dataset consisting of 1440 sq.km of 3D seismic, 700 wells and 400 m of cored intervals from 17 wells, has helped to improve the geological knowledge of the area. In this part of the basin the thickness of the Centenario Fm. varies from 120 m to zero due to erosive truncation of the Intersenonian Unconformity. The contrast with the thickness of over 800 m that this unit shows at the basin axis suggests that clastic input, sourced from the ESE, was focused along that direction. Meanwhile north of the Río Colorado region a lower subsidence area developed in a lateral and distal position from the sedimentary source. Two third-order sequences have been identified in the Centenario Fm. where only the transgressive (TST) and highstand system tracts (HST) are developed. Both sequences coarsen upwards and the change from the basal shaly-marly sections to the uppermost sandy units is generally transitional. Nevertheless, there are some sharp contacts that reflect high-order local regressive events. On the basis of vertical and lateral facies arrangement, trace fossil associations and body-fossil occurrence, different sedimentary environments were identified. The distal parts of the unit accumulated in a prodelta to wave-dominated delta front and interdistributary bay environments, with the proximal counterparts represented by a coastal plain setting. TST sections show sedimentary structures, body-fossil and trace-fossil assemblages characteristic of an open-marine depositional setting: e.g. (1) wave-generated sedimentary structures; (2) the presence of the fossils *Amnobaculites* sp.cf. *A. subcretaceous* Cushman y Alexander, *Eogutulina* sp.cf. E. *liasica* (Strickland), *Trochammina depressa* Lozzo, *Epistomina australis* Masiuk y Viñas y *Haplopragmoides* sp.; and (3) trace fossils such as *Diplocraterion*, *Chondrites* and *Rhizocorralium*. In particular, the TST of the Upper Centenario Sequence shows evidence of a rapid transgression event. The base of HSTs were deposited at a brackish, transitional-marine, tidally dominated setting, interpreted from the presence of agglutinated foraminifers (*Trochammina depressa* Lozzo, *Silicosigmoilina* sp., *Psamminopelta* sp., *Ammobaculites* sp.cf. *A. alaskaensis* Tappan) and marine-continental palinomorphs, scarce root traces and a low diversity / diminutive assemblage of trace fossils comprising *Skolithos* and *Planolites*. Scarce and poor quality reservoirs are present in this section. The uppermost part of HSTs contains sand bodies (the main reservoirs) that were mainly deposited within fluvial and locally tidally influenced channels in the coastal plain. The presence of rare *Planolites*, *Skolithos*, and *Thalassinoides* suggests that these channels were at times brackish-water in nature. Reservoirs correspond to very fine and fine grained feldespathic litharenites, well sorted, fairly consolidated, with excellent petrophysical properties (porosity from 25 to 38%, and permeability from 0.5 to 4 D). In spite of the degree of sorting, subtle changes in grain size distribution strongly impact pore-throat sizes, thus affecting the production performance and recovery factor. These reservoir types show different levels of hydrocarbon saturation, down to irreducible oil saturation in the poorest-quality reservoir class. A variety of enhanced oil recovery techniques have been tested in the trend. These include: heavy-oil production with sand, water and steam flooding, horizontal wells and ASP injection. Geological characterization played a key role in meeting the many challenges involved in the exploration and development of the trend.

High-energy tide-influenced channel deposits in a semi-arid alluvial - coastal system; Utrillas Fm, Albian, Iberian Ranges, Spain

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Tide-influenced arkosic sandy channel fills with dispersed rounded quarzite pebbles and ventifacts near Uña (SW Iberian Ranges, Spain), some 45 km inland from the paleocoastline, reflect an arid source area and redistribution in a highly energetic tide-influenced system. The area was connected with the Tethys towards the SE through a funnel-shaped relatively narrow, 25 km wide embayment controlled by two NW-SE faults. Palaeozoic metamorphic quarzites, some 75 km to the NW, are the most nearby possible source area for the quarzite pebbles, and the Iberian Massif at some 200 km distance, where granites crop out, likely was the source area of the feldspars. Five, about 100 m long sections along a well exposed 400 m long outcrop show 3 facies associations: (i) ephemeral tide-influenced alluvial channel fills, (ii) overbank deposits with palaeosols, and (iii) one conspicuous, isolated high-energy tide-influenced channel fill. The 2D correlation panel, to be presented during the meeting, shows the vertical and lateral relationships, sandstone body geometries, and the general facies architecture. (i) Channel bodies are interbedded in floodplain deposits as isolated bodies and also as amalgamated multi-storey bodies. Grain size in these channel fills is fining upward and ranges from very fine to very coarse sand with rounded pebbles and ventifacts. Pebbles occur (a) dispersed within the sandstones, (b) they also form flat-based dm-scale massive tabular layers, (c) laterally persistent planar, single pebble lineations, and (d) dm-scale planar cross bedding. These characteristics suggest a discontinuous supply in a semi-arid alluvial system. Cross beds of variable grainsize, including foresets with pebble strings, reflect alternating bimodal, i.e., seaward and landward directed palaeocurrents within all studied sections. The regular occurrence of Arenicola-type bioturbation in the channel bodies suggest that at least intermittently intertidal conditions occurred. (ii) Overbank deposits are characterized by green to red sandy clays with root traces and deep reddish mottling related to palaeosol development. Root traces commonly continue downwards into channel sandstone bodies suggesting that, after burial, these served as fresh-water aquifers. (iii) The 9 m thick and 64 m wide, isolated, carbonate-cemented high-energy channel fill with a strongly erosive basis shows frequent upper stage plane bed lamination of varying grain size. Pebbles are strikingly absent in this channel fill, and palaeocurrent directions reconstructed from preserved cross beds are dominantly flood-oriented. The strong tidal motions needed for the formation of these high-energy, flood-dominated deposits and the location 45 km inland of the palaeocoastline, are indicative of a period of funnelling and amplification of the tidal wave through the narrow connection with the adjacent Tethys.

Tectonic framework and multiple episode tectonic evolution in deepwater area of Qiongdongnan Basin, Northern South China Sea

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The Qiongdongnan Basin (QDNB) lies in the west part of northern South China Sea, which is an N-E trending Cenozoic basin. The deepwater area of the QDNB is located in the southern part of the basin, where the present water depth is at least 200 m. To the west, the basin is bounded by the Red River Fault and the Yinggehai Basin, to the east by the Pearl River Mouth Basin, and to the south by the Xisha Rise. The deepwater area of the basin includes the Ledong, Lingshui, Beijiao, Songnan, Baodao and Changchang depressions, and the Beijiao uplift. QDNB displays a characteristic passive-margin basin development from rifting to regional subsidence, and is filled with Eocene and Oligocene rift sediments and Miocene–Quaternary post rift sediments. Based on structural interpretation of available high-resolution geological- geophysical and well data, a tectonic framework with a zonal array in N-S direction and a block division in W-E direction was established in the deepwater area of QDNB. A key tectonic boundary T70 was identified by integrated tectono-stratigraphy analysis, subsidence history and depocentre migration. A series of small NE-trending faulted basins are widely distributed below this boundary, while the basin depocentre of QDNB above T70 boundary is located in a center depression area trending in NE－WE－NWW directions, forming a great fault-sag type basin, superimposed over the faulted basins located below the T70 boundary. Analysis of genetic type and geometry of the basin-boundary fault indicates that a NW-SE extensional tectonic stress field strongly controlled the development of the small distributed NE-trending faulted basin group underlying T70 boundary, and a nearly N-S extensional tectonic stress field caused the formation of the fault-sag basin over this boundary. The T70 boundary can be found and traced in Northern continental margin basins of South China Sea. Regional and biostratigraphical correlation shows that the age of this boundary is 32 Ma, which is consistent with the time of initial spreading of South China Sea. Thus T70 boundary is a regional tectonic revolutionary boundary. The development of this boundary leads to a complex tectonic framework and structural evolution. According to this and combined with other important boundaries identified by other authors in the basin and from subsidence analysis, four tectonic episodes for the QDNB are proposed in this paper: a syn-rift episode, a fault-sag episode, a post- rift thermal subsidence episode and a post-rift accelerating subsiding episode. Finally, Cenozoic lithospheric dynamics and kinematical reorganization of plates circum-South China Sea controlling these tectonic episodes are deeply discussed.

Diapir structure and its implication to hydrocarbon in Yinggehai Basin, Northern South China Sea

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Diapirs have been observed in a number of sedimentary basins across the world, and the range of diapir basin detailed described is equally wide. Yinggehai basin(YGHB), developed in the northern continental shelf of the South China Sea, is an ideal region for studying shale diapirs tectonics in sedimentary basin. So far, in the sea-floor of South parts of basin, there are still gas seepages and pockmarks left by shale diapirism, especially around the marginal No.1 Fault (also named Red river fault) of the basin. Migration pathways of shale diapirs, such as gas chimneys in the central Yinggehai depression, are revealed by conventional seismic sections and called “diapir-like structures”. It has been speculated that fluids at depth flowed upward along these zone, resulting in geothermal and overpressure anomalies in shallow sediments on the diapir-like structures. This study is based on a series of multichannel seismic profiles that cross and parallel the strike of YGHB, including 2-D and 3-D seismic reflection data, and 29 boreholes with wireline-logs provided by China National Offshore Oil Corporation. Four structural domains in and around the diaper are defined: (1) Roof zone; (2) root zone, (3) diapir core zone, and (4) sheath strata surrounding the diapir zone. Structures related to diapir are recognized, i.e. gas chimney, diapiric faults and paleo-crater. Our study also proposed a model to clarify initiating mechanisms, forming process and features associated with collapse of shale diapir. This model shows diapiric structure in YGHB can be divided into three categories: buried diapir, piercing diapir and collapsed diapir respectively. And the first categories can be subdivided into deep buried diapir, shallow buried diapir and failed diapir. Meanwhile the diapir evolution may be divided 4 stages. Process of diapirism is controlled by combination of high subsidence rate and high paleogeothermal gradient, together with tectonism. Recent exploration has shown that occurrence of commercial gas pools is located in shallow reservoirs of Late Pliocene and Quaternary age above the diapiric structures. Mechanism of generation, migration, and accumulation of the natural gases in the basins is detailed discussed in our study.

Multidisciplinary characterization of Holocene Rhone river flood deposits in Lake Le Bourget (NW Alps, France) and implication for paleohydrological reconstructions in mid-Europe

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A multidisciplinary study of Holocene clastic sedimentation in Lake Le Bourget combining acoustic mapping techniques and sediment core analyses has been performed since 2004, within the frame of INSU- ECLISPE II “Aphrodyte” and ANR “Pygmalion” French research programs. Over the last decades several seismic reflection surveys (air gun and sparker seismic sources) were also performed in this lake and allowed in particular to document the extension of the Rhone River paleo fan delta developed in the northern part of this large alpine valley lake (20 km long, 145 m deep) during the deglaciation, when the Rhone river was its main tributary. Today only large Rhone River flood events are overflowing a large swamp separating the lake basin from the Rhone River. In order (i) to date the onset of the present day conditions, (ii) to evaluate the preservation of flood deposits on deltaic environments during lake level fluctuations or earthquakes shaking and (iii) to document the frequency of major Rhone River flood events over the Holocene epoch, we performed very high resolution seismic reflection surveys (3.5 kHz pinger and 12 kHz chirp seismic sources) and a mutlibeam bathymetric survey. These surveys were essential to optimise both the location and the interpretation of a 14 m long piston core retrieved by 110 m water depth, within “proximal” meso- and hyper-pycnal Rhone river flood deposits. On cores, Rhone river flood deposits have specific signatures and can be clearly distinguished form the background sediments, either visually or using high-resolution proxies such as: laser grain-size, magnetic susceptibility, gamma density, diffuse reflectance or micro fluorescence (XRF). Up to 14 AMS radiocarbon ages in addition to 210Pb and 137Cs dating together with the identification of historical events (eutrophication of the lake, historical Rhone river flood events) were used on core LDB04 to establish a detailed chronology of flooding activity over the last 9400 years. A constant illite cristalinity index typical from the Mont Blanc Massif was here used to identify the main source area of Rhone River flood deposits in Lake Le Bourget. The confrontation of LDB04 sediment lightness (L*) with available glacier fluctuations in the Alps and lake-level changes in mid-Europe, highlight enhanced Rhone river flooding activity during periods of glacier advances and higher lake level phases. This relation suggest that L* in core LDB04 can be considered as a continuous proxy of Holocene precipitation over the Rhone River catchment area (4000 km2) in the NW Alps. This study also suggest that mass wasting processes reworking essentially mesopycnal flood deposits are mainly triggered by earthquake shaking rather than lake level changes. Finally, wavelet analysis of the L* record clearly shows a dominating millennial (920 -1000 years) periodicity between 9400 and 6000 years evolving into 1700 and 650 years periodicities during the second part of the Holocene. These periodicities are suggesting the dominating influence of solar forcing and of oceanic circulation patterns on precipitation regimes during the first and the second part of our interglacial period, respectively. At higher frequencies, however, the influence of both North Atlantic and sun activity are suggested over the last millennia.

Tracking high-frequency Holocene glacier fluctuations in the Southern Hemisphere: the sedimentary record of Table fjord, Kerguelen Island, Southern Indian Ocean

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In order to better understand the timings of inter hemispheric climate changes during the Holocene there is a growing need for high- resolution records of glacier fluctuations in the Southern hemisphere and in particular at the mid latitudes where climate is closely related to the strength of the westerly winds belt. Here, we present a 36 m long well-dated glacio-marine sequence from the Table fjord (49°S) draining the Ampère glacier (one fifth of the Cook Ice Cap) on Kerguelen Island. Over the last decades the Ampère glacier highlighted a significant retreat essentially in response to changes in precipitation regimes. This glacier retreat exposed some Holocene peat deposits and develops large proglacial lakes draining into the Ampère fluvioglacial outwash plain and at the Ampère delta in the Table fjord. During the MD172-VT104 KAVIAR/TABLE cruise on the R/V Marion Dufresne II in March 2009, three coring stations were selected based on multibeam bathymetry and 3.5 kHz sub bottom profiling (chirp source) in the Table fjord. Calypso giant piston cores together with gravity cores and box cores at each station allowed to retrieve well preserved glacio-marine sediments from the main glacial basin of the fjord. These cores were correlated based on available chirp seismic profiles, core lithologies and their petrophysical sediment properties (magnetic susceptibility, gamma density, P wave velocities) measured on board during the cruise using a Geotek multi sensor core logger. Additional measurements on these dark colour bioturbated muds frequently interrupted by graded sandy or silty beds include radiocarbon dating of (numerous) bivalve shells and (few) terrestrial macro remains. On going measurements concern punctual analysis of organic matter content and characteristics (Rock Eval pyrolisis, palynofacies identifications), sediment grain size and the geochemistry of several tephra layers retrieved at the three stations. This data set highlights significant fluctuations of sediment magnetic susceptibility (MS) in phase with sediment gamma density (GD) that can be seen at the three stations. In addition at least one tephra layer can be correlated across the fjord. These correlations suggest that the frequent graded beds were significantly erosive events close to the Ampère delta, but essentially depositional in the deep central basin where they develop a clear sediment depot-centre and did not reach the most distal station in the fjord. Thus, a detailed age-depth model has been focused on the central station based on up to 18 AMS radiocarbon ages covering the last 4200 years. These ages are in chronological order and suggest: (i) the existence of reservoir effect of ca. 135 years only and (ii) a very high mean sedimentation rate (ca. 8.5 mm/yr). Frequent graded beds up to 10 cm thick in the central station are interpreted as hyperpycnal flood deposits and could be related to proglacial lake outburst events in the Ampère fluvio-glacial outwash plain. The comparison of sediment SM and GD fluctuations with the ages of recently exposed Holocene peat deposits in front of the Ampère glacier and Holocene glacier fluctuations documented in New Zeeland and Chile, suggest that Ampère glacier advances occurred between 3800-3750; 3150-2750; 2150-2000; 1550-850; 700-600 and 450-250 cal BP. These changes in glacio-marine sediment composition may here reflect significant fluctuations in precipitation regimes over the Ampère glacier over the last 4200 years and could be used as a key proxy to reconstruct the strength of the Westerlies in this part of the Indian Ocean.

Multidisciplinary characterisation of Holocene marine sedimentation in North Western Patagonia (Chile): evidence for climate and tectonic forcing in Seno Reloncavi and Golfo Corcovado

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Little is known about the nature, the dynamic and the preservation of Holocene marine sedimentation in North Western Patagonia. This part of South America is however characterised by strong westerly winds, large coastal currents, very high precipitations, dense vegetation cover, large glaciers and rivers, the interior Sea of Chiloe, numerous fjords and bays. In addition, the region has been frequently affected by major subduction earthquakes and contains numerous active volcanoes of Late glacial and Holocene ages. In order to better understand the respective contribution of climate and tectonic on the evolution of Northern Patagonia terrestrial and marine environments, we combined high-resolution seismic profiles (chirp, pinger and sparker data) and a multidisciplinary investigation of giant piston cores retrieved during the MD-159 PACHIDERME (IMAGES XV) cruise in March 2007 in the Chiloe Continental Sea between 41 and 44° S. Seismic profiling was particularly essential to optimise the location of sediment cores in the Reloncavi bay and fjord but also in the Corcovado gulf, because of the occurrence of strong bottom currents controlling the distribution of sediments in the numerous sub basins of glacial origin and of gravity reworking phenomena affecting deltaic environments. CASQ and Calypso cores retrieved in the Reloncavi Bay and Fjord, were correlated based on chirp seismic profiles, core lithologies and their petrophysical sediment properties measured on board the R/V Marion Dufresne II using a Geotek multi sensor core logger. Additional measurements performed on these cores since the survey include, XRF core scanning, continuous diffuse spectral reflectance measurements, as well as punctual measurements of organic matter content and characteristics (Rock Eval pyrolisis, palynofacies identifications), laser grain size and radiocarbon dating of (few) terrestrial macro remains and of (numerous) bivalve shells identified within bioturbated muds. In the Calypso core retrieved in the Gulf of Corcovado, post survey studies included diffuse spectral reflectance, punctual measurements of organic matter content and characteristics and radiocarbon dating of shell fragments. In addition, the geochemical signature of tephra layers identified in these cores allows some regional correlations with several sedimentary sequences on land, in lakes and offshore Chile. This dataset is highlighting that Holocene marine sedimentation consists of a mixture of Fe-rich clastic and organic-rich authigenic particles and resulted from a combination of climatic and tectonic forcing. In particular, high sediment accumulation rates are documented during the early Holocene in the Gulf of Corcovado, while higher accumulation rates are occurring during the Late Holocene in the Reloncavi Bay and Fjord. These changes are suggesting the influence of strong bottom currents on the construction of contourite drift deposits and a contrasted pattern of bottom currents between the south and the north of the Chiloe Continental Sea before and after the culmination of the Holocene marine transgression. In addition, up to 9 megaturbidite (MT) deposits were identified in the Reloncavi Fjord over the last 7500 cal BP. Over the last 2000 years, 7 MT can be correlated with 3 historical major subduction earthquakes and 4 pre- historical ones documented in the literature by tsunami deposits in the nearby Maullin Estuary. Finally, in Reloncavi cores the identification of historical events and the confrontation of radiocarbon dates on terrestrial macro remains and shells, suggest that a radiocarbon reservoir correction ranging between 400 to 575 years should be applied during the late Holocene and before the mid Holocene, respectively.

Silica Budget at the sediment water interface in the Central Indian Basin

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Silicate is one of the essential macro-nutrients in the ocean and siliceous plankton contributes to 30-40% of primary productivity in surface waters, and thus plays a major role in the oceanic biological pump. Processes affecting the oceanic silica cycle in the water column and at the sediment-water interface are important aspects in understanding present day benthic biogeochemistry and productivity of past oceans. Biogenic silica has been extensively used as a proxy for reconstructing paleo-productivity of the world oceans and mass balance for the global oceans have also been estimated. However, little is known about the present regional distribution of biogenic flux, accumulation and their relation to primary production in the surface waters of the Central Indian Basin (CIB). Although, the CIB is oligotrophic in nature, the abyssal areas situated below the carbonate compensation depth (CCD) are major sinks for silicate remains of biota. The CIB, along with the Wharton in the east and Somali basins in the west form a continuous belt of silica accumulation, but these areas are not considered in general estimates of silica accumulation in view of the paucity of data. Here we make an attempt to estimate the silica budget for the benthic region of the CIB and its contribution to the world ocean silica balance. Biogenic silica (BSi) and dissolved silica (DSi from porewater) were estimated from two sediment domains (siliceous ooze and pelagic clays) at 6 sites at 1° interval along 75.5°E longitude and 10°S and 15°S latitude. BSi concentration in the region ranges between 18% and 37% (by weight). The accumulation rates of BSi range between 0.29 and 3.83 mmol m-2 y-1, with a gradual decrease from north to south which is attributed to a higher sedimentation rate (0.83 cm ka-1 versus 0.29 cm ka-1) and siliceous productivity in the north. Mass balance calculations showed that the annual opal delivery to the seafloor reconstructed from sedimentary fluxes ranged from 8% by 23% with a major portion (76- 91%) of biogenic silica being dissolved in water column. Significant changes were seen at the benthic boundary layer where only 0.014 % to 0.29 % of BSi reaching the seafloor is preserved which through diagenetic processes may re-enter the geologic cycle. A compilation of biogenic fluxes collected at 7 sites with sediment traps deployed at 7m above sea floor contradict and give a more robust picture where ~95 to 98% of silica gets dissolved in water column and only 1% - 4.52% was retrieved in the sediment traps. Dissolution rate at the water sediment interface (7m above seafloor) was estimated to be ~ 98 % to 99.6 % of the biogenic silica retrieved in sediment traps leaving a very small fraction (0.014 %) to be preserved/buried in the sediment. The preservation index is very less compared to equatorial region of the Pacific and Atlantic oceans where preservation is ~ 3%. High fluxes of dissolved silica (~ 395 mmol m-2 y-1) in surface sediments which results from these higher dissolution rates are related to the salinity maxima of deep waters from northern Indian Ocean and indicate that the CIB is under saturated with respect to opal. Total biogenic flux to the sediments of CIB is estimated to be between 5.24 and 177.3 G mol Si per year and out of which only 0.072 to 1.70 G mol Si per year is preserved. Comparing our results to world ocean (5.9 T mol Si per year), silica-rich region in CIB contributes to ~ 0.028% (0.0017 T mol Si per year) of the global accumulation of biogenic silica. Our work represents the first step towards modeling the benthic biogeochemical Si cycle in the CIB.

A comparative study of incised valleys, estuaries and lagoon sediment-fill along French coasts

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This study aims at comparing modern examples of French incised valleys for unraveling the stratigraphic processes controlling their evolutions. Despite their relatively small length (5500 km), French coasts offer the opportunity to compare a wide variety of coastal environments associated with incised-valleys, from wave- to tide-dominated systems, from microtidal to megatidal environments, from rocky to depositional coasts, from open estuaries to lagoons. This comparison is based on a selection of papers published in the special publication "French Incised valleys, estuaries and lagoons" of the Bulletin de la Société géologique de France and on abundant papers recently published on modern French incised valleys. These papers allow comparing incised valleys within the same setting of tectonically stable and sediment starved margins, but showing contrasted conditions of hydrodynamics, sediment supply and bedrock control. All studies are based on high and very high resolution seismic data, mostly focused on the Holocene record, groundtruthed by cores and dated by radiocarbon analyses. At a stratigraphic level, sea-level variation is the main parameter controlling incised valley formation and sediment fill. Given the French examples have experienced relatively similar sea-level changes and crustal motions during the Holocene, the observed high variability in valley-fills is explained by other controlling factors including hydrodynamics (waves, tidal currents, and fluvial input), sediment supply (basically marine and fluvial including small and large rivers), geomorphology (rocky versus depositional coasts), climate and human activities. The observed variations allow defining valley-fill categories that match the classification based on the energy/morphology of the related present-day estuaries. Then the first-order controlling factor explaining the observed variations in valley fills is hydrodynamics. Three valley-fill categories are highlighted: tide-dominated, mixed tide-and-wave and wave-dominated, that match the classification based on hydrodynamics and morphology of present-day estuaries or lagoons. The second-order controlling factor explaining the observed variations in valley fills is the antecedent morphology of the bedrock, which in turn controls hydrodynamics and sediment supply. Finally, a promising result is the demonstration of the potential of incised valley fills to record high frequency environmental changes related to climate events and human activities. Such diversity showed by French incised-valleys contributes to complement the facies model of Zaitlin *et al.* (1994) and to provide new insights for the relative importance of the parameters controlling these sedimentary systems.

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Lithilogy features of placer-bearing Oligocene formations of West Siberia

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Research of lithostratigraphic subdivisions of Oligocene of West Siberia is necessary both for detailed elaboration of regional stratigraphic chart and determination of perspectives of heavy mineral placers (HMP) of titan and zircon mineral. Source of heavy minerals of West-Siberian terrigeneous-mineralogical province is connected with Late Mesozoic - Early Cenozoic weathered crusts that developed on magmatic and metamorphic rocks of surrounding area. Tectonic activation had been started in Oligocene resulted to erosion of the crusts and transportation of eroded material to shallow lacustrine - marine sedimentation basin located on the territory of present-day West Siberian plain. Researched placer bearing area has intermediate location between east piedmont of Ural Mountain System and west setting of Siberian plain that determine special features of regional stratigraphic scales. Perspective for HMP Lower Oligocene unit has unclear developed stratigraphic division. It is described as undivided Atlym (At) - Novomikhailovskoe (Nm) - Kurtamysh (Kr) group which corresponds to Ruppenian stage of Europe. The first two formations are determined on the territory of West Siberian plain, the third one is known on the East Ural piedmont. Everywhere this group is underlain by green clays of Eocene Tavda formation (Bartonian - Priabinian Stage) and overlaid by silt clay of Upper Oligocene Turtass formation (Chattian Stage). At formation consists of mainly quartz fine sand with interlayers of silt, clay and lignite plant detritus. Nm is represented by interstratifications of dense brown (chocolate) clays and feldspar - quartz sands with lignite lenses which is unique and well-recognized on studied area. Kr formation consists of fine to medium-grained sand with thin interlayers of brown plastic clay and organic material. Research of sedimentary structures of Kr allows revealing in the region of four adjoining facial zones (from west to east): fluvial paleovalleys area, beach and submarine delta, shallow sea/big lake of moderate wave influence and bottom depressions without wave activity. Last research of this group allows determining of interrelation of the formations. In the basin of Konda River typical Nm deposits are observed. In the lateral and vertical direction these layers are eroded and changed (in series) by conglomerate of brown clay clasts, sand with well-rounded clay pebbles, fine sand and silt. Thus, we meet here paleoshoreline where cliff and bedrock consisting of Nm formation was eroded by Late Ruppenian fluvial - lacustrine/sea paleosystem. Deposits of this basin and laterally adjoining fluvial - paleodelta complex very likely corresponds to Kr formation. Concentrations of heavy minerals in Nm are widespread but moderate. Separation of eroded sediments in the littoral zone result to deposition of HMP in Kr basin. So Nm is intermediate host for Kr HMP. Border of Nm and Kr with basal conglomerate of clay pebbles is search indicator for beach HMP.

Characteristics and causes of suspended matters in South of the Taiwan Strait

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42 stations of CTD/turbidity/chlorophyll-a and samples of Suspended matter in south of the Taiwan Strait are collected respectively in spring of 2003, summer of 2004 and autumn of 2006.The characteristics and causes of suspended matter are discussed.Some conclusions are achieved, as below: 1) In sea area near shore upwelling happens mainly in summer, but not always happens in spring and autumn, which are likely depended on strength of southwest monsoon. In outer edge of the Taiwan Bank, the upwelling happens all seasons, and upwelling depth vary in different season. Upwelling is typical hydraulics and ecosystem phenomena feature in the study area, which helps to growth of marine plankton, and affects sedimentation. 2) High turbidity happens in sea area near shore and outer edge of the Taiwan Bank, especially in near bottom water, and low turbidity happens above the Bank. High fluorescence happens at depth of 20- 70m in outer edge of the Bank, which represents high productivities to ecosystem. 3) The turbidity near shore and at outer edge of the Bank, has characteristics of highest in winter, secondly higher in autumn, third in spring, and lowest in summer. The season variability phenomenon reflects effect caused by the Littoral Current. 4) Terrestrial input of suspended matters from the Mainland China has important effects to the study area, which mainly happens in day of heavy wind in winter and heavy rainfall in summer, in those conditions the high turbidity water from the Littoral Current would break through the South China Sea Warm Current and flow into study area, which forms same mineralogy distribution in south of the Strait. Based on data of remote sense and current direction, input materials from west coast of the Taiwan Island seldom flows into the study area, means slight effects to the formation of suspended matters in study area. 5) In fair day, wave combined with current hardly re-suspend surface sediment in study area, but in storm condition the combined force by current and wave would likely make the sediment moving and re- suspension, which is other cause forming suspended matters in the area. 6) High fluorescence helps to improving turbidity in water, but is much lower than inorganic matters, including minerals. Water temperature, salinity and density spring-layer take control of distribution of high fluorescence. High turbidity weakens sun light propagation in water, which restrains phytoplankton's photosynthesis, and affects distribution of fluorescence and functions of ecosystem.

The South American summer monsoon during the Holocene

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Southeastern South America is the most densely populated and agriculturally productive region of the continent, greatly relying on South American Summer Monsoon (SASM) precipitation. A comprehensive understanding of the SASM activity on different time scales is thus a key issue. Here we explore the main forcing factors controlling SASM behavior during the Holocene using a ca. 14-ka-long marine sediment core from the continental slope off southeastern South America. The Fe/K and Al/Si ratios of terrigenous sediments delivered to our core site accurately reflect the intensity of chemical weathering and consequently SASM precipitation over southern (sub)tropical South America. Our data show that until ca. 8 ka B.P. SASM variability was strongly linked to Northern Hemisphere climate and to changes in Atlantic meridional overturning circulation strength. Two wet periods (i.e., Younger Dryas and between 10.3 and 8 ka B.P.) highlight that remnant glacial boundary conditions still performed a great influence on southern tropical climate. After ca. 8 ka B.P., subtropical summer insolation controlled SASM intensity that was characterized by a dry mid Holocene and a wet late Holocene.

Abrupt sea level rise and terrigenous sedimentation off southeastern South America since the LGM

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The Plata River drainage basin (PRDB) is the second largest drainage basin in South America delivering annually ca. 130 million t of suspended sediments into the western South Atlantic. Although the present day distribution of PRDB sediments at the South American continental margin is relatively well understood, there is a lack of information about the main depocenter for PRDB sediments during past sea level lowstands (e.g., Last Glacial Maximum; LGM) and subsequent abrupt pulses during deglacial sea level rise (e.g., meltwater pulse 1A; MWP1A). There are at least two possibilities regarding the position of the main depocenter for PRDB sediments during the LGM: (i) the continental slope immediately in front of the Plata River mouth at ca. 37°S, characterized by the shortest distance between the present-day river mouth and shelf break, with PRDB sediments feeding a number of canyons at the continental slope; and (ii) the Rio Grande Cone, a major depositional feature of the continental slope at ca. 33°S, characterized by a much longer sedimentary pathway from the present-day river mouth to the shelf break if compared to (i), involving an abrupt inflection of the paleovalley of the Plata River towards the northeast at the exit of the modern estuary. Here we present preliminary geochemical, geophysical and bathymetrical data from the continental shelf and slope off southeastern South America in the attempt to tackle this issue. A detailed radiocarbon-based age model from a marine sediment core collected at the upper continental slope at 32.5°S (Rio Grande Cone) shows a marked stepwise decrease in sedimentation rates where the steps are remarkably synchronous to meltwater pulses (19 ka MWP and MWP1A, respectively). Bulk sediment Fe/K ratios in this core point to the PRDB as the main sedimentary source throughout the core. On the other hand, neodymium isotopes from another marine sediment core collected in the lower continental slope at 39.3°S show a typical signature of the Southern Andes throughout the analyzed period, with no significant PRDB sediments reaching the site. Seismo-acoustic and bathymetric data from the continental shelf allow the identification of a partially filled (paleo)valley that connects the exit of the Plata River estuary to the Rio Grande Cone. Thus, our preliminary data favor the second hypothesis, i.e., the Rio Grande Cone as the main depocenter for PRDB sediments during the LGM. The data also raise the hypothesis that abrupt sea level rise at ca. 19 and 14 ka BP flooded the continental shelf, trapping a significant portion of PRDB sediments and displacing the main depocenter landwards. Further studies will focus on the possible landward migration of depocenters during abrupt sea level rise.

Carbon-isotope stratigraphy of the Frecheirinha Formation cap carbonate, Ubajara Basin, Northeastern Brazil

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The Middle Coreaú Domain, state of Ceará, is characterized by a series of grabens and horsts whose boundary faults trend SW-NE. The Ubajara Group sedimentary rocks were deposited in the Ubajara Basin, which is delimited to the southeast by the Sobral-Pedro II shear zone, considered part of the shield-scale Transbrazilian lineament. The Frecheirinha carbonates rest on reddish to purple slates and quartzites and at the Angostura Farm, these carbonates (rhythmites) overlie itabirite (BIF) of the Caiçaras Formation. Arkoses and graywackes of the Coreaú Formation overlie carbonates of the Frecheirinha Formation. Between Frecheirinha and Coreau towns, northward-dipping Frecheirinha limestones overlie a conglomerate of red matrix that dips southwards. About 350 samples were collected on a meter scale over ~100m traverses across the strike of carbonates of the Frecheirinha Formation, including samples from near the contact with the Caiçara slates and near the Coreaú sandstones. Marly limestones in the lowermost portion of this sequence are replaced upsection by fine-grained limestones ($CaCO_3$> 85%). The $\delta^{13}C$ in four of the sampled sections is +1‰VPDB while in the upper carbonate layers values jump to +2.5 to +3.7‰. $\delta^{13}C$ for the marly carbonates at the lowermost portion of the Frecheirinha Formation is negative (-8 to -1.2‰VPDB) coinciding with the highest $\delta^{18}O$ values (-6.9 to -5.3 ‰VPDB) in the sequence. These marly carbonates were probably deposited under lower temperature conditions, in a post-glacial transition to a warmer climate. The C- isotope pathway for the Frecheirinha Formation with negative δ13C values in the base and positive values up to 3.7 ‰VPDB in the top of the Formation is compatible with pathways for cap carbonates elsewhere. On the contrary of other studied cap carbonates in northeastern Brazil (e.g. Sergipano and Seridó Belts and Rio Pardo Basin), no $\delta^{13}C$ value > + 3.7‰ has been recorded in the Frecheirinha Formation, suggesting an Ediacaran age for this carbonate sequence. The only age available for the Frecheirinha Formation (0.61 Ga) is based on a poor Rb-Sr isochron for clay fractions from slates of the Caiçara Formation. The Mucambo pluton intruded Frecheirinha Formation carbonates at 0.54 Ga developing a thermal aureole, and sets a minimum age for this Formation. Frecheirinha Formation carbonates show $^{87}Sr/^{86}Sr$ values ~ 0.7075 which do not allow an unambiguous age assignment. Similar values and associated BIF without glacial features occur in the Ediacaran Arroyo del Soldado Group of Uruguay.

Rhythmic climbing-ripple cross-lamination in inclined heterolithic stratification (IHS) of a macrotidal estuarine channel, Gomso Bay, West Coast of Korea

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Well-developed rhythmic climbing-ripple cross-lamination (RCRL) was described from estuarine tidal channels in Gomso Bay, west coast of Korea. Associated with upper intertidal point bars of closely spaced meandering channels, RCRL occurs between mean sea level and mean neap high-water level. RCRL is typically less than 40 cm thick, and constitutes the upper part of fining-upward channel-fill successions that are capped by intensely bioturbated mud. RCRL consists of mud-draped climbing-ripple cross-laminae that are continuous along strike direction of the channel for 10–20 m. Climbing patterns are dominantly supercritical and less commonly subcritical. Flood-oriented RCRL is developed in the landward part of the meander bend, while ebb-oriented RCRL is developed in the seaward part. RCRL demonstrates rhythmic change in cross-lamination thickness, which resembles various hierarchical tidal cycles, such as diurnal inequality, synodic neap-spring tidal cycle, and anomalistic tidal cycle. Truncated tidal rhythmicities registered in RCRL and fine-grained textures are consistent with an upper intertidal origin. Common links of RCRL with inclined heterolithic stratification (IHS) and tight meander bends as well as high sedimentation rate is suggestive that RCRL can serve as a diagnostic indicator of active channel migration in the fluvio-estuarine transition. This study highlights the significance of RCRL bearing well-preserved tidal rhythmicities in the reconstruction of paleodepositional environment, paleoelevation in terms of tidal frame, and paleogeography.

Sedimentology and morphodynamics of intertidal channels in the macrotidal Han River Delta, Korea – potential modern analogue of tide-dominated Oil Sand Reservoir in Canada

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Up to 6-km wide, extensive tidal flats are developed at Yeochari, sourthern Ganghwa Island in the macrotidal Han River delta, west coast of Korea. The flats are divisible into two morphologic zones, a monotonous, concave-up upper intertidal flat and a channelized, middle to lower intertidal flat. Along the transect YC-1, four channels (CH-1, CH-2, CH-3, and CH-4 from seaward to landward) are recognized in the lower to middle intertidal flat. The channels are 240–570 m wide and 1.2–2.4 m deep. Repeated profilings of YC-1 using a total station revealed that channels are actively migrating at a remarkable rate. In particular, CH-4 migrated about 100 m during 10 months, resulting in the rapid deposition of interlaminated sands and muds that constitute inclined heterolithic stratification (IHS) of a point bar. Erosion remnants of the IHS exposed on the present cut-bank of CH-4 indicate that channel migration is multidirectional and extensive. Long-term observations of channel morphology suggest that tidal channels are highly mobile to form complicated architecture of channel-bank deposits. Considering the seasonality of precipitation due to monsoon climate, the mobility of tidal channels seems to be pronounced presumably during summertime rainy season when ebb currents are reinforced by increased runoff discharge. Tidal channels in the Yeochari tidal flat are comparable in size and facies architecture to heterolithic oil sand reservoirs encountered in Alberta, Canada. Results of this study may facilitate the characterization of estuarine to deltaic tidal channel reservoirs, which were formed by interaction between tide, wave and river with the presence of strong climate influence.

Discontinuity surfaces in a Jurassic ramp (High Atlas, Morocco) and in a Triassic atoll (Latemár, Dolomites, Italy): characterisation and mechanisms of formation

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Discontinuity surfaces are features in the sedimentary record related to a break in sedimentation (hiatus). Discontinuity surfaces are of significance for the understanding of sequence stratigraphy as they form sequence boundaries and they control fluid flow in carbonate reservoirs as they reflect intervals characterized by markedly different diagenetic histories. This project forms part of a larger applied research- initiative covering aspects such as spatial facies distribution, fracture- pattern / facies relationships and prediction of fluid flow. It aims to characterize discontinuities and lateral facies change in two shallow- marine carbonate settings, a Jurassic ramp (Bajocian, Assoul Formation) and a Triassic atoll (Ladinian, Schlern Formation). The project aims to establish a hierarchical classification of discontinuity surfaces based on their lateral extent and variability, degree of bioturbation, and facies changes across surfaces. The study areas chosen for this project are located in the Amellago Canyon, High Atlas of Morocco, and on the Latemár, in the western part of the Dolomites, Italy. Several study windows, expanding laterally for many hundreds of meters were investigated in detail using densely-spaced and correlated stratigraphic sections. The discontinuity surfaces studied show: (1) field characteristics of marine omission surfaces in the ramp setting and (2) field characteristics of subaerial exposure surfaces in the atoll location. (1) Jurassic ramp: field observations include boring and encrusting in- and epi-fauna, iron staining and an increase of pre-lithification burrowing towards the surface (omission). The spatial and temporal distribution of surfaces is compared in several physiographic domains (proximal ramp setting, intermediate ramp setting and outer ramp setting). Based on data obtained, omission surfaces can be classified into three groups: (i) surfaces showing incipient lithification and condensation, (ii) firmgrounds (partially lithified surfaces), (iii) hardgrounds (fully lithified surfaces). The frequency and lateral extent of surfaces reaches a maximum in the higher-energy setting of the intermediate ramp domains whereas both frequency and lateral extent of surfaces decreases seawards: hardgrounds form mainly in relative high-energy settings. In the intermediate ramp setting, a preliminary interpretation of the mechanisms leading to discontinuity formation include sea-level fall, lowering of the permanent wave base and winnowing of the carbonate seafloor (wave-base rasor). Field evidence for subaerial exposure is lacking but more investigations are under progress. Though ambiguous, stable-isotope data are indicative of marine and burial isotopic signatures, when combined with observation in the field and preliminary outcomes from cathodoluminescence miscrocopy, but complementary petrographic work is under way. (2) Triassic atoll: surface characteristics exhibit staining, red internal layers and dolomitized caps at cycle tops, reworked red breccias and tepees. Surfaces can be classified into two groups: (i) intratidal discontinuities (dolomite-capped surfaces) and (ii) supratidal discontinuities (subaerial exposure surfaces). Of particular interest is the observation that some exposure surfaces display several superimposed diagenetic processes. Field descriptions have been complemented by the analysis of stable isotopes of specific components (micrite, cements, etc.) present in slabed rock speciment sampled at the surfaces. Preliminary geochemical data across Latemar discontinuity surfaces remain positive and invariant and show little relationship to exposure surfaces. We aim at combined field data and the analysis of thin sections under cathodoluminescence microscopy as well as detailed geochemical investigations in order to provide a in-depth analytical interpretation of the diagenesis stages across discontinuity surfaces.

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The Vinchina Broken- Foreland Basin: tectonic controls in the evolution of the fluvial systems of the Toro Negro Formation (Neogene), NW Argentina

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During the Andean Orogeny, inland foreland basins developed in NW Argentina under an arid to semiarid climate. Tectonics played a major control in the evolution of such basins. The Toro Negro Formation (Miocene-Early Pliocene) exhibits a complete record of the broken foreland stage of the Vinchina Basin when the uplift of the Famatina System and Toro Negro range segmented the foreland area. The Toro Negro Formation is composed of conglomerates, sandstones and mudstones together with some levels of breccias and tuffs deposited in fluvial environments. The control exerted by the intense tectonic activity over the fluvial systems of the Lower Member of the Toro Negro Formation is analyzed in this contribution. Eight facies associations (FA) have been identified in the Lower Member of the Toro Negro Formation. FAI is composed of massive intraformational breccias and cross-bedded conglomerates deposited in braided fluvial systems that filled a deep paleovalley formed in the north of the studied region. FAII has been only identified in the margin of the paleovalley and is composed of conglomerates and sandstones forming channel belts incised within alluvial plains deposits. FAIII comprises multistorey sandy-gravelly channels with thin muddy alluvial plains interpreted as deposited in semi-arid anastomosed fluvial systems. FAIV, also interpreted as formed by anastomosed rivers, shows thick alluvial plain successions including well developed crevasse splay deposits. Encapsulated channel complexes, integrated by coarse-grained sandstones and conglomerates, form FAV. Channels appear encased in thick muddy alluvial plains successions that include well developed sandy crevasse splay accumulations. FAVI covers a low-relief erosive surface and it is almost entirely composed of conglomerates and gravelly sandstones deposited in broad alluvial plains. This fluvial system evolved to a lower energy fluvial one (FAVII) characterized by the increase of muddy flood plain deposits and the existence of fine-grained sandstone lobes with conglomeradic lenses. Finally, FAVIII is dominated by fine grained rocks (claystones and siltstones) with sporadic intercalations of sandstones. This unit is interpreted as sedimented in a playa lake environment that occupied the south and central parts of the basin. The genetic stratigraphy of the fluvial systems recognized in the Lower Member of the Toro Negro Formation is analyzed using two principal concepts: 1 accommodation space and 2. degree of incision of the fluvial systems. Using these concepts two depositional sequences have been recognized (Sequence I and II) as well as five major accommodation space stages: 1. Early confined low-accommodation space, 2. Confined low-accommodation space, 3. Confined high- accommodation space, 4. Unconfined high-accommodation space, and 5. Unconfined low-accommodation space. The intraformational breccias at the base of the FAI are interpreted as deposited during the early confined low-accommodation space stage belonging to Sequence I. Confined low-accommodation stage is represented in the middle and upper parts of the FAI (in the central part of the paleovalley) and FAII (in paleovalley marginal positions). FAIII and FAIV were deposited in confined high-accommodation space conditions that favoured the formation and preservation of thick floodplain deposits. The loss of confinement of the fluvial system is well recorded in FAV (unconfined high-accommodation space). This facies association is characterized by the extent of sedimentation throughout the basin after the paleovalley was totally filled. FAVI, formed in braided alluvial plains, marks the base of Sequence II and represents unconfined low-accommodation conditions. Finally, a progressive increase in accommodation space is shown in FAVII and FAVIII.

Isotope stratigraphy of Upper Jurassic limestones: Early marine lithification and differential diagenesis of epioceanic and epicontinental deposits (Iberian subplate)

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Four Upper Jurassic Ammonitico Rosso (AR) sections from the Betic Cordillera in SE Spain are compared to three sections from Majorca Island and southern Portugal. Stable isotope records (C and O) are used to interpret paleoenvironmental conditions and to approach potential variations within the epioceanic fringe, in comparison with an epicontinental setting. Studied materials correspond to Late Jurassic epioceanic settings (Cardador, Salcedo, Cañada del Hornillo and Puerto Escaño sections, SE Spain and Cuber and Cala Fornells sections, Majorca Island), characterized by the occurrence of more or less calcareous AR horizons with variable nodularity from the middle Oxfordian to the latest Tithonian. A comparatively proximal, epicontinental section (lower Kimmeridgian) was investigated for comparison at Rocha Poço (Southern Portugal). At least one bulk sample per ammonite biozone was retrieved under a strict biochronostratigraphic control. Analysed carbonate materials comprise matrix micrite, carbonate cements and skeletal material (mainly belemnite rostra). The degree of diagenetic imprint was acessed by cathodoluminiscence analysis. Dull luminescent matrix micrite is interpreted as fairly preserved, while carbonate cements showing zoned blocky calcite suggest shallow marine burial conditions. Intrinsically luminescent belemnite rostra, ocasionaly cross-cut by fine veining, reveal minor diagenetic imprint. Carbon isotope chemostratigraphy from matrix micrite resembles the known trends for Jurassic northern Tethyan margins. Absolute values, from 1 to 3.5‰, are within the usually reported range. The epicontinental Rocha Poço section shows $\delta^{13}C$ from -6 to -1‰ for less calcareous horizons, whilst more calcareous levels present marine carbon isotope signature. This can either reflect original higher organic matter content as well as facies dependent higher diagenetic overprint in more clayey-silty horizons. At all studied sections, carbonate cements overlap matrix micrite values and belemnite rostra are characterized by $\delta^{13}C$ values as much as 3‰ lower. A probable source for lighter carbon may be metabolic carbon. Oxygen isotope values from matrix micrite present higher variability. Epioceanic sections in Southern Spain present stratigraphic trends attributed to relative sea level changes (e.g., mid- Oxfordian transgression reflected as a 1‰ positive shift, Coimbra *et al.*, 2009). Absolute values range from -1.5 to 1‰, with local variations, rendering palaeo-temperatures similar to those reported for coeval well preserved belemnite rostra (Price and Sellwood, 1994). Similar variations affect the Cala Fornells section, but with lower values (-3 to 0‰), while more variable $\delta^{18}O$ occur in the Cuber section, with negative shifts (Δ=-4‰) fairly corresponding to matrix micrite samples retrieved from horizons bearing siliceous nodules. Lower values throughout the uppermost Tithonian are also observed (around -3‰). Diagenetic, facies dependent overprint may generate such changes. At the Rocha Poço, clayey horizons contrast with calcareous ones ($\delta^{18}O$ values from -5 to -4‰ vs. -4 to -2‰). Original differences in depositional conditions and/or facies dependent diagenetic overprint are assumed. Compared to encasing micrite, carbonate cements present up to 6‰ depleted $\delta^{18}O$ attributed to shallow marine burial stage. Belemnite rostra overlap matrix micrite $\delta^{18}O$ values in all studied sections, except in the epicontinental and more diagenetically affected Rocha Poço section.

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Provenance of pyroclastic deposits in the back-arc basin in the Northwest of Argentina (Eocene - Pliocene)

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The interruption of the sedimentation of the Salta Group and the erosion of different horizons of the Santa Barbara Subgroup produced by the movements happened during the upper Paleocene - early Eocene, in the zone of Eastern Cordillera and Subandean Belt. These different erosion layers are filed on the Umbral de los Gallos, where the base of the Oran Group lies on different deposits of the Santa Barbara Subgroup or more older terms. This area behaved as the marginal forebulge of the foreland basin. The dispersion of the Oran Group deposits is wider than Salta Group's in the oriental and austral portion of the foreland basin and the general structural characteristics do not differ with regard to the design of the cretaceous rift basin. In Luracatao Valley and in the western of the Calchaquí Valley, thrusts would have been produced shaping the western edge of the foreland basin, which would have been the provenance area of the Los Colorados Formation deposits (Payogastilla Group) of middle to upper Eocene age (Payrola Bossio *et al.*, 2009). In the Puna, the tertiary basin of Pastos Grandes has offered paleontological information proceeding from the basal portion of the Geste Formation and it is Eocene age. These intermontane basins would have evolved together with the foreland basin, in the intra-arc/intra-plateau. During the upper Miocene, with the advance of the Nazca plate subduction to the eastward, thrusts were added in the western edge of the Luracatao-Calchaquí Valley. They would have constituted a wedge top, causing the deepening of the Payogastilla Group basin. The Paleogene and Neogene clastics sequences, in the intra-arco/intra-plateau basin, and in the foreland basin, have many pyroclastic levels. The ages of these deposits, many prominent and potentially correlatable pyroclastic layers, are identified in different profiles of the Pastos Grandes Group, Payogastilla Group, Oran Group and equivalents. They show a clear correspondence with explosive events associated with big calderas evolution of the arc and retroarc region of north of Puna and north of Chile. The volcanism reached its climax between 10 my and 2 my, with episodes to 10-9.8 my; 8.4-8.3 my; 6.6-5.6 my; 4-3.5 my and 2-0.4 my. Pyroclastic events of magnitude also were recognized in the south of Puna at the same time, having been registered, on the other hand, to this latitude in Chile episodes before 26 my and 19-16 my, as to the north of the 22º S, in the Altiplano - Eastern Cordillera. These differences in time and space of the explosive cenozoic volcanism in Central Andes, have distinctive compositional characteristics of the centers located along the above mentioned andean strip. These pyroclastic records are guide horizons to use, characterized by the clastic sequences that lodge them, for the comprehension of the tecto-sedimentary evolution of the back-arc basin. The tecto-sedimentary evolution of the region, related to the creation of positive reliefs that should have acted as orographical barriers (Proto- Eastern Cordillera, upper Eocene), or those that determined migration of the thrusts (Oligocene to middle Miocene) or those that indicated stages of segmentation of a basin of simple foreland to of piggy back basins (upper Miocene to Pliocene). They are analyzed on the base of the pyroclastic records far away from the cenozoic volcanism in the region. The sum of paleontological evidences and of those records allows to define correlations and homologations in the continental sequences of red-beds in the back-arc basin in the norwest of Argentina.

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Ecosystem record of climatic fluctuations during the Lower to Middle Miocene from isotope composition and structure of paleosols in a fluvial succession (Digne Valensole Basin, south-eastern France)

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Lower to Middle Miocene alluvial systems are of great interest to understand the continental response to climatic fluctuations that characterize the early growth of the Antarctic ice cap. The Lower to Middle Miocene continental succession of the Digne Valensole Basin (SE France) presents numerous paleosols that constitute a detailed record to investigate continental ecosystem dynamics during that period. Based on chemostratigraphy, this continental succession is correlated with the marine isotope record, providing a stratigraphic resolution from 1Ma to some tens of ka. The ecosystem trends are inferred from the isotopic record of the paleosols, the structure of their profiles and the paleoenvironmental reconstructions of several coastal and inland sections. During the Aquitanian, carbon and oxygen isotope composition are similar over the area, both showing a large decrease of nearly 2‰. The carbon isotope values are far heavier than the expected values from a C3 vegetation. As no C4 vegetation has been identified as early (although their existence is inferred since longer time), it is more likely that the Digne Valensole record indicates a period of decreasing aridity with the concomitant shift in the oxygen isotope values that is interpreted as a drop in temperature, estimated at 4°C (assuming a stable rain source). During the Burdigalian, no major trends are observed in the oxygen values. The carbon isotope values from the coastal area are in perfect agreement with a C3 vegetation. The inland isotope values largely fluctuate, from the coastal values to heavier ones, suggesting cooler periods during which ecosystems were similar between coastal and inland sites and warmer periods, characterized by differentiated vegetations attributed from the oxygen record to vegetation growth in connection with winter rainfall. During the Langhian, both coastal and inland sites recorded very heavy carbon and oxygen isotopic values. The amplitude of the increase in temperature is estimated at 4°C from the coastal site data. The restitution of the vegetation, suggests some aridity even in the coastal site or the occurrence of some C4 plants (up to 30 %), those having been identified as early as 17 Ma. The early Serravallian is marked by a return to C3 vegetation on the coastal site, as a consequence of the major cooling indicated by the oxygen values. The isotopic composition and the maturity stage of the paleosols in the Digne Valensole area show that the aggradding fluvial system recorded all major trends of the global climatic evolution including minor fluctuations. Among these: 1) a significant drop in temperature and in aridity following the first cold event (Mi1) resulting in decreasing maturity of the paleosols despite increasing pedogenesis duration, 2) minor climatic fluctuations during the Burdigalian, characterized at the inland sites by winter vegetation growth, 3) a return to conditions similar to that prevailing during the Early Aquitanian during the Middle Miocene Climatic Optimum with similar ecosystems at the coastal and inland areas.

Evaluation of key parameters for reproducing a fluvial meandering reservoir using FLUMY, a stochastic process-based model

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Stochastic process-based models offer the possibility of reproducing complex sedimentary architectures by simulating the spatial distribution of the sedimentary bodies, providing a detailed description of heterogeneous reservoirs. Conditioning such simulations to data is an important issue for industrial purposes. We present a comprehensive model dedicated to meandering fluvial systems, FLUMY, and illustrate on a case study the method developed to choose the parameters from field data. The simulation is based on the migration of the channel, based on hydraulic equations. The model reproduces the growth of meander loops, including chute and neck cut-off. Associated deposits correspond to pointbars built up in relation to the migration, sand and mud plugs filling the abandoned channel in association to neck cut-off. Aggradation is controlled by the frequency and intensity of overbank floods, resulting in coarse sandy deposits at the bottom of the channel, deposition of silty levees in the vicinity of the channel and shale alluvium further away in the floodplain. Levee breaching results in crevasse splays and may generate avulsion, creating a new channel path. Some regional avulsions are introduced to simulate levee breaching occurring upstream of the modelled domain. The model is capable to reproduce various architectures despite a limited number of parameters. Choosing these parameters from any set of data is a key issue in the success of any simulation. Specific tools have been developed to obtain directly a consistent set of parameters from available data. We present a case study from the Loranca succession (Spain) that offers large outcrops allowing a good evaluation of parameters: - Channel depth is estimated from single point bar heights. The measured heights are converted into a mean water depth, taking into account channel curvature, giving a value of 2.5 m. Channel width is difficult to measure in the field, due to outcrop orientation and similarity between mudplug and floodplain facies. It is calculated using classic hydraulic equations. - Sandbodies correspond either to individual or to amalgamated pointbars. Their extension is at maximum 400 m, giving an extension/height ratio of 160. - Overbank intensity is evaluated from the levee thickness, giving a mean value of 0.4 m, indicating sheet flood deposits. - Sand proportion is calculated from measured sections. It was found equal to 0.36 for the lower unit, presenting amalgamated channelized deposits, and 0.18 for the upper unit, with isolated pointbars. To perform the simulation, the missing parameters, frequencies of overbank floods and avulsions, are defined using heuristic formulas specifically developed to provide whole sets of consistent parameters (Rivoirard *et al.*, 2008). Assuming standard conditions with one migration every iteration, a period of 3000 iterations for avulsions and 300 iterations for overbank floods are then selected for the lower unit, against 700 and 75 for the upper one. The simulated 3D blocks clearly reproduce the amalgamated channelized deposits in the lower unit and the more isolated sand bodies in the upper unit, giving sand proportion of 40% and 20% per unit. These results show that the combination of field observations with the use of the formulas leads, without trial and error, to a set of parameters that is in the expected range of values, demonstrating the interest of such heuristic formulas.

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Clay minerals evolution and thermal burial history of the Neogene Bermejo foreland basin, south-Central Andes

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The Bermejo basin, in the Eastern Precordillera region (30º-33º LS), records part of the Andean synorogenic wedge accumulated in a segment for which it is inferred a current flat subduction regime. This stratigraphy is partly exposed in the Precordillera thrust belt immediately to the west and remains in the subsurface within the Bermejo basin, located between the thin-skinned thrust belt and the present-day broken foreland to the east. Stratigraphic analysis has allowed recognition of a three-formation division: Huachipampa Fm, Quebrada del Cura Fm and Rio Jachal Fm. The Bemejo foreland basin migrated gradually to the east during the last ~20 Ma from a position approximately aligned with the present position of the Western Precordillera to its current position acquired by the Late Miocene-Early Pliocene. Previous work has divided the stratigraphic history of these successions in three main stages linked to the Andean Orogeny. The first two developed between 20 and 7 Ma have been associated with the evolution of an asymmetric flexural foreland (simple foreland), controlled by the thrusting and loads of the Cordilleran tectonic sheets. The third stage corresponds to a broken foreland and extends from 7 Ma to present. The stratigraphy in several deep wells within the Bermejo basin, a frontier exploration area, shows as much as 6000 m thick record. As such, a detailed knowledge of its thermal history and burial trajectory of this, still unroofed stratigraphy, is extremely relevant for applied purposes. Here we present a preliminary thermal study based in clay mineralogy characterization from a deep well within the Bermejo basin, the Pozuelos borehole (YPF.SJ.P.es-1; ~5150 mbs). Samples were analyzed with a PANalytical XPert PRO X-Ray Diffractometer. Orderings in interstratified illite/smectite (I/S) were established through decomposition of detailed X-ray diagrams. Clay mineral assemblage from the sallower sample (250-255 mbs) is dominated by R0, R1 and illite with absence of R3 ordering. Between 1175 and 5128 mbs, R0, R1, R3 and illite are present, with a clear decrease in R0 content with depth, but without disappearing even in the deepest levels of the well. The distribution of I/S phases along the borehole allows us to suggest a progressive illitization process (R0 - R1 - R3 - I) related to the burial history of the Tertiary succession. This is clearly related to a gradual increase of ordering in the I/S and illite content from the top to the base of the unit and with a strong correlation between the degree of illitization and stratigraphic age of the rocks. The presence of R0 even in deeper levels shows that the basal filling from the basin does not exceed the diagenetic field, with maximum temperatures bracketed between 100 ± 20°C. These results are consistent with the thermal gradients of 20°C/km estimated from borehole data (121°C at ~5132 mbs), suggesting that the illitization is related to a continuous burial under the present thermal regime and allows interpreting that the Bermejo basin is a cold and immature depozone. The low-thermal regime could be related to a very- low heat flow, compatible with the presence of the flat subduction in this segment of the Andes. Moreover, progress of illitization is comparable to that recorded for exhumed correlative deposits in the Vinchina Basin to the north, although even lower thermal conditions were established for that basin (~17°C/km, Collo *et al.*, this congress). Our studies allow suggesting some prospective potential in the immediately underlying stratigraphy.

Collo, G., Dávila, F.M. and Astini, R.A. Burial and thermal history of an unusually thick foreland basin fill in the Central Andes (28º-29º SL): signature of the Neogene flat subduction? This congress.

Burial and thermal history of an unusually thick foreland basin fill in the Central Andes (28º-29º SL): signature of the Neogene flat subduction?

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The Vinchina Foreland Basin in western Argentina contains a chronologically-constrained exhumed Neogene stratigraphy with a thickness of ~10 km that shows a progressive illitization process (R0 to R1 to R3), consistent with a relatively incipient burial history. The random clay mineral ordering (R0) is persistent to a depth of ~7 km. This clay ordering is not stable at ~120ºC and its appearance, even in the deepest levels, is consistent with previous thermochronologic studies on detrital apatites. The maximum paleotemperature estimation and basin depth implies a very low geothermal gradient of ~17°C/km during the time between sedimentation (ca. 19 Ma) and tectonic exhumation after 3.4 Ma. Therefore the Vinchina Basin is interpreted as an immature and "cold basin". Sedimentary basins recording low paleogeothermal gradients have been attributed to thermal blanketing effects or to brief burial residence time and/or deformation. However, the tectonic scenario of our Neogene case study combined with results from equivalent successions from exploration wells within the Bermejo Basin (Collo *et al.* this congress) indicates that this segment of the Central Andes has had a very low heat flow transfer, comparable with the heat contribution from the crust, with minimum input from the asthenosphere. This suggests a refrigerated lithosphere under segments with flat subduction and declining influence of the astenospheric wedge. Thus the geometry of subduction may exert a strong control on the temperature flux in this and perhaps other retroforeland sedimentary basins with similar characteristics that may by of importance to applied studies.

Collo, G., Dávila, F.M and Astini, R.A. Clay minerals evolution and thermal burial history of the Neogene Bermejo foreland basin, south-Central Andes. This congress.

Tectonic and climatic control on the fluvial architecture and fossil preservation of the Upper Triassic Ischigualasto Formation, NW Argentina

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Ischigualasto Formation in Northwestern Argentina consists of 300-700 m of fluvial deposits that were accumulated in a northwest-trending continental-rift basin during the Late Triassic. The Ischigualasto sequence is integrated by channel sandstones, overbank mudstones and paleosols with abundant vertebrate and plant fossils. Vertical variation on the fluvial architecture and paleosols along the Ischigualasto section has been previously studied, recognizing four members: La Peña, Cancha de Bochas, Valle de la Luna and Quebrada de la Sal. This variation is coincident with the taphonomic characterization of fossil preservation. In addition to the temporal variation, spatial changes in the fluvial architecture, paleosols and taphonomy of the fossils can be observed along the Ischigualasto Formation. Both, temporal and spatial changes illustrate the tectonic and climatic controls during the deposition of the Ischigualasto sequence. These controls produced recurrent changes in the stream equilibrium profiles of the fluvial systems originating successive periods of erosion and aggradation. In the examined case modifications in the stream equilibrium profiles did not reflect sea level changes but rather the tectonic activity of the rift basin and the alteration of the climatic system because of the Pangea existence. The Ischigualasto Formation sequence starts with a regional erosive surface in the contact with Los Rastros Formation, which pass to a non-erosive surface towards the margin of the basin. This erosive surface corresponds to the development of an incised valley during a lowering of the stream equilibrium profile of the fluvial systems (bypass stage) probably related to tectonic activity. The erosive surface is overlain by amalgamated channel conglomerates (confined low-accomodation stage) that vary to sandstones from the center (El Salto area) to the margins of the basin where it disappear (La Peña Member). These channel bodies represent the point when the stream profile reached the stream equilibrium profile with lack of accommodation space confinate in the incised valley. A period with important lateral differences in the fluvial architecture, paleosols and fossil taphonomy starts from this point (Cancha de Bochas Member). Close to the center of the basin amalgamated channels are continuously stacking up for approximately 200 meters, showing consecutives fall episodes of the stream equilibrium profile, fasting reached by the stream profile (unstable-accomodation stage). These incisive surfaces are correlated to the margins of the basin with well drained floodplains with the mature calcic-paleosols and an anomalous amount of vertebrate fossils, interlayer with minor meandering and anastomosing channels. The enormously amount of paleovertebrates with different stage of preservation (weathering, articulation, etc.) and the calcisols suggest long time of surface exposition (terrace development). Transitionally, a change from calcisols to argillisols, a decrease in the amount of paleovertebrates and a change in their mineralization to ferrous one, together with the preservation of a complete spectrum of paleoflora (i.e. tree trunks, cuticles, palynomorphous) imply an increase in the humidity of the system (Valle de la Luna Member). This allocyclic climatic change produced an elevation of the stream equilibrium profile (unconfined high-accomodation stage). After a period of important aggradation, new amalgamated channel sheets occur, although without incised bases, as it is expected when the topography reach the stream equilibrium profile after a period of aggradation (unconfined low-accomodation stage). Finally a new period of aggradation, expressed by fluvial systems with similar proportion of channels and floodplain (Quebrada de la Sal Member) took place (unconfined high-accomodation stage).

Comparison of tempestite characteristics at different spatial scales: a means of assessing storm activity? (Late Jurassic, NE Spain and western France)

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The physical criteria, such as the thickness and structure of tempestites, the diversity, abundance, size, sorting, and shape of grains, and their vertical trends depend on flow velocities and quantities of transport and reflect paleostorm intensity. Changes in paleostorm intensity and their comparison with the factors that controlled sedimentation such as sea level, climate, tectonics, etc. is a means of better understanding controls on storm activity. The climatic and palaeogeographic settings of the Late Jurassic favoured the cyclone genesis up to 40° North and the development of wide shallow-water carbonate platforms where numerous tempestites were preserved. The Late Jurassic deposits of northeastern Spain and western France are marl-limestone alternations that contain tempestites. Several five metres thick sections, which are located close to Zaragoza in northeastern Spain, form a four kilometres long transect that is perpendicular to the palaeoshoreline. This transect is compared with six five meters thick sections, located close to La Rochelle in western France, that form a fifty-meters long transect, which is also perpendicular to the palaeoshoreline. There, transect is attached to a microbialite and coral reef, which is supposed to be the potential source of sediments. In both case, the studied sections last 100 ky and contain a great number of tempestites. During the Late Jurassic, sea level changes were low and tempestites formed in a physical setting that remained stable throughout the studied period. In this setting, the thickness and structure of tempestites, the diversity, abundance, size, sorting, and shape of grains and their vertical trends are analysed to determine the most significant criteria that can be used to assess the physical processes responsible for these deposits. Then, the distribution of these characteristics along the studied transects allow the effects of the distance to the source and bathymetry to be evaluated. Lastly, the detailed analysis of host deposit facies and their evolution through time allow the definition of the factors that controlled the formation and preservation of tempestites (e.g., sea level, climate, sedimentation rate, diagenesis). In northeastern Spain, the most significant criteria are the diversity, size, and abundance of grains. Their interpretation indicates that water depth controlled the formation and preservation of tempestites, and that the middle ramp deposits are the most appropriate to determine palaeostorm intensity. In western France, the lateral and vertical changes of the structure of tempestites and the size and sorting of grains give information about the physical processes that caused these deposits. Consequently, the very detailed facies analysis of several tempestites and their comparison at spatial scale ranging from several kilometres to few meters is a means of assessing the full range of processes (i.e., from the most global to the most local) that controlled the formation and preservation of tempestites and to better characterise the storms that formed these deposits.

A significant case of cold-water coral carbonate mounds from the Western Mediterranean: the Melilla Mound Field (Alboran Sea)

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Large clusters of Pleistocene-Holocene cold-water coral carbonate mounds -the Melilla Mound Field (MMF)- exist in the Moroccan margin on the Alboran Sea. The mounds were first revealed in seismic and swath-bathymetry records (MARSIBAL Cruise; R/V BIO *Hespérides*, 2006), and then resurveyed and sampled (SAGAS Cruise; R/V *P. Logachev* TTR17-2008) to prove the mound's nature. The MMF lies in a gentle slope at water depths ranging from 250 to 500 m and occupies an area more than 500 km2 paralleling the margin. Multichannel to ultra-high-resolution seismic profiles, swath bathymetry, and high- resolution sonographs investigated the MMF to identify their internal structure and morphology. TV runs show the living ecosystem on mound tops. Gravity coring, dredging and grabbing prove the coralline nature of the mounds. Mineralogical and geochemical analyses establish different environmental controls on mound development, and radiocarbon dating determines ages from upper parts in the mounds. The mounds exposed above the seabed correspond to elongated single edifices or branched mound-cluster ridges (100–250 m wide and 2-6 km long) rising up to 250 m above the surrounding bottom. These seamounts are surrounded by 5- 50 m deep and 50-150 m wide moats. Buried or partly buried mounds, shown on seismic and acoustic profiles, are elongated and domed families of connected buildups (transparent acoustic facies) rooted on highly reflective sediment layers and bounded by dark reflective moats, with dome-size increasing seaward. Some mounds nucleated on former ones so that buried constructions (columnar appearance in acoustic profiles) built through repeated growth phases to reach at least 160 m in height. Three generations of successive mound-growth are observed. The internal architecture of buried clusters suggests that mounds developed under sea-level drop or slope-uplifting conditions, and surrounding moats indicate presence of contour currents creating dynamic current flows that intensify around topographic rises. Sampling proves that the Alboran mounds correspond to cold-water coral knolls formed by muddy calcareous-clayed sediments baffled by coral frameworks (*Lophelia pertusa, Madrepora occulata, Caryophyllia sp, Desmophyllum sp*), associated to benthic fauna. Dead *scleractinean* corals and diverse living biota dominated by soft corals, sponges and asteroids are observed in TV runs. Radiocarbon dating from 4-10 m-long cores gives ages ranging from 1.000 BP to 30.000 BP years. Extrapolations based on accumulation-rate estimates (ranging from about 70 mm/a to 10 mm/a) *versus* major thickness encountered on the vertical development of mound-clusters suggest that the MMF may start to develop about 200.000 years ago. Down-core geochemical profiles in on-mound and off-mound sites assess variations in coral habitat indicators (i.e., contrast in Sr/Ca, U/Th, Ba/Al, Si/Al ratios) that point to notable changes on siliciclastic sediment input, organic-matter content, nutrient flux, and red-ox conditions during mound growing. A setting of important Plio-Quaternary, still active, wrench tectonics involves the Moroccan Alboran margin. Seismic profiles across the MMF show that faults exist beneath the mounds, and some mounds locate above fault plains. Furthermore, the MMF occurs about 200 km east of the Alboran Mud-diapir Province where mud volcanoes, pockmarks fields, and seepages (methane) are driven by recent or actual tectonics. Some Alboran mud volcanoes have coral-drapes of similar nature to those forming the Melilla cold-water coral mounds. Therefore the origin of the MMF may be associated with fluid venting via fractures (thermogenic gas or cold hydrocarbons) in addition to the paleo-environment and hydrodynamic control in mound's development.

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Evolution of the Andean uplift and the forced regression during the lower Tertiary in southern Mendoza, Argentina

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The study was carried out between the top of the Roca formation and Pircala-Cohiueco formation, which were deposited during the Maastritchian to Upper Paleocene and mark the evolution of the Neuquén Basin during this period of time in the region between the rivers Atuel and Barrancas, Mendoza province. The contact between the two units is transitional and indicates the continentalization in the region. The Roca formation is a carbonate platform developed during the Maastritchian-Danian transgression and suffered a restriction in the marine sedimentation with predominant S-SE direction during the early Paleocene, generating a system of continental lagoons with a rapid developed. The lagoons and the rapid continentalization of the abandoned platform, indicates the period of post-Danian regression. The presence of volcanic material (volcanic ash and agglomerate level) indicates the activity of contemporary volcanic arc, distant or with low activity. The Pircala-Coihueco formation is a sequence of continental psammitic deposits, with a high presence of volcanic material. The basal section is transitional with the top of the Roca formation, and occurs as small isolated channels, flattened, which represent low sinuosity river systems. This single channel system, gradually become bigger and will merged, producing a moderate sinuosity in the fluvial system, probably part of the distal floodplain. In the middle section of the stratigraphic column, levels of bioturbated paleosol are presents, developed in the interfluves areas. This level was eroded by a river system of higher energy and high sinuosity, developing psephitic bars, moderate braiding parameters and wide floodplains. Tectonic and paleoenvironmental evolution During the Maastritchtian transgression a carbonate sedimentation platform took place in the passive margin (Roca fm). In the upper Danian, this situation changed abruptly. The passive margin, pass to behave as active margin (due the start of Andean uplift) and produced the regression of Danian Sea as a regional scope. For this reason, the study area becomes a transition zone between the sea and the mainland (top of the Roca fm and base of Pircala-Cohueco fm), so quickly was affected by marine regression which led to a rapid progradation of shallow continental deposits, generating a discontinuity of type 1 accompanied by the developing of incised valleys with paleosols (central section of Pircala-Coihueco fm) which is interpreted as evidence of a forced regression. Over this important surface, numerous prograding parasequences features are presents (top section of Pircala Coihueco fm). The presence of this forced regression with local characteristics is related with the action of the tectonic and stratigraphic events. The Danian regression and the gradual and constant change in the upper areas of the river systems, are linked to the beginning of the Andean uplift, and as a result of building up a sinorogenic prism in this sector, which according to several authors, began during the Eocene (55 Ma). The entire upper section of Roca formation and Pircala-Coihueco formation, constitute mark the beginning of a foreland basin of paleogene age, therefore the discontinuities that limited each parasequences, may be interpreted in the classical sense, refer to a tectonic reactivation or corresponding to a forced regression.

Characterization of pyroclastic sequences in the lower section of Pincheira Formation (Late Miocene), Cordillera Principal- Mendoza- Argentina

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The Pincheiras Formation is made up by a sequence of tuff, agglomerated tuffs, volcanic agglomerates, and volcaniclastic sediments; it has a thickness greater than 500 m that were deposited within the basin Pincheira-Ventana of the Cordillera Principal. This sequence, whose base is 10.8 ± 0.8 Ma (K / Ar), can be divided into three sections. The lower section has two main lithofacies (B1 and B2). B1: Lapilli-vitrea tuff, greyish blue color, with crude crosses stratification to massive (xsLT to mLT). The deposit has different thicknesses varying from 1 to 15 m. The contacts are flat and non erosive. This lithofacies contains pipes and traction and deformational structures. The structures are developed in white coarse lapilli pumice levels. In other sectors parallel lamination at different scales, and various lithic and pumice grading patterns are presents. The microscopic examination indicates 95% vitreous material and 5% of lithoclasts and crystaloclasts components. The fragments are light brown, slightly altered without distortion, and no preferred orientation, most of the fragments are monoaxons. The lithoclasts are from basalt, volcanic pumice and lithic altered. The crystaloclasts are mainly of labradotite, almost idiomorphic, with polysynthetic twinning and zoned, mostly undisturbed, randomly arranged and surrounded by patches of calcite. Other fragments present are pyroxene. B2: Welded crystalline tuff. (xsT), white, with horblende crystals (2 to 3 mm). The thicknesses deposit varies from 0.8 to xx m. Showing different tractive structures: from planar to fine wave lamination. Small ripples are presents. The deposit has a good sorting. Microscopically consists almost entirely by highly vesicular pyroclatics, glassy pumices and fresh. They look between 0.66 and 1.04 mm. To a lesser extent were observed crystaloclasts of green hornblende, subhedral to euhedral, pleochroic, plagioclase and quartz. As accessory apatite spicules were observed, and cubic crystals of opaque minerals. Some cumulate plagioclase crystals, sometimes broken, but with little movement. There are some patches of calcite. This tuff was dated by K / Ar. B1 is interpreted as a body of the pyroclastic flow, deposited mainly by flows of high concentration of particles and aggradations (is) progressive (s) of the same and B2 is interpreted like as deposits from ash cloud surge (s). The lithofacies association that characterized the lower section of this unit is related with a repetitive "Pyroclastic flow with ash cloud" and is constitute by B1 and B2 lithofacies and represents a typical pyroclastic flow deposit (ignimbrite), where the body is B1 and the ash cloud is B2. The lateral gradation (observed in B1) between xsLT y mLT can be explained by changes in the particles concentration, downstream, passing from a pyroclastic diluted flow to a granular fluid-based current. This constitutes a flow-boundary zone transformation. The observed pumice gradations can be explained by changes in the selective filtering properties of the flow-boundary zone, while the deformational structures were made by gravitational collapse of the unstable layer, that were accompanied by liquefaction and up down injection of mLT. A down slope shear can cause asymmetry. The elutriation pipes may develop as escape of dusty gas accompanies the loading-liquefaction. B2, represent the ash cloud surge, developed over the ignimbrite body. This deposit was developed by the low concentration of down streams particles (hot and dry surge). The subparallel stratification, indicate the deposition from a traction-dominate flow boundary. The enrichment of crystals and vitreal fragments, is due the lost of fine fragments from the interior to the edge of body, that is due to the loss of the fine particles inside of the ignimbrite body. Outside the ignimbrite, these materials are held in suspension by the turbulence of the flow.

The ichnological diversity of the Yacoraite Formation (Salta Group, Cretaceous-Paleogene): The first approach to its complexity and paleoenvironmental significance

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The Yacoraite Formation (Maastrichtian-Danian) is a one of the most extensive units in northwestern Argentina and is coeval with several units located along of South America, as part of the typical Late Cretaceous transgressions systems. It represents a carbonate deposit that comprises a set of carbonate and clastic marine and coastal lithofacies, resulting from environmental changes during its accumulation, as part of the initial stage of thermal subsidence of the Salta rift distributed principally in five subbasins (Tres Cruces, Sey, Lomas de Olmedo, Metán and Alemanía) (Salfity y Marquillas 1994; Marquillas *et al.*, 2005). The ichnological framework of the unit has been poorly analyzed, probably because of the importance of the Precambrian-Paleozoic trace fossils in northwestern Argentina that has captured the main focus of the research in the last decades. We present subsequently for the first time, the more extensive integration of the ichnological diversity from the Yacoraite Formation. With this purpose we have identified the trace fossils of nine stratigraphic profiles of the Tres Cruces, Metán and Alemanía subbasins. As result we are defined a cyclical set of traces that comprises loose, softground ichnofacies *Skolithos*-*Cruziana* transition (*Skolithos*, *Arenicolites*, *Diplocraterion*, *Rhizocorallium*, *Thalassinoides*, *Ophiomorpha*, *Chondrites*, *Lockeia* and *Teichichnus*) facies-crossing traces (*Planolites*, *Palaeophycus*), and firmground-hardground traces characterized by *Glossifungites*-*Trypanites*-*Entobia* ichnofacies (*Gastrochaenolites*, *Glossifungites*, *Trypanites*, *Entobia*, *Caulostrepsis*). This cyclical alternation of the ichnofacies suites allows us to define a complex variation of the shoreline along the stratigraphic sequence, which has generated a succession of recurrent environmental conditions. The correlation of several omission surfaces has been used to detect hiatuses characterized by lowest sedimentation rates. The ichnological diversity is mainly controlled by environmental energy, availability of nutrients, salinity and the variations of texture. Finally we emphasize the coincidence between the sedimentological-stratigraphic framework and the ichnological settings that is typical to a shallow marine environment.

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Seismic stratigraphy and integrated reverse-basin and forward stratigraphic modelling of the southern Brazilian margin (Campos, Santos and Pelotas basins)

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An integrated approach of sequence stratigraphy, reverse-basin and forward stratigraphic modelling is applied in three seismic reflection profiles (300-340 km long), located in the Campos (CB), Santos (SB) and Pelotas (PB) basins, offshore Brazil. Twenty-one calibration wells provide lithologic and bio-/chronostratigraphic data, paleobathymetry and formation tops of the Barremian- Holocene basin fill. The integration of seismic and well data resulted in a robust sequence stratigraphic framework for the continental shelf top to the deep basin margin, containing twelve to fourteen seismic units (3-50 m.y. of duration) in each basin. They include specific stacking patterns and sequence stratigraphic surfaces, used as input information for numerical modelling. Two-dimensional flexural reverse-basin modelling quantitatively analyzes and restores the basin architecture in time. The model was developed with Phil/Basim stratigraphic simulator. The dataset includes lithology, thickness and age of seismic units, paleobathymetry, eustatic sea-level and crustal flexure parameters (e.g. rigidity of the crust and mantle density). Main results are: (i) recognition of six subsidence trends (ST1 to ST6) controlling the Barremian syn-rift to Holocene drift basin development; (ii) analysis of subsidence genetic components: thermo-tectonic, flexure and compaction; (iii) analysis of processes controlling accommodation space and basin infill: subsidence, eustacy and sediment supply; (iv) impact of rift-to-drift tectonic evolution stages on basin architecture. Forward stratigraphic modelling was applied in order to simulate the depositional history and predicts the sedimentary distribution. It incorporates reverse-basin modelling results of subsidence, paleobathymetry and sediment flux. This method allows the evaluation of internal and external parameters governing deposition (e.g. carbonate and siliciclastic deposition, sediment transport, erosion, compaction, gravity-induced sediment flow). Main results include time-series slices and cross-sections showing the basin architecture and distribution of lithofacies, depositional environments and lithophysical properties (e.g. density and porosity). The basin analysis modelling indicates that high rates of thermo-tectonic subsidence (100-350 m/m.y.) controlled Barremian syn-rift brittle extension (subsidence trend ST1) and triggered rapid creation of accommodation space. Mechanisms of crustal deformation varied along the southern Brazilian margin: in the PB, Barremian syn-rift volcanism (SDRs) and crustal thickening preceded Aptian post-rift clastic progradation in open marine environments; northward in the SB and CB, depth-dependent lithospheric extension triggered widespread uniform subsidence rates (ST2, 50-80 m/m.y.), which controlled the Aptian syn-rift sag stage. Lacustrine environments with anoxic conditions dominated, which evolved to salt basins in the Late Aptian prior to continental break-up. During the Late Cretaceous drift stage (ST3), decreasing subsidence rates (15-20 m/m.y.) record the thermal phase typical of passive continental margins. However, depositional patterns differ between basins: long-term retrogradation in the CB and PB contrast with progradation in the SB, led by higher sediment supply. During the Tertiary (ST4-ST6), flexural-induced subsidence controlled accommodation space development. Subsidence/uplift trends are highly variable along the shelf-deep basin transition and between basins. These variations are related to onshore tectonism and resulting changes in sediment flux (10,000-30,000 m^2/m.y.) as well as to far-field stress and thermal re-adjustments of the crust. Salt deformation in the CB and SB was also a major control on sedimentation patterns, and increase their hydrocarbon potential (e.g., creation of stratigraphic-structural traps). In the PB, where the salt succession is absent, the basin development was largely controlled by differential flexural subsidence

Exploring the linkage between lacustrine proxy data and instrumental record for reconstructing past hydroclimatic variability in the southern Pampas

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Long-term climate reconstructions are essential to place recent climate and environmental changes into a broader perspective and a larger time- window. In this context, Argentinean Pampean lake systems (Laguna Mar Chiquita 30°S; Laguna Melincué 34°S; Lagunas Encadenadas del Oeste, 36°S) are exceptional sites to record low frequency climate variability over long periods of time (1000's to 10's of years). Lake systems respond physically, chemically and biologically in front of hydroclimatic changes (external forcings) which may be registered along the lake sedimentary records. Lagunas Encadenadas del Oeste (LEO), located in the southwestern part of the Argentinean Pampas (36º S - 62º W), are very reactive in front of the recent and past South America Moonsonal System variability. Here we explore the relationship of the proxy record with the last ~100 yrs of instrumental data. The objective of this study is to understand how the hydroclimatic variability trigger lake changes, that in turn, are recorded as distinctive feature in the lake sediments. Thus, selected proxies can be used to perform more reliable climatic reconstructions for periods prior to the beginning of the instrumental record. A multi-set of sedimentary cores from LEO system was dated using ^{210}Pb and analyzed for total nitrogen (TN), total carbon (TC), total organic carbon (TOC), $CaCO_3$, magnetic susceptibility and water content. Several lithological units were defined in the cores based on sedimentary textures and structures, lithology, sediment color, and organic matter content. Comparisons between the proxy data and the homogenized instrumental data were based on linear regression analysis (proxy data: response variable; instrumental data: predictor variables). To synchronize the records, the climatic predictor variables (monthly standardized precipitation anomalies) were smoothed along time applying a 10 or 6-point Low-pass Gaussian filter (10-LGF and 6- LGF, respectively). Linear regression analyses were then used to find the linkage between the proxy data and the climatic forcing. The highest regression coefficients were found when considering smoothed (6-LGF and 10-LGF) Annual precipitation index (API) and Wet precipitation index (WPI) against proxy data. Conversely, there is a lack of significance when Dry precipitation index (DPI) is considered. The correlation with WPI smoothed data (6-LGF and10-LGF) indicate that proxies are capturing the low frequency variability. Some proxies show statistically significant relationship with the instrumental record. For instance, TOC and TN, which are strongly related to the primary productivity, show significant relationship with WPI. Our results highlight the importance of proxy validations and the development of reliable chronologies to reconstruct climate changes beyond the instrumental record. Results point toward the main influence of decadal climate variations on the lake hydrological balances over the Southern Pampean region of Argentina.

The clastic signature of the Beacon Supergroup (Transantarctic Mountains) in the AND-2A Miocene glacimarine drill core deposits (ANDRILL Project, Southern Victoria Land, Ross Sea, Antarctica)

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The international ANDRILL drilling project developed during the austral spring of 2007 in the Southern McMurdo Sound (Southern Victoria Land Basin, Ross Sea, Antarctica), performed a sedimentary drill core 1138 meters thick. This last span in age from Early Miocene to Late Miocene, with Plio-Pleistocene at the top. The Miocene succession consists mainly of diamictites with minor sandstones, conglomerates and mudstones, infilling an Eocene-Pleistocene half-graben basin, which is part of the Ross Sea rift system. Diamictites are rich in dispersed coarse clasts (from granules to cobbles), mainly supplied from basement crystalline rocks (Granite Harbour Intrusive Complex, Skelton metamorphic Group, Koettlitz metamorphic Group, etc.), from volcanic rocks (Cenozoic McMurdo Volcanic Group) and very subordinately from sedimentary cover rocks; particularly significant are also the diamictite/conglomerate intraclasts derived by the intrabasinal reworking. The coarse sedimentary clasts are the object of this study, with the aim to understand the changes in provenance and their inferences with palaeoclimate and tectonic factors. The sedimentary extrabasinal clasts sourced exclusively from the Beacon Supergroup, which crops out widely in the Transantarctic Mts, both in nearby and far areas with respect to the drill site. So the recognition of different rock types, sourcing from different stratigraphic horizons in the Beacon Supergroup, allows us to speculate about provenances, feeding-transport pathways and depositional systems. The Beacon Supergroup represents the Devonian-Triassic continental sedimentary cover of the Transantarctic Mountains. It lies sub-horizontally onto the crystalline Precambrian-Ordovician basement, through the Kukri erosional surface. The Beacon Supergroup has been subdivided into two stratigraphic groups, which are the lower Taylor Group and the upper Victoria Group. The former is made of several formations, altogether consisting of very mature sandstones (quartzarenite and subarkose) and siltstones. The latter is formed by less mature sandstones fms (arkose, arkosic litharenite, lithic arkose and subarkose). The Beacon Supergroup is also strictly close to the magmatic Jurassic Ferrar Supergroup. The sedimentary clasts are as follow: petrofacies A and A'–arkose, lithic arkose and arkosic litharenite; p. B–quartz arenite; p. D–subarkose; p. C-hybrid/mixed arenite; p. E–biomicrite/wackestone; p. Q–volcanic litharenite/breccia; p. K and K' respectively diamictite and conglomerate/coarse sandstone intraformational clasts. Lithological types, based on stratigraphic distribution, have allowed subdividing the sedimentary succession in twelve Sedimentary Petrographic Units (SPU), characterized by specific compositional markers. The main Beacon Supergroup dismantling signature characterizes the intermediate portion of the succession (from 225 to 775 mbsf), with emphasis on the alternation from the two lithostratigraphic groups, so to highlight the eventuality of multiple source unroofing processes. In particular, the petrofacies A, A' and D indicate a provenance from the Victoria Group, where the mixed petrofacies C, E and E' could hypothetically suggest a provenance from the Lashly Fm., sourced from the Royal Society Range (Lashly Mts., Mt. Crean), through local glaciers (Blue and Koettlitz glaciers). Differently, the petrofacies B and D indicate a provenance from the Taylor Group, through proximal glaciers as the Ferrar Glacier, Blue Glacier or Koettlitz Glacier (Beacon Heights), or also through far sources as the Skelton Glacier (Warren Range and Boomerang Range). The recorded down core changes in composition, can be related with palaeoclimate changes, with a maximum glacial expansion and alternation of advancing or retreat of the East Antarctic Ice Sheet (glacial vs. interglacial phases), and characterized by fluctuating of proximal minor glaciers.

Different types of coarse disorganised/chaotic beds within foredeep turbidite successions, as indicators of flow processes and provenance (Late Oligocene, Northern Apennines, Italy)

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Coarse-disorganised deposits (clasts > 5 cm) generally occur inside very proximal turbidite systems, whereas are unusual for distal and high-efficiency ones. Coarse-disorganised deposits are important to reconstruct the clastic source areas and the physiography of the sedimentary basins. The provenance of the coarse-disorganised deposits and of the "normal" turbidites close to the same clastic system, can be common or not, depending by a lot of factors. The compositional and sedimentological analyses come to help for this discrimination, in order to understand the eventual link between the two kinds of massive flow deposits. The significance and importance of the coarse-disorganised deposits associated with the turbidite systems have been often undervalued, also due to their subordinate recurrence. In this research, the coarse-disorganised deposits occurring in the Northern Apennines foredeep turbidite successions (Late Oligocene-Early Miocene) have been studied. Their setting inside a coherent palaeogeographic regional framework of the orogenic wedge-foredeep system will be of primary importance. The turbidite systems objects of this research are the so-called "Macigno costiero" and "Macigno del Chianti" fms, ranging in thickness about 600 meters for the former and 1500-2000 meters for the latter. They are represented by several facies associations, recalling respectively a low-efficiency system and a high-medium efficiency system. Their turbidite successions include, at different stratigraphic horizons, thick levels of olistostromes (submarine slides coming from the orogenic units stack) and of coarse-disorganised deposits, these last object of the research. The only areas in Southern Tuscany, where such deposits crops out are along the Tyrrhenian coast ("Macigno costiero") and in the Chianti Mts. ("Macigno del Chianti") in the Tuscany inland. All the studied coarse-disorganised deposits show similar textures, with minor differences in terms of thickness and lateral extent, clast/matrix ratio, mud amount of the matrix, shape and grain-size of the clasts, sedimentary structures. The texture is chaotic, with clasts (pebbles and cobbles) dispersed inside a muddy matrix and with none or very poor organisation, due to a slight orientation of the clasts. These last are well-rounded with spherical or bladed shapes. The features of the coarse-disorganised deposits agree with very immature sediments, deposited in proximal sites with respect to the sources of the flows, so to exclude long transport pathways. They allow interpreting them as produced by submarine cohesive debris flows, interacting with deep-sea turbidite fans. The composition of the clasts is relative to basement crystalline rocks and subordinately to volcanic and sedimentary rocks. It is well comparable with the composition of the closed turbidite sandstone beds, so to reveal the same or similar provenance. So, the cohesive debris flows were the products of the reworking of more proximal sedimentary systems (e.g. fan-deltas or alluvial fans), relative to extrabasinal clastic drainage. Finally, the joining of sedimentological and compositional characters of the coarse-disorganised deposits and of the interlayered sandstones represents a powerful tool to reconstruct the source vs. basin infilling history and to interpret the regional-geodynamic framework. In fact, this study demonstrates the close association between debris flows and turbidite flows, implying that the sources were common and that the sourcing apparatus of the Upper Oligocene – Lower Miocene foredeep turbidite systems of the Northern Apennines, could be located not in remote areas as the Western Alps with a longitudinal feeding to the basin, as hypothesized by several Authors, but in the hinterland of the foredeep, as the Corsica-Sardinia Massif, part of the European basement, with a transversal feeding.

Provenance history in a glacimarine setting: data from coarse clasts in AND-2A core, ANDRILL Southern McMurdo Sound Project, Victoria Land Basin, Antarctica

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During the austral spring of 2007, the international ANDRILL Southern McMurdo Sound drilling project allowed to recover a drill core sediments 1138 meters thick in the Southern Victoria Land Basin, Ross Sea, Antarctica. Such basin has been defined as extensional (half-graben), rifted from Eocene with occurrences of Late Neogene magmatic activity (McMurdo Volcanic Group). The drill core spans in age from Early Miocene to Late Miocene, with Plio-Pleistocene at the top, subdivided by a few unconformities. Sediments consist mainly of diamictites, with mudstones and sandstones interlayered. The deposits are consistent with a glacimarine setting, with facies indicative of proximal-glacial up to distal-glacial environment, reflecting several cycles of advancing and contracting ice sheets. Diamictites are characterized by the occurrence of a great amount of coarse-size clasts (>>2 mm), dispersed inside the matrix. These clasts, derived by several types of source rocks, are fundamental to suggest hypothesis about provenance of the sedimentary system, as the result of complex interactions between the Transantarctic Mountains (TAM) uplift, the Victoria Land Basin subsidence, the palaeoclimate changes and the ice sheet fluctuations. More than 100.000 coarse clasts in the core were logged on ice at McMurdo Station Crary Laboratory and of these several hundreds have been petrographically analyzed. The observed clast distribution patterns highlight significant down core compositional changes. Clasts are dominated by volcanic and, to a lesser extent, by intrusive rocks of the Granite Harbour Intrusive Complex. The first showing a down core increasing trend, whereas intrusive rock amount decreases down core. Metamorphic rocks and dolerites are minor but persistent components throughout the core, whereas intrabasinal and extrabasinal sedimentary clasts represent very minor constituents. Extrabasinal clasts derived from the dismantling of the TAM, from nearby sources (medium-high grade metamorphic rocks of the basement and the Devonian-Triassic Beacon Supergroup sandstones) in the Royal Society Range (present-day Koettlitz-Blue Glaciers) and the region located further to the South including the Skelton-Mulock Glaciers (where basement metamorphic rocks are mainly low-grade metasediments). Based on coarse-clasts distribution, the sedimentary succession can be subdivided in a few main sequences, showing different assemblages. In synthesis, the lower portion (Early Miocene) shows a mixed-source from the Koettlitz-Blue Glaciers and from the Skelton-Mulock Glaciers, without the involvement of the Beacon Supergroup; intrabasinal diamictite reworking has been detected in the lowermost part. The intermediate portion of the succession (Early to Middle Miocene) shows a far source from the Skelton-Mulock Glaciers, changing upward to a proximal source from the Koettlitz-Blue Glaciers coupled with a mixed source (Koettlitz+Skelton). In this portion the sedimentary covers were also involved as source rock units, as indicated by the occurrence of Beacon Supergroup lithologies and of hybrid-carbonaceous sandstones. During Beacon Supergroup's contribution, multiple source alternations from the lowest and lesser mature Taylor Group (quartzarenites), to the uppermost and more mature Victoria Group (arkoses and litharenites) are common. The upper portion of the succession (Late Miocene to Pleistocene) shows clast assemblages mainly from the Koettlitz-Blue Glaciers area, coupled with significant intrabasinal diamictite reworking, lacking of the involvement of the sedimentary covers.

Quantitative habitat characterization of current-facing cold-water coral ridges at the base of the Miami Terrace, Straits of Florida

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Although cold-water scleractinian corals are often associated with a strong bottom current, no studies have yet quantified the relationship between the spatial coral distribution and the local hydrodynamic regime. An innovative approach, combining high-resolution geophysical and oceanographic data (collected via an autonomous underwater vehicle, AUV) with submersible ground-truthing, reveals a 16 km^2 field of up to 20-m-high cold-water coral ridges at the base of the Miami Terrace, Straits of Florida (water depth 710-840 m). These ridges are asymmetrical, regularly spaced (between 50 and 250 m), extend over lengths of 1000- 2000 m, and resemble waveform features. A quantitative spatial analysis of habitat characterization maps (derived from the 200 kHz multibeam and 120 kHz side-scan sonar data) indicates that coral distribution is directly correlated to depositional profile and bottom current direction. The analysis extracts coral facies through discrimination of backscatter amplitudes, and then quantitatively correlates this facies with bathymetric variables (i.e. dip angle and azimuth). Bottom currents were also continuously recorded for 24 hrs with a 300 kHz ADCP on board the AUV. The results show that dense coral accretion occurs dominantly along the ridge edge and the northern, current facing flank of the ridges (modal dip angle 7°; azimuth N – N030E). This asymmetrical distribution of coral facies: (1) is dictated by the current regime, which is unidirectional with a dominant southerly component (average direction and velocity, 173° and 15 cms-1, respectively); and (2) exaggerates the depositional profile, creating a positive feedback mechanism that drives ridge development at the base of the Miami Terrace. The 3 kHz sub- bottom seismic data, also collected by the AUV, indicate that this depositional profile is not inherited from antecedent topography. The Miami Terrace appears to be the first example of a cold-water coral ridge field oriented perpendicular to a unidirectional current flow, not inherited from pre-existing topography. The linear configuration results from the preferential settlement and growth of corals facing into the dominant current flow, coming from the north. Once established, coral framework accretion creates a feedback mechanism in which the relief and the geometry of the ridge are amplified as corals position themselves laterally in order to maximize nutrient uptake. Though the waveform morphology is often suggested to be the result of corals colonizing paleo-sand dunes, the sub-bottom data and the quantitative analysis indicate that the landscape pattern reflects biogenic growth. Due to similarities in their geometries, facies pattern and depositional environment, this cold-water coral ridge system can be used as an analog to cold-water mound systems in the geological record (e.g., cold-water bryozoan mounds). The integrated approach and quantitative analysis applied here provides significant insights into the controlling factors on cold-water mound environments and templates for preservation of these delicate deep-water ecosystems.

The impact of feral water buffalo in the floodplain ecosystem in Maracá-Jipioca Ecological Station, Amapá's Coastal Region, Brazil

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The Maraca - Jipioca ecological station, located in the Atlantic Coast of the Brazilian region of Amapa, is formed by two islands: Maraca and Jipioca. These two islands occupy a total area of 72000 ha, between flooded field and mangroves. Maraca island is divided in turn into two islands: Maraca Norte (MN) and Maraca Sul (MS). Only MS Island has suffered changes in the wild buffalo population, which were introduced 20 years ago, compromising the environment and the biodiversity preservation. This study was purposed to identify and evaluate the environmental impacts caused by the wild buffaloes through data collection of quality of soils and vegetation of flooded fields. This research was carried out in four areas, two areas impacted by the presence of buffaloes in MS Island and two no-impacted areas in MN Island. In each study area, surface soil samples were collected for physic and chemistry analysis. The vegetation were also identified, quantified and related with the impacts in the landscape. Leopold matrix was used to identify and evaluate the anthropogenic impacts. The results demonstrate that on the floodplains of the MS Island had significantly altered spaces (compactation of soils, soil erosion, removal of the vegetative cover and changes in species composition) due to buffalo activity with intermediate level of impacts.

Exoscopic analysis in tsunamiites

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Seven coastal lowlands are being studied with the objective of analyzing microtextural signatures of quartz grains in tsunami and storm deposits, of Portugal (AD 1755 tsunami – Martinhal, Boca do Rio and Salgados), Scotland (Storegga tsunami – Shetland Isl.; Great Storm January 2005 – Hebrides Isl.) and Indonesia (26th December 2004 tsunami - Lhok Nga). The exoscopic analysis is being used to investigate and distinguish signatures associated with the transport during high- energy marine inundations from inherited features characterizing the source area. A total of 1248 quartz grains, corresponding to 89 samples collected from distinct present-day coastal environments (nearshore, beach, dune and alluvial), and well documented tsunami and storm deposits, have been selected and prepared for analysis under Scanning Electron Microscope (SEM). The laboratory pre-treatment included sieving at 0.5 phi intervals and random selection of at least 12 grains per sample taken from the 125-500 micra fraction). Grains were coated either with gold or carbon to prevent electromagnetic interference in the SEM images. An atlas was organized to facilitate comparison and identification of features in grains and about 20 different microtextures were identified, later regrouped into five fundamental microtextural familiesroundness, fresh surfaces, percussion marks, dissolution marks and adhering particles, to more clearly expose contrast between the studied sediments and environments. A semi-quantitative approach to the microtextural classification of each grain was used, based upon the proportion of grain surface occupied by each feature (0 (absent) to 5 (> 75% of the grain surface)). A wind tunnel experiment was also conducted to investigate the imprint of microfeatures exclusive of Aeolian entrainment and transport. Results were interpreted using statistical methods of analysis (classificatory, cluster, ANOVA, multivariate and factorial). Preliminary results indicate that the classification based in five microtextural families is adequate to differentiate sedimentary environments. A clear distinction between beach and tsunami (both exhibiting higher values of fresh surfaces and percussion marks) and alluvium, dune and nearshore grains (with higher values of dissolution and adhering particles) was obtained. Furthermore the data analyzed so far (strongly) suggest that a spatial (geographical) signal is also present in sample grouping, thus indicating permanency of a source signature, which may considerably vary between coastal contexts. The classificatory analysis of the 89 samples reached a success rate of 62% (91% with 2nd order probability). Regarding the tsunami grains, they are characterized by a high number of fresh surfaces (especially the Indonesian samples). Moreover, the Scottish tsunami samples present strong dissolution (interpreted as post-depositional and favored by a long post-event burial period) but the number of fresh surfaces that can be identified is still considerable. On the other hand, the Portuguese samples are characterized not only by higher number of fresh surfaces but also by the extremely abundant percussion marks including near total resurfacing of some grains. However, the results so far do not unequivocally identify any peculiar microtextural feature or features caused exclusively by tsunami or storm action without considering the sedimentological and geomorphological context of the study area. This may be further complicated in the studied contexts and elsewhere by the non obliteration of a source signal in the microtextural compositions of the tsunami deposits. At this stage of the research, the potential of the exoscopic analysis as a complementary sedimentological technique to be used in the discrimination of coastal sedimentary environments and in the identification of abrupt marine invasions deposits is relevant, especially if considered within the regional dynamic, sedimentological and geomorphological context.

Sedimentary recognition of a palaeotsunami in Lagoa dos Salgados (Algarve, Portugal)

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Although rarely subjected to extreme storms and tsunamis, the Algarve coast is a high-risk and vulnerable area to tsunami inundation. It was devastated by the AD 1755 tsunami and in several locations (Martinhal and Boca do Rio) fine tsunami deposits were described. Other tsunamis mentioned in the scarce (and sometimes vague) documentary record affected the same area, though coeval deposits have not yet been found (e.g in AD 1722, Tavira; 63 BC, the whole coast). The Salgados lowland is located in the central Algarve. This coastal embayment features a 6 km-long sand beach backed by a continuous, 3 to 17 m-high vegetated foredune covering Pleisto-Holocene aeolianites and beachrock. The lagoon extended across some 1.5 km2 but its eastern section (about ½ of this surface) has been reclaimed for a golf course. The remnant forms a flat-floored depression that collects water and muddy sediment from the adjacent watershed and is usually flooded by about 1 m of brackish water, the bottom developing about 1.1 - 1.7 m above mean sea level. Hundred and fifty eight short sediment cores (up to 5m long) were obtained from this lowland using hand-operated gauge, Edelman augers, van der Staay and Livingstone corers. A multi-proxy analysis of both cored and present day sediment (e.g. visual description, grain size, $CaCO_3$ content, SEM exoscopy, foraminifera and ^{14}C, ^{137}Cs and ^{210}Pb) was conducted with the results presented below. The cored sedimentary infill consists of four main lithostratigraphic units accumulated in the Late Holocene (ca. 5900 BP to present) and within the topmost mud-dominated unit (0.70-1.90 m thick), a single laterally continuous and conspicuous sand lamina was found, at app. 40 cm below surface. It consists essentially of medium quartz sand with marine shell fragments and mud intraclasts (rip-up clasts). The sediment grain size decreases inland and upwards typically within one phi size- interval. Within this coarser sediment an increase in the proportion of claysilt was detected a few cm above the base in cases where rip up clasts are not evident suggesting an additional sediment source or intercalation of a lower energy depositional phase within the general context of high energy inundation. The benthic foraminifera association in the coarse lamina shows higher diversity and number of marine species, when compared with the framing mud. The thickness of the lamina decreases from about 80 cm close to the sea to a few mm about 850 m landward of the coastline, well beyond normal overwash and tidal influence. Mapping of the lamina suggests a wide, fan-shaped feature, implying an exceptionally large inundation of marine origin. The linear extrapolation of sedimentation rates derived from ^{210}Pb and ^{137}Cs concentration profiles in the mud (2-2.6 mm/year) indicates an age range (AD 1780-1830) for resuming permanent sedimentation following a high energy disturbance indicated by the coarse lamina, compatible with the AD 1755 tsunami. The combination of sedimentological, palaeontological, geometrical and dating results, which are in agreement with well established criteria used to recognize tsunami deposits in Portugal and elsewhere indicates that the Late Holocene sedimentary infill of Lagoa dos Salgados contains record of at least one event of extreme marine inundation that we associate with the AD 1755 Lisbon earthquake and tsunami.

Proterozoic glauconitic facies and depositional environment: Ritmito Superior Paranoá Group in the region of Bezerra, Goias, Brazil

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Inserted in the Brasília Fold Belt (BFB), central Brazil, the Paranoá Group (PG), meso-neoproterozoic, consists mostly of terrigenous rocks, with carbonate contribution at the base and the top. The glauconitic levels are present in its upper unit, defined as Ritmito Superior (RS) in the region of Bezerra, Goiás - Brazil. These levels occur at different positions within RS, and locally, directly overlayed the Nível Arcosiano Unit – NA, attributed to fluvial deposition. The RS is formed by laminated siltstones, rhythmic intercalations of siltstone, mudstone and sandstone, lenticular bodies of coarse sandstones, black shales, interlayered with glauconitic levels, and carbonate lenses sometimes stromatolitics. The glauconite is widely used in the characterization of depositional environments, since it requires specific conditions for their deposition. The characterization of glauconitic levels was performed in order to contribute to understanding of the deposition conditions of the RS. The distinct glauconite facies of this level are designated as: 1) Green Glauconitic Sandstones - GGS, 2) Siltstone with Glauconite - SwG, 3) Light Sandstone, with grains of Glauconite - LSG, 4) Breccia Glauconitic - BG. The GGS facies, predominantly, is expressed as continuous levels of sandstone colored bright green to pale green, thickness ranging from 3 to 10 cm and altering to iron oxides or chlorite - when associated with carbonates. They consist predominantly of glauconite (48%) and quartz (30%), also contains detrital micas (07%), feldspar (05%) and accessory minerals diagenetic (Opaque 05%, 02% chlorite, calcite and illite 03%). The glauconite globules are green, 0.1 mm to 0.7 mm in diameter, forming sheets intelayered between levels of sand and silt. In many cases the glauconite globules are in optical continuity, containing quartz grains, generally subrounded. In SwG the glauconite facies is a very fine matrix between larger grains of quartz and feldspar in a siltic rhytmite, or irregular strip between layers of black shales. In these, the glauconite is also associated with a centimetric shapeless mass of phosphate, identified by electron microprobe. The facies LSG is characterized by glauconite globules (about 0.3 mm in diameter) dispersed in clean sandstones, composed mainly of quartz and feldspar. The glauconite makes up between 2% to 8% of the rock, with dirty aspect from alteration to iron oxide. Intercalated in siltic rhytmite, the facies BG consists of decimetric clasts of different facies of RS (mainly GGS and SwG) supported by mudstone. Generally associated with black shales, the fragments are strangled endings or discontinuous levels that clearly undergoing deformation during sedimentation. The glauconitic facies of the RS allow the following inferences about the depositional conditions: 1) glauconite associated with masses of phosphates and other marine lithofacies indicates deposition in condensed section. 2) The glauconite deposited directly on the rocks from the fluvial environment (NA) allows inferring a rapid arise of sea level. 3) Glauconite dispersed in feldspathic sandstone indicates post- authigenesis reworking. 4) The Breccia facies event is syn-sedimentary deformation, characterized as slumping.

Upper Cretaceous carbon-isotope stratigraphy of eastern Venezuela: increasing stratigraphic resolution and correlation of black shales

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Organic-rich limestones and mudstones ("black shales") characterize the Upper Albian to Campanian Querecual Formation of Venezuela, considered to be the main petroleum source rock in the Eastern Venezuela Basin. Two stratigraphically overlapping outcrop sections, one on Chimana Grande Island, the other along the Querecual River, have been measured and sampled for microfossils and for the determination of the carbon stable-isotope composition of organic matter (δ^{13}Corg). The resulting composite section is 800 m thick. A biostratigraphic framework has been established on the basis of foraminifera, studied mainly in thin sections, but stratigraphic resolution is compromised by the rarity of key taxa in these organic-rich facies. Positive and negative δ^{13}Corg excursions on the isotope profiles have been used to identify nine chemostratigraphic events from the Cenomanian to Santonian that correspond to those recognised in Europe (Jarvis *et al.*, 2006). These include the Albian-Cenomanian Boundary Event, marked by a δ^{13}Corg minimum immediately above the top of the *Thalmanninella appenninica* Zone, and Mid-Cenomanian Event I, represented by a positive excursion in the *R. cushmani* Zone. A third event, in the uppermost Cenomanian, constitutes the largest positive δ^{13}C shift in the succession, with an increase of 2.7 ‰ corresponding to the Cenomanian-Turonian Boundary Event. Low biostratigraphic resolution in the black shales allows to determine only a range of Lower to Middle Turonian *Whiteinella archaeocretacea* to *Helvetoglobotruncana helvetica* zones for the overlying beds, but the Holywell, Lulworth and Round Down δ13C events are readily identified. The Holywell and Round Down equivalents occur below the first occurrence of *Dicarinella primitiva*. A trough and a peak in the undivided Upper Turonian to Coniacian interval (*Marginotruncana sigali – Dicarinella primitiva* to *D. concavata* zones) can be correlated to the Glynde and 'Pewsey' events, respectively. The first three events display good agreement with their age assignments in the English Chalk. However, discrepancies arise in the age determination of the features correlated to the Glynde and 'Pewsey' events, which are considered to be Late Turonian to Coniacian in Eastern Venezuela, and Middle Turonian in the English Chalk. A positive δ^{13}C excursion in the Upper Turonian to Coniacian interval corresponds to the Hitch Wood Event. This lies below the last recorded correlatable age-diagnostic marker, *Globotruncana linneiana*, which indicates a Coniacian age. Above this, the White Fall Event is recognised which, based on the first occurrence of *Globotruncana linneiana*, is assigned a Santonian age; this conflicts with a Middle Coniacian age for the event determined using macrofossils in the English Chalk. Better agreement is observed, however, when the bio- / chemostratigraphic data from Venezuela is correlated to the Gubbio section in central Italy, where a Tethyan microfossil biostratigraphy has also been used. To elucidate the apparent age inconsistencies identified, further integrated micropalaeontological and chemostratigraphic studies need to be carried out on key sections located at different palaeolatitudes. Results can be compared to macrofossil biozonations to assess the true positions of stage and substage boundaries in different faunal realms.

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Large scale, cross-bedded sandstone bodies in a Cenozoic, tide-dominated embayment

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The Late Oligocene – Early Miocene "Patagonian" transgression covered a huge area in Patagonia. It is represented by shallow marine to coastal deposits exposed in several localities in a large area of Santa Cruz province, Argentina, in which conspicuous, large scale cross-bedded sandstone sets, 3 to 10 meters thick, are found intercalated with numerous oyster-rich beds. Two episodes of sedimentation are recognized within the "Patagonian" transgression. The first one of Late Oligocene age, was restricted to the eastern part of the studied area, and the second one of Lower Miocene age, covered a much larger area. Large scale (5 to 10 meters thick), cross-bedded sandstones where observed at San Julián area, with a clearly coarsening upward trend and an internally complex arrange of low angle master bedding planes and superimposed medium scale cross-beds. Palaeocurrent analysis showed south-directed downstream accretion, with few reversals indicating tidal action, and fossil content indicate normal marine conditions. These beds are composed of fine, well-sorted sands at the base, grading upwards to coarse sands with increasing proportion of biogenic particles. A bioclastic dominated cross-bedded set culminate the succession, which is followed by deeper shelf, fine-grained sediments. About 200 kilometers to the west, at Lago Cardiel area, two superposed large sandstone bodies were recognized. The lower one is composed of simple, tabular cross-bedded fine sandstones up to 7 m thick, with evidences of slack-water periods and dipping to the SSE. The upper, 5 m thick body is composed of coarse bioclastic sandstones with sigmoid master bedding planes and internal decimeter scale cross-beds. All these planes dip in the same direction (SE) pointing to downstream accretion. This body reaches about 2 kilometers long, and can be traced up to 20 kilometers. No reversal neither slack-water evidences were found. Southward directed large-scale bedforms are widespread in Lago Argentino area. They consist of simple to composite cross-beds up to 3 meters thick, composed of coarse sandstones with abundant biogenic particles. They lie above a discontinuity which can be traced about 30 km and according to the stratigraphic analysis it is inferred to represent a low order sequence boundary. The entire succession lying above the discontinuity shows a prograding trend from shallow marine-estuarine to fluvial setting. Sedimentary structures such as herringbone cross- stratification, mud drapes and heterolithic bedding indicate that tidal currents played an important role in sedimentation. Additionally, adjacent sets of cross-stratified sandstones show opposite directions of migration. Although all these deposits are probably not time equivalent, it is evident that tidal currents played a primordial role in the formation of these cross-bedded units as well as in the sedimentary history of the basin. The outcrop distribution and palaeocurrent analysis, together with the paleoenvironmental and paleogeographic reconstructions, and the lack of evidence of channel confinement, indicate that a wide embayment with tidal amplification was the most suitable setting for the origin of these large-scale bedforms, and they reflect tidal dynamics at the embayment scale. The bedforms were preserved almost complete suggesting high sedimentation rates within a wide, shallow embayment, deep and energetic enough to allow sandwaves to develope. The marked difference in energy between these cross-beds and the underlying sediments, and the high amount of biogenic particles in some bodies, suggest erosion prior to development of sandwaves (tidal ravinement surface?). The reworking of previous deposits is probably related to the instauration of strong tidal currents enhanced by the shape of the basin and triggered by high-order relative sea level rises.

Preservation and modes of deposition of two pyroclastic levels: environmental control on the stratigraphic record of ash layers

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Two thick, fine-grained, siliceous pyroclastic beds are intercalated in a shallow marine to transitional Miocene siliciclastic succession of Patagonia. Both pyroclastic beds are mostly composed of fallout particles originated in explosive eruptions. Despite their common origin both deposits have different facies and geometry product of their reworking in different sedimentary environments with little or no mixing with the background sediments. The "Patagonian" succession was formed during a transgression that covered most of Patagonia in the Early Miocene. In the study area, at the southern tip of Argentine Patagonia, it is known as the Estancia 25 de Mayo Formation and it is conformably overlaid by a terrestrial succession known as Santa Cruz Formation. The stratigraphically lower pyroclastic bed is interbedded with fine-grained fossiliferous marine sediments in the lower part of the Estancia 25 de Mayo Formation. The stratigraphically upper bed lies in the transition between this unit and the Santa Cruz Formation, within channelized sandstone bodies of fluvial origin. The Lower level is tabular in shape, with subtle thickness variations, laterally continuous by about 30 kilometers. Its maximum thickness is four meters, dying out gradually to both sides. Its base is sharp and plane. On the other hand, the Upper level is composed by a discontinuous net of lenticular bodies, reaching fifteen meters thick and one hundred meters width, with a concave up base and a plane top. Internally, the Lower level only exhibits parallel lamination at its base, with structureless fine grained tuffs in the upper part. Unlike the surrounding sediments, no bioturbation is visible. In contrast, the Upper level shows parallel lamination, ripple lamination, mud drapes and trough and tabular cross-stratification. Bioturbation is also not visible. Both levels are composed of siliceous, vitreous material (pumice and shards) with variable proportions of crystals (mainly quartz and plagioclase) and minor accidental fragments. The Lower level shows no mixing with epiclastic material and a fining upward trend. The Upper level shows a coarsening upward trend from fine tuffs to coarse tuffaceous sandstones, in concordance with an increasing degree of mixing of pyroclastic and epiclastic material. The similar composition and age of both levels suggest that the volcanic material was probably sourced by two different eruptions of the same volcano. The grain size distribution of the Lower level indicates that this source was located to the west or south west of the area, in the Andean range. The parallel lamination in the sandy tuffs of the Lower Bed is explained by sedimentation in upper flow regime. In a low energy marine environment, the most likely way of generating this type of currents is through hyperpicnal, sediment-laden flows. This is likely where pyroclastic material saturated the rivers entering the sea with an extremely large amount of sediments. The lack of bioturbation points to a very high sedimentation rate. The Upper level with many small-scale tractional sedimentary structures, suggest that they are not the result of direct ash fallout but are the product of deposition by currents within a fluvial channel. The upper flow regime parallel lamination, the small scale cross-bedding, plus the appearance of mud drapes, points to an origin by shallow streams with short slack water periods, that rapidly fulfilled the space available for sediment, preserving the channel shape. Both beds are thicker than the normal, distal, fine-grained fallout deposits. The big thicknesses of the two levels indicate remobilization of the pyroclastic material and deposition under very high sedimentation rates. In both cases, the minor or lack of mixing with epiclastic material could be explained by the rapid deposition and the inability of streams and marine currents to erode the substrate, as they were suddenly over-saturated with pyroclastic sediments.

Petrographic, chemical characterization and genesis of calcretes of a continental rift basin (Curitiba Basin, Brazil)

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The Curitiba Basin (Miocene-Pleistocene) has an area of approximately 3,000 km^2. It is partially overlapped with the metropolitan region of the city which has the same name, located in the south of Brazil. The basin is an elongated depression in the ENE direction, which belongs to the Cenozoic Rift System of South and Southeast of Brazil. The Guabirotuba Formation is the main unit of this sedimentary basin and consists of arcosic sands, locally conglomeratic, and muds accumulated above the metamorphic and igneous Precambrian rocks of the basement. It corresponds to the deposits of marginal alluvial fans and braided rivers and to shallow water bodies from the interior region of the basin. In some places it shows intervals cemented by carbonate with nodular, laminar, and diffuse textures, which may form hard crusts of some centimeters thick. There are also registered centimeter-thick faults and joints surfaces filled with carbonate. The calcretes result from cementation and / or replacement of the sediment framework by precipitation of $CaCO^3$ by edaphic processes (pedogenetic) or related to groundwater movement (water table). In sections described in the field calcretes occur as: 1) profiles with friable, nodular, laminar horizons, and/or hard crusts, 2) reworked fragments in conglomerate strata; and 3) within discordant fractures. Some microscopic features are typical of these calcrete's textures and are produced by biogenic processes and / or physical-chemical: 1) alpha type, those with a predominance of non- biogenic processes and 2) type beta, with biogenic processes. The alpha type calcretes are characterized by rhombic crystals of calcite. It's formation comes from precipitation and recrystallization of $CaCO^3$ by circulation of groundwater. The beta type of calcite crystals exhibit texture features in the meniscus, greater porosity. The formation of the beta type calcretes seems to be related to high over saturation or microbial activity. The alveolar structures are typics from this calcretes they're formed by septa arched long variable that develop within the empty spaces, as molds of roots or pores into of the grains. The optical petrology of thin sections of several intervals showed the predominance of alpha type microstructure association. With a scanning electron microscope (SEM) alpha and beta microstructure associations were identified. The preliminary results indicate the action of polycyclic processes, with groundwater dynamics superimposed to the previous pedogenetic one. The presence of crusts and laminar intervals, as well as subvertical tubular carbonate nodules, is assigned to exposure of the sediments to intense evaporation conditions under semi-arid climate, when little or no sedimentation occurs.

Slope carbonates within the Adriatic-Dinaridic Carbonate Platform domain (central Dalmatia, Adriatic region of Croatia)

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The Upper Cretaceous carbonate succession on the Island of Èiovo in central Dalmatia (Adriatic region, Croatia) differs from the typical platform development in the region (e.g., the Sumartin Formation on the neighbouring Island of Braè: Gušiæ & Jelaska, 1990), implying a different depositional setting. Several methods, including integrated stratigraphy (litho-, bio-, and chemo-stratigraphy of C and Sr isotopes) along with petrological analysis, are being used to constrain the regional stratigraphic correlation. Approximately 300 m thick succession of Cretaceous carbonates is measured and analyzed on the westernmost coast of the island. The lower part of the succession is referred to as the Dol Formation of Campanian age, characterized by pelagic bioclastic wackestone/packstone with chert nodules and rare allochthonous intercalations. Depositional setting of the Dol Formation is presumed to be toe-of-slope/slope. Two Campanian discontinuity surfaces (hard-/firmgrounds) occur in the uppermost part of the Dol Formation. These surfaces will be analysed using several methods (including C isotope stratigraphy) to explain their genesis and to determine their possible correlation to some global eustatic/isotopic event. The upper part of the succession is in general represented by massive to thick-bedded resedimented allochthonous grainy limestones. These are mostly bio-lithoclastic packstone (rarely grainstone/rudstone) with predominantly echinoderm fragments (crinoids, echinoids) with syntaxial overgrowths, mollusk fragments (rudist), benthic foraminifera, bryozoans, coralinacean algae, lithoclasts, and pelagic admixtures. This part of the succession was deposited in slope/toe-of-slope settings, as also indicated by the benthic foraminfera assemblage. This assemblage is represented by *Siderolites calcitrapoides* , *Lepidorbitoides* sp., *Pseudosiderolites vidali*, *Orbitoides tissoti/media*, and *Vanderbeekia catalana* indicating late Campanian (?Maastrichtian) age. During subaerial exposure “paleokarstic pockets“ in the form of paleosols with Microcodium structures developed in the uppermost ~10 m of this Upper Cretaceous succession, which is unconformably overlain by the transgressive Paleogene (?Eocene) Foraminiferal limestones over the regional type 1 sequence boundary. Although the depositional setting and lithology of the upper part of the Èiovo succession can be correlated with that of the Braè „marble“ member of the Puèišæa Formation or „atypical“ allochthonous facies (Draèevica) of the Dol Formationm on the Island of Braè (Gušiæ & Jelaska, 1990), the stratigraphic range and the relationships with overlying strata require establishment of a new formation, which is called here the Èiovo Formation. While the Sumartin Formation on the Island of Braè (Gušiæ & Jelaska, 1990) represents a typical inner- platform development, penecontemporaneous deposits of the Èiovo Formation likely represent deeper water slope/toe-of-slope depositional settings, presumably facing the NE Adriatic trough (see review in Korbar, 2009).

Gušiæ, I. and Jelaska, V. (1990) Upper Cretaceous stratigraphy of the Island of Braè within the geodynamic evolution of the Adriatic carbonate platform. Djela Jugoslavenske akademije znanosti i umjetnosti, 69, 160 pp.

Korbar, T. (2009) Orogenic evolution of the External Dinarides in the NE Adriatic region: a model constrained by tectonostratigraphy of Upper Cretaceous to Paleogene carbonates. Earth-Science Reviews, 96, 296– 312.

Solar-atmospheric effects on flood frequency in a 450-year varve record from pre-alpine Lake Ammersee (South Germany)

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The recent series of extreme floods in large European river systems, so-called 100-year events, is assumed to be induced by climatic change. Instrumental flood data, however, rarely exceeds 100 years and is therefore too short to evaluate recurrence intervals of these events and, even more important, to investigate the link between flood frequencies and different climate boundary conditions. In annually laminated (varved) lake sediments, flood triggered fluxes of detrital catchment material result in seasonally resolved flood layer time series that provide the potential to extend instrumental flood time-series for thousands of years. Pre-alpine Lake Ammersee is an ideal site for the reconstruction of long time series of flood frequencies. Its annual laminations enable reliable detection of flood layers by their sedimentological and geochemical features. Precise dating of these events at seasonal precision can be obtained by varve counting and the determination of the micro-stratigraphic position of each layer within a varve. Available instrumental and historical flood data of the main inflow River Ammer can be used to calibrate the palaeoflood-record. The existing high-resolution palaeotemperature reconstruction derived from ostracods in Lake Ammersee sediments facilitates to discuss changes in flood frequency with respect to changes in climate boundary conditions. Complementary micro-facies analyses and X-ray fluorescence measurements at 200 µm resolution applied on two varved sediment cores from Lake Ammersee enabled the reconstruction of a 450-year flood layer time series at to date unprecedented precision. A comparison of the seasonal flood layer record with daily River Ammer runoff data of the last 74 years confirms that detrital layers represent a suitable time series of high-magnitude River Ammer floods covering 71 % of the highest flood events. The frequency of these floods during the entire 450 years is not stationary, but reveals distinct peaks mainly for summer floods coinciding to colder periods in the Little Ice Age with lowered solar activity. Further, the flood frequency record is in agreement with the frequency of flood-prone weather regimes in the Ammer catchment since AD 1881. The intriguing agreement of the flood layer record with both, solar activity variations and the frequency of flood-prone weather regimes suggests possible solar effects on mid-latitude atmospheric dynamics.

Depositional sequences of permocarboniferous Itarare Group: turbidites, pelites and chaotic beds of a Gondwana glacial sucession

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Outcrops of sedimentary strata from Mafra and Rio do Sul formations (Itararé Group, Paraná Basin) constitutes the record of the Gondwana permocarboniferous glaciation in southern Brazil. These deposits were mainly deposited in glacially influenced prodeltaic and in relatively deep and distal settings related to marine glaciers. They are constituted by sandy and conglomeratic turbidites, slowly settled pelites, deposited below storm wave base, and chaotic strata, originated by debris flows, slumps and slides. Outcrops of these units have an outstanding quality when compared with other brazilian rock expositions, and have been used by oil companies to train sedimentology and stratigraphy methodology and trace comparisons with deepwater petroleum reservoirs. Five depositional sequences, with regional extent, can be mapped along along 300km. Each sequence initiates with the abrupt entrance of sandstones and conglomerates over muddy beds, marking a downward shift of depositional facies to the basin interior, in consequence of a relative sea level fall. Sequences 1 to 4, main targets of this study, are equivalent the Itararé Group, reaching a total thickness of 450 m. The glacial influence in these sequences is remarkable, registering the phase when Gondwana continent was situated next to the polar region during Carboniferous and early Permian. These glacio-influenced units present a change in the climatic pattern, from sequences 1 up to 4. Sequences 1 and 2 records colder conditions, passing to a mild, temperate climate, marked by glacier retraction and concurrent establishment of fluvial systems and vegetation during sequences 3 (final) and 4, as the Gondwana moves away from the polar region. The lowstand systems tract of sequences 1 to 4 are characterized by thick turbidites, generated by subaqueous outwash flows, produced by retreating marine glaciers and by hiperpicnal flows, produced by catastrophic fluvial floods. Tillites are very rare deposits, formed in moments of significant advance of glaciers in the basin, causing glacio-eustatic sea level falls. Prodeltaic pelites and fine grained deposits related to tidewater glaciers are interbedded with thin bedded turbidites and chaotic strata, constituting the most common deposits of the transgressive systems tract of sequences 1 to 4. Rapid progradations, developed during the highstand systems tract, triggered the deposition of unstable pelitic packages, frequently remobilized as slumps and more evolved debris flows, resulting in thick chaotic beds. The change in paleocurrent directions indicates an important modification of sediment supply in the basin during the “Itararé time”. Paleocurrents of sequences 1 to 3 indicates a sediment transport to the north, while paleocurrents from the upper part of sequence 3 and 4 indicates an increasing sediment supply to south and southwest, preceding the main tectonic inversion registered by Fm. Rio Bonito. Sequence 5 is composed of post-glacial Rio Bonito formation sediments, deposited in deltaic, fluvial, and shallow marine (waves and tides) contexts.

Application of the allostratigraphic approach to the study of volcano-sedimentary rift sequences: an example from the Jurassic of the Neuquén Basin, Argentina

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Allostratigraphic schemes have been used for decades for the understanding and interpretation of many sedimentary basins and hydrocarbon systems in the world. However the difficulties in finding key surfaces and the intrinsic complexities of volcanic successions are obstacles to the application of this methodology when studying the history of volcano-dominated basin-fills. Despite the natural shortcomings when using this methodology in non-marine volcanic and volcaniclastic successions, its uses when devising a qualitative chronostratigraphic scheme was found valuable in the analysis of an extensional basin that have the signature of volcanism in their infill. The Neuquén basin is located on the eastern side of the Andes in Argentina and central Chile, and it constitutes one of the most important hydrocarbon basins of South America. The history of the basin is very complex, involving an early stage of extension (Upper Tr–Lower J) and subsequent stages of inversion and extension during Mesozoic times. The initial configuration of the basin was characterized by the development of isolated deep depressions bounded by normal faults and filled with volcanosedimentary successions. The syn-rift infill is known as Precuyano, which is constituted by different lithostratigraphic units. The study of the syn-rift succession was carried out through geological mapping, and the measuring of stratigraphic and structural sections. Several lithofacies and facies associations were determined. The characteristics and geochemical signatures of volcanic and pyroclastic rocks were studied through the analysis of thin sections and chemical analyses, while the petrographic analyses on the volcaniclatic rocks determined the nature of their procedence and the relationship with the volcanic facies. Discrete depositional units (accumulation units) were defined based on identification of distinct bounding surface, in conjunction with the facies associations. The main framework of accumulation units in the syn-rift includes volcanic (vents, dikes, domes and lava flows), pyroclastic (ignimbrites) and sedimentary units (volcaniclastic alluvial and fluvial systems, coarse-grained and fine- grained delta systems, offshore marine and mixed shallow marine systems). The integrated analysis was performed by ranking the regional key surfaces (discontinuity surfaces) to define an allostratigraphic scheme. Three tectosedimentary units (UTS) were defined. UTS I is an Upper Tr–Lower J continental silicoclastic sequence deposited prior to the onset of volcanism. UTS II is a continental unit mainly defined by its volcanic signature in which composite volcanoes and volcano-tectonic depressions were interpreted. UTS III is represented by mixed marine units with a minor influence of volcanism. As a result, the superimposition of these tectosedimentary units represents a multiepisodic rifting that lasted over 30 ma from Upper Tr to Pliensbachian times. The result of this research enabled the definition of the major volcanic and sedimentary environments within the syn-rift succession and the main tectonic (accommodation space, polarity of sedimentary and volcanic environments, spatial distribution of depocentres and eustatic cycles) and volcanic controls (types of volcanic environments, and quantity and characteristics of the clastic material provided to the depocentres). Compared with the lithostratigraphy, which is characterized by lateral continuity of the effect of an event, the allostratigraphic approach emphasizes the complex interaction between depositional, non-depositional, and erosional events. This enables a more precise identification of the distribution of different environments and their 3D stratigraphic changes along time. Finally, this methodology could be used as lithology predictor to understand the facies distribution and geometries of different stages of volcano-dominated basin-fills and to make a comparison between surface information and subsurface data sets.

Sedimentology and palinology of Quaternary deposits from eastern Marajó Island, Pará State, northern Brazil

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Analysis of Quaternary sediments in Amazonia is of great interest for reconstructing the dynamic evolution of its drainage basin, and to support discussions related to paleoclimate, sea level and tectonics. Few studies emphasize this type of approach, which is mainly due to the lack of natural exposures in this low topographic area. This work integrates facies analysis, radiogenic dating and pollen analyses of an 124 m-thick core obtained in the area located near Lake Arari, northeastern Marajó Island in the Amazonas mouth. The studied sediments were deposited in the last 50 ka, and record the following depositional environments: fluvial channel, outer estuarine basin to shallow marine, inner estuarine basin, tidal flat, estuarine channel, and lagoon. Facies interpretation was complemented by pollen analysis, performed on 108 siltic/muddy samples, selected with basis on facies variations. The data revealed low palynomorph concentration, with discontinuous record along the studied section. Two stratigraphic intervals were richer in pollen material. The first one comprises the uppermost 18 m succession, which corresponds to lagoon deposits formed during the last 10,000 ^{14}C yr BP. In this interval, pollen concentration ranges from 3,539.6 to 13,124.2 grains/ cm3. The dominant pollen type is Rhizophora (20.8% and 45.0%), which is a mangrove index element. Other pollen trees include Alchornea (1-7.8%), Anacardiaceae (0–6%), Euphorbiaceae (0–4.9%), Fabaceae (1– 8.2 %), Mauritia (0–4%), Melastomataceae (0.8–9.8%), Moraceae/Urticaceae (0–5%), and Rubiaceae (0–6%). Herbaceous vegetation includes Amaranthaceae/Chenopodiaceae (0–4%), Cyperaceae (1–20%) and Poaceae (1.3–11%) species. The second interval is located between 77 and 93 m depth and corresponds to inner estuarine basin sediments, with basal age estimated at 50,795 ± 5,090 ^{14}C yr B.P. Pollen concentration varies from 9,095.5 to 22,688.5 grains/ cm3. Herbaceous pollen has higher concentrations (1,330.0 to 7,911.6 grains/ cm3) than in the first interval and, with prevalence of Poaceae (9 – 26.5%). Among tree types, the highest frequencies were of Alchornea (0 – 16%), Celtis (0 – 7.1%), Euphorbiaceae (0 – 8%), Fabaceae I (psilate type) (1- 14%), Ilex (0 – 4.1%), Mauritia (1–10.7%), Malpigiaceae (0–7.1%), Melastomataceae/Combretaceae (1 – 10%) and Rubiaceae (0 – 7%). Analysis of the stratal architecture of the Late Pleistocene and Holocene deposits in Lake Arari area reveals that sedimentation took place mostly under estuarine conditions, which evolved over several episodes of transgression and regression, as indicated by their cyclical nature. Fluvial deposition occurred between 40,950 (±590) and 50,795 ± 5090 ^{14}C yr B.P., followed by an episode of rising relative sea level started between 35,567 (±649) and 39,079 (±1,114) ^{14}C yr B.P. An overall transgression occurred up to 29,340 (± 340) ^{14}C yr B.P., with deposition of outer central basin to shallow marine deposits. This was followed by a sea level fall, which has favored stream rejuvenation and valley incision. New elevation of relative sea level took place around 10,479 (±34) ^{14}C yr B.P., culminating with estuarine valley fill. Significant fluvial inflow into the island ended around 10,479 (±34) ^{14}C yr B.P, with the evolution of the estuary into a lagoon setting. A drop in relative sea level occurred in the late Holocene, resulting in a northward coastal progradation, a process that would have culminated with the development of the modern Lake Arari from a lagoon.

Influence of base level variations, flow discharge and concentration in the evolution of deltaic systems: a physical model-based approach

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In natural environments, deltaic systems dominated by rivers are important elements for the accumulation and transfer of sandy material into lacustrine and marine basins. The characteristics of the deltaic wedge and the amount of sand that is kept at the coast or transferred to the deep basin depend upon, among other factors, the characteristics of the flows (sediment concentration and composition, flow dynamics, etc.) as well as base-level variations. In ancient systems, those parameters are hardly verifiable. Physical modeling provides the tools to reproduce these systems in a controlled manner. This work presents the results of a tank simulation of a river-delta-basin system in order to characterize its spatial and temporal evolution under different scenarios of flow behavior and base (tank) level. The parameters evaluated were: (1) base (tank) level fluctuations (lowering, rising and rapidly lowering base level), (2) inflow discharge (increasing, decreasing and millennium peaks), and (3) volumetric concentration of the mixture (2 to 10%). A large dimension 3D T-tank (2.0 x 1.0 x 1.2 m river section and 7.0 x 5.0 x 1.2 m basin section) was used for simulations. The flow was a mixture of water and mineral coal (ρ = 1.19 g/cm3) composed by equivalent grain size of 20% silt and clay, 60% very fine and fine sand and 20% medium sand. At total, 40 hours of simulation was performed divided in five successive runs. A digital laser system scanned the deposit created at the end of each run (draped by coloured markers) yielding the physiographic reconstruction for each depositional cycle. After the last run, the whole deposit was sliced in dip and strike sections in order to evaluate its internal architecture and external geometry. Three scenarios were tested: (1) lowering base (tank) level: in which a decreasing peak flow discharge and volumetric concentration were used alternating with catastrophic events of flooding (high peaks of discharge); (2) rising base (tank) level; and (3) rapidly lowering base (tank) level (50% faster than the first case) with a lowering concentration (from 10 to 2%) associated with high-discharge peaks. In the first case, the sedimentation was dominated by braided shallow subaerial channels and retrogressive channel incision. The deltaic system prograded and created a Gilbert type delta. The deposit shows tabular sheet layers at the base, prograding clinoforms layers in the delta front passing to channels at the top. In the second case, as base (tank) level raised, the lowstand channels were filled by millimetric tabular beds of coarser sediments and then, radial spreading at the top of the whole plain dominates the sedimentation process. The deposit is composed mainly by tabular layers forming a thick package above the top of the previous one and there isn't significant sedimentation on the delta front. In the third case a large incised valley appeared on the river system, associated to strong changes in the flow and to the loss of accommodation space. In this phase, the sediments were transferred basinward, but kept within the delta complex developing a thick delta- front wedge. In this feature, the lack of clear internal features suggests dominance of mass flows. The simulations demonstrated how sensitive the deltaic system evolution is to base level variations. In addition, it was observed that the intensity of discharges can be related to channel development, whereas a decrease in concentration was related to an increase of the erosion capacity of the system. In this sense, changes in discharge rate can produce either erosional or depositional channels, whilst the depth of erosion (and transfer to the delta front) is mainly related to concentration. Documenting such cause-response mechanisms in physical modeling provide a powerful tool for the interpretation of natural systems.

The impact of deforestation in fluvial sediment supply: the Jequitinhonha river delta plain, Bahia - Brazil

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The Jequitinhonha River Delta, with an area of approximately 800 km^2, is one of the largest deltas of the Brazilian coast. In the last centuries, activities such as deforestation, mining and, more recently, the construction of dams, have occurred in the Jequitinhonha River basin, strongly affecting its hydrosedimentological dynamics. The assessment of progradation rates of the delta plain showed an increase of approximately 6 times in the average rate of progradation of the shoreline during the period between 310 years BP and the present (11m/year) compared with the period between 2500 and 310 years BP (1.5m/year). The volume of sediments deposited in the delta plain for these two periods were compared with the modeled sediment yield of the Jequitinhonha River basin. Two scenarios were modeled using the Universal Soil Loss Equation (USLE) calibrated by sedimentometric measurements. One scenario considered the present vegetation cover and the other considered the original vegetation cover. The solid sediment discharge calculated for the scenario of present vegetation was 27,000,000 t/year and for the scenario of original vegetation cover was 1,000,000 t/year. The contribution of fluvial sediments modeled for both scenarios are consistent with the calculated rates of shoreline progradation, and show that changes in land use were the main factor responsible for the recent increase in progradation rates. A similar situation was observed in some Mediterranean deltas, where the increased rates of progradation were associated mainly to deforestation.

Recent tephra records in lacustrine sequences from Nahuel Huapi National Park: incidence of the spatial distribution in tephrochronological frameworks

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Volcanic ash layers are a typical allochthonous material that can be found in lacustrine sedimentary sequences providing a valuable tool for the development of chronological frameworks. These volcanic products can be widely dispersed, allowing reliable correlations for long distances when they are well characterized. The northernmost sector of the Andean Range, where the Nahuel Huapi National Park (NHNP) is situated, is located in the South Andean Volcanic Zone, including several active centers in the late Holocene. Tephra falls from these eruptions have affected large areas, covering hundreds of kilometers from the volcanic sources to the region of the northern Patagonian lakes, generating lacustrine records of the volcanic eruptions. The high frequency of these events deserves an accurate characterization of the volcanic products for the source identification, as well as the evaluation of their spatial distribution. Few comprehensive geochemical and morphological works characterizing these products have been undertaken showing that accurate tephrochronological correlations and the spatial distribution evaluation are difficult to achieve. Lakes provide a continuous record of their depositional history, with high temporal resolution and potential for preservation of climate change signs, anthropogenic impact, and records of volcanic activity, offering exceptional stratigraphical and chronological control. However, each lacustrine system has a particular dynamics with different morphometrical and geological conditions, which is reflected in the sedimentation and in the deposition of the volcanic ashes that arrive to the lake bottom. In order to provide information to establish a tephrochronological framework for the last millennium in the NHNP region, regarding particularly the spatial distribution of the volcanic ashes, the tephra layers identified in four short lacustrine sedimentary sequences were studied. Lakes Nahuel Huapi (Brazo Rincón sector), Moreno, Tonček, and Ilón were selected among several lakes in the NHNP considering different latitudinal and altitudinal locations. Primary volcanic components, including white and brown pumice, scoria, and glass shards from different particulate size fractions were characterized by measuring major and trace element contents by Instrumental Neutron Activation Analysis. The sequences were previously dated by Pb-210 and Cs-137 techniques. Four tephra layers were identified in Brazo Rincón site, nine in lakes Moreno and Tonček, and three in Lake Ilón. Previous studies have shown the characterization of these tephra layers and their geochemical composition has been compared with whole-rock data taken from the literature of volcanoes from the Southern Volcanic Zone Llaima, Villarrica, Cordón Caulle, Calbuco, and Osorno, active during historical times. In this work we attempt to analyze these results focused on the evaluation of the spatial distribution of the products of the different events and the establishment of a chronological framework for the area. The two volcanic sources identified as the most influential in the study zone are the Cordón Caulle complex and the Calbuco volcano. The comparison of the four sequences demonstrates a strong spatial variability in the lacustrine volcanic records within the NHNP, likely due to the influence of the dominant winds and the topography. Also, the variability in such volcanic records indicates the sedimentation conditions and the different potentials of preservation of the volcanic deposits in each lake. However, at least three tephra layers could be identified and correlated in the sequences, with the potential to be considered as the main tephras to be looked for in lacustrine sequences in the area for tephrochronological applications, namely the 1960 and 1961 Cordón Caulle and Calbuco eruptions, respectively, the 1893-95 Calbuco event, and the 1759 Cordón Caulle eruption.

Fluvio-glacial deposits associated with lake-level fluctuations: characteristics and depositional significance (Los Antiguos area, Buenos Aires Lake, Santa Cruz Province, Argentina)

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Fluvio-glacial deposits are located along the margins of the Los Antiguos River as it flows into Buenos Aires Lake. These sediments are siliciclastic and were transported by the river into deltaic bodies in the southern margin of the lake. The analysis of the deposits together with the study of the depositional architecture allows us to determine the oscillations of the lacustrine water level during the Holocene. The materials studied are composed of different layers of gravels, sands and muds at various altitudes located close to La Atravesada hill. The outcrops show that the total sedimentary thickness of Holocene deposits is approximately 120m. There are diverse facies associations. Facies association A comprises disorganized, coarse-grained sandy lutites with dispersed clasts, exhibiting cross-stratification marked by brown, thin sandy intercalations, with a total thick of about 30m. This facies overlies the Miocene basement. Facies association B contains disorganized muddy gravels in light brown tabular bodies (1-2m thick) with a flat base and a convex-up surface. Facies association C is comprised of coarse gravels interfingered with brownish fine- to medium-grained sands showing high-angle cross-stratification, forming lithosomes that are a few meters thick. Facies association D has fine- to medium-grained sands with subhorizontal flat stratification, forming tabular lithosomes that are few meters thick. Facies association E contains light brown gravels containing pebbles to cobbles as fining- upwards successions, forming lithosomes a few meters thick with a concave base and a flat upper surface. The depositional architecture allows the differentiation of sedimentation episodes punctuated by several erosive events. Episode 1 - Facies association A has a noticeable absence of tractive primary sedimentary structures suggesting accumulation as a result of diverse massive flows into the lacustrine basin. Episode 2 - Overlying an erosive unconformity, the geometry of the chaotic deposits of facies association B suggests correspondence to the front lobe of a mass flow. Facies association C is interpreted as the progradation of a deltaic body on top of the B facies. Episode 3 – Overlying another erosive unconformity, the sediments of the D facies association is interpreted as prodeltaic deposits. Episode 4 – The third erosive unconformity contains large- scale paleotopographic irregularities over which the E facies, corresponding to fluvial deposits, accumulated. Interpreted specifically as deltaic plain sediments, various episodes of mass flow deposition punctuated traction deposition by rivers. Episode 5 –After yet another erosive event in the upper part of a deltaic plain, more fluvial deposition occurred. There are also two other deltaic bodies located at levels close to the present lake border marked by a four erosive unconformities, defining marked several lithosomes composed of facies association A and identified as stabilization of lake levels during the late Holocene. Episode 6 – the last two small deltaic bodies are related to the present lake-level fluctuations.

Lithofacies associated with gravity flows in slope environment adjacent to stromatolitic constructions, Morro Agudo area, Paracatu, Minas Gerais, Brazil

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In the Morro Agudo area (Minas Gerais, Brazil), stromatolitic reef constructions of the Morro do Calcário Formation belong to the upper part of the Neoproterozoic Vazante Group. They occur along a north- south trend. The bioherms are constituted by columnar and planar stromatolites and show the characteristic microbial lamination. The columnar stromatolites present millimetric convex laminations and, exceptionally, conic laminations. The reef system crops out locally in Morro do Calcário and is also observed in Morro do Tamanduá, a few kilometers north of the studied area. On the bioherm s western side, the lithofacies associations are characteristic of slope depositional system with the development of three subsystems: proximal, intermediate and distal. The proximal subsystem is represented by dolomitic breccias with clasts of different sizes (blocks to granules), immersed in dark to light grey dolomitic matrix. The clasts are formed by fragments of the stromatolitic bioherm, dolarenites and dololutites. They are angular to sub-rounded and present dark to light grey color. The intermediate subsystem is characterized by breccias with dolarenite matrix and by fine to coarse dolarenites. The dolarenites show dark to light grey well rounded intraclasts within a dolomitic matrix composed by micrite or sparite. In some layers, ooids are an important constituent. Locally, the dolarenitic breccias and the dolarenites are cemented by sphalerite and galena. Laminated dolomites are less frequent in this subsystem. The distal subsystem is constituted by shales and diamictites. The shales are dolomitic and present a characteristic alternate dark clayey and light grey dolomitic lamination. Black shales rich in organic matter and syndiagenetic pyrite are frequently observed. The deposition of the black shales occurs in deep quiet anoxic waters, where the organic matter is preserved and can accumulate. The diamictite lithofacies is represented by dolomitic clasts immersed in dark clayey matrix. The clasts are constituted by microbial dolomites, dololutites, dolarenites, laminated dolomitic shales and black shales. Their size is variable, from blocks to granules and sands. The clayey matrix is frequently rich in organic matter. Sedimentary structures as slumping and compaction deformation are observed in this facies. The diamictites form layers of variable thicknesses from few centimeters to tens of meters. The recurrence of the diamictite facies evidences the episodic character of this type of sedimentation and its relation to gravitational debris flows. These three subsystems have repeated and alternated through time as it is observed along the drill cores of the Morro Agudo Mine. The lithofacies succession recognized on the western flank of the stromatolitic construction follows a vertical pattern from base to top: breccias, dolarenitic breccias, dolarenites, dolomitic shales, black shales and diamictites. Adjacent to the bioherm s western flank, the lithofacies associations and the subsystems are distributed following a sedimentary zonation that evidences a reef slope depositional system. Clayey carbonates of the Serra da Lapa Formation cover the slope and reef system, and represent a major transgressive event with regional expression that indicates a general basinal subsidence and marks the end of the stromatolitic reef sedimentation.

Exploring the relationship between sedimentation rates and the neoichnological character of a sandy tidal flat: Boundary Bay, Canada

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Neoichnological trends across a modern tidal flat can be used to predict the variability inherent in the ichnology of paleo-tidal flat successions. These trends can also be linked to sedimentological and environmental stresses, to establish the main controls on distribution of biosedimentary structures. The Boundary Bay tidal flats occur in a polyhaline (18 to 30 psu) setting where sedimentation is dominated by tidal processes, with wave processes secondary. Neoichnologically, there is clear heterogeneity in both the diversity of traces and the intensity of burrowing. This heterogeneity reflects a myriad of depositional, environmental and sedimentological stresses, with the gross sedimentation rate (GSR) dominating organism distributions. The gross sedimentation rate is defined as the cumulative thickness of all sediments and bedforms deposited on a surface. In settings subjected to strong currents and laterally shifting bedforms, the GSR is high. For Boundary Bay, the effects of the GSR are evident in the resulting neoichnological character of the flats. Across all substrates, the total area occupied by organisms rarely exceeds 3% of the tidal-flat surface, and is commonly less than 1%. This equates to a bioturbation index (BI) value of one. To reach BI values of two to six, sediments must be available (i.e., not buried) to biogenic reworking and / or recolonization. With an increasing GSR, substrates are rapidly buried and re-exposed, which limits the time a substrate is available to colonization. For paleo-ichnological studies, this research presents a few interesting results. 1) Tiering relationships in tidal-flat successions commonly reflect natural heterogeneities in the infaunal communities, rather than changing environmental conditions. 2) Ichnofabric analysis of paleo-tidal-flats with a high GSR would yield fabrics that do not reflect variability in the depositional conditions, but natural heterogeneities within the environment. 3) The composite trace-fossil assemblage of the Boundary Bay tidal flats cannot be attributed to a single ichnofacies, but instead comprises elements typical of multiple ichnofacies. 4) The main controls on trace assemblages across Boundary Bay are sedimentological, and include the gross sedimentation rate and, to a lesser extent, grain size.

Tidal effects on the shoreface: towards a conceptual framework

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Tidal processes have a significant impact on the sedimentological and ichnological character of shoreface deposits. However, tidal processes can be manifest either directly or indirectly. Direct tidal effects are best expressed in the offshore and lower shoreface, and to a lesser extent in the middle shoreface. Key evidence of direct tidal control includes uniform sediment calibres from the upper shoreface to the offshore, with little or no mud preserved in the lower shoreface. Additionally, sands in the lower shoreface and offshore tend to be intensely bioturbated. If sedimentary structures are preserved, they largely comprise current-generated structures. Such shoreface deposits are referred to herein as “tide-influenced shorefaces”, and are expected in settings with low storm-wave input and strong tidal currents (e.g., straits). Indirect tidal influences are manifest by the lateral translation of wave zones across the shoreface, and are best developed in macrotidal to megatidal settings. Indirect tidal influences are best expressed in the upper and lower shoreface through the interbedding of sedimentary structures produced by shoaling waves, breakers and surf, swash-backwash, and surface runoff. The boundaries between shoreface subenvironments are poorly defined. The foreshore is generally much thicker in these settings (typically 4 to 5 m), depending upon tidal range. Bioturbation tends to be patchy across the shoreface, and is dominated by vertical structures. Such shorefaces are referred to as “tidally modulated shorefaces”. Using well-established sedimentological and ichnological criteria for recognizing wave-dominated shorefaces – wherein sediment deposition across the shoreface is nearly wholly controlled by fair-weather wave and storm-wave processes – a conceptual model is developed for recognizing fair-weather shorefaces, storm-influenced shorefaces, and tidally influenced shorefaces. Five distinct shorefaces are defined, each of which is gradational with the others. These five include: storm- affected, storm-influenced, storm-dominated, tide-influenced, and tidally modulated shorefaces.

Differentiating deep-marine overbank from crevasse splay deposits in outcrop: an example from the Windermere Supergroup, Castle Creek, British Columbia

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In the Castle Creek study area a thick succession of vertically-dipping basin-floor to base-of-slope Neoproterozoic rocks is superbly exposed. In the base-of-slope part of the section millimetre- to decametre- scale sedimentological and stratigraphic observations identified two sandy interchannel elements: overbank splays and crevasse splays. Splays are typically observed on the outer bends of sinuous leveed-channel systems where energetic sediment gravity flows escape the confines of the channel. Anomalous large magnitude flows that overtop the levee and deposit in the distal levee form overbank splays whereas those that breach and incise the levee form crevasse splays. Based on seismic observations, overbank splays are typically an order of magnitude smaller than crevasse splays, being 100's of m² compared to several km². Two end member kinds of overbank splays are recognized: isolated and multiple bed complexes. Isolated beds are single, thick-bedded (40-200 cm), Tbcd or Tbd turbidites encased in thin-bedded (1-30 cm) turbidites. The planar laminated division (Tb) is medium-grained, ungraded and comprises ~75-90% of the bed. Beds are tabular with sharp, planar and non-erosive bases. Multiple bed complexes consist of amalgamated, normally graded, coarse-grained structureless sandstone units 2-4 m thick. Multiple bed complexes are laterally continuous over several hundreds of meters, however, individual beds are laterally discontinuous, extending less than 100 m. Isolated and multiple bed complexes have a low (10% or less) detrital mud matrix content. Thick-bedded turbidites were deposited on the distal part of a subaqueous outer bend levee. Along the outer bend, superelevation and flow stripping increased sedimentation rates and hence levee growth. Upon exiting the channel, flows bypassed the proximal levee, accelerated down its steeply-dipping backside and deposited on the lower slope of the distal levee. In the case of isolated beds, thick flows that were not completely confined to the channel, overflowed, and under competence-driven conditions, deposited a succession of planar laminated sand. In the case of multiple bed complexes, a partial breach allowed several consecutive flows to escape the channel and under capacity-driven conditions, deposit the graded, structureless beds. Note that flow deceleration was not accompanied by a hydraulic jump like in crevasse splays (see next). Crevasse splay deposits consist of coarse-grained, poorly-sorted, coarse-tail graded, structureless sandstones with a high (30-50%) mud matrix content. Units range from 2-8 m thick and beds range from 5-125 cm thick. Two end member kinds are recognized: tabular and amalgamated. In tabular units, sandstones commonly contain a small number of large, isolated, tabular mudstone clasts. Beds generally show negligible change in facies or thickness laterally. Amalgamated units contain mudclasts which tend to be smaller (< 50 cm) but are more abundant, locally forming breccia layers. Individual beds are discontinuous and cannot be traced for more than 150 m laterally. Mud-matrix-rich structureless sandstones reflect rapid, capacity-driven deposition possibly downflow of a plane-wall jet with jump. The jump formed at an abrupt change in slope downflow of a major levee breach where supercritical flow ($Fr > 1$) transformed to subcritical flow ($Fr < 1$). The levee breach allowed most of the thickness of the flow to escape the channel and be diverted into the interchannel area. At the jump, beds were deeply scoured and quickly draped by a layer of sediment from the collapsing sediment cloud depositing the amalgamated facies. Beyond the jump, locally-generated turbulence was damped by high sediment concentration and seafloor scour became negligible. Nevertheless, sedimentation rate remained high as the dispersion continued to collapse and deposited the matrix-rich, tabular deposits.

Depositional sequences, parasequences or isolated sandstone bodies in cratonic basins: how far can we go?

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The necessity of improved mapping and correlations within the Devonian of the Brazilian cratonic (Gondwanic) basins, has led to a new a stratigraphic investigation of the Paranaíba Basin (NE Brazil), started in 2003. The Devonian stratigraphic succession is composed of mixed fine to medium sandstones and shale intervals (Itaim, Pimenteira, Cabeças and Longá formations), which range from Emsian (late Early Devonian) to Frasnian (Late Devonian), and were deposited in deltaic to shallow marine paleoenvironments, both storm and glacially influenced. Previous (1990s) basinwide correlations were made solely on geophysical logs (GR) from the sparse exploration wells in the basin, and favored 3rd order (or bigger) genetic sequences (Galloway's) or 'parasequence-like' depositional sequences (Exxon's), limited by flooding surfaces (right- deflected GR curve), both containing TSTS and HSTS depicted respectively by FU and CU cycles. In the early 2000's some of the authors (CGKY and LB), based on a detailed facies anaysis on cores from one of the shaly intervals (Pimenteira Fm) in the Eastern basin's border, recognized facies shifts (or breaks) in the "normal regressive" CU cycle, usually at the base of HCS sandstone bedsets, and recognized sequence boundary unconformities related to forced regressions; other sequence boundaries ("regressive–transgressive surfaces") were also placed on the top of those HCS sandstone bedsets, sharply overlaid by heterolitic or bioturbated facies. Based on that analysis an "isolated sandstone body" (ISB) stratigraphic model was proposed for those sandstones, tied up in a 4th/5th order depositional sequence framework. This review, now extended to the Western basin's border and to a wider interval (Itaim, Pimenteira and Cabeças fms), is also based on detailed facies analysis on well-corings (total 600 m), and discusses the applicability of the 'onset' or the 'maximum forced regressive' surfaces for correlations, like those initially applied in the basin's Eastern border. The use of the maximum forced regressive surface (MRS), identified initially as "regressive– transgressive surfaces" by some of the authors, raises questions on how far an ISB can be recognized and mapped as "falling stage system tract" (FSST) in a higher order depositional sequence or as parasequence. Decisions will depend on the study scale, data availability and investigation method itself.

Erg margin-marine interaction in the mid-Cretaceous Iberian Desert System; comparison with recent counterparts

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The mid-Cretaceous Iberian Desert System (Spain; Rodríguez-López *et al.*, 2008) extended over an area of more than 16,000 km2 in eastern Iberia, at a palaeolatitude of 25°-30°N, i.e., slightly south of the boundary between the Northern Hot Arid Belt and the Northern Warm Humid Belt. The highlands of the Variscan Iberian Massif along the western margin were the main catchment of this desert system, and to the east it was bounded by the Tethys Ocean. Erg-marine interaction along the Tethys led to a variety of sedimentary facies. Facies associations of aeolian dunes, playa lakes, coastal lakes with tidal creeks, marshes, embayments with tide-influenced deltas, and subtidal deposits, are organized in several stacked cycles bounded by transgressive and sand-drift surfaces. Transgressions over the aeolian deposits of the erg-margin system, interpreted to have resulted from climate-induced declines of sand supply during ongoing subsidence, led to deep incisions and semi- restricted to restricted lagoonal embayments with organic matter accumulation and small tide-influenced deltas. Storms flooding the lagoons and aeolian interdunes areas produced intraformational conglomerates. During relative sea-level highstands, tide-influenced deposits with mud drapes covered aeolian dune foresets. Thick-thin variations in the foreset laminae, double mud drapes, and bidirectional current ripples indicate that the marine intervals developed in a shallow semi-diurnal tidal system. The marine-erg margin system shows similarities with aeolian-marine interaction processes along the east coast of Qatar, the southern margin of the Persian Gulf, and Guerrero Negro (California).

Rodríguez-López, J.P., Meléndez, N., De Boer, P.L. and Soria, A.R. (2008) Aeolian sand sea development along the Mid-Cretaceous Western Tethyan Margin (Spain): erg sedimentology and palaeoclimate implications. Sedimentology, 55, 1253-1292.

Mineralogy of clay fraction and geochemistry of two soil profiles in a Pleistocene fluvial terrace in Mogi-Guaçu River basin (São Paulo State - Brazil)

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Alternations between wetter and drier palaeoclimates during the Quaternary were very significant. Some authors (Martin & Suguio, 1982) propose that there were three periods of glacial maximum; the most recent at 18,000 years BP, another 50,000 years BP and the last in the Middle Pleistocene between 120,000-130,000 BP. In addition, Suguio & Martin (1978) indicate a transgressive event (Cananéia) 123,000 BP on the coast of São Paulo (Brazil), which can be considered a record of transition from a glacial to interglacial period. Here, this paper aims to discuss pedogenesis of the northeastern state of São Paulo (Brazil) during this period, on alluvial sediments dated to 130,000 ± 21,000 BP. Two soil profiles were studied in a river terrace in the Jataí Ecological Reserve - Luiz Antonio, SP (Brazil) developed over the Quaternary alluvial sediments in an area of numerous abandoned meanders. These soils indicate under what conditions the landscape has evolved over the past thousands of years. Thermoluminescence dating of alluvial sediments at the base of a soil profile provided the age of 130,000 ± 21,000 BP, indicating a Middle Pleistocene age. Mineralogical analysis of the clay fraction by X-ray diffraction and geochemistry by X-ray fluorescence spectrometry were carried out, with the aim of identifying, through pedologic characteristics, climatic and geomorphologicalchanges during the Pleistocene. Kaolinite was identified as the most abundant mineral in the two studied profiles, although there are also peaks of vermiculite, a clay mineral which may have been formed by the alteration of ferromagnesian minerals from the dacites of Serra Geral Formation in the region. Besides that, the ki and kr indexes of the soil profiles, compared to the sediment, also showed an advanced stage of chemical weathering. The Cr horizon (alluvial deposit) showed 99.4% SiO2, loss on ignition was 0.18%, indicating that there was little organic matter and the silica mostly exists as quartz. Immediately after deposition, the river level rose and other materials were deposited, then intensely altered and the Cr horizon was preserved from chemical weathering that ensued after a possible climate change to a warmer and humid climate.

Facies sequence of a Holocene storm-dominated regressive barrier, Praia de Leste, Southern Brazil

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Modern transgressive barriers biased clastic-shoreline facies models because the most modern examples are derived from Northern Hemisphere coasts. These models are in contrast with several Southern Hemisphere regressive strandplains formed during sealevel lowering after postglacial maximum (7,000 to 5,000 years BP). Along the Praia de Leste coast (25º 41' S latitude), positive sedimentary budget and 3,5 ± 1 m lowering of the sea level after postglacial maximum gave rise to a 3-5 km wide prograded strandplain. Sand quarries 3.5 km distant from the present coastline have provided exceptional outcrops of 75% of the Holocene barrier facies sequence (lower 25% of the facies sequence was accessed only by cores). The Praia de Leste coast is characterized by very fine to fine quartzose sand beaches with one or two longshore bars. Gradients vary from 0.2 % on shoreface to 1‰ on inner shelf settings. Regional climate is humid subtropical and mean rainfall reaches 2,500 mm/yr. Waves from East and South reach the coast with a maximum period of 16 seconds and seasonal maximum height between 4.0 and 6.4 m. Net longshore drift is towards northeast (104 to 105 m3/year) and the tides are semidiurnal with 1.4 m amplitude. Sedimentary facies allowed the recognition of five facies associations corresponding to inner shelf, lower, middle and upper shoreface, and foreshore. Paleobathymetry of facies formations was defined with accuracy of ±1 m. Based on 14C dating, age spans from 4,402–4,135 cal yr BP near the barrier base to 2,987–2,751 cal yr BP near the top. The studied barrier is 12 m thick and its deposition took place between 2 m above and 10 m below mean paleo-sealevel. Facies architecture shows a regressive sequence lying on an erosional surface and downlapping Pleistocene sediments. Paleoenvironmental conditions during barrier formation were: (a) 2 ± 1 m sea-level falling; (b) sediment supply composed by abundant fine to very fine sand, mud and vegetal debris; and (c) frequent storm waves. There are remarkable differences in relation to clastic shoreline models summarized by Clifton (2006). The main differences are the high content of fine sediments (25-50%), probably released by large estuarine complexes coeval to the barrier formation, and the predominance of swaley cross-stratified sand facies with abundant vegetal debris on the middle and lower shoreface (3-8 m paleodepth). Vegetal debris associated with swaley cross stratification are frequently older than the barrier formation, resulting in several ^{14}C age inversions (Angulo *et al.*, 2008). Debris have probably accumulated below the storm wave base during sealevel highstand and have been reworked and transported by storm waves during sea level lowering. Beach step facies are notably preserved, allowing tracing continuously seaward dipping low angle cross-stratification to sigmoidal cross-stratified sand facies at the beach step. In conclusion, barriers of the Praia de Leste strandplain are good examples of wave-dominated clastic strandplains formed during highstand depositional system tract and could be used to improve facies models of regressive wave-dominated environments.

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Different types of fan-shaped sedimentary deposits on Earth, on Mars, and in the laboratory

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Fan-shaped sedimentary deposits, such as alluvial fans and deltas, are formed by surface-water flow, with different degrees of fluvial or debris flow components. On Earth, different sedimentary deposits have been identified and classified based on various different factors such as upstream (e.g. discharge, sediment type, feeder structure) and downstream (e.g. basin architecture) characteristics. Martian fan- shaped deposits vary greatly in terms of size, shape and morphology, but these deposits exhibit architectural elements similar to those of terrestrial analogues, e.g. lobes, terraces, and incised delta fronts. The presence of these elements aid in the understanding of the processes present during formation of the deposit. Many of these elements are visible in the high-resolution images taken by the High Resolution Stereo Camera (HRSC) onboard the Mars Express, as well as in other satellite imagery. Both alluvial fans and deltas have been studied in detail with the use of HRSC topography, and we have classified Martian fan- shaped deposits into five classes based on morphology, size, and fan gradient. Deltaic deposits (formed into ponding water), comprise four out of these five classes, including back-stepping, back sliding, branched and smooth-topped deltas; differences in morphology are mainly responsible for the different classes. We have formed morphological analogues under controlled conditions for all the different types of Martian deltaic deposits in the Eurotank facility in Utrecht, The Netherlands. We investigate the similarities and differences in deltaic deposits on Mars and on Earth, and compare that to the different deposits that were formed in the laboratory. Good terrestrial examples for arid alluvial fans are found in Svalbard, Northern Chile, and other hyper-arid regions. Good terrestrial analogues for deltas are harder to find due to the large amounts of vegetation that occurs on the delta floodplain, however, some analogues do exist, for example the Pleistocene Emme delta in Germany (example of a stepped delta in a lacustrine environment) and the modern day Okavango river delta in Botswana (example of a branched delta in a lacustrine environment). The study of both terrestrial deposits as well as deposits formed in the laboratory is an important way to connect aerial satellite views of Martian deposits with ground-based analysis in order to understand the formation processes.

Interpretation of processes in Martian deltas based on experimental work

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Deltas have been identified on Mars and clearly indicate that water flowed on the surface during the planet's history. These sedimentary deposits and their feeder channels record flow event duration and magnitude. Volumes of deltas can be used to calculate flow and sediment dynamics as well as a minimum time of formation, with the use of flow and sediment transport predictors, a simple morphological model (described elsewhere) and measured channel and delta dimensions. Pilot experimental results have shown that Martian deltas show architectural elements similar to those of terrestrial analogues, e.g. lobes, terraces, and incised fronts and the interpretation of these elements can be used to infer the processes that were active on the fan surface during formation. Delta morphology is related to flow discharge and duration (upstream conditions), sediment properties, and basin size (downstream conditions). However, it remains challenging to relate surface morphology and climate. Laboratory experiments were conducted in the Eurotank facility at Utrecht University to investigate the morphologic development of fans as well as the influence of different external factors which control delta morphology, such as water level, water discharge, and sediment type. We have also investigated the effect of horizontal scale as well as vertical exaggeration in the experimental set-up, as well as the effects of feeder valley size and shape and that of the ratio of feeder valley width to basin width. Experimental set-up involved the construction of circular basins similar in shape to that of a typical impact crater, with the average depth/diameter relationship as that of large complex Martian craters. The first set of experiments were performed in 2 m diameter crater with twice vertical exaggeration. The second set of experiments were performed in a 4 m diameter crater with no vertical exaggeration. Each experiment had two phases: During the first phase of the experiment, the crater filled with water, resulting in a retrograding, back-stepping or back-sliding delta (fewer distinct steps than the back-stepping cases, probably related to lower discharge) similar to the stepped or terraced deltas on Mars. In the second phase of the experiment, a breach in the crater rim was initiated, resulting in a prograding, branched delta similar to the branched deltas on Mars, or in some cases, a smooth-topped, Gilbert-type delta, also seen on Mars. We see that significant amounts of sediment transport still takes place even without the aid of vertical exaggeration. Additionally, we see that most morphologies are independent of scale, but that it is easier to construct certain morphologies with larger craters when the lowering of the water level is more constant and less sudden. The results from these experiments are in the first place evidence of the fact that we are able to recreate the morphologies of all different delta-types on Mars by merely varying basic parameters such as water level, discharge and sediment type; and in the second place an independent test of the assumptions that are used in the numerical morphological model. Furthermore, these results are important for trying to understand the processes that are responsible for the formation of fan-shaped sedimentary deposits on Mars and in doing so, understanding the climatic conditions during which these deposits were formed.

Palaeoflow reconstruction from fan delta morphology on Mars and in controlled laboratory experiments

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Alluvial fans and deltas on Mars record past hydrological conditions. Until now these conditions have been inferred from the morphology of the feeder channels and the deposits from images and digital terrain models (DTMs), as well as from calculations of the bulk fluxes of water and sediment based on the dimensions of up-stream channels. However, neither method can distinguish between dilute (river-like) flows and dense (sediment-laden) flows, while the formation time- scales for these two sediment transport modes differ by orders of magnitude. The objective is to compare DTM data of Mars and of controlled laboratory experiments quantitatively with a morphological model to infer sediment transport mode and formative duration. We present a quantitative morphological model for fan and delta formation that assumes as little as possible. The model calculates the growth of a sedimentary body in a crater lake, represented by a low-gradient (subaerial) cone on top of a high-gradient (subaqueous) cone. The volume of the cone is constrained by the influx of sediment while the elevation of the break in slope, that is, the shoreline, is constrained by the influx of water. The water and sediment fluxes were calculated with physics-based predictors based on the feeder channel. Small- scale morphology, such as crater wall irregularities, concavity of the fan surface and channel avulsion, is ignored. The model produces alluvial fans, stair-stepped deltas and Gilbert-type deltas. The parameters that determine which morphology emerges are the supply of sediment and water to the basin, the size of the basin and the duration of the flow. A comparison between the experimental deltas and the model shows good agreement in morphology and formative duration. Differences are attributed to feeder channel wall collapse, which is not incorporated in the model, and to groundwater outflow, which effectively reduces the ratio of discharge and sediment flux. Two Gilbert-type deltas were formed in over-spilling crater lakes from long low-gradient upstream channels. One alluvial fan was formed in a similar manner except that the damaged crater did not lead to ponding. Three stair-stepped deltas were formed from short high-gradient upstream channels that only partially filled the crater lakes. A direct comparison between the cone model and DTM data for several Martian deltas and an alluvial fan on Mars demonstrates that single-event dilute flows of short duration (days to years) could have created all of the deposits.

Paleogene foreland evolution in the Puna - Cordillera Oriental regions, NW Argentina

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The identifications of tectonically significant features like distinct unconformity surfaces and growth-strata, along with the study of the stratigraphic record linked to structural analysis and vertical and lateral distribution of arc/backarc volcanism are proxies to constrain the history of mountain formation and foreland basin evolution. Due to its recorded history and evidence for uplifting of a non-collisional plateau, the origin of the Central Andes is a matter of controversy and constant research. Former research proposed a migration of deformation and exhumation in time and space southward (along-strike) and eastward (across-strike), consequently it is possible to track the chronology of mountain ranges formation and basin shifting cratonward. According to this, progressive propagation of sedimentation-deformation toward the east was proposed from the Cordillera Domeyko (Chile) in the Cretaceous-Paleocene to the Altiplano-Puna (Argentina) in the Oligocene, and subsequently to the Cordillera Oriental and Sierras Subandinas in the Middle Miocene. However, new investigation in the last years documented that the Andean deformation and sedimentation started in the Cretaceous time in Chile, but since the Eocene it expanded simultaneously within the Cordillera Domeyko, in the Puna (Pastos Grandes-Arizaro depozones) and in the Valles Calchaquíes – Cordillera Oriental. Current hypotheses consider that the Paleogene foreland deposits in the Puna and in the transition between Puna-Cordillera Oriental represent sedimentation in a wedge-top depozone basin as it has been already suggested for Bolivia. However structural analyzes revealed basement-involvement in deformation both in forethrust and backthrust styles. Also nearly 1500 – 2000 meters of preserved coarsening upward successions with mainly local provenance along with the presence of growth-strata and intraformational unconformities are evidence of active deformation and the existence of incipient relief dividing depozones. The described features support the idea that several belts of Paleogene deformation started simultaneously in a broad - 300 km across-strike - in which related depocenters accommodated the main sediment input. Toward the east (eastern portion of the Cordillera Oriental and Santa Bárbara System), the presumed Paleogene foredeep sedimentation is recorded in nearly 300 meters thick of mainly fine-grained sediments. The overall data suggest the existence of a series of Paleogene meridional depocenters analogous to compressional basins and ranges compatible with a scenario fitting a wedge-top basin model. Nevertheless some of the features mentioned also suggest that an alternative intermontane basin model should be considered.

Stratigraphic and sedimentological model of Escandalosa “O” and Gobernador formations, Barinas sub-basin, western Venezuela

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The aim of this paper is to establish the geometry and physical quality of the Middle Eocene and Late Cretaceous main sedimentary deposits in the Barinas Sub-Basin and contribute to increase the exploratory success. It is located in the northwestern portion of the Barinas sub-basin, towards the north of the traditional oil production fields. The stratigraphic succession of the area is composed of three Tectonosequences (TS) and two Maximum Flooding Surfaces (MFS). The three TS are: SK1: Aguardiente Formation (Albian-Cenomanian), Escandalosa Formation (Cenomanian-Turonian), Navay Formation (Members: La Morita from Turonian-Santonian and Quevedo from Campanian-Maastrichtian), SK2: Burgüita Formation (Maastrichtian) and SE: Gobernador and Pagüey formations (Middle Eocene). Molasse sediments of Parángula and Rio Yuca formations (Pliocene-Oligocene) were finally deposited. The two MFS according to Hardenbol *et al.* (1998) are: MFS1 in the middle Turonian (91.5 Ma) and MFS2 in the middle Eocene (42 Ma). These surfaces were used as stratigraphic datum. The stratigraphic and sedimentological model was based on the interpretation of 895’ of cores and previous studies. From the stratigraphically point of view the analysed interval comprises the Escandalosa Formation and the Gobernador Formation. Macroscopic core description results show the identification of twenty nine lithofacies: 1.-Fifteen sandy lithofacies (S/S1/S11/S11gl/S3/S2/SC/ S3B/ S3G/S31/S2B/S2Bca/S2Bgl/S11B/S11ca); 2.-Four shaly lithofacies (H/HB/L/L1); and 3.- Ten carbonatic lithofacies CmB/CmG/Cmf/CM/CmfB/Cmbi/Wm/Dare/Dm/Dw). They can be grouped in four distintive sedimentary facies associations: tidal influenced amalgamated fluvial channels, tidal influenced estuarine channels, coastal to middle neritic and clastic influenced carbonate ramp. Conventional petrographycal analysis allowed the identification of the following microfacies: Escandalosa “O” Member: massive dolostones, sandy dolostones, dolomitized sandstones and micritic sandstones; Gobernador Formation: quartzarenites and quartz wackes; and Masparrito Member: sandy allochemical limestones, allochemical sandstones, micritic sandstones, sandy micrites, allochemical wackestones, quartzarenites, feldespatic sandstones and quartz wackes. The observed events and their products indicate that the sediments have reached the late diagenetic state. Major diagenetic processes responsible for porosity creation are: dissolution of diverse textural elements, matrix and cements, dolomitization and microfracturing; while the processes destroying porosity are: compaction, cementation, precipitation of clay minerals and dedolomitization. Porosity (POR), permeability (K) and shale volume (Vsh) have allowed to define three quality rock types: Excelent quality rock/Type A (S/S3/S31/S11 facies; $K \geq 1300$ mD; $POR \geq 15\%$; $Vsh < 0.10$)), Moderate quality rock/Type B (S1/S2/S2Bg and Dw facies; $150 \leq K < 1300$ mD; $7\% \leq POR < 15\%$; $0.10 \leq Vsh < 0.20$) and Moderate to poor quality rock/Type C (S11g/SC/CM/HB and Dare facies; $K < 150$ mD; $POR < 7\%$; $Vsh \geq 0.20$). The sedimentary facies with better physical quality are more abundant in the Gobernador Formation, which matchs to the production behavior observed in the reservoirs in the area. Lithofacies analysis, ichnofacies, fossil content and sedimentological parameters have allowed us to interpret the depositional environment of the Escandalosa "O" Member as a carbonate ramp with associated distal estuarine environments to the south. The Gobernador Formation is characterized by coastal deltas to the east, estuarine environments to the southeast and coastal environments to the southwest; while for the Masparrito Member carbonate ramp systems with associated coastal deltas in distal positions to the south have been interpreted.

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Stratigraphic and sedimentological model of the Miocene aged section in the Morichal, Cerro Negro and Budare oilfields, Orinoco Oil Belt, southern Venezuela

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The objective of this study was to establish a sedimentological and stratigraphical model for the Miocene Sequence (Oficina Formation) in the Morichal, Budare and Cerro Negro oilfields, in the Orinoco Oil Belt (OOB), located in the Guárico, Anzoátegui, Monagas and Delta Amacuro states, in order to improve the oil exploration and exploitation activities. The stratigraphic section was divided in two sequences: a lower sandy sequence (Merecure Formation); and an upper shaly and heterolithic sequence (Oficina Formation). Progradational or coarsening upward parasequences are predominant as well as parasequence sets. Two transgressive parasequence "sets" were recognized in the Lower Sequence separated by a local Flooding Surface. Seven regressive/transgressive parasequence “sets” were recognized in the Upper Sequence with a transgressive character. Macroscopic description of 2784’ of core allows the identification of twenty two lithofacies: 1.- Nine sandy (S, S3, S3B, S2, S2B, S11, S11B, S11BC and S11C); 2.- Two silty (ST and STB); 3.- Eight shaly (LCG, LF, L, L1, LS, LG, LAG and LC); 4.- One coaly (C); 5.- Two heterolithic (H and HB) and the basement (BAS). The S, S3, S11 and S2 lithofacies and the basement show the best oil impregnation. Conventional petrographycal analysis allowed identify the following microfacies: quartzarenites, sublitharenites, litharenites, lithic wackes, subarkoses, calcarenites with bioclasts, sandy micrites, sandy micrites with bioclasts, micritic arenites and micritic arenites with bioclasts. Mixture carbonates are characteristic of the upper portion of the Morichal, Yabo and Jobo members. These rocks show diagenetic processes that indicate an early diagenetic state. Phyllites and quartz micaceous amphibolitic schists were identified in the basement. Permeability and shale volume allows the definition of three quality rock types: Type A/excellent quality rock (S/S3), Type B/moderate quality rock (S11) and Type C/ moderate to poor quality rock (S2/S21/S22 and bioturbated sandstones). The facies with better physical quality are more abundant in the Morichal Member, which matches to the production behavior observed in the reservoirs in the area. Micropaleontological studies indicate that these sediments were deposited at or near the margins of a deltaic system, in environments ranging from marginal neritic, to transitional and purely terrestrial. The integration of micropaleontological data with the sedimentary facies analysis and their associations, have allowed to interpret the depositional environment for the Morichal Member, as a fluvial dominated deltaic system, ranging from upper-lower delta plain at the base to lower delta plain and prodelta towards the top. This behavior has been observed from south to north in the study area, constituting a transgressive character sequence, with a Maximum Flooding Surface (MFS) at the top of Morichal Member (15.6 M.a). Biostratigraphic analysis indicates that the age for this interval is Late to Early Miocene; the paleoenvironments range from Transitional to Continental-neritic environment. The identification of *Helicosphaera Ampliaperta* bioevent (15.6 m) allowed the correlation at the top of the zone NN4 (calcareous nannoplankton). In the Budare Field, in the absence of this bioevent, was used *Bombacacidites Cyclusphaera Zuatensis*, as a stratigraphic equivalent to establish the early Miocene-middle Miocene limit (Delgado *et al.*, 2008).

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REE patterns of Sinemurian (Lower Jurassic) automicrite-sponge mounds (Djebel Bou Dahar, High Atlas, Morocco)

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The Sinemurian-Pliensbachian Djebel Bou Dahar (DBD) carbonate platform (High Atlas, Morocco) evolved from a low-relief depositional system into a high-relief platform. This study focuses on geochemical data (stable isotopes, trace elements) from decametre-scale siliceous sponge mounds (upper Sinemurian) developed in a mid- to outer ramp setting. Trace element analyses were carried out on thin sections using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Stable Oxygen and Carbon isotopes of mound automicrites have mean values ($\delta^{18}O$ -2.780 ‰, SD 0.55; $\delta^{13}C$ 2.34 ‰, SD 0.28) comparable to those from early marine, radial fibrous (RF) cement ($\delta^{18}O$ -1.6 ‰, SD 0.26; $\delta^{13}C$ 2.29, SD 0.08), brachiopods ($\delta^{18}O$ -2.70 ‰, SD 0.29; $\delta^{13}C$ 2.23, SD 0.72) and published Early Jurassic marine values. Blocky sparite (BS) cement of burial origin is characterized by mean $\delta^{18}O$ -5.54 ‰ (SD 0.33) and $\delta^{13}C$ 1.77 ‰ (SD 0.85). Precipitation of automicrites occurred in equilibrium with sea water without major enzymatic fractionation and they were not subjected to significant meteoric diagenesis. The RF cement has shale-normalized (sn) REE+Y patterns comparable to modern open-ocean seawater with: 1) light REE (LREE) depletion (average Ndsn/Ybsn = 0.19, SD 0.05; Dysn/Ybsn = 0.42, SD 0.07); 2) superchondritic Y/Ho ratio (mean Y/Ho = 81.29, SD 15.12); 3) positive La and Gd anomalies, and 4) negative Ce anomaly consistent with oxygenated waters. The BS cement has: 1) bell-shaped, MREE-enriched REE+Y patterns (mean Ndsn/Ybsn = 1.77, SD 0.38; Dysn/Ybsn = 2.03, SD 0.29); 2) low Y/Ho ratios (36-64); 3) mostly small negative Ce anomalies; 4) variable, mostly positive La anomalies; and 5) positive Eu anomalies (mean Eu/Eu* = 1.25, SD 0.33). Allomicrite (i.e., particulate fine carbonate sediment) has relatively high REE concentrations (ΣREE = 19-26 ppm) with sea water-like, but LREE enriched, flat REE+Ysn patterns (mean Ndsn/Ybsn = 0.79, SD 0.016; Y/Ho = 19-26; mean Ce/Ce* = 0.87, SD 0.08). Their reduced LREE depletion and high ΣREE cannot be explained by shale contamination and may reflect incorporation of particulate matter that scavenged LREE from the overlying water column. Automicrites have variable REE+Y signatures. Three samples have patterns representative of sea water (mean Ndsn/Ybsn = 0.29, SD 0.011; Y/Ho = 54-78; mean Ce/Ce* = 0.64, SD 0.04), however most samples have reduced LREE depletion and more variable anomalies (mean Ndsn/Ybsn = 0.76, SD 0.21; Y/Ho = 34-62; variable positive or negative Ce anomalies: mean Ce/Ce* = 1.03, SD 0.31; mean ΣREE = 9.4 ppm; mean Al2O3% = 0.36%, mean Zr = 4.0 ppm; mean Th = 0.34 ppm). REE distributions of automicrites are interpreted as being variably contaminated by LREE-enriched allomicrite and early diagenetic processes. Hypothetical mixing lines between early marine cement and shale (MUQ) show that shale contamination cannot explain the elevated LREEs. The positive Ce anomalies in some automicrites may reflect precipitation in dysoxic surface or early diagenetic microenvironments. Time-equivalent mounds in Morocco were interpreted as being deposited near the OMZ. Regardless, REE distributions of most automicrites were enriched in LREEs, leaving few samples with pristine seawater signatures. Stable isotopes suggest that the diagenetic alteration occurred in a burial, rather than meteoric, setting. The better stability of REE patterns in RF cements probably reflects their lower porosity relative to the microporous automicrites and lack of particulate matter. The RF cement REE patterns confirm that pre-Cenozoic (Early Jurassic) REE patterns were comparable to modern ones. Our data also show that the robust marine REE patterns of automicrites may be significantly contaminated in relatively clean carbonate environments, in this case by LREE-enriched allomicrite. In situ LA-ICP-MS analyses are superior to bulk rock analyses in isolating different components for evaluation of hypothetical mixing lines.

Parameters influencing the reservoir characteristics of hydrothermal dolomite (HTD) bodies in back-reef and inner-platform carbonates, a case study from Ranero and Bueras (northern Spain)

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Hydrothermal dolomites (HTD) are well-known as producing reservoir rocks globally (e.g. Middle East, North America). Nevertheless, their heterogeneous reservoir characteristics, depending on the precursor limestone, the structural context and paragenesis, are not well understood. This study aims to compare two major dolomite bodies exposed in the Ramales Platform (northern Spain). This platform formed in the Basque-Cantabrian Basin during Aptian and Albian transtensional rifting, and is built up by Urgonian limestones. The genesis of the HTD occurring in the Ramales Platform is identical for both case studies. Two major dolomitisation phases can be differentiated, resulting in respectively Fe-rich and Fe-poor dolomites. Both HTD bodies are characterized by distinct precursor limestones. The HTD occur in platform slope and back-reef limestones in Ranero and in inner-platform limestones in Bueras. All samples were categorised based on their texture and petrophysical (Phi, K) characteristics. Geostatistical analysis was performed to compare and investigate the spatial distribution of porosity and permeability of the HTD bodies. The Ranero body is a massive dolomite body controlled by the transpressive Ranero Fault. Sections trough the HTD body were sampled from the Ranero Fault to the HTD bodies' margin. Three dolomite types are defined for the HTD occurring in Ranero, i.e. matrix, zebra and massive cement dolomite. Geostatistics proved that porosity values of the three dolomite types are significantly different. So to interpret the porosity distributions, one needs to understand the spatial occurrence of the HTD types. Omnidirectional semivariograms show the presence of two directions of anisotropy in the spatial distribution of dolomite types, respectively N35W and N60E. N35W corresponds to the orientation of the Ranero Fault. The N60E orientation can be attributed to two features: dolomite vein orientation and orientation of the platform edge. The latter possibility is most significant since only a limited population of small dolomite veins with a N60E orientation was observed in the field. Furthermore, dolomite types can be associated to a specific dolomitisation phase. Matrix and zebra dolomite are mainly generated by the first, while cement dolomite by the second dolomitisation phase. It was demonstrated by geostatistics that permeability values are not directly dependent on the dolomite type, but on the dolomitisation phase. Cement dolomites resulting from the second dolomitisation phase have significantly lower permeabilities than zebra and matrix dolomites. The decrease in permeability can be attributed to overdolomitisation. The Bueras Quarry gives a good 3D overview of the characteristics of stratiform HTD hosted by inner-platform carbonates. The quarry is located near the HTD bodies' margin, relatively far from its feeder fault. It should be noticed that in the quarry 95% of the HTD are Fe-poor dolomites. Only minor zebra dolomite layers occur and most of the HTD can be classified as matrix dolomites. However, three types of matrix dolomites can be distinguished, depending mainly on the amount of bioclasts i.e. the precursor limestone: 1) dark grey microcrystalline matrix dolomite characterized by intercrystalline porosity superposed with some small-sized (mm- to cm-scale) vuggy porosity, 2) dark grey matrix dolomite surrounded by recrystallized, coarse crystalline dolomite with larger vugs, and 3) beige-white coarse crystalline dolomite with large vuggy pores (up to cm-scale). Primary structures are still visible and the petrophysical characteristics (Phi, K) of these carbonates are rather good. Dolomite-blocking cements are not present. In summary, the reservoir characteristics of the Ranero HTD body are controlled by their paragenesis, while in the Bueras quarry the dolomite bodies are facies-controlled. The influence of the distance to the feeder fault can be important, but has not been investigated yet.

Global climate forcing on erosion of mountain belts: the case of the Eastern Alps (Italy)

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In spite of the abundant literature proving that climate affects erosion rate at different time-space scales, it is still debated and virtually unknown what is more efficient as erosion driver between tectonics and climate changes, and which aspect of climate changes is most effective in modulating erosion in mountain ranges on a geological time scale (0.1-1 Ma). This problem is particularly important when considering the last 5 Ma, since a general increase of detrital input was observed world-wide and it has been interpreted as the result of global climate forcing. To challenge these basic problems, a detailed reconstruction (at 0.1 Ma steps) of the detrital flux from the Eastern European Alps to its retro-foreland basin is used to discuss if and how global climate has controlled belt erosion; in addition the Pliocene-Pleistocene detrital flux is compared with Middle-Late Miocene one to discuss the relative efficiency of thrust tectonics and global climate variability as erosion drivers. The first result is that Pliocene-Pleistocene climate has been approximately 3 times more efficient in triggering erosion than Miocene thrust tectonics, when the most important deformation phase in the Eastern Southern Alps belt occurred. The second result is that no single climate parameter drove erosion, but rather a simple combination of them; this is proven by the fact that detrital flux in the basin during the last 5 Ma correlates well (correlation coefficient 0.69) with a new simple index (index of cumulative global Climate Erosion Power; CEP) calculated according to marine $\delta^{18}O$ data, taken as a proxy of global temperature changes. The correlation coefficient increases to 0.82 if very few regionally-controlled events are excluded. The proposed index is based on the degree of stability of the erosion system respect to the existing relief, and combines the amplitude and frequency of climate cycles with the long term global isotope trend; as it is based on globally valid isotopic data, it can be used world-wide to compare detrital flux in sedimentary basins with global climate changes in order to investigate their coupling. These results have several implications. Firstly, they show that the long- term global climate trend has a role, but it is relatively minor compared to cyclicity. This explains why Pliocene-Pleistocene climate seems to have had an unprecedented impact on erosion of mountain belts, at least if compared with the rest of the Cenozoic Era. Secondly, as expected, the obtained correlation implies that the less stable the erosion system, the higher the climate erosion power. Moreover, the results suggest that, at least at mid-latitudes and during relatively cold time spans, such as the one experienced by Europe during Pliocene- Pleistocene, further cooling enhances erosion, and, conversely, warming reduces it. This is probably linked to the effect of long term cooling both on rainfalls storminess and vegetation cover. These results give new insights relevant for understanding the coupling between global climate and erosion of mountain belts.

Cretaceous evolution of the Neuquén Basin recorded by U/Pb ages of detrital zircons

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The Neuquén Basin is a complex retroarc-foreland basin that developed during Mesozoic-Cenozoic times along the Andean margin east of the Principal Cordillera between 36-41° S latitude. Ten km of sedimentary rocks ranging in age from Late Triassic to Pliocene record approximately 220 Ma of subsidence and detrital input from the surrounding Cordilleras and crystalline massifs. In this study we focus on around 15 My of this long lasting story, and specifically on the clastic continental succession spanning in age from Albian to Campanian. This succession includes the Rayoso Formation, which is the upper unit of the Aptian-Albian Bajada del Agrio Group, and the overlaying Cenomanian-Campanian Neuquén Group. The Bajada del Agrio and Neuquén Groups are divided by a an unconformity that marks the transition from an extensional to a compressive tectonic regime, coupled with basin change from a retroarc to a foreland type. We use U-Pb ages of detrital zircons as tracers for provenance changes of detritus delivered to the basin during this important geodynamic change. The obtained age spectra show that an important source change accompanied this geodynamic event, passing from a dominant Precambrian-Paleozoic crystalline source in the Rayoso Formation to a more complex source in the Neuquén Group. The variations in space and time within the Neuquén Group show Cretaceous-Jurassic arc volcanic rocks as a source in the area near the orogenic front in the base of the group (Candeleros Formation). Younger and more distal facies represented by the Huincul, Portezuelo and Bajo de La Carpa formations preserve a basement source from the foreland. The Precambrian-Paleozoic basement sources are derived from the eastern San Rafael Block and the southern Northern Patagonian massif. These sources also provide Triassic-Jurassic zircons derived from volcanic rift facies. The basement sources are accentuated from the older to the younger sequences. The frequency patterns of these detrital zircons are consistent with a peripheral bulge source that is being eroded in the eastern and southern parts of the basin. The proximal facies were partially cannibalized by the eastern shifting of the orogenic front from Late Cretaceous to Miocene times.

Regional Paleoecology of Near-Field Marine Faunas during the late Paleozoic Ice Age, western Argentina

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The late Paleozoic Ice Age (LPIA), which spanned from 370 to 260 million years ago, has long been known as an important climatic event in Earth's history. The end of the LPIA is the only example in Earth's history where a vegetated and biologically complex Earth transitioned from a bipolar icehouse to a greenhouse state. Currently, Earth's climate system is undergoing a similar change, with glaciers and ice sheets melting, global temperatures increasing, and sea levels rising. For these reasons the LPIA is of great interest, yet many questions remain about environmental and biotic changes that occurred during this interval of time. Recent studies show that LPIA climate changes broadly affected marine invertebrate faunas: glaciations decreased origination and extinction, and long-term, gradual global warming during the final deglaciation altered paleocommunity composition. Regional far-field studies demonstrate that LPIA shallow tropical paleocommunities were stable or weakly distinguishable and comprised of similar sets of eurytopic taxa. However, studies in near-field areas have shown that fauna proximal to glacial ice experience very different environmental conditions, especially during times of glacial retreat. Regional effects of LPIA glaciation and glacial retreat on paleo-high latitude ("near-field") marine biotas have received very little attention. We hypothesized that glacial to post-glacial fluctuations in near-field settings were not conducive for community stability. It was predicted that near glacial margins, faunas exhibited characteristics indicative of low oxygen and high sedimentation, including low diversity, small body size, and opportunistic behavior. The southwestern margin of Gondwana (present-day Argentina) has been shown to have a complex history of interacting tectonism, climate, and sea-level changes. The stratigraphy of the LPIA is well-exposed in the Paganzo, Río Blanco, and Tepuel-Genoa basins of northwestern and southwestern Argentina. Glacial and post-glacial strata were examined in the Guandacol, Tupe, Río del Peñon, and Pampa de Tepuel formations. These were compared in order to gain additional environmental perspectives (i.e. latitude differences, fjord vs. open ocean environment) on the effects of deglaciation on biota. Strata in near-field regions, like Argentina, are advantageous because they provide the most detailed and sensitive records of glacial-interglacial climate changes due to their former positions proximal to glaciers and ice sheets. In northwestern Argentina, the Guandacol and Tupe formations of the Paganzo Basin exhibited glacial to post-glacial marine deposits that included rare, stressed organisms exhibiting opportunistic behavior. It is proposed that this faunal assemblage was subject to localized proximal and distal glacial stresses in a fjord environment. The Río del Peñon Formation of the Río Blanco Basin, conversely, contained a diverse faunal assemblage in coastal shallow marine facies. In southwestern Argentina, the middle section of the Pampa de Tepuel Formation in the Tepuel Basin included offshore mudstone facies intercalated between diamictites, and yielded a diverse collection of cold water Lanispustula fauna. The combined sedimentologic, paleoecologic, and paleoenvironmental emphases of this project will lead to understanding short-term and broad-scale biotic change in response to climate changes concomitant with varying glaciation history. The effects of this climate change on community structure were determined using aspects that have been largely ignored, such as relative abundance, diversity (e.g. Shannon and Simpson Indexes of Diversity), and guild organization. Thus, this work is important in further completing the late Paleozoic paleoecologic record and predicting future implications of global environmental change in current glacial marine communities.

Some remarkable conglomerates from the Upper Cretaceous of Namibe (SW Angola). Architecture and allogenic controls

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Along a narrow and steep valley (Mariquita damba, 50 km north of the bay of Namibe) two conglomeratic units outcrop under outstanding conditions of exposure. The lower unit, a Gilbert-delta accumulation which was found only in this valley, extends for more than 1 km defining a wedge-shaped geometry, thickening westward and reaching approximately 30 m in thickness. Distal and laterally it has sharp terminations against basin deposits. The Gilbert-delta accumulation integrates a well differentiated topset (up to 10 m thick) and a foreset-bottomset association (up to 25 m thick), defining a progradational-aggradational architecture. The basal surface is either a truncation over the previous Cretaceous units, frequently showing less steep clinoforms, or a downlap with the coeval basin deposits. These coarse-grained deposits were formed after a volcanic complex with recognizable lava flows, dykes, necks and sills of presumed Turonian to Pre-Santonian age. The diversified volcanic constructions in the proximity to the Gilbert delta (less than 0.5 km) and the local angular unconformity with previous Cretaceous sediments suggest that the deformation that pre-dates the Gilbert-delta accumulation was related to the volcanic activity. Such post-rifting deformation event was probably linked to a crustal uplift (upbulge) of the basin margin. The prograding-aggrading architecture suggests that although the accommodation conditions were increasing, they were surpassed by the sedimentation rate. These features of the Gilbert-delta units indicate that it was formed under a singular conjugation of allogenic controls. The regional volcanic activity must have created coastal reliefs and the subsequent fluvial incision and may have allowed the exposure and reworking of the Aptian-Albian coarse continental conglomerates. During an interval of high sediment influx and accommodation creation an incised valley was filled by the Gilbert-type delta. The accommodation was created either by regional subsidence (in a tilting model) and/or eustatic sea-level rise. In a higher stratigraphic position occurs a more extensive conglomeratic unit, previously referred as “Conglomerates with Inoceramus” (Campanian). This unit can be followed for several tens of kilometers in the onshore. It is tabular-shaped, with approximately 20 meters thick, and consists mostly of massive or crudely horizontally-bedded deposits. At its basal portion occasionally occur west dipping conglomerates that may interfinger with sandstones. This unit was probably deposited during the highstand of the Campanian transgression, after the maximum flooding, in a setting of reduced relief – probably a platform with a gentle slope - and under accommodation/sedimentation ratio lower than the older Gilbert-type accumulation found in the area.

The Shelf-Edge: criteria for its recognition in the stratigraphic record. An example from the Tanqua Karoo Basin of South Africa

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Shelf-edge successions have received much attention in recent years because of their roll in delivery of sediment to deeper-water environments and because of a focus of hydrocarbon exploration in shelf-edge settings. Although shelf-edge stratigraphic architectures are well imaged seismic features, detailed sedimentary facies models are based on a mere handful of outcrop and sub-surface examples. The earliest-Triassic fill of the Tanqua depocenter, Karoo Basin, South Africa contains stacked deltaic sand wedges deposited in an outer-shelf to shelf-edge setting with superb exposure. We present a detailed description of these shelf-edge successions focusing on the depositional and deformational facies transitions between the shelf edge and upper slope. Facies based criteria for identifying shelf-edge successions from sedimentary facies will improve methods for identification of further shelf-edge successions worldwide and lead to a greater understanding of how terrigenous clastics are transported into deeper-water environments. The study area encompasses several mountain ridges offering extensive 3 dimensional (3D) exposures over an area of 100km2. The shelf edge is identified by a gradient break in stratal surfaces parallel to regional paleo-flow directions. This subtle (<1°) break corresponds to distinct transitions in depositional and deformational facies which we propose as additional evidence for distinguishing the shelf edge. The shelf-edge packages occur within flooding-surface bounded parasequences and contain a variety of deformed sediment facies including in-situ dewatering and loading structures as well as chaotic slumps and debris flows indicative of down-slope movement of material. These deposits are interbedded with undeformed mouth-bar sands, laminated silts and extensive thin-bedded rippled hyperpycnal-flow deposits. In outermost-shelf areas, parasequences are characterized by undeformed mouth bar sands interbedded with packages of syn-depositional loading and dewatering features deformed with little horizontal movement of material. At the shelf edge, these packages are replaced by slumped units and debris-flow packages indicative of down-slope mass movement, these features are derived from collapsed mouth-bar packages. On the upper slope, the undeformed mouth-bar sands pinch out within 2km of the shelf break and most slumps and debris flows pinch out within 4km of the shelf break. Farther down the slope, parasequences are finer-grained, characterized by interbedded silt and sand-prone turbidite packages with isolated, sandy channelized turbidites. Recognition of shelf-edge successions in outcrop can be difficult when the difference between shelf and slope gradient is small and even more so in cases such as the southern Tanqua Karoo where there has been some degree of post-depositional structural adjustment. The exposures discussed here provide a unique insight into the 3D architecture of shelf-edge successions and highlight a link between shelf-edge and upper slope depositional systems.

Discriminating palaeoclimatic and volcanic influences on clay-mineral assemblages in Andean Palaeogene foreland basins from Northwestern Argentina through integrated analysis

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Clay minerals are common products of earth-surface processes, such as weathering and authigenesis, controlled by the complex interaction of source-area lithology, continental morphology, depositional environments and paleoclimate. Variations in the clay-mineral assemblages in ancient continental deposits are frequently employed to reconstruct past climate changes, based upon the premise that the other variables play a secondary role. However, in active settings, volcanic events can supply highly labile volcaniclastic material, which can easily be transformed into smectite via diagenesis, which could produce a noticeable footprint in clay-mineral assemblages. Southern Central Andean foreland deposits represent an appropriate case study to ascertain the preservation of climatic signal, as tectonic uplift, volcanism and sedimentation have been interacting since Cretaceous times. In this context we have undertaken the study of a 1400-metre-thick coarsening-upward Palaeogene succession corresponding to the Tin Tin basin (Calchaquí Valley, Argentina). We have applied an integrated approach including x-ray diffraction (XRD), SEM and TEM analyses, along with detailed sedimentary facies analysis. The aim of this survey is to compare tendencies outcoming from vertical fluctuations in clay-minerals assemblages with evidence coming from sedimentological analysis. In the analyzed levels, illite-muscovite plus smectite account for 78% to 100% of the clay minerals in the fine fraction, with kaolinite and chlorite in subordinate amounts. The vertical variation of sedimentary settings from overbank/lacustrine domain to fluvial braided plains and an aeolian dune field suggests a gradual increase in aridity upsection. However, smectite abundance do not show a gradual decreasing trend compatible with progressively lower hydrolyzing conditions; their relative abundances vary widely throughout the section, depicting pulse-like, abrupt fluctuations. Smectite depicts under SEM a rose-like texture typical of authigenic origin; furthermore, smectites with such morphology were found in close association with heulandite. Despite the absence of field evidence of volcanic influence, other indications of volcaniclastic material have been found in levels with high smectite abundances from the middle to the top of the succession. They include quartz crystals exhibiting embayments and skeletal forms, with smectite filling the voids and microcrystalline silica. Furthermore, the XRD analyses of these levels evidence well-crystallized smectite, characteristic of a volcaniclastic origin. Therefore, the increase in smectite abundance in these beds probably reflects a significant volcaniclastic contribution, which is also evidenced towards the top of the sequence by a centimetre-thick ash layer. The only smectite-rich level located near the base of Tin Tin section can be interpreted in the same way since it contains well- crystallized smectite associated with heulandite. We infer that most of the smectite in these sediments formed during early diagenesis, probably through the dissolution of labile tuffaceous material. However, SEM images also reveal the occurrence of mainly smectitic rounded pelitic lithoclasts in several levels from the middle of Tin Tin section. This implies an additional subordinate origin for smectite from reworked fines (including palaeosol levels) from the floodplain. This survey demostrates that textural and morphological analysis by SEM is essential to recognise diagenetic reactions, like smectite authigenesis, or to identify reworked fines, and thus decide if clay mineral assemblages could be interpreted in terms of paleoclimate.

The evolution of pelitic sedimentation and its relationship with magnetic susceptibility in the clastic estuarine Jaboatão River, Pernambuco, Brazil

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A continuous sediment record, measuring 50cm in length, was collected from the Jaboatão River estuary in the State of Pernambuco, northeast Brazil. 4 km from the river mouth, sediments were sampled at 5cm intervals and were subjected to particle size analysis as well as chemical and magnetic susceptibility (MS). Quarzt and aluminosilicates (Al_2O_3) distributions are inversely correlated, which produces a strong negative correlation between SiO_2 and Al_2O_3. Si/Al ratios strongly fluctuate in the lower portion of the profile, up until the 35-40 cm interval, thereafter it gradually decreases in value towards the top of the core. This indicates that the sedimentary regime steadily shifted, becoming a lower energy hydrodynamic environment. This data suggests that the quartz lower sediments represent a deposition under more strong energy conditions, while the organic-pelitic sediments signify cool and anoxic conditions, found in the upper midsection in this estuarine area. These conditions were favourable for the preservation of organic matter (OM) and combined with the significant input of clay minerals (indicated by the high Al_2O_3 content) is probably the reason for the sorption and abundance of heavy metals species. The divergence of the sedimentary and geochemical profiles therefore demonstrates that varying environmental conditions existed within the estuary. These differences were likely due to the interplay between fluvial and estuarine influences. However, it is also important to note a sandy interval at the base of the profile, which indicates that in spite of the estuarine environment, there were pockets of more intense hydrodynamic energy. The inverse relationship between fine particles and sand, demonstrates that the system is partly controlled by the relationship between quartz and clay flux. This, again, indicates the dynamic nature typical of the estuarine environment. Strong hydrodynamic regimes are commonly associated with thicker terrigenous facies and quartz, as well as higher levels of dissolved oxygen (DO).This results in the poor preservation of OM and to relative low contents of clay minerals. Conversely, less energetic regimes are characterized by finer terrigenous material, clay and subordinate quartz. The variation in sediment nature between the lower and upper portion of the profile will have exerted a strong control on their respective geochemical signatures. For example the lower sandier SiO2-rich portion constitutes a poor substrate for binding heavy metals. In contrast, the upper pelitic fraction has good sorption capacity due to the presence of the associated OM. A continuous interdependency between the MS and the pelitic fraction is present along the profile. This correlation is expected given the significant role of ferromagnetic oxide minerals in the bulk composition of low hydrodynamic environments. The fine fraction is more abundant in the area of lowest energy of the estuary, bordered by mangroves, which serves as a repository of pelitic sediments and where the MS values are higher. MS values are highest in the upper section, reaching a peak in the range of 31 x 10-6 m^3 kg-1 to 73 x 10-6 m^3 kg-1, between 0-5 cm.

Sedimentary architecture modelling of syn-rift fluvial sediments (Delft Sandstone Member, Lower Cretaceous, The Netherlands): target for deep geothermal energy production

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Geothermal energy production from deep aquifers and depleted hydrocarbon reservoirs is an attractive CO_2-neutral alternative for conventional energy production. Key element in the successful and cost-effective development of a geothermal production project is the reduction of inherent uncertainty of the sedimentary architecture of the reservoir target, i.e., the shape, size, spatial distribution and connectivity of the hot water reservoir units, and their internal permeability heterogeneities. In this paper we present a TU Delft-initiated project with the aim to drill a geothermal doublet on the university premises. The doublet will produce hot water from one well; cooled-down water with CO_2 is re-injected into the same sandstone at two kilometer distance from the production well. Drilling permission has been granted and drilling is planed early 2011. The project is primarily designed for commercial heat production for a grid-heating network in a co-generation power plant and will use innovative lightweight composite drilling technology to minimize the operational footprint during drilling. Furthermore, it will serve as an in-situ laboratory for geothermal measurements and experiments. As such, it provides for an energy production facility, a technology demonstration case, and a research facility. Stacked fluvial sandstone deposits in a lower coastal plain syn-rift setting (Delft Sandstone Member, Lower Cretaceous, West Netherlands Basin (WNB), The Netherlands) are the target of the Delft Geothermal Project. The WNB is a transtensional basin that formed in an Early Cretaceous rift phase and comprises a series of NW-SE oriented half-grabens bounded by normal faults. Thrust faults in the basin formed during basin inversion from the Paleocene onwards. The WNB is an oil and gas province; hydrocarbon accumulations are mainly found in structural traps. The 60-km-wide basin was filled with an up to 1-km-thick stack of fluvial sediments with a transition to shallow marine deposits in the NW. The Delft Sandstone Member is part of the Nieuwerkerk Fm. of Valanginian-Hauterivian age and consists of NW-trending distributary-channel complexes in a coastal plain setting. The horst-and-graben topography and syn-sedimentary tectonic movement conditioned the sediment fill of the basin and caused local depositional centers with lateral and vertical differences in stacking density of the fluvial sandstone. Core, well-logs and cuttings analysis from nearby wells penetrating the Delft Sandstone Member show 1.0-4.5-m-thick fluvial sandstone beds embedded in floodplain fines. Overall net-to-gross is 0.66. The Delft Sandstone Member is subdivided in three units on the basis of lithofacies characteristics and well-log facies: (1) a lower unit consisting of single fining-upward medium- to fine-grained meandering river sandstone bodies interbedded with claystone and siltstone floodplain deposits; (2) a middle unit dominated by interbedded floodplain claystone and siltstone deposits with coal layers; (3) an upper unit consisting of multiple-stacked coarse- to fine-grained fluvial channel sandstone bodies. The differences in net-to-gross and stacking pattern are attributed to variations in accommodation development during syn-rift movement. A 3-D static sedimentary architecture model of the fluvial deposits in the Delft Sandstone Member was constructed by integration of correlated well-logs, core- and cuttings-based sequence analysis and seismic data, and geothermal well trajectories into the best reservoir target, i.e., the upper unit, were designed accordingly.

Sedimentary architecture and lithofacies characteristics of a heterolithic tidal-estuary valley fill: Pano Formation (M. Eocene), Spain

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The Pano Formation (Lutetian, M. Eocene) consists of a transgressive barrier-island complex deposited on top of a blind lateral thrust ramp in the South Pyrenean Foreland Basin (SPFB). Tectonically-induced base-level fluctuations caused truncation of the barrier-island complex and incision of a 20-m-deep valley which subsequently was filled with heterolithic tidal-estuary deposits. The lithofacies characteristics, shape and spatial arrangement of the incised valley fill reveal a multi-storey stack of tidal-channel, tidal point-bar and tidal-flat sandstone and siltstone contained in the incised valley. The bioturbation grade is very low and marine body fossils are absent. Trace fossils comprise a dwarfed fauna of decapod tracks and bivalve resting traces. Five lithofacies associations are distinguished in outcrop: (1) inclined heterolithic stratification (IHS) facies produced by lateral accretion of tidal point bars, (2) lenticular sandstone facies produced by bed-load transport of megaripples over tidal channel floors, (3) slumped heterolithic deposits at the base of IHS and sandstone lenses, caused by massive gravitational sliding of unconsolidated, water-saturated sediment, (4) planar bedded heterolithic facies formed by vertical aggradation of tidal flats, and (5) structureless claystone facies. The sedimentary structures in the IHS show a rhythmic alternation of siltstone and sandstone layers on centimetre- and decimetre-scale, diagnostic for semi-diurnal and spring-neap tidal cyclicity in a sub-tidal environment. The incised-valley fill vertical succession shows the change from lateral amalgamation and vertical stacking of tidal point bars - tidal channels in the lower part to extensive tidal flats in the upper part. The top of the tidal-estuary succession is an erosional surface, marked by strong increase of grain size and bioturbation. Wedge-shaped flood-tidal delta sand¬stone beds and lower shoreface fossiliferous sandy shale with abundant Nummulites foraminifers, Velates shells and echinoid fragments overlie the erosional surface, and thick sand-filled burrows extend down into the underlying structureless claystone facies. The erosional surface marks a shoreface ravinement with abrupt landward coastline shift after the sea level rose above the incised valley and accommodation space rapidly increased. A sedimentary architecture model of heterolithic tidal point bars and associated lithofacies was constructed from outcrop analysis. The model provides a detailed insight in lateral facies arrangement, connectivity and permeability heterogeneity, which can be used to improve the reservoir modelling in highly heterogeneous estuarine reservoir settings.

Shelf-edge sedimentary systems off Rio de Janeiro State: seismic architecture of an upbuilding-outbuilding system in a "starved" shelf, northern Santos basin Brazil

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The shallow sedimentary record of the continental shelf off Rio de Janeiro State comprises the topmost series of a so-called sediment-starved shelf, considered to have been developed in the context of a thermally-old and tectonic stable margin of the northern Santos basin, southeastern Brazil. The combined analysis of a recovered set of vintage paper seismic records, coupled with chronostratigraphic data from oil industry's exploratory wells, allowed us to outline a first architectural framework for the area, composed of eight major stacked seismic sequences bounded by angular unconformities. According to the geometry of their clinoforms, internal architecture and estimated ages, the seismic sequences were grouped into two distinctive stratigraphic sets, identified as Set I (mostly Pliocene in age) and Set II (Upper Quaternary in age). These two sets reveal depositional features of a mostly prograding shelf of circa 200-300 m thick, at the mid-shelf level, that were interpreted as depositional sequences induced by repeated glacioeustatic cycles. Some architectural components of note include: (1) the characteristic upbuilt-outbuilt geometry of sequences that compose Set I (SqA, SqB and SqC) indicates that deposition has probably been favoured by a combination of prevailing subsidence regime (upbuilt pattern) accompanied by forced regressive deposits (outbuilt pattern). Such conditions permitted both sequence preservation (about 100-150 m thick at the level of the mid-shelf) and significant shelf progradation (over 25 km in the period); (2) the majority of sequences that make up Set II outbuilts as a composite seaward-thickening progradational wedge formed under dominant forced regression conditions, implying that the generation of accommodation space was less important than during the build-up of Set I. However, these sequences consistently pinch out in a progressively landward direction, suggesting a prevailing and increasing subsidence regime. The seaward tilting of the margin during the middle-late Pleistocene allowed the partial preservation of regressive sequences of about 100-150 m thick at the level of the present-day mid-shelf, and shelf progradation for circa 15-25 km. These architectural elements hint at a prevailing subsidence regime and effective sediment supply into the basin that clearly contrast with the conveyed idea of a sediment-starved and tectonic stable shelf during the Quaternary. Sediment architecture naturally raises questions about the nature and origin of sediment supply, since no significant point siliciclastic source flows directly into the shelf. Stemming from that, we are forced to speculate about: (A) the role of neotectonic movements involving the Serra do Mar coastal mountain ranges to potentially source clastic influx into the basin during the Quaternary, or about the real importance of secondary drainage basins debouching directly into partially-enclosed coastal environments, like the Guanabara and the Sepetiba bays; and (B) the mechanical nature of a supposed subsidence during the Pliocene and the Quaternary time span (overloading ? sediment compaction ?).

Can seismites reveal the frequency of flood events in pre-vegetation fluvial systems?

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Pre-Silurian fluvial deposits have been usually associated with modern arid and semi-arid braided river systems and in this way are frequently associated with ephemeral flow regimes. The Guarda Velha Formation is a more than 1,000m thick fluvial succession developed in a period of great tectonic subsidence from the early stages of the Guaritas Rift System (Eocambrian, Southern Brazil) on an axial fluvial system with up to 5km wide fluvial plains, characterized by coarse grained sandstones and conglomerates. The scarcity of fine-grained deposits suggests that the sediment supply was much greater than the accommodation generation. The depositional architecture is dominated by sandy bed forms and laminated sand sheets, with rare floodplain deposits. It commonly presents strata sets bearing liquefaction structures associated with current shear and overlain by undeformed erosive surfaces and strata sets. This relationship shows a peculiar recurrence that can bring information about the paleohydraulics of this fluvial system. The distribution of these different structures and surfaces are investigated through outcrop description, depositional architecture analysis, and confrontation with structures generated in laboratory by other authors, aiming at the interpretation of the time relations of the implied processes. These sin-sedimentary structures suggest three simultaneous phenomena: the water saturation of the pores (inherent to liquefaction), current shear, and earthquake events with magnitude higher than 5 degrees (that also causes liquefaction). The erosive surfaces are not affected by liquefaction and the relationship between deformed and undeformed strata in rhythmical sequences reveals the recurrence of earthquakes simultaneous to current shear followed by periods of fluvial deposition without major seismicity. Consequently, many seismic events represented by liquefaction structures occurred when the water flow of the river was active. As this recurrence is not expected to happen by chance, we discuss its implications on the environmental reconstruction. We propose that this pre-vegetation river system was fed by a perennial water supply. Thus, the similarity of this fluvial system with modern ephemeral rivers may be duo to the highly variable discharge caused by the lack of land plants, and not necessarily due to climatic controls.

Geological data for Pietroasa Gypsum deposit (Transylvanian Basin, Romania)

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The Pietroasa Gypsum is part the Badenian deposits present in the western part of the Transylvanian Basin, Romania. The deposit begins north of the town Turda and continues toward the south passing through the villages of Cheia, Moldovenesti, Pietroasa, Podeni, and Aiud. The study of the Pietroasa Gypsum deposit began with geologic field work beginning with geologic mapping, 44 drill holes, core sampling, and collection of outcrop samples. The investigated region lies at the contact between two different structural units: Apuseni Mountains in the west and the Transylvanian Basin in the east. The Turda - Moldovenesti - Pietroasa region, lies at the eastern edge of the Apuseni Mountains and is characterised by the presence of eruptive basic rocks (ophiolites) and a Jurassic limestone. In the Transylvanian Basin, the eastern part of the Turda - Moldovenesti - Pietroasa region belongs to the Transylvanian Basin and consists of sedimentary rocks from the Neogene (Badenian, Sarmatian, and Pannonian). The Badenian strata were deposited transgressively on top of the ophiolites. The contact between the two formations can be followed from the Cheia locality and it continues towards the south, to Moldovenesti, Pietroasa and Podeni, following a sinuous line, with accumulating within gulfs in the ophiolitic strip. The largest deposit is present in the Pietroasa region. Here, the Badenian section begins with an onshore facies consisting of conglomerates, calcareous breccias and sandstone above which a fossiliferous organogenic limestone horizon follows that contains Lithothamnion and is also rich in corals, foraminifera, mollusks, gastropods and echinoids. In certain areas of the sedimentary basin, where there were favourable conditions, a lagoon- like facies was established, now represented by saline clays, and saline breccias (surrounding the town of Turda), thick salts (Turda, Valea Florilor) and gypsum lenses (at Copaceni, Cheia, Pietroasa, and Valea Florilor). In the PIetroasa - Podeni region the Badenian sea shifted to the west, and created a small gulf in which sediments with onshore facies characteristics were deposited and then, after the separation from the rest of basin, sediments with lagoon-like characteristics. The Badenian stratigraphic succesion begins with arenaceous limestone with Lithothamnion, on top of which greenish tufa, tufa sandstone and clay can be found. The gypsum facing continuous sedimentation presents a stratiform - lenticular character with an inclination of 10 - 15 NE. Across the top of gypsiferous horizon ashy Badenian clays can be found, above which there are Quaternary clays. The Quaternary is made up of sandy clays accumulated at the base of slopes, with alluvial clays extending along the length of the valleys as well as clay accumulations resulting from landslides containing rock fragments. This gypsum deposit is regionally made up of two separate lenses - a lens in the northern part of the area and another in the south. The gypsum in this region is estimated as about 15,000,000 tonnes and is utilized for plaster, plasterboard and cement fabrication.

Common Evolution of Drowned Barrier Reefs along the Mixed Continental Shelf Edges in the Gulf of Papua and the western Gulf of Mexico

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Drowned coral reefs along the mixed shelf edge in the Gulf of Papua and the western Gulf of Mexico evolved very similarly. The Gulf of Papua (GoP) is one of the best modern example of low latitude mixed carbonate/siliciclastic system where the northern extremity of the Great Barrier Reef meets huge volumes of siliciclastics dumped by the Fly and others Papua New Guinea (PNG) rivers. Results of studies, since 2004, focusing on the GoP shelf edges and adjacent upper slopes, demonstrate a clear switch from thick prograding muddy early sea level fall siliciclastic wedges and lowstand shelf edge deltas to trangressive growth of coralgal edifices. In the northern part of Ashmore Trough, the surveys uncovered a 30 to 50 m-high ridge that parallels the shelf edge with linear segments exceeding 10 km in length. Analyses of a core, recovered in a re-entrant in front of the ridge, demonstrate that a coastline, essentially siliciclastic, reached the present-day shelf break during Last Glacial Maximum - LGM and the Oldest Dryas - OD (17.5-16.5 cal. ky. BP). During a major pulse of sea level rise, between ~ 15.0 and 13.0 ky cal. ky. BP, a coralgal reef established itself on top of a LGM/OD siliciclastic beach barrier complex, and subsequently drowned. On the northwest PNG shelf edge, an early transgressive, as thick as 80 m, coralgal edifice complex, sampled at its flank by a piston core at ~ 107 m below modern sea level, established itself on top of a LGM shelf edge delta lobe, partially eroded and located at about 120-125 m below modern sea level. Southern Bank is one among 20 coralgal reefs of latest Pleistocene age occurring on the edge of the southern Texas shelf between the Rio Grande and Brazos/Colorado lowstand deltas. These drowned reefs, partially buried in Holocene clay-rich deposits, referred to on the Texas shelf as "the mud blanket," are cropping out today on the sea floor in water depths ranging from 58 to 82 m. Description and interpretation of published single-channel seismic lines crossing several banks and acquired multi- channel high-resolution seismic profiles in the area of Southern Bank demonstrate that the coralgal edifices are partially buried in clays and twice as thick as the average 20 m of relief exposed on the sea floor. The seismic images illustrate well the establishment, growth, and demise of the reefs. The reefs were established sometime after 18,000 years BP (21,500 calendar years BP) and stopped accreting at about 10,600 years BP (12,300 calendar years BP). These 30- to 50-m-thick coralgal edifices were constructed at maximum rates of reef growth during the first 7,000 years of the deglacial interval. The timing of reef demise falls either within or at the end of the Younger Dryas, a ~1,000-year-long time interval when the rates of sea-level rise first slowed down considerably, possibly dropped by several meters, and then significantly accelerated. Subsequent to the drowning of the reefs, Holocene clay- rich deposits partially buried the coralgal edifice.

Peat and lacustrine sediments from dystrophic lakes of the Wigry National Park (NE Poland) – implications for reconstruction of the vegetation history in the Holocene

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The Wigry National Park (WPN) landscape was shaped during the Baltic Glaciation period. Numerous lakes and small water basins are remnants of the glaciation periods. They have various shapes, areas and depth. The Park is a site of 42 lakes, the largest being Wigry Lake of 2,187 ha of area and up to 73 m in depth. It occupies the central part of the Park. Lakes represent different limnological types and vary in terms of productivity, thermal stratification, and concentration of humus compounds. Particularly interesting are small (0.5 – 3 ha) dystrophic lakes situated within the forests, surrounded by peatmoss communities, called "suchary". Water in these lakes is characterized by high concentration of humic substances and acid pH (6 – 6.5). Among 18 dystrophic lakes described in the WPN territory, 3 are located near the southern coast of Wigry Lake: Jezioro Slepe Lake (JS), Jezioro Sucharek Lake (JSch) and Jezioro Widne Lake (JW). Their genesis is probably connected with rise of the water table in Wigry Lake in the beginning of the Holocene. This paper presents the first attempt to know development of these three dystrophic lakes in the light of their vegetation history. Three cores of sediments, using "Instorf" sampler, were collected during field work. Borings were made in the bogs of the margin areas of each lake. Macrofossil remains analysis was the main used method. It let to recognize vegetative and carpological findings occurring in sediments. Decomposition degree of peat was also fixed for each peat sample. This parameter informs about ground-moisture in the past, during process of peat forming. Age of sediments was dated by radiocarbon method. Transition and fen peat were described. Their botanical composition evidences specific character of sediments and classification is often problematic. In Jezioro Slepe lacustrine-like sediment was recognized. It consists of peat and aquatic plants remains with mud admixture. Accumulation of biogenic sediments started in the beginning of the Holocene in the region of Jezioro Slepe Lake (9560±35 BP). Genesis of the other dystrophic lake from WPN territory – Suchar Dembowskich Lake is also connected with the Preboreal period. Type of sediment reveals that forming process ranged the border line of two accumulation environments: water and land. Aquatic plants remains are present also in upper layers of peat, which is saturated, so slightly decomposed. *Sphagnum fallax* was a dominant component of subfossil plant communities. In the bottom of margin areas of Jezioro Sucharek Lake and Jezioro Widne Lake peat accumulated directly on the mineral ground. It was formed in the Boreal period and in the Atlantic one (8765±50 BP and 7790±50 BP, respectively). Subfossil plant communities occurring by Jezioro Sucharek Lake were dominated by sedges (probably tall sedges) with admixture of common reed *Phragmites australis*, reed-mace *Typha sp.* and swamp horsetail Equisetum limosum. Only in the youngest phase of development bog species occurred: *Sphagnum fallax*, *Sphagnum* sec. *Acutifolia*, *Polytrichum strictum*, what could reference to the present-day vegetation. Peat forming process in the region of Jezioro Widne Lake was initiated by peatmoss-sedge communities with pine and birch. Contemporary vegetation consists of peatmosses and sedges mats, rushes and willow shrubs. Age of biogenic sediments accumulated in the vicinity of three dystrophic lakes situated in the same region (in the south coast of Wigry Lake) is different.

The Lower Jurassic of the Lusitanian Basin (Portugal). A good example of educational activities and public understanding of sedimentary geology

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The Lower Jurassic is well represented in the Lusitanian Basin (west Portugal), being mainly composed of shallow to deep-marine carbonate deposits. Above the evaporitic and dolomitic facies of the Hettangian-Sinemurian age, the series records the opening of the basin to marine influence, characterized by significant marly limestone deposits, well controlled by ammonites and with basinwide occurrence of benthic and necktonic macrofossils. In this context, some localities of the basin contain outcrops that are of great scientific, educational and scenic value, confirming its relevance in terms of geological heritage (Duarte, 2004). Localities of the basin such as Peniche or S. Pedro de Moel, well known by international Jurassic specialists, have been the stage of important research conducted by several international field-trips groups, associated to meetings co-organized by institutions including the International Association of Sedimentologists, ProGEO and International Subcommission on Jurassic Stratigraphy (e.g. Duarte *et al.*, 2004; Rocha, 2007). Besides this scientific interest, there is also a clear potential for educational activities, illustrated by the high number of training programmes carried out with geology undergraduate and masters students, as well as with high-school teachers. In recent years, these outcrops have been the focus of various initiatives, both at regional and national scale, with the objective of the popularisation of science. One of them, called "Geology in the Summer" and sponsored by the Portuguese Ministry of Sciences and Technology, takes place each year and involves people from across the country. Such experiences, spanning over more han ten years, have had a positive impact in imparting knowledge to the general public of the (sedimentary) geology of the Portuguese Lower Jurassic. The scientific-educational relevance of the different themes ranges from a more classic approach to the sedimentary geology, such as the impact of fossils in the palaeoenvironmental reconstructions, to a wide variety of features of ocean-atmospheric interaction during the Jurassic period which are widely recognized in the Lusitanian Basin since the work of Hesselbo *et al.* (2007).

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Carbon isotope stratigraphy of the Lower Jurassic hemipelagic deposits in the Lusitanian Basin, Portugal

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In the Lusitanian Basin (Central Portugal), the Lower Jurassic is characterized by carbonate deposits and the uppermost Sinemurian-uppermost Toarcian is dominated by fossiliferous hemipelagic series (marl-limestone alternations), sometimes with organic-rich facies. These units, controlled by an accurate ammonite and calcareous nannofossil biostratigraphy, are included in the Água de Madeiros, Vale das Fontes, Lemede, S. Gião and Cabo Carvoeiro formations. Carried on bulk carbonate sediments of approximately 730 samples from several reference sections, this work presents the carbon-isotope vertical and lateral distribution in this interval. During the latest Sinemurian (Raricostatum Zone) to the uppermost Toarcian (Aalensis Zone), $\partial^{13}C$ values show a large variation, fluctuating between -4.96‰ and +4.29‰. Lowest values are measured in the Upper Sinemurian organic-rich carbonate intervals (Polvoeira Member of Água de Madeiros Formation), whereas the higher values are observed in the middle part of the Levisoni Zone (S. Gião/Cabo Carvoeiro formations; Lower Toarcian). Across the Upper Sinemurian to Lower Aalenian, isotopic curves are marked by several variations that are evidenced at the basin scale. The main positive excursions are measured in the Lower Toarcian (upper Polymorphum and middle/upper part of Levisoni zones, here reaching values above +4.00‰), whereas the base of the Levisoni Zone records the most negative excursion. Furthermore, other interesting variations are recorded in the series: positive trends, around the Raricostatum/Jamesoni Zone boundary, in the upper part of the Margaritatus Zone and in the upper part of the Bifrons Zone; negative trends are observed in the Spinatum Zone, in the middle part of the Bifrons Zone and in the Gradata-Bonarellii Zone interval. The most pronounced excursions, recorded in the Lower Toarcian, are clearly associated to global carbon cycle perturbations, including the well-documented oceanic anoxic event (e.g. Hesselbo *et al.*, 2007; Suan *et al.*, 2008). However, besides the carbon cycling interest and the global nature of the Lower Toarcian isotopic events, our data demonstrate that $\partial^{13}C$ reflects the sedimentary variability of the several lithostratigraphic units which characterize the Lower Jurassic of the basin. In fact, $\partial^{13}C$ evolution seems to be associated to the 2nd and 3rd-order transgressive-regressive cycles (Duarte *et al.*, 2007). It has also to be noted that some abrupt negative fluctuations recorded in the middle part of the Raricostatum Zone seem to be related with differences in burial organic sedimentation present in the western sector of the basin.

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Dynamics of turbid plumes generated by marine aggregate dredging. Example from a macrotidal environment (the Bay of Seine, France)

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During the last decades, marine aggregate extraction has increased in the English Channel (NW European marine platform). This environment is sensitive and already anthropized (fisheries and 20% world maritime traffic). Following the international recommendations (Rio de Janeiro in 1992 and Johannesburg in 2002), in an Integrated Coastal Zone Management context, it is necessary to get a better understanding of the physical impact of dredging activities on this sensitive environment. The present study is completed in the framework of the regional programme "SIEGMA" including scientists and stakeholders, and is reported to the ICES Working Group "WGEXT" and the COST "MAGGNET" European programme. The research project is carried on an experimental area in the Bay of Seine (Eastern English Channel, France), situated on a marine continental platform with a macrotidal regime and characterized by coarse sediment (fine sediment < 1 to 2%). During dredging operations, turbidity is created by the head of dredge pipe on the seabed (bottom plume) and by the throw back of the sediment-water mixture from the dredge vessel (surface plume). The aim is to determine the plumes geometry and composition, the time of plumes dispersion under various environmental conditions and to evaluate the evolution of the seabed due to the plumes particles settling. This characterization is based on field measurements of the properties of the marine environment (turbidity, temperature, salinity, currents, waves), materials overflow (nature, size, morphology) and particle behavior in the water column (settling velocity, dispersion). These surveys are repeated several times in order to cover different hydro- sedimentary conditions (tidal cycles, wave, wind) and different dredging terms (dredging course against current, kind of overflow and nature of suspended sediments). A numerical model is also developed to simulate the plume dispersion for various hydro-sedimentary and dredging scenarios. The field data constitute the primary model inputs. The tools used during the oceanographic surveys (LISST, ADP, OBS) allow characterizing surface plumes due to overflow. An active surface plume settles quickly under the dredging vessel and around the dredging area and is principally made of fine sand. A passive surface plume settles slowly, moves with the currents as far as 7 km beyond dredging area and persists about 3 hours depending on the hydrodynamic conditions. Monitoring from the oceanographic vessel does not provide a detailed picture of the bottom plume. The bottom plume seems to settle quickly below the dredge and / or could be anecdotal compared to the surface plume. This field data are compared to the model results. The model allows defining the plume depositional area that is compared with the field observations.

How to differentiate mud from mud – a palynofacies study of Lower Miocene back-barrier to offshore marine depositional environments

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Palynofacies studies are an important tool for interpreting the depositional history of a study area. In order to interpret palynofacies data, however, it is helpful to have a robust reference dataset that documents the characteristic palynofacies of sedimentologically well-constrained depositional environments within broadly coeval successions. The Miocene succession in Denmark has been studied intensively during the last 10 years and a large database has been acquired from more than 50 boreholes, 25 outcrop sections and a series of seismic profiles. The geological development of the succession is thus well known. In the Early Miocene the coastline ran across present-day Denmark and a warm-temperate to sub-tropical climate prevailed. The coastal plain was covered by extensive swamp forests from which large amounts of wood particles, partly degraded vitrinite and terrestrial and fluvial palynomorphs (pollen, miospores and freshwater algae) were transported to the sea via large rivers and delta systems where they were deposited together with marine algae (dinoflagellate cysts). Here we present the results of a comprehensive palynofacies study of a series of sedimentologically well-constrained depositional environments in this Lower Miocene succession. More than 100 sediment samples have been analysed. The sedimentary organic particles were subdivided into three main categories: wood particles, amorphous organic matter (mainly partly degraded vitrinite), and palynomorphs. The palynomorph category was further subdivided into the following sub-categories: Dinoflagellate cysts (dinocysts), acritarchs, Botryococcus (a fresh- to brackish-water algae), saccate pollen, non-saccate pollen, microspores and freshwater algae (other than Botryococcus). First, a minimum of 200 organic particles from each sample were counted and divided into the three main categories, and second a minimum of 300 palynomorphs were counted and referred to one of the sub-categories. The palynofacies results showed some overall trends from the proximal to distal parts of the depositional system and furthermore revealed some characteristics for each of the depositional environments: • Inner and outer shelf: Dominance of palynomorphs and relatively few (less than 20%) wood particles. Palynomorphs dominated by saccate pollen and dinocysts, less than 22% non-saccate pollen. • Prodelta: Large variation probably reflecting shifting delta lobes and thus variable freshwater influence. • Estuarine: Combination of common dinocysts and common non- saccate pollen. Slightly more freshwater algae than in shelf environments. • Shoreface: More than 25% wood particles. More than 25% non- saccate pollen. Dinocysts are common. • Backbarrier flat: Dominated by wood particles, while AOM is rare. Dinocysts are also rare, while acritarchs, Botryococcus and other freshwater algae occur frequently. • Lagoonal clay: Marked strong dominance of AOM (between 60- 90% of the sedimentary organic particles). Dinocysts are rare, while non-saccate pollen comprise more than 50% of the palynomorphs. • Floodplain: Dominance of AOM and wood particles. Palynomorphs dominated by non-saccate pollen. Microspores are common, while dinocysts are rare. The results from the study represent the first step in defining a reference for interpretations of depositional environments in Miocene depositional systems within the North Sea Basin. The results may be used in undeveloped/new areas with Miocene deposits and in wells without cores and without seismic coverage.

Relating a complicated near-bottom current pattern to the variability of cold-water coral mounds in the Straits of Florida

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The Straits of Florida is a large cold-water coral province with variety of cold-water coral mounds. The Straits is also the conduit for the Florida Current that flows as a warm surface current northward to form the Gulf Stream. The Florida Current does, however, not fill the entire Straits and deep, opposing undercurrents and coastal countercurrents occur off Florida and the Bahamas produce a complicated near bottom current pattern. Measurements of the near-bottom flow field by an Autonomous Underwater Vehicle (AUV), cruising 40 m above sea floor document bi- directional near-bottom currents, produced by semi-diurnal tides, on the lower slopes of the Bahamas where mounds form kilometer long ridges as high as 120 m. Near-bottom currents flow north in the middle of Straits but generally south along the Miami Terrace. The mound morphology varies widely between sites and no obvious (i.e., direct, linear) correlation exists between current strength and mound height. However, a major morphological change is seen in mounds situated in the uni-directional (south or north flowing) flow regime versus those in the bi-directional flow regime. The mounds in the uni-directional flow regime tend to be smaller (5 – 10 m, up to 40 m), aligned perpendicular (Miami Terrace) or oblique (middle of the Straits) to the current, and cover up to 70% of the seafloor. At the slopes of Great Bahama Bank where the current is bi-directional, mounds are up to 120 m high, form large ridges and isolated mounds, and no consistent elongation or alignment of individual mounds to the current direction is discernible. In addition, at this location, the antecedent topography and sediment input from the bank top influence mound location and height. New observational and model data document also that the near-bottom current field in the Straits of Florida is repeatedly perturbed by atmospheric cold fronts none of which is reflected in the cold-water mound morphology. During the observation period of December 2005, a recurring current variability is due to a sequence of deep cyclonic eddies that originate approximately every ten days near Cay Sal Bank and move northward on the eastern side of the Straits. Offshore Bimini the near-bottom eddies intensify and start to move westward. When reaching the Miami Terrace the eddies occupy the entire water column. The timing of the perturbations correlate remarkably well with the passage of atmospheric cold fronts. A probable mechanism for the generation of the near bottom cyclones is the interaction of Florida Current with Cay Sal Bank during these cold-fronts causing near bottom perturbations that intensify with time.

The depositional signature of positive surges in supercritical turbidity currents: experimental suggestions for the origin of vertical transitions in turbidite sandstone beds

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A typical internal vertical organisation is sometimes recognised in ancient deposits of submarine turbidity currents (the “Bouma-sequence”): A massive, badly-sorted division (Ta) is overlain by a fining-upwards laminated division (Tb-e). The lower division has been interpreted as the result of quick deposition from a flow that is carrying a large surplus of sediment over it’s carrying capacity. The upper division is the result of various phases of bed-load transport beneath relatively slow sediment fall-out. The two divisions are commonly separated by a by-pass surface, often coated with a thin coarse-grained veneer and scour features. Experimental reproduction of this full sequence has so far eluded researchers so that the coupling between the fluid mechanics of turbidity currents and the vertical transitions observed in their deposits is still unclear. We present vertical profiles of velocity from supercritical experimental turbidity currents moving down a continuous slope and propose that the transition from the rapid suspension dropout of the Ta division to sediment by-pass and scouring may be linked to the passage of a positive surge, a type of moving hydraulic jump. Flow velocities in the body of turbidity currents are higher than in the head of the flows. Thus, in a Lagrangian framework moving with the speed of the nose of the flow, sediment-laden fluid is translated from the body towards the front and decelerated. The present experiments exhibit an internal hydraulic jump at some distance behind the front where this deceleration takes the flow conditions from supercritical to subcritical. In the Lagrangian frame, the architecture is that of a normal hydraulic jump: fluid passes from a supercritical state upstream, through a hydraulic jump to a subcritical state downstream. This transition will cause the sediment laden fluid to be charged with sediment well above the carrying capacity, resulting in rapid sediment drop-out. However, at any one point that lies in the advancing flow’s path, subcritical flow precedes the passage of the hydraulic jump and is followed by supercritical flow. Therefore, from the point of view of the eventual deposit, rapid sedimentation of a poorly sorted sandstone division precedes the passage of the surge at the back of the head and is followed by a supercritical flow phase in the body that winnows the top of this division, creating the coarse armoured by-pass surface, which is finally overlain by the laminated waning tail deposits.

Evacuated mass wasting architecture in the deep-water Lower Cretaceous Britannia Sandstone Formation (UK North Sea)

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The Lower Cretaceous Britannia Sandstone Formation comprises deepwater sandstones deposited in the Witch Ground Graben, Outer Moray Firth, UK North Sea. The sandstones form a major gas condensate reservoir stratigraphically trapped against the Fladen Ground spur. Although the first-order architecture is a simple north-wards-thinning wedge, the lower part of the reservoir has a high degree of internal heterogeneity. The presence of thick debrites interleaved with or replacing sandstone units suggests that large-scale remobilisation has significantly impacted the sandstone distribution. This paper reconstructs the style, geometry and history of the remobilisation over a 20 km2, densely drilled area of the Britannia Field, focussing on the lower reservoir interval where remobilisation is thought to be prevalent. This part of the study is based on documentation of approximately 2,000 ft (610 m) of high quality core from 11 wells, together with wireline data from an additional 27 wells. Two main phases of remobilisation are recognised, each associated with excision surfaces removing up to 45 m of previously deposited stratigraphy. These surfaces are overlain by debrites that can be an order of magnitude thinner than the inferred excision depths, so that up to 40 m of differential topography was created as a consequence of the remobilisation. Subsequent sandstone intervals are shown to heal this differential topography, giving rise to a simple layer-like, large-scale architecture despite the complex internal remobilisation-induced heterogeneity. Remobilisation has thus affected the sandbody geometry both by removing previously deposited sand intervals and by controlling the thickness distribution of subsequent sandstones. Integration of the model with data from uncored wells shows that spatial variability may in some areas occur on distances smaller than current core-spacing (450 m), diminishing the geometric predictive value of the model in these areas. The fully mixed nature of the debrites is interpreted to indicate efficient transformation of the remobilised mass into a debris flow, controlling the highly evacuated morphology of the failure source. This link between morphology and process is used to characterise the Britannia remobilisation morphotype and place it into existing mass wasting classifications.

Role of facies and dolomitisation in porosity generation in the Dahra Formation Middle/Late Paleocene, western Sirt Basin, Libya

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The Sirt Basin is currently a major target for petroleum exploration and there is much reservoir potential in the Middle / Late Paleocene carbonates. These were deposited on shallow to moderate depth ramps developed upon structural highs, separated by deeper water mudrock facies in basinal depressions. Several major reservoir units occur within the Dahra Formation in the western part of the basin, and porosity appears to be controlled by regional zones of early to late dolomitisation and the pattern of carbonate cycles. Dominant microfacies are: dolo-mudstone, planktonic foraminiferal wackestone, bioclastic wackestone, foraminiferal packstone and bioclastic grainstone. Coarsening-upward, shallowing-upwards and thinning-upwards packages can be recognised in core, with porous zones located chiefly in the shallowest parts of these cycles, which in many cases are associated with zones of dolomitisation. A notable feature is that many of these intervals are characterised by significant concentrations of pyrite and iron minerals with smaller amounts of phosphate and authigenic clays. In some cases, cycles begin with argillaceous limestone and pass up into dolomitised wacke-packstone. Of note is that despite the fact that dolomite-dominated cycles are relatively thin in relation to the limestone dominated-cycles they generally have fair to good porosity even in the mud-supported intervals. The diagenesis has also involved some early dissolution of metastable grains from meteoric influences, but most alteration has taken place during shallow to deep burial. Dolomite occurs as a replacive mineral and a void-filling cement, with the replacement process mainly controlled by original grain mineralogy, rather than grain-size. Dolomite occurs as disseminated cryptocrystalline (few microns) through to coarsely crystalline (250 microns), locally ferroan burial precipitates, precipitated from circulating seawater. Calcite and dolomite cements are responsible for reducing the reservoir quality of the Dahra Formation, but the grain-matrix dissolution, often associated with the dolomitisation, along with fracturing, has led to the development of secondary porosity.

Tectonic implications of deep-marine Miocene strata in the western Andean Cordillera of south-central Chile (40º-42ºSL)

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Deep-marine Mio-Pliocene strata correlative with the Navidad Formation crop out along the forearc of south-central Chile (34º- 41ºSL). These deposits have similar ages as well as akin sedimentary facies and fossil content. However, at Lago Ranco (40ºSL) and Ayacara (42ºSL) there are outcrops of marine strata whose age and correlations with these units remains uncertain. These units, known as the Estratos de Lago Ranco and Ayacara formations, consist of rhythmic successions of sandstone and siltstone representing marine facies similar to those of the Navidad and correlative formations. They both crop out in the western Andean Cordillera near the limit with the Intermediate Depression at Lago Ranco and the submerged equivalent of this physiographic unit at Ayacara. The few studies carried out on these units are mostly internal reports and unpublished theses. In order to unravel the sedimentary environment, age, and tectonic history of this area during the Neogene, we carried out sedimentological, ichnological, and micropaleontological studies. In addition, we dated detrital zircons by U-Pb (LAICPMS and SHRIMP). Our studies show the presence of sedimentary features and ichnofacies typical of deposition in a deep- marine environment for these units. In agreement, benthic foraminifers indicate lower-bathyal depths. The occurrence of the planktic foraminifera Globorotalia siakensis (P22-N9), Globigerinoides quadrilobatus (N6-Recent) and Globigerinoides sikanus (N8-N9) in the Ayacara Formation indicate an early to middle Miocene age for this unit. The biostratigraphic determination is in agreement with the radiometric dating (U-Pb in detrital zircons), which indicates a maximum depositional age of about 20 Myr for these units. Our findings indicate that, in the early to middle Miocene, the area corresponding to the western Main Andean Cordillera in south central Chile experienced major subsidence. This has been attributed to a significant event of subduction erosion that would have removed the underside of the upper continental plate and caused its thinning. The depositional age of the Ayacara and Lago Ranco formations have also important tectonic implications because indicates that the uplift of the western Andean Cordillera at these latitudes took place after the early-middle Miocene.

Accumulation in an obliquely contractional continental borderland: the Neogene Barinas foreland-basin strata of the southeastern foothills of the Venezuelan Andes

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The Barinas-Apure basin, Venezuelan Andes, and Maracaibo basin of western Venezuela comprise part of an active continental borderland. Both significant contraction and dextral strike-slip faulting occurred in Neogene time through this region. Both basins constitute foreland basins with depocenters near the Venezuelan Andes. The Maracaibo basin has been intensively studied. In contrast, this study addresses the less well known early foreland strata of the Barinas-Apure foreland basin. A 1700-m thick stratigraphic section was measured in the Quebrada Parangula near Barinas, Venezuela. This section passes through the Neogene foreland-basin strata and extends from the base of the Parangula Formation, which rests above an angular unconformity on the Eocene Paguey Formation, up to the middle part of the Rio Yuca Formation. The upper contact of the Rio Yuca Formation is not seen in surface sections. Coarse cobble alluvial fan accumulations of the Guanapa Formation unconformably overlie the section. Strata were measured at the sub-meter scale and lithofacies were interpreted on the basis of grain-size distribution, sedimentary structures, and early post-depositional modification structures (e.g., root traces and reduction haloes). Five lithofacies associations were identified: floodplain, crevasse splay and low-sinuosity channel, distal alluvial fan, hypoxic organic-rich tropical lake, and lacustrine fan-delta. Deposition progressed upwards from alternations of crevasse/channel and floodplain facies associations in the ~550-m thick Parangula Formation to alternations of distal alluvial fan and both lacustrine facies associations in more than 1000 m of the Rio Yuca Formation. A companion petrographic study reveals a classic unroofing sequence through the section. Quartz arenites with recycled sedimentary-rock clasts dominate the Parangula Formation. At the formational transition, metamorphic and igneous clasts appear and then eventually dominate clast composition up into the Rio Yuca Formation. Well into the Rio Yuca Formation, feldspars and lithic clasts become prevalent causing sandstones to become lithic arkoses and feldspathic litharenites. Detrital apatite fission-track and magnetostratigraphic sub-studies have been completed. A maximum age of deposition can be approximated after consideration of the lag time between the start of accumulation of fission tracks through exhumation and erosion of the apatite grains. When combined with results from the magnetostratigraphic study, our analysis shows that accumulation of the Parangula Formation began at the study site at approximately 10 Ma (early Late Miocene) and continued until approximately 5 Ma (earliest Pliocene) in the midst of the Rio Yuca Formation. The Parangula-Rio Yuca formational contact occurs at approximately 8 Ma. Average sandstone composition and depositional environments change comtemporaneously near the Parangula-Rio Yuca formational boundary. Elsewhere in the Barinas foothills, this contact shows angular discordance associated with shortening through the foothills region. Shortening on this southeastern flank of the Venezuelan Andes appears coincident with exhumation of the metamorphic and igneous core of the orogen and both increased subsidence and sediment accumulation in this foreland.

Mineral sorting within depositional environments: a detrital petrographic study of alluvial to marine systems in the Kennebec and Penobscot drainages, Maine USA

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A combined light-mineral (LM) and heavy-mineral (HM) petrographic study has been initiated on detrital sands in the Kennebec and Penobscot river drainages in Maine, northeastern USA. The goal of the study is to elucidate patterns of LM and HM compositional variation and to determine whether correlations exist between these variations and depositional environments and their sediment-transport and sediment-sorting potential. ~70 samples from ~40 sites were collected from within the Kennebec drainage downstream to the Gulf of Maine; comparable numbers of samples will be collected in the coming months from the Penobscot drainage. Source rocks are the primarily plutonic and medium- and high-grade metamorphic rocks found between the Maine-Quebec border and the current drainage divide. Low-grade metasedimentary rocks from the low-relief areas to the south of the drainage divide are presumed to contribute minimally to HM diversity. Recycling of Pleistocene glacial till and moraines probably was pervasive in upland regions, but less common closer to the coast where they are generally covered by early post-glacial marine strata. Meter-scale sedimentologic analyses were carried out at sample sites in transgressive and regressive marine sequences, nearshore, beach, delta front, and alluvial systems. Sediment sorting within 1- to 4-m, vertically composite samples is quantified by mechanical sieving and weighing of size fractions. Sorting of grain sizes varies considerably within depositional environments, yet appears to vary more in relation to mean grain size than with depositional environment. At the time of this writing, too few samples have been point-counted to generate statistically significant conclusions. Nevertheless, tentative correlations and interpretations can be made. Diagenetic alteration of detrital grains is negligible; an iron-oxide coating on both HM and LM is common though not pervasive. Some fraction of feldspars show incipient sericitization, though this is interpreted to have occurred prior to transport and deposition. No authigenic or diagenetic minerals have been observed to date. Very fine-grained lithic fragments (volcanic and fine-grained metamorphic) diminish in abundance with increasing distance from the current drainage divide, despite that downstream areas are rich in fine-grained bedrock. In contrast, medium-grained lithic fragments (plutonic and medium-grained metamorphic) maintain nearly constant abundance with increasing transport distance. Consequently, the ratio of Quartz+Potassium feldspar+Plagioclase (QKP) to total grains increases from proximal to more distal depositional sites. The populations of HM are quite diverse, consistent with the diversity of source rocks and the minimal chemical alteration of detrital grains. There appears to be a weak correlation between depositional environment and the ratio of HM to mica plus chlorite. QKP ratios show no appreciable variation over a range of transport distances (all less than 150 km) and depositional environments.

Sequence stratigraphic architecture of Early Pennsylvanian foreland basin deposits in the Appalachian Pocahontas Basin, Southwestern Virginia, USA

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Early Pennsylvanian, coal-bearing, siliciclastic strata of the lower Breathitt Group in the Pocahontas Basin, southwestern Virginia, define a southeasterly thickening clastic wedge that was deposited in continental to marginal marine environments influenced by high-amplitude, relative sea level fluctuations. We interpret the stratigraphic history of the lower Breathitt Group utilizing more than 1200 geophysical well logs, five cores and numerous outcrops. The dataset permits an unprecedented reconstruction of an early Pennsylvanian lithologic record of sedimentation in a foreland basin during the Late Paleozoic Ice Age and allows for an improved understanding of the sequence stratigraphic architecture of siliciclastic strata and >30 intercalated, economically important coal seams. A high-resolution sequence stratigraphic architectural analysis of this succession is based on regional flooding surfaces and bounding discontinuities that can be traced across multiple cross sections. These surfaces allow for a unified stratigraphic model at both basin-wide regional and coal bed methane field-development scales. Parasequence sets are associated in fifteen high-frequency sequences (cyclothems) with predominantly aggradational and progradational stacking patterns. Within sequences, braided-alluvial facies that infill incised valleys define lowstand systems tracts. Overlying estuarine facies comprise transgressive systems tracts whereas fluvio-deltaic parasequence sets comprise highstand systems tracts. High-frequency sequences are stacked into three composite sequences. The stratigraphic succession in the Pocahontas Basin consists, from oldest to youngest, of the Pocahontas, Bottom Creek, Alvy Creek and Grundy formations separated by the Dark Ridge, Hensley and Dave Branch Shale members. The Pocahontas Formation is interpreted as a dominantly non-marine facies assemblage with subordinate fluvio-deltaic facies whereas the Bottom Creek Formation is interpreted as non-marine with increasing estuarine and deltaic facies upwards. The abrupt appearance of diagnostic marine ichnofabrics at the Hensley Shale Member in several cores and in outcrop signifies increasing marine influences through time on the depositional style of the Pocahontas Basin. These ichnofabrics, as well as a decrease in sandstone to mudstone ratio, and increasing facies association rhythmicity, estuarine facies thicknesses, and brackish-marine fossil contents, suggest a gradual widening of the basin during deposition of the Alvy Creek and Grundy Formations. Calculation of net sandstone to mudstone ratios of each formation allows decompaction estimates for basin history backstripping analyses. Semi-quantitative basin history techniques integrate 15 flooding-surface-bounded sequence thicknesses from ten key wells with published geochronologic and regional time scale data to estimate average sequence durations. Sequences average 153 ± 44 ka (2σ), suggesting allocyclic controls within the short eccentricity band of Milankovitch-forced glacio-eustatic cycles common during global icehouse periods. Three asymmetric, 3rd-order composite sequences of approx. 600-800 ka duration are attributed to lower-frequency changes in tectonic accommodation. Within sequences, economically important coal seams are developed at the top of transgressive systems tract deposits related to allocyclic controls, and cap parasequences within highstand system tract deposits related to fluvio-deltaic avulsion.

Lower Carboniferous sandy turbidites of northern margin of Siberian Craton

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The study area is located on the northeast margin of the Siberia Craton. Late Paleozoic sedimentation in this area characteristically shows abrupt transition from carbonate sedimentation in Tournaisian to black cherts and shales in Visean. Typically Visean cherts are up to 50 m thick and overlie Tournaisian limestones with a hiatus at the base. Only in the Krestiakh Cape (Lena River delta) sandy and conglomeratic turbidites are observed up to 250 m thick. Three units have been distinguished on the basis of texture and sedimentary structures throughout of Krestiakh Cape coarse-grained turbidites: Unit 1 is represented by graded beds with total thickness more than 100 m. Thicknesses of individual graded beds vary from 0.8 to 4.5 m. The coarsest portion is composed of pebbles of carbonate rocks, basalts, argillites. The gravel-sized clasts are commonly concentrated at the base of the graded beds, but they may also be randomly distributed throughout some beds. The uppermost portion of the graded beds is formed mainly by coarse- to medium-grained sandstone. Sandstone represents mainly by lithic arenite with predominance of carbonate debris (30-60%) eroded from underlain Silurian, Devonian and lowermost Carboniferous carbonate rock units. Sandstones are poorly sorted, grain-supported and contain less than 10% of muddy matrix. They are interpreted as proximal turbidites, deposited rapidly from suspension by high-density turbidity currents. Unit 2 consists of graded sandstone beds about 90 m thick. Thickness of individual graded beds ranges from 0.3 m to 1.5 m. The sandstone beds are normally graded, with unstratified, very coarse- to coarse-grained sandstone at the base, grading up into fine-grained sandstone and siltstone. The sandstone is characterized by poor to moderate sorting, subangular grains, and low mud matrix content (<10%). Sandstone unit with slump folds (20 m) was observed in the middle part of Unit 2. We interpreted Unit's 2 as turbidites, deposited in the distal part of submarine fan. Unit 3 is the coarsest part of succession up to 45 m thick. The lower part is represented by very coarse to medium-grained sandstones with lenses of conglomerates with measured thickness ranges from 20 – 30 m because of erosion by overlying conglomerate layers. The upper part of bed consists of grain-supported conglomerates up to 15 m thick. This unit is interpreted as the filling of a submarine canyon. The formation of sand-rich submarine fans is usually related to high tectonic activity epochs. Coarse-grained turbidites outcropped along the Krestiakh Cape are represented by coarse-grained sandstone composed mainly of carbonate grains. These compositionally immature strata indicate that distance and time of terrestrial transport were relatively short. The fluvial systems associated with this sand-rich submarine fan probably was characterized by relatively steep gradients and a narrow coastal plain located close to mountains. The source of the sediment was nearby mountain ridge composed of Devonian and lowermost Carboniferous carbonate rocks. Several local uplifts were located in the study area pointing to Early carboniferous tectonic activity in the NE part of the Siberian Craton.

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Tectonic influence on the Early Cretaceous fluvial deposition in the northern part of Priverkhoyansk foreland basin

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The study area is located on the eastern margin of the Siberian craton, in the northern part of the Priverkhoyansk foreland basin. It extends for 1100 km separating the Verkhoyansk fold and thrust belt to the east from the Siberian craton to the west. Folding in the Verkhoyansk fold and thrust belt formed as a result of late Mesozoic collision between the Siberian craton and Kolyma-Omolon superterrane. The main phase of uplift occurred from Valanginian to Late Cretaceous, causing filling of the foreland basin with non-marine sediment. Several thousand meters of sediment accumulated in nonmarine environments from Valanginian to Aptian (Albian?) during the filling in of the Priverkhoyansk foreland basin. This study specifically targets two sections of Lower Cretaceous fluvial strata located on the Chekurovka Cape (key section) and Chucha Cape of the Lena River, NE Siberia. For fluvial deposits the traditional lowstand-transgressive-highstand system tracts nomenclature is replaced with low- and high-accommodation system tracts that reflect changing fluvial accommodation conditions through time. Accordingly, we subdivided the fluvial section by categorizing rocks into two systems tracts, a low-accommodation systems tract characterized by amalgamated channel belts and a high-accommodation systems tract characterized by channel belts dispersed within fine-grained floodplain deposits. Lower accommodation deposits are usually represented by medium to coarse grained white to light grey arcosic sandstones which form a succession of stacked channels. Facies architecture of high-accommodation successions is characterized by well preserved fining-up abandoned channel fills and bars within sandy channel belts dispersed within finer crevasse splay delta deposits, swamp deposits, and well distinguishing lake deposits. Four sequences of the Lower Cretaceous deposits in the Chekurovka Cape were identified. Each of the four sequences identified within the Chekurovka section were also identified within the Chucha Cape section. Although thickness of the individual sequences varies, all sequences and the respective high-accommodation, base of sequence and low- accommodation, top of sequence, systems tracts are recognized and correlated between these two sections. Variations in foreland-basin stratigraphic architecture usually form in response to the relative influences of subsidence & sediment supply. Tectonic subsidence in foreland basins is induced primarily by flexural loading of thrust belts. During thrust belt advancement phases the lithosphere is presumed to be loaded causing the basin to subside rapidly. This model is applied to the Priverkhoyansk foreland basin. Our interpretation is that deposition of the high-accommodation system tracts was driven by high tectonic subsidence rates. This interpretation is based on almost constant thickness of observed sedimentary units, lack of obvious scour surfaces and condensed. An abrupt increase in subsidence at this time most likely is related to pulses of thrusting and increased loading in adjacent fold and thrust belt. Low-accommodation strata is represented by successions of incised valley deposits correspondent to the postorogenic phase with predominant erosion of the advancing thrust and decreasing of the tectonic loading. Evolution of the foreland basin is obviously linked to evolution of the Verkhoynsk fold belt. According to our data, we can infer at least three stages of thrusting during Early Cretaceous in Verkhoyansk fold and thrust belt that induced variations in subsiding rate.

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Study of heterogeneities inside confined turbidite lobes (Eocene-Oligocene Annot Sandstone formation, SE France)

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Turbidite systems have been known for at least two decades to be prolific hydrocarbon reservoirs as technical progress since the late 90's allowed to drill them in deep-water settings. Present mud-rich systems have been the focus of large integrated studies and are well understood now, but sand-rich systems are not so well known. The Annot Sandstone formation that crops out in the SE of France has been commonly considered as an example of good analogue for sand-rich turbidite systems. This siliciclastic formation represents the northward infill by gravity flow deposits of small foreland basins developed parallel to the Alpine Thrust. These tectonically controlled and topographically isolated sub-basins are thought to be fed by proximal fan deltas supplied by Corsica-Sardinia and Maures-Esterel massif during Eocene and Oligocene. They consist in short transit channels, evolving to confined turbidite sand bodies interpreted as depositional lobes (Joseph & Lomas, 2004).This study aims to provide high resolution outcrop descriptions with a particular attention given to small scale sedimentary structures (ca. 0.01 m to 1 m scale). The analysis of various types and geometries of turbidite sedimentary bodies from proximal to distal settings, will allow us to distinguish the interactions between gravity processes and basin morphology. Thus, the main purpose of this study is to describe the heterogeneities (facies changes, grain size, sedimentary features, sediment thickness, etc.) in thick sandstone beds and to provide some interpretation about their transport and depositions process. This work particularly focuses on sand bodies formed by gravity flow deposits in sand-rich lobes, such as in the Mont Tournairet, Lauzanier and Trois-Evêchés areas. On the basis of the hierarchical organisation of turbidite lobes described by Prélat *et al.* (2009), first results show a high complexity in internal architecture in confined settings (channeled /non-channeled lobes) from lobe bed to lobe element scale. This complexity generates heterogeneities including sediment thickness changes (pinching out bodies in onlap areas), facies distribution (traction/fall-out, scours with associated by-pass, freezing and mud-clasts-rich beds). Preliminary results also show frequent interactions between turbidite flows and basin floor, especially on the basin sides where paleoslope is subject to erosion and remobilisation and where flow can undergo significant changes. In more distal settings, whereas sedimentation is dominated by homogeneous and tabular sand bodies (sheet sands and non-channeled lobes), first results revealed similar relative complexity. Indeed, these most distal deposits still showed numerous internal multiple scours, intense dewatering features, granular to coarse grained tail grading as well as freezing and mud-clasts. However, at lobe, lobe bed and lobe element scales amalgamation predominates and sand bodies are more homogeneous.

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Lateral variations inside carbonate turbidite lobes (Middle Jurassic Guwayza Formation, North Oman)

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The middle Jurassic Guwayza Formation (Aalenian- Oxfordian) crops out in thrusted nappes in North Oman and represents one of the remnants of the Tethys paleomargin, lately obducted during the Maastrichtian during the formation of the Samail ophiolitic complex (Cooper, 1989). This formation is mainly composed of calciturbidites (oolitic limestones) alternating with calcareous muddy turbidites, deposited in the distal part of the Hawasina Basin (base-of-slope to basin plain). Sediments arose from the remobilisation of the Mesozoic Arabian Shelf and the deep water submarine turbidite system is thought to have an extension of several 100's of km and a paleobathymetry from 1000 to 3000 m. Previous studies (Guillocheau *et al.* 2003) showed four sequence orders (30 m.y., 1 to 10 m.y., several k.y. and 1 k.y. sequences) controlling its stratigraphic framework and the spatial partitioning of its deposits. At the 1- 10 m.y. scale, two systems were identified: a "mud-rich" and a "sand-rich" system. In the former case, the sedimentation is dominated by heterolitics in which muddy turbidites alternate with microconglomerates interpreted as proximal deposits related to the deep water continuity of small fan deltas. This system is thought to be related to sea level lowstand. In the latter case, the sedimentation is dominated by homolitics made of oolitic grainstones. In this case, the system is related to sea level highstand and maximum productivity of the oolitic barrier. At the top of the Guwayza Formation, a thick (up to 90 m) massive homolitic bed has been studied in detail. High resolution multiple scale outcrop descriptions, from small scale sedimentary structures (ca. 0.01 m to 1 m scale) to architectural elements scale (ca. 10's m. to km scale) allow a better understanding of gravity processes involved in transport and deposition of carbonated particles. Field work was done in two main areas situated in the Hamra ad duru range, corresponding to the distal part of the basin where the sedimentary bodies are interpreted as turbidite lobes. This backstepping massive unit mostly contains coarse to fine grained facies which share very similar characteristics with siliciclastic mass-flow deposits (sandy debris flows) such as dewatering structures, multiple scours, base- flow freezing and mud-clasts layers. The vertical continuity of theses facies underlies the significance of deposition versus by pass. The large scale internal morphology of these deposits consists in very extensive tabular and isopachous layers. Both high spatial continuity of bed thickness and low erosion of genetic units contrast with the amount of coarse grained facies and the volume of sediments involved. This organization demonstrates the major role of margin physiography in turbidite systems. In this specific context, the gentle slope and the unconfined settings of the margin contribute to create a basin floor fan made of sheet like deposits in its distal part. Nonetheless, on a closer examination, lobe beds and elements laterally show important topographic compensation.

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Tectonic/structural control on the development of temperate-water carbonates: Upper Ordovician Lexington Limestone, Central Kentucky, U.S.A.

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The Upper Ordovician (lower Katian; mid-Caradoc) Lexington Limestone of central Kentucky was deposited in the foreland of the Taconian orogeny at about 25° south latitude on the southeastern margin of the Laurentia in a subtropical setting. Yet, despite the warm-water setting, the nearly omnipresent brachiopod-bryozoan assemblage, abundance of phosphorite, abundance of marine-cemented mineralized hardgrounds, and absence of warm-water features, such as a chlorozoan fauna, algal laminites, oolites, and evaporites, indicate that cool- or temperate-water conditions prevailed. Immediately prior to Lexington deposition, the region was characterized by widespread, peritidal deposition of pelletal carbonate muds on the very shallow Blackriver carbonate platform that predominated across east-central United States during Sandbian (early Caradoc) time. The pelletal carbonate muds and a sparse chlorozoan fauna suggest deposition in subtropical conditions, but in moving immediately across the overlying unconformity into the Lexington Limestone, evidence supports abruptly changed conditions. Mapping regional distribution of lower Katian facies coeval with Lexington deposition shows that the Blackriver platform abruptly collapsed along older Keweenawan, Grenvillian, and Iapetan structural trends and differentiated into more localized structural highs like the Lexington and Galena-Trenton platforms and intervening structural lows like the Sebree Trough. This collapse event was coeval with inception of the Taconian tectophase at the New York promontory of Laurentia and probably reflects cratonward movement of largely tensional far-field tectonic forces during early parts of the tectophase. The structural highs acted as foundations for the extensive buildup of temperate-water carbonates that would become the Lexington and equivalent limestones, whereas the intervening lows accumulated dark muds and were sufficiently depressed to make contact with deep open seas to the south. Yet, even while temperate-water carbonates were being deposited on these structural highs, evidence from other parts of the area supports presence of warm surface waters in a subtropical setting. So how can temperate-water fauna and sediments in the Lexington Limestone be accommodated in an apparently subtropical, warm-water setting? The answer most likely reflects the interaction of regional paleoclimate, paleogeography and tectonics. Tectonic collapse of the Blackriver platform created a series of structural highs and the intervening Sebree trough. The trough made contact with deep open seas to the south, which in the existing Laurentian paleogeographic and paleoclimatic setting promoted quasi-estuarine circulation across the region. This circulation funneled deep, cold, mineral-rich waters from seas on the southern margin of Laurentia into structural lows like the Sebree trough between the platforms and generated conditions that forced these waters to upwell onto the platforms, thereby changing the regional subtropical setting so that more localized temperate-water carbonate platforms developed. The presence of upwelling also explains the abundance of phosphorite in the Lexington Limestone and the apparent rapidity with which these temperate-water carbonate buildups developed. Some workers have suggested that glaciation precursory to the latest Ordovician Hirnantian glacial event was responsible for initiating the temperate-water conditions. Although glaciation is an attractive solution for seemingly anomalous temperate-water conditions in low-latitude settings, changes in the tectonic framework, especially in the proper paleogeographic and paleoclimatic settings, may generate similar conditions. Southeastern Laurentia in early Late Ordovician time apparently provided just the right setting for the warm-to-temperate water changes, and may provide a model for understanding similar changes in other low-latitude, foreland settings with coeval orogeny.

Using dark shales to understand orogeny and foreland-basin development in time and space: examples from the Eastern United States and Southern China

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Foreland basins are considered to be flexural responses to deformational loading in an adjacent orogen, and recent work has shown that these basins migrate in space and time, tracking the progress and location of orogeny. It is now also clear that orogenies are not single, long-term events, but are composed of a related series of convergent or collisional events, called tectophases. In some orogens, these tectophases are controlled by convergence with successive continental promontories, so that each tectophase reflects major convergence with a different promontory. Foreland-basin subsidence is a flexural response as the crust attempts to relax loading-related stress from the nearby orogen. Relaxation through subsidence proceeds through a series of stages, each of which has a stratigraphic/sedimentologic response in the foreland basin. The total of these responses produces a third-order, unconformity- bound, regressive sequence, called a tectophase cycle, which may be up to several thousands of meters thick. Each tectophase produces a cycle, so that each orogeny is represented by one or more stacked tectophase cycles in the foreland basin. Most of each cycle is composed of coarser clastic sediments, but the basal part of each cycle consists of a thick unit of organic-rich, marine, dark shale. Because of their distinctive lithology and more radioactive nature, they are easily distinguished in outcrop and in the subsurface (via gamma-ray logs), making their distributions easy to map. Early foreland-basin development is characterized by rapid subsidence with little clastic influx because most early loading is subaqueous. In the resulting, deep, sediment-starved, oxygen-poor conditions, organic matter from the water column is readily preserved. Hence, dark shales typically reflect early, foreland-basin subsidence, and mapping their distribution commonly shows the greatest extent of subsidence. As these basins track the progress of orogenic loading, mapping successive dark-shale units also shows the course of orogeny in time and space and time. Two patterns of foreland-basin dark-shale migration reflect two types of convergence: oblique and orthogonal. Oblique convergence occurs in a scissors-like, diachronous fashion such that convergence progresses parallel to orogen strike in time. In the Paleozoic Appalachian Basin of the eastern United States, most convergence was oblique, so that foreland- basin dark shales not only migrated cratonward, but also parallel to the strike of the orogen. As examples, dark-shale foreland basins, which formed during three tectophases of the Middle Ordovician–Early Silurian Taconian orogeny, migrated progressively northward in time, tracking the northward course of island-arc collision. In contrast, in the Early Devonian–Early Mississippian Acadian orogeny, dark-shale foreland basins not only migrated cratonward, but also from north to south, tracking the southward progress of microcontinent collision with the margin of Laurentia during four tectophases. In orthogonal collisions, plates collide head-on at more or less the same time across the entire orogenic belt. As an example, in the Zhe-Gan- Xiang-Gui foreland basin of south China, dark-shale basins formed and migrated northwestward during the Early Ordovician–Early Silurian Nanhua orogeny that probably marks convergence between Cathaysian and Yangtze plates. Dark-shale basins show mainly cratonward (westward) migration with little along-strike movement. Because of high organic-matter content, foreland-basin dark shales are commonly prospected as potential hydrocarbon source and reservoir rocks. Clearly, they are the products of distinctive tectonic frameworks and histories, but aside from any economic value, their major significance may lie in providing additional controls on the timing, location and development of those tectonic events.

Facies and architectural elements of Missão Velha Formation (Upper Jurassic-Eocretaceous), Araripe Basin, Northeastern Brazil

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The Araripe Basin represents the most complete intracontinental basin of the northeast Brazil. The origin and geological evolution of the Araripe Basin are related to the tectonic events that resulted in the Gondwana Supercontinent breakup, and also to the opening of South Atlantic Ocean. The Araripe Basin involves four main depositional megasequences: (i) Syneclisis sequence, formed by Mauriti Formation represented by large coarse-to-medium fining-upward sandstones; (ii) Rift Initiation to Early Rift Climax sequence of Upper Jurassic age, composed of the Brejo Santo and Missão Velha formations, seen in the horstes and grabens of the two main sub-basins separated by the structural high of Dom Leme: Cariri at East and Serrolândia to the West; (iii) Mid to Late Rift Climax sequence formed solely by Abaiara Formation (Neocomian age) and (iv) Post-Rift sequence, separated into two rift depositional sequences, post-rift I sequence aged Aptian-Albian, constituted by the Rio da Batateira, Crato, Ipubi, Romualdo and Arajara formations; and post-rift II sequence, Albian-Cenomanian age, characterized by alluvial sediments of Exu Formations. This paper focuses on revision of the Missão Velha Formation through detailed facies analysis, architectural elements, depositional systems and palaeocurrent data. The facies were identified in accordance with the predominant lithology, geometry of rock bodies, main sedimentary structures and palaeocurrent pattern. The main facies recognized can be summarized as: (i) coarse-grained feldspathic conglomeratic sandstones (Sc), locally pebbly conglomerates (Gp), with abundant silicified fossil trunks, organized in fining-upward cycles and several large–to-medium trough cross-stratifications and predominantly lenticular geometry; (ii) (St and Sp) lenticular coarse–to-medium arkosic sandstones with some granules, locally pebbly conglomerates, with abundant silicified fossil wood and trunks, arranged in fining-upward cycles; the main sedimentary structures are large–to-medium trough and planar cross-stratifications, cut-and fill and mud drapes at the foreset of cross-strata, (iii) (Sh) poorly sorted medium-grained sandstones with sparse pebbles and with horizontal stratification, (iv) (Sr and Sl) fine to very fine siltic sandstone, well sorted, stratified and laminated, with climbing-ripple cross-lamination, interlayered with (v) (Fl) decimetric pelithic layers with parallel stratification. As a common feature to these facies there is: fining-upward cycles, presence of thin layers, subangular sparse pebbles, truncate cross-strata (diasthems) and stratification well marked. The paleocurrent measurements have to be dispersion pattern to S, SE and SW. Seven architectural elements were recognized: CH: Channels, SB: Sand bars and bed forms, GB: Gravel bars and bed forms, DA: Downstream accretion macroforms, LS: Laminated sand, LA: Lateral accretion and FF: Floodplain fines. Not all of these features were observed at each outcrop. These elements, defined by their geometries and bounding surfaces, form the basis for interpreting depositional environments. The facies and architectural elements described above were interpreted as generated by alluvial systems represented by (i) high energy braided river systems with the following characteristics: fining-upward cycles, trough cross-strata, channelized features, truncate cross-strata (diasthems), presence of sandstone lenticular geometry, channeled sandstones, sparse pebbles and (ii) meandering river systems by the presence of flood plain deposits (claystones and other fine deposits), crevasse splays and point bars deposits. Aeolian sand dunes and sand sheets generated by the reworking of alluvial deposits can be also occur.

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Stratigraphy and sedimentology of the rift initiation to rift climax stages of the Araripe Basin, Northeastern Brazil: new considerations

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The tectonic events that resulted in the Gondwana Supercontinent breakup, and to the opening of South Atlantic Ocean, culminated with the formation of structural depressions and their filling during the Mesozoic. An example of these important changes can be found in the Araripe Basin, in northeast Brazil. This involves four main tectonic sequences, redefined here: (i) Syneclise sequence, formed only by the Mauriti Formation; (ii) Rift Initiation to Early Rift Climax sequence, composed of the Brejo Santo and the basal portion of the Missão Velha formations; (iii) Mid to Late Rift Climax sequence formed by the upper portion of the Missão Velha Formation and Abaiara Formation (Neocomian) and (iv) Post-Rift sequence, separated into two post-rift sequences, post-rift I sequence (Aptian-Albian), constituted by Rio da Batateira, Crato, Ipubi, Romualdo and Arajara formations; and post-rift II sequence (Cenomanian), characterized by the Exu Formation. One of the most significant features of these events is the development of the long and narrow Afro-Brazilian Depression, initiated during the rifting in the Upper Jurassic. The Rift Initiation to Early Rift Climax sequences (Upper Jurassic to Early Cretaceous, Dom João age) comprises the Brejo Santo Formation and the basal portion of the Missão Velha Formation, lying unconformably on the Mauriti Formation. The Brejo Santo Formation is formed by layers of red to brick-red shales and claystones, with decimetric intercalations of fine to medium sandstones and ostracode-rich laminae of argillaceous calcarenites. The basal portion of the Missão Velha Formation displays layers of medium to fine sandstones with small-scale trough and planar cross-stratification, and decimetric heterolithic intercalations with climbing ripples. Dom João age is individualized by the typical ostracofauna of biozone NRT-001 that in the Araripe Basin is characterized by the association of species *Bisulcocypris pricei* and *Darwinula oblonga*, among others. Paleocurrent data show a dispersion pattern to SE and SW. The Mid to Late Rift Climax sequence (Neocomian) involves the upper portion of the Missão Velha Formation (conglomerates and coarse to conglomeratic sandstones) and the Abaiara Formation (shales and siltstones with lenticular fine sandstones with tabular cross-stratification). The Mid to Late Rift Climax sequence shows an intraformacional unconformity on Missão Velha Formation where trough and planar cross-stratified pebbly-conglomerates lies directly by erosional contact on medium to fine stratified sandstones. These conglomerates pass laterally and vertically to amalgamated coarse to conglomeratic sandstones with medium scale trough and planar cross stratification containing abundant silicified fossil wood and trunks of the genus Dadoxilum benderii up to 1.50m long at the top of the Missão Velha Formation. The Abaiara Formation comprises, at the base, reddish to purple laminated silty shales, and variegated well laminated siltstones, with decimetric layers of laterally discontinuous intercalations of lenticular fine sandstones showing planar cross-stratification and laminae of argillaceous carbonates. Towards the top, interlayered with greenish silty shales, meter-scale lenses of coarse to fine quartzose conglomeratic sandstones with silicified wood fragments are observed. The unit culminates with decimeter-to-meter scale fine to medium sandstones, with planar cross-stratification and common convolute structures formed by penecontemporaneous deformation. Paleocurrent data show a broad and wide dispersion pattern. These data indicate that Missão Velha Formation contains an important unconformity interpreted as the start of the Rift Climax stage, instead of the previously postulated start in the Abaiara Formation.

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Extreme climate events revealed by multi-proxy analysis of the Rhone prodeltaic sediments (Gulf of Lions, NW Mediterranean)

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The Rhone is the second largest river in the Mediterranean and is the main sediment source to the shelf of the Gulf of Lions, with about 80% of the total sedimentary input. The retreat path of the river during the last ca. 20 kyr is marked by a pronounced sediment bulge deposited from the shelf break to the present shoreline. The sallow marine deposits formed transgressive parasequences that reveal the pulsed evolution of the post-glacial sea-level rise (Berné *et al.*, 2007). Detailed analysis of the delta plain led Vella *et al.* (2005) to recognize 6 major deltaic lobes, linked to migrating Rhone distributaries. Offshore seismic profiles and piston cores showed that these lobes have been partly preserved in the form of marine prodeltas constituting expanded sedimentary archives of the post-glacial environmental changes because of high sedimentation rate (more than1 cm/yr, on an average). The present study is focused on the modern history of the subaqueous Rhone delta. In particular we focused on the most recent Peygoulier (XVIIIth century) and the Roustan lobes (XXth century, Maillet *et al.*, 2006), belonging to the Grand Rhône system. The core RHS-KS57 located on the prodeltaic lobe Roustan, retrieved during the RHOSOS cruise in September 2008, has been used for multi- proxy analysis, in order to link the changes of marine environmental parameters to climate fluctuations. Chronostratigraphy has been established on the basis of seismic, radiochemistry and ^{14}C dates. In addition, benthic assemblages (ostracods and foraminifera) and organic and inorganic geochemistry were used for characterizing paleoenvironmental changes in order to link those to rapid climate fluctuations. Our work provides a detailed sedimentary history of prodelta lobes during the last four centuries. The imprint of extreme climate events (floods) can be detected on the basis of: - ostracod distribution: the presence of opportunistic species at discrete levels possibly marks the increased nutrients input during significant flood episodes, that are also pointed out by the sudden arrival of fresh- water assemblages; - benthic foraminifera: different assemblages change under the influence of river plume input; - sedimentary facies (small-scale sedimentary structures); - and the geochemical characteristics of deposits (*i.e.* organic matter content *vs* detritic component).

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Secondary dolomitization of carbonates of the Ordovician plateau (vicinity of St. Petersburg, northwestern Russia): new interpretation

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The study area is located in the northern part of the East-European platform to the south of the Baltic (or Scandinavian) Shield and to the north of deep Moscow Basin. Our study specifically targets the Lower to Upper Ordovician carbonate rocks of the Ordovician plateau. The carbonate Ordovician strata are divided into 14 regional stages. Most of them are presented by limestones (clayey mudstones-packstones and grainstones) and only Keila Regional Stage consists of primary sabkha dolomites. Widespread dolomitization of limestones occurs in many outcrops and boreholes and involves rocks on area about 50,000 sq. kilometers. The secondary dolomite is recognized in rocks by its typically zonal and azonal rhombic crystal forms with idiotopic or slightly xenotopic texture. It fills pores, replaces bioclasts or matrix. Distribution of the dolomite is very irregular as in the range of a thin section, a sample, and a whole outcrop or borehole. The dolomite is more commonly dispersed in rocks and does not form isolated bodies. Sometimes the dolomite forms isolated bodies connected with fractures systems and containing minor sulfide mineralization. These bodies occur only in non-porous porcelain-like mudstone of Rakvere Regional Stage, Upper Ordovician. The secondary dolomite is non-stoichiometric, Ca-rich (Ca60-70 Mg40- 30), with admixture of clay minerals, limonite, and rare iron, zinc and lead sulfides. The δ^{13}CPDB values of the dolomite range between -0.3 and 2.2‰, whereas the δ^{18}OPDB values range from -1.9 and -5.4‰. According to Hardie's empiric diagram (1987) of dolomite isotopic composition, samples of the secondary dolomite are similar to hydrothermal dolomite. Samples of the primary dolomite by its isotopic composition are closer to hydrothermal dolomite than to primary sebkha dolomite. Probably, the composition is a result of postsedimentary changes. The geological age of the dolomitization was assumed as Upper Silurian - Devonian by geological setting, but the source of magnesium in the region is still unclear. Previous researchers discussed two main hypotheses of this process. The first one supposes that magnesium solution infiltrated down from brackish lagoons that were widespread in the region in Devonian. However there is no direct relation between the Devonian lagoon deposits and appearance of the dolomitized Ordovician rocks. Moreover, according to our isotopic data the secondary dolomite has a hydrothermal nature. The second model suggests that dolomitization was caused by hydrothermal solutions originated from ultramafic intrusive bodies in the crystalline basement and seeped out upward through fracture systems. But there is no data about volumes of ultramafic rocks in the granite gneiss basement. Our model explains the dolomitization under compaction fluids generated in adjacent area. According to recent researches in adjoining Scandinavia, in Late Silurian and Devonian there was a deep foreland basin in front of the Norwegian Caledonides that covered wide area of the contemporary Baltic Shield. The foreland basin was probably filled by mafic and ultramafic debris derived from eroding ophiolites of Norwegian allochtons. Compaction of magnesium-rich foreland sediments caused extraction of high-magnesium solutions, hot enough to dolomitize carbonate rocks outside of the basin. Fluids migrated through fracture systems and pores in the south direction to the Ordovician Plateau situated at the time between the foreland basin and the Moscow basin and caused the dolomitization of the carbonate rocks there.

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Lateral accretion packages in submarine channels: occurrence, geometry and processes governing their deposition

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Sinuous submarine channels often show bank-attached bar-forms termed Lateral Accretion Packages (LAPs). LAPs are interpreted as the preserved deposits associated with lateral or downstream migration of channel bends. Processes responsible for the formation of these deposits have been a recent topic of enthusiastic debate. We have used geometric properties of LAPs as well as the geometry of associated channel bends to analyze: 1) the fraction of LAPS built from bedload versus suspended sediment deposits; and 2) whether sedimentation was tied to helical flow within the bends or connected to low velocity zones associated with flow separating from the inner banks of bends. We present a detailed geometric analysis of accretion surfaces mapped in the deposits of 12 channel bends from two different channels that are imaged by high resolution seismic data from offshore West Africa. The first channel has an average depth of 40m, average width of 550m and sinuosity of 1.95. Bends in this channel show curvature maxima of 0.08-0.25 degree/m and are separated by straight channel segments that have lengths 1.5-3 times average channel width. The second channel has an average depth of 25m, an average width of 270m and a sinuosity of 2.36. These bends show curvature maxima of 0.12-0.26 degree/m and are connected by straight channel segments that are 2-6 times average channel width in length. Fourteen of seventeen mapped packages are characterized by surfaces that persist from the apex of one bend to the apex of the bend immediately downstream. We will hereafter refer to these as Type 1 bars. Heights of the accretion surfaces were measured where their rollovers are well-imaged. Measured accretion-surface heights are similar to local channel depths. Estimated slopes of these surfaces are 10-14 degrees. Three of the mapped packages show accretions that only span between the bend apex and the point of channel inflection immediately downstream. We will refer to these as Type 2 bars The heights of these accretions are significantly less, only a quarter to two thirds the channel depth. The slopes of these surfaces are 4-7 degrees. We suggest that Type 1 bars are suspension dominated, deposited in low velocity zones created due to flow separation from the inner bank. Physical experiments of turbidity currents passing through sinuous channels show the formation of these low-velocity zones along the inner bank of bends downstream from high-curvature. These zones of low velocity develop due to flow separation. Deposition at these sites is predicted to be dominated by suspension fall-out and relatively starved of coarse sediment, being away from the path traveled by the sediment-rich core. Heights of the Type 1 accretions support this interpretation as suspended sediment is distributed throughout turbidity currents, which have thicknesses that are commonly equal to or greater than channel depth. On the other hand, Type 2 bars show smaller heights indicating that these were probably deposited from lower elevations within the flow and thus are likely to have a richer bedload component. Prevalence of Type 1 bars in this dataset suggests that LAPs in submarine channels are deposited chiefly due to flow separation at the inner bank downstream of high-curvature bends and are primarily suspension-dominated deposits. In both channels the horizontal thicknesses of bar deposits are comparable to channel width; the bar packages are 0.5-1.5 times channel width. This indicates that while these channels have migrated laterally, the extent of this migration is limited. Systematic height changes in accretion surfaces that occur in the cross-channel direction lead us to conclude that these bars developed while the channels were bypassing to weakly incisional.

Three carbonate platform episodes in the Early Aptian of N Spain

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The Lower Aptian sedimentary succession of the Basque-Cantabrian basin in North Spain is relatively complete and continuous. We have correlated a W-E transect along 200 km, from western Cantabria to the eastern Aralar trough in the central Bilbao area. Unlike many other successions in the world typified by one or two carbonate platform episodes, the Basque-Cantabrian succession records a threefold carbonate platform development through the early Aptian: 1-The lowermost carbonate platform is developed in both the western and eastern margins of the basin. It is dated as D. oglanlensis Zone. In the eastern margin it is 20 m thick and consists of micritic coral boundstones (Abrevadero Mb) grading laterally to mound fringing bioclastic calcarenites and further downramp, to marls with orbitolinid limestones and finally, to marls in the deeper areas. The base of this platform is gradational and the top is a sharp erosional surface encompassing a subaerial exposure and a superimposed hardground. In the western part of the basin it forms a calcarenitic unit with several internal palaeokarst surfaces and a drowning surface at top. This first carbonate platform is covered by siltstones and marls with ammonites of the Errenaga Formation in the east. These fine-grained deposits of the weissi, deshayesi and deshayesi-furcata transition Zones record the OAE1a based on isotope geochemistry and TOC analyses. 2- The second carbonate platform is developed in the eastern part and some western parts of the basin and it is dated as deshayesi-furcata transition Zone. It is composed of rudist micrites up to 178 m thick (Sarastarri Fm), with associated shallow calcarenitic trough-filled bodies about 1 km wide. The lower boundary of the platform is gradational and the upper part records two consecutive erosional subaerial exposure surfaces, followed by marls and lutites with ammonites (drowning phase) of the furcata Zone. 3- The third carbonate platform is developed only in the central part of the basin in the Bilbao area. It consists of 200 m of rudist micritic limestones, dated as late furcata Zone (meyendorfi Subzone). The cover sediments are Late Aptian (martini Zone). The lower boundary of this platform is gradational and the top is a palaeokarst surface, overlain by deeper water marls and black shales. This study is relevant as an outcrop reference for coeval Early Aptian carbonate platforms such as the Shuaiba with supergiant oil reservoirs in the Middle East. It also constrains the age of OAE1a based on well- documented ammonite biozones.

Volcano-sedimentary settings: petrology and petrophysic in sandstones hydrocarbon-bearing, Bajo Barreal Formation (Cretaceous), San Jorge Basin, Argentina

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The outcrops of the Bajo Barreal Formation (Middle Cretaceous) extend along the Deseado River (Santa Cruz, Argentina) for several tens of kilometers and are 100 to 200 m thick. The lower section of the Bajo Barreal Formation shows volcano and sedimentary deposits, this section produces heavy and middle oils. The strata strike N160ºE and dip 10º. The lower Bajo Barreal Formation is a continental unit composed by the alternating of middle and coarse sandstones, siltstones, tuffs, volcaniclastic materials and thin lens of basalt. Sandstones and siltstones represent fluvial deposits, permanent rivers and flooplains respectively; while volcanic, volcaniclastic and piroclastic deposits are associated to intra- and extra-basin tectonic activity. The sandstone bodies are mainly thin lens of 0.3-0.5 m thick and less than 10m width but some few sandstone bodies reach 2.5-3 m thick and more than 100 m width. The trough cross stratification, ripples and parallel lamination were recorded in channels and bars deposits. The mudstones are mainly light brownish gray siltstones in tabular to lenticular massive beds, some of these fine deposits are altered and partially reworked tuff falls. The piroclastic deposits are white grayish tabular beds, fining upward with a glassy matrix. Some fractures oriented W-E and 0.2-0.5 m width show piroclastic and volcaniclastic materials as fill. This study allowed understanding and quantifying the quality of oil reservoirs in tuff sandstones from petrographic and field studies in outcrops, cores and cuttings. The high proportion of volcanic rock fragments produced a decreasing in the porosity and permeability, and hence in the reservoir quality. The laying relation among clastic, piroclastic and volcaniclastic materials indicates contemporaneous accumulation of these deposits and a strong effect in the quality of reservoir in the sandstones hydrocarbon-bearing.

Influence of tides and waves on sediment fluxes and dune migration. Example from the Eastern English channel

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The dynamics of marine dunes is mainly controlled by tides and waves. These forcing agents influence the sedimentary seabed at various time-scales. The present study aims to improve the knowledge on dune dynamics, from an example located off the Bay of Somme, on the French side of the Eastern English Channel. Thanks to bathymetric and seismic measurements realised on a 56-year period, dune dynamics seems to be strongly controlled by the decennial variability of storm activity in this area (Ferret *et al.*, accepted). Two oceanographic surveys have been conducted in 2007 and 2008, during 21 and 15 days respectively, to realise current measurements, multibeam bathymetric soundings and sediment samples, in order to collect data to quantify the influence of tides and waves on sediment fluxes and dune dynamics at the scale of processes. The influence of tides on sediment dynamics has been evaluated for the study area. Mobility tresholds (U*cr) of sedimentary particles and friction velocities (U*) have been estimated from grain-size data and current mesurements. Corresponding tidal ranges have been calculated. The results indicate that: (1) sediments are permanently mobilized in the eastern part of the study area (fine sands), (2) flood currents in mean to spring tidal conditions are required in the western part, to mobilize the medium to coarse sands composing the seabed, (3) pebbles, in between dunes, are not mobilized by tides. Calculations of sediment fluxes have been realised in tide- and-wave-combined conditions using a 1DV model (SEDTRANS05) (Neumeier *et al.*, 2008). Two formulations for bedload transport have been tested (Yalin, 1963 and Van Rijn, 1993), since they are widely used by the sedimentologists or adapted to estimate the transport of heterometric gravelly sand sediments. Sensitivity tests have been realised for grain-size, form-roughness (presence or absence of ripples) and wave conditions, parameters that influence strongly sediment dynamics. They have allowed to estimate value ranges for bedload sediment fluxes. Calculations of sediment fluxes put some results forward: (1) residual sediment transport is oriented toward the East, (2) the influence of wind on sediment transport is clear: calculated fluxes in gale conditions (up to 3 m wave height) are about ten times higher than in fair weather conditions. Multibeam bathymetric profiles realised during the periods of current measurements allow to analyse dune dynamics and to quantify the volumes of eroded-deposited sediment at the semi-diurnal and semi-lunar time-scales. These volumes can be compared to sediment fluxes estimated from current measurements in order to determine: (1) the respective influence of tides and waves on short-term dune dynamics, (2) the respective contribution of erosion, deposition and by-pass within the system.

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Sampling and characterization of small-scale cores in laboratory: new methodology applied in a 3D physical experiments

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In sedimentology and stratigraphy, the description of cores of sedimentary deposits is an ordinary method of analysis for industrial and academic purposes. Subsurface sampling of sediments allows us to determine the sedimentological properties of deposits, such as particle size and sorting, type of sediment, fossil content and age, sedimentary structures, depositional and erosional boundaries, and correlative facies, and thus explain the evolution of a depositional system. However, many of these properties are difficult to identify in sedimentary deposits generated by physical modelling. This paper describes a new methodology for the sampling and description of small- scale cores in the laboratory, applied to a river-dominated deltaic system formed in a large 3D T-shaped tank under controlled parameters. First, the method consists of creating a discrete, spatial grid of coring locations that cover the fluvial, deltaic and deep marine parts of the delta. Then, a cylindrical piston is inserted into the deposit at each location, the sediment-filled cylinder is removed, and the holes in the deposit are filled with diluted epoxy resin. The resin penetrates horizontally into the sediment by a few centimetres, the exact distance depending on variations in the local porosity and permeability. Upon drying, rigid cylinders that preserve the textural and structural properties of the deposit are created. The cores are then described visually using a magnifying glass, millimetre ruler and size grading scale. These descriptions are performed from bottom to top along the 360º of the cylinder, thereby identifying and describing sedimentary facies based on grain size grading, sedimentary structures, erosional scours, truncations, etc. This process includes the use of a mathematical code based on elements of technical drawing methods and trigonometry. This new method was applied to 30 cores in scale models of deltas and it showed promising results. It was possible to identify grain-size variations (very fine to medium sand) as well as fining upward trends within the cores. It was also possible to recognise sedimentary structures and architectural elements, such as climbing ripples, channels, and erosive truncations. However, poorly sorted massive layers were dominant. The sedimentological information extracted from the cores matched up well with the observed direction of evolution and dip angle of deltaic lobes. From the core data, it was possible to recognise deltaic parasequences (prodelta, delta front and plain) in vertical profiles, and correlate them with images of dip and strike slices of deposits. In conclusion, the new core sampling method proved to be very useful for describing the internal properties of deposits generated by model simulations in the laboratory. The cores allowed us to identify the main characteristics of the deltaic deposits, and create evolutionary models of the deltaic systems as a whole. A key advantage of this new method is that it is much faster than other methods, such deposit slices, lacquer peel, etc. Also, the use of rigid cylindrical cores enables easy handling, and consequently sedimentological interpretations can be performed carefully and meticulously across all scales of observation, ranging from particle to system scale. The method consist in established points in surface area of the deposit generated (including fluvial, deltaic and deep marine part) creating a spatial discrete grid of cores. After that, an empty cylinder piston is inserted throughout deposit thickness and removing the inside sediments, creating a hole which is filled with diluted epoxy resin. The resin penetrates horizontally a few inches in the sedimentary layers (due to porosity and permeability of the generated deposit) and, after completely dried, a rigid cylinder was created. Each cylinder preserves the internal properties of the deposit layers, with their main characteristics: grain size and structure. The description of the space-oriented sedimentary layers (cylinder core sample) is visual using specific tools as magnifying glass, millimeter ruler and grading scale for better viewing of the grains. The analysis is performed from bottom to top along the 360º of the cylinder, identifying and describing layers, as its size, gradation patterns, structures, erosive surfaces, truncations. Then, these data are inserted (draw) directly into the computer creating a vertical sequence of facies. Additionally, in order to measure the attitude of the layers, it was developed a mathematical code based on elements of technical drawing and trigonometry. The results obtained with the description of 30 cores located all over the deltaic systems shows promising results. It was possible to identify grain size variation (very fine to medium sand) as well as fining up gradation of the cores. It was also recognized some depositional elements and structures such as: climbing ripples, paleochannels, erosive and truncation surfaces. However, the main feature founded was poorly sorted massive layer. The attitude of the layers matched up well with the direction of the evolution of deltaic lobes and the angular dip value observed in the simulated model. From these data it was possible to recognize the vertical profile of some parasequence deltaic systems (prodelta, delta front and plain) and correlate them with images of dip and strike slices of the deposit. The core sampling method proved to be very useful for describe internal properties of the deposits generated by physical simulations. The description of each sample core here allowed identifying the main characteristics of the deposit (properties and process) and created a global evolution model of the deltaic systems. The total time of this technique is key advantage, as it uses tens times less lab-time than other techniques (deposit slices, lacquer peel and so on). Also, the rigid cylinder core enables easily handling; consequently the geological interpretation can be performed carefully and meticulously including all scales of observation, ranging from the particle to the macro-shape scale.

21st century sea-level rise: implications for tropical shallow-water carbonate production

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21st century sea-level rise is projected by the IPCC to be on the order of 0.2 to 0.5 m. Although this projected sea-level rise is relatively small compared to the rises that accompanied Quaternary global deglaciations, it will have the capability to alter shallow-water carbonate factories in significant ways. Atolls and distal barrier reefs will likely experience increased productivity, as incremental increases in water depth may simply provide additional growing space. In contrast, the fringing coral reefs adjacent to populated high islands may be adversely affected, because sea-level rise could compound the problems created by sediment influx from coastal watersheds already altered by human activities. Fringing reefs comprise a significant portion of reef environments in the Caribbean and central and western Pacific, where sedimentation and suspended sediment are leading contributors to reef degradation. Rising sea level in these locations has the potential to reduce reef growth even more and shut down the carbonate factory. Our field observations and modeling in Hawaii show that even small rises in sea level will increase wave energy on depth-limited reef flats and the adjacent coasts. Furthermore, greater water depths may allow for stronger wind-driven currents on reef flats. As sea level rises, these combined factors will increase stresses on the seabed and allow for greater suspended-sediment concentrations on many reef flats. As shown on Molokai, Hawaii, high sediment yield in the watersheds adjacent to fringing coral reefs commonly leads to incomplete bypassing and the accumulation of sediment on the reef flat, typically in thin (2-20 cm) layers that are resuspended daily by waves and currents generated by trade winds. Increasing the stillwater level by 0.2 m to 0.5 m would significantly change nearshore physical processes such that sediment resuspension and turbidity would be exacerbated. Even small increases in sea level in the next decade will lead to enhanced bottom stresses on fringing reef flats; this in turn may lead to an increase in both the duration and magnitude of sediment suspension events. Water depths critical for resuspension will be reached earlier during rising tides and be maintained longer during falling tides, resulting in longer and more intense episodes of elevated turbidity. These processes may limit coral growth and contribute to overall reef degradation through reduced water clarity and reduction of recruitment sites. Additionally, the higher water levels, increased wave energy, and stronger currents will likely result in increased erosion of Holocene coastal plain and fan delta deposits. Many of the reef-protected shorelines are only thin sandy veneers capping older, unconsolidated deposits. Coastal plains and alluvial fans composed of fine-grained sedimentary deposits are commonplace adjacent to healthy reefs areas in Hawaii and many other locations throughout the Pacific and the Caribbean. Waves attacking these coasts for prolonged periods, or at higher stillwater levels, will have an increased potential to erode unconsolidated subaerial coastal deposits in certain areas and increase the abundance of fine particles in the coastal waters, further limiting carbonate production. The impacts to carbonate systems in the 21st century by warming surface waters and decreasing ocean pH are potentially severe. The additional likelihood for increased turbidity and terrigenous sedimentation related to sea-level rise makes it all the more probable that carbonate productivity on fringing coral reefs will be significantly disrupted in the 21st century.

The Upper Cretaceous Ferron Sandstone in southern Utah, USA, as an ancient example of a longshore-deflected deltaic complex

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Facies analysis of the Upper Cretaceous (Turonian) Ferron Sandstone in the western Henry Mountains of south-central Utah, USA, indicates sediment accumulation in a series of flood-dominated, marine current- and wave-influenced, deltas. Twelve lithofacies are recognized: 1. erosionally based, thick cross-bedded sandstone bodies (Distributary Channels), 2. similar though thinner bodies containing common bioturbation (Marine-Influenced Distributary Channels), 3. root- penetrated, plant fossil bearing siltstone with minor sandstone (Coastal Floodplain and Floodbasin), 4. coal and carbonaceous shale (Coastal Mire), 5. thin-bedded, carbonaceous and bioturbated sandstone/siltstone (Coastal Lagoon), 6. erosionally based sandstone with large- and small- scale cross-bedding and bioturbation (Mouth-Bar Complex), 7. sharply based sandstone bodies internally dominated by hummocky cross- stratification, soft-sediment deformation, or lacking structure (Proximal Delta Front), 8. sharply bounded, calcareous, fossiliferous and bioturbated sandstone sheets (Abandoned Delta Lobe), 9. thickly interbedded sandstone, coarse- and fine-grained siltstone (Medial Delta Front), 10. thinly interbedded sandstone, coarse- and fine-grained siltstone (Distal Delta Front), 11. mainly siltstone with minor thin-bedded sandstone (Prodelta) and 12. fine-grained siltstone with bentonite beds (Offshore). Deltas prograded into shallow water, forming mainly sharp-based mouth-bar sand bodies. Mouth bar and delta front sandstone bodies are broad lenses to sheets in the north-south (depositional strike) direction, and many are laterally amalgamated and extensive over distances of several km. The upper delta front was evidently fluidal and prone to failure, leading to the development of rotational slope failures, debris flow filled gullies, and, in places, growth faults. Paleocurrent data indicate that the regional sediment dispersal direction was eastward. Data from delta-front facies, however, suggest that outflow plumes and associated bottom currents were deflected towards the southeast, giving rise to an asymmetric delta planform. The Holocene and modern Burdekin River Delta of NE Australia is considered a close planform, process, and facies analog for the Ferron Notom deltas. The Burdekin Delta facies assemblage is vertically and laterally heterogeneous, despite being the product of a consistent array of environmental controls. Adopting a model that incorporates such a degree of heterogeneity may negate the need for multiple depositional models for complex stratigraphic intervals such as the Ferron Sandstone. The facies model also suggests that deltas showing planform asymmetry may be produced by directional growth of delta lobes, rather than by deflection of beach ridges about the river mouth. Such a model of asymmetric delta lobe growth in the direction of dominant longshore sediment transport may also help to explain the common occurrence of apparently isolated, elongate and broadly shoreline-parallel sandstone bodies, detached from the contemporaneous shoreline by 10s of km, in the Cretaceous of the North American Western Interior Seaway and elsewhere.

Contrasting fluvial styles in syn-rift deposits of the São Sebastião Formation, Tucano Basin (Early Cretaceous, Northeastern Brazil)

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The São Sebastião Formation is the most representative unit of the syn-rift of the Tucano basin (Early Cretaceous, northeastern Brazil). Previous studies of seismic sections revealed that the sin-rift stage is marked by the activity of master faults located on both sides of the basin, as attested by the extensive deposition of alluvial-fan conglomerates at the borders of the more than 7 km thick syn-rift section. The São Sebastião Formation comprises fluvial facies that were deposited on the inner part of the basin at the latest phase of rift activity. The unit is mainly composed of sandstones, siltstones and shales, which are well exposed. Nevertheless, facies and architectural elements analysis of the unit are scarce, and restricted to the southern exposures of the unit, mainly in the Recôncavo basin. The present study shows examples of fluvial deposits of the São Sebastião Formation in the central part of the Tucano basin. The preliminary results revealed two distinct alluvial styles for the the rift stage, respectively interpreted as 1) a meandering fluvial system, characterized by the existence of bar macroforms (downstream or lateral accretion), mud-filled abandoned channels and levee and flood plain deposits; and (2) an ephemeral fluvial system, composed of non-channelized geometries, forming laterally continuous bodies of fine sandstones with plane-parallel lamination, sandstones with climbing ripples and minor trough cross-bedded sandstones with mudstone intra-clasts. The interpretation of fluvial styles with different flow regimes in the same unit may suggest rapid changes in the system, maybe due to climate change, with important implications for the reconstruction of the Early Cretaceous environment during the break-up of the Gondwana continent.

Internal organisation of coarse-grained volcaniclastic conglomerates as a key to megaturbidite emplacement and flow processes

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Megaturbidites are currently defined as thick, laterally-extensive beds emplaced by a single particulate gravity current event that differ lithologically from their host rock (Bouma, 1987). Although they are widely recognised, relatively little is known about their processes of flow and deposit emplacement, except that they are thought to be characterised by multiple particle support mechanisms. Megaturbidites are geologically significant because their occurrence and individual style can be used as chronostratigraphic and seismic markers, they may be indicative of the style of hinterland evolution and they can form hydrocarbon reservoirs. The aim of this presentation is to elucidate the emplacement mechanisms of megaturbidites and the flow processes leading to their deposition via analysis of the internal structure of megaturbidite outcrops from the Miocene Waitemata Basin, New Zealand. Observations and flow process interpretations from this case study are compared with several other examples worldwide, including the Gordo Megabed in South East Spain. They will be compared in terms of grain size, thickness, extent, vertical and lateral structure and flow process. The Waitemata Basin megaturbidites comprise polymict conglomerates hosted within a deep marine turbiditic succession. They contain clasts of basalts; plagiogranites; scoria; sandstones; mudstones and limestones. Six intervals can generally be recognised within a single event bed, occurring in vertical succession. The basal interval comprises a clast-supported conglomerate, in which all clast types are represented with poorly sorted and sub-angular clasts ranging in size from very large pebbles to boulders. The second interval contains large sandstone clasts up to 1.8 m in diameter; these are entrained via substrate injection. The third interval consists of small to medium pebble sized clasts injected between large imbricated mudstone clasts. This interval is clast-supported, moderately sorted and the clasts are sub-rounded to-rounded. The fourth horizon of the conglomerate displays normal grading from granule to medium sandstone. This unit grades into the fifth horizon, a sandstone which is matrix supported and well sorted.This sequence is capped by a sixth interval, a mudstone layer which can vary in thickness from 10-60 cm. There are multiple megaturbidite event beds present in the Waitemata Basin: each is distinctive in terms of their coarse grain size. Deposits of an individual flow event at one site may form from a succession of different flow types and this introduces considerable complexity into classifying the flow event or component types from the deposits.Thus the internal organisation of the conglomerates display features suggesting the deposit emplacement is either by cohesive (debris flow) or non-cohesive (frictional flows, i.e., hyperconcentrated and concentrated density flows or turbidity flows in this case).Cohesive flow deposits generally consist of poorly sorted sediment (>5% gravel with variable sand proportion) and may transport boulder-sized clasts of soft sediment or rock and very large rafts or olistoliths– a characteristic feature of intervals 1 and 2 of the Waitemata megaturbidites. Debris flows typically have a chaotic clast arrangement due to *en masse* deposition, although coarse particles may be concentrated in particular horizons or given a directional fabric as a result of pulsed shearing within the flow body. The imbricated mudstone clasts seen in interval 3 may form in this way, but could also be formed by hyperconcentrated density flows. Granular (frictional) flows transport and segregate large clasts more easily than cohesive flows due to the upward movement of particles not being restrained by a cohesive matrix and therefore large mudstone clasts and rafting are common. This could also explain interval 2 and 3 of the megaturbidite. The upper intervals are interpreted as the deposits of hyperconcentrated and turbidity current flows.

Suspended sediments sizing using a submersible difractometer

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In water bodies, contaminant transport is directly related to suspended sediments, particularly to clays and fine silts. In order to characterize suspended sediment based on their sizes and concentrations, it is necessary to have reliable measurements. The LISST-25X sensor is a diffractometer designed for field and laboratory measurements of Sauter mean diameter of the total suspension (SMDt), Sauter mean diameter of the coarse fraction (SMDg), total suspended sediment concentration (SSCt), concentration of coarse sediments (SSCg), and optical transmission level (TO). The Sauter mean diameter, also known as Surface Area Moment Mean, D (3.2) (Rawle, 2010) or d32, is an estimate of the average size of a particle distribution. The LISST-25X operates in the range of concentrations from 0.10 to 1000 mg/L. It detects average diameters in the range 2.50 - 500 µm and between 63 and 500 µm for the coarse fraction, with TO between 0.30 and 0.95. The operating principles of LISST-25X, can be found in (Agrawal and Mikkelsen, 2). The main objective was to verify the SMDt results obtained with the LISST-25X in laboratory tests on sediment samples from the Salado river, with results of SMD and d50 measured with a Malvern diffractometer for the same samples. Samples within a range of SMDt from 10 µm to 300 µm were analyzed, with the LISST, in the Laboratorio de Química y Ambiente (FICH- UNL): 16 sediment samples were taken from the lower reach of the Salado river (Gallo *et al.*, 2006), 2 samples from the middle reach of the Paraná river, 2 samples consisted of mixtures of sediments and 1 sample comprised calibrated glass microspheres (Whitehouse Scientific). For each analysis, concentrations of 100 mg/L and 200 mg/L were prepared, in 1.35 L of distilled water inside the LISST tests chamber and the measurements were taken every 5 seconds. The granulometric distribution of the samples was determined with a Malvern Mastersizer 2000 diffractometer.

The granulometry results showed that samples can be divided into three groups according to the percentage of fines: 80%, 55% and 20% respectively. A noticeable similarity between the SMD measured by both devices was observed. Agreement between results is satisfactory, particularly for the finest samples, when SMD is less than 12 µm. The minimum registered difference was 0.06 µm and the maximum 11.16 µm, with a CV (variation coefficient) between 0.02 and 0.25. This indicates that LISST-25X can measure the SMDt reliably for the following intervals: 10 µm < SMD < 300 µm and 100 mg/L < SSC < 500 mg/L. A SMDt - d50 correlation was noted, with a determination coefficient R2 = 0.75, represented by the equation: d50 = 4.1774 SMDt. This shows that the LISST-25X can provide, indirectly, additional useful information on the granulometric characteristics of the samples. As regards concentrations, the best results were obtained for 0.60 < TO < 0.80.

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Rheological controls on glaciotectonic deformation of permafrost

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Studies conducted around the margins of modern glaciers and areas occupied by glaciers during the Pleistocene have demonstrated widespread evidence of glaciotectonic deformation and the development of distinctive landforms (i.e. push moraines). However, palaeoglaciological reconstructions that can be made from deformed sediments are constrained by our poor understanding of the variables that control the deformation of materials. In this paper we examine two related dimensions of this problem: how thermal conditions at glacier margins define the rheological behaviour of sediments, and to what extent is permafrost a requirement for the development of strong coupling between a glacier, its bed and the glacier foreland. The environmental context for this study is McMurdo dry valleys where cold-based glaciers rest on thick permafrost. This area affords an opportunity to study the structural evolution of glaciotectonic deformation in an environment where groundwater does not play are role in decreasing the shear strength of sediments. Logging of deformed sediments, together with ground penetrating radar surveys to map sub-surface structures and mapping of glacial landforms have been used to characterize the deformation of permafrost. The data show that the primary deformation structures consist of listric low angle thrusts that have propagated from the ice margin into the frozen foreland of the glacier. Steep reverse faults extend from the thrusts into the overlying sediment and in several locations zones of brecciated frozen sand blocks rest immediately adjacent to undeformed, planar bedded sand. Below the thrusts deformation structures range from gentle drag faults and folds to large recumbent and sheath folds. The hanging wall of the thrusts are characterized by overturned folds which have developed when the leading edge of the steepening thrust rotated back toward the thrust plane. Because all of the thrusts are rooted in layers of ice-rich permafrost it is possible to conclude that the development of thrusting is directly controlled by the rheological properties of the permafrost. In addition, the ice concentration in the permafrost controls the style of deformation: ductile deformation structures are associated with ice-rich permafrost, which is characterized by relatively low shear strength, and brittle deformation is confined to sediment-rich permafrost, which has relatively high shear strength. The data suggests that although thick, deeply frozen permafrost is not very sensitive to disturbance if overridden by cold glaciers, the combination of structural and compositional defects within the permafrost (i.e. layers of ice and ice-rich permafrost), can lead to thrusting and the development of a wide range of ductile and brittle deformation structures adjacent to each other.

Deposition of mud in the Wadden Sea: evidence for the existence of several hydraulic populations comprising sortable silts and a variety of aggregated particle groups

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The interpretation of mud distribution patterns in the Wadden Sea (and probably many other muddy depositional environments) is complicated by the fact that the mud fraction is composed of a variety of particle groups which have different hydraulic properties. Besides "sortable" silts (sensu McCave *et al.*, 1995), which (like sands) are essentially transported as individual mineral particles, there are a variety of "aggregated" particle groups produced by both physico-chemical (e.g. flocs) and biological processes (e.g. faecal pellets). Aggregates are composed of smaller grains held together by weak chemical bondings (e. g. clay minerals) and organic substances. As such, they form ideal substrates for microbial activity which further contributes to the transformation of the aggregates. In addition, seasonal differences in energy flux, water temperatures (kinematic viscosities) and biological activity also strongly influence aggregate size, composition and transport behaviour in the course of a year. Recent research based on in situ size measurements (laser diffraction) and the size analysis of dispersed pump samples has shown that, in the Wadden Sea, sortable silts are predominantly composed of particles >8 µm (<7 phi) in size, whereas aggregates consist of particles <8 µm (>7 phi) in size (Chang *et al.*, 2006). This distinction is also borne out by the fact that organic matter does not correlate with the total mud content but instead with the >7 phi mud fraction (<8 µm fraction). When looking at the distribution of individual mud fractions, then complex distribution patterns are observed which suggest the existence of discrete size populations that respond independently to the hydraulic sorting process. Thus, the particle group comprising sortable silts is composed of two size populations, one consisting of very coarse and coarse silt (4–6 phi), the other of medium silt (6–7 phi). In the aggregated particle group, which consists of particles finer than 8 µm (>7 phi), at least three hydraulic populations can be distinguished, as revealed by the dissimilar distribution patterns of the 7–8, 8–9 and >9 phi size classes. At the present stage of the investigations it is not entirely clear how these discrete size populations are formed. Besides floc formation in the water column, it is hypothesised that the production of faecal pellets (and pseudo-faeces) by different adult and juvenile benthic organisms (especially bivalves and polychaetes) may explain the existence of different types of aggregates composed of a variety of particle size spectra. Different types of aggregates evidently respond very sensitively and individually to the hydraulic sorting processes to produce the observed spatial size segregation involving discrete populations. Mud can therefore not be viewed as a single entity but must instead be regarded as representing a complex mixture of different hydraulic populations, the deposition of which is controlled by complex interactions between the physical energy gradient, flocculation processes in the water column, local production of faecal pellets and pseudo-faeces by benthic organisms, and the hydraulic behaviour of the individual particle groups.

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McCave, I.N., Manighetti, B. and Robinson, S.G. (1995) Sortable silt and fine sediment size/composition slicing: Parameters for palaeocurrent speed and palaeoceanography. Paleoceanography, 10, 593–610.

Depositional architecture and sequence stratigraphy of the Karoo basin floor to shelf edge succession, Laingsburg depocentre, South Africa

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The Laingsburg depocentre of the SW Karoo basin, South Africa preserves well-exposed 1300 m thick succession of late Permian strata that record the early filling of a basin during an icehouse climate. Uniformly fine-grained sandstones were derived from far-field granitic sources, possibly in Patagonia. Coeval staging and delivery systems are not preserved. Early condensed shallow marine deposits are overlain by distal basin plain silt-prone turbidites and volcanic ashes. An order of magnitude increase in siliciclastic input to the basin plain is represented by up to 270 m of silt-prone turbidites (Vischkuil Formation). The upper Vischkuil Formation comprises three depositional sequences, each bounded by a regionally developed zone of soft sediment deformation related to emplacement of major debrites that represent the initiation of a major sand delivery system. The overlying 300 m thick sandy basin floor fan system (Fan A) is divisible into three composite sequences arranged into a basinward stepping-aggradational-landward stepping stacking pattern, followed by 30 m of basin-wide hemipelagic claystone deposition. Interfan A/B is a lobe that lies 10 m beneath Unit B, which is a sandstone-dominated succession that averages 150 m thickness and is interpreted to represent a channelized lobe system around the toe of slope profile position. Unit B and the A/B interfan together comprise 4 depositional sequences in a composite sequence with an overall basinward stepping stacking pattern that is overlain by 30 m of hemipelagic claystone. The overlying 400 m thick mud-dominated slope section (Fort Brown Formation) is characterized by 10 – 120 m thick sand-prone to heterolithic packages separated by 30 – 70 m thick claystone units. On the largest scale the slope stratigraphy is defined by two major cycles. The lower cycle comprises lithostratigraphic units B/C, C and D while the upper cycle includes Units D/E, E and F. In each case a sandy basal composite sequence is represented by an intraslope lobe (Units B/C and D/E). The second composite sequence in each cycle (Unit C and Unit E) is characterized by slope channel-levee complexes with distributive lobes 20-30 km down dip. The uppermost composite sequences in each cycle (Units D and F) are characterised by deeply entrenched slope valley systems. Most composite sequences comprises three sequences. Architectural style is similar at individual sequence scale in comparable positions in each major cycle. The main control on stratigraphic development is interpreted as late icehouse glacio-eustasy but along-strike changes as a function of shelf edge delivery system and variable substrate compaction complicate the resultant stratigraphy.

Cold-water corals and the hydrochemistry of ambient bottom water masses – new insights from the E-Atlantic and the Mediterranean Sea

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Physical and chemical parameters were measured in five different regions of the East Atlantic with known occurrences of cold-water coral reefs and mounds and in the Mediterranean, where these corals form living carpets over existing morphologies. In this study we analyzed 282 bottom water samples regarding δ^{13}CDIC, δ^{18}O, and DIC. The hydrochemical data reveal characteristic patterns and differences for cold-water coral sites with thriving coral communities and ongoing reef and mound growth at the Irish and Norwegian sites. However, the localities in the Mediterranean, the Gulf of Cadiz, and off Mauritania show only patchy coral growth or dead communities on mound-like reliefs and various substrates, as indicated by the hydrochemical data. The analysis of δ^{13}C/δ^{18}O indicates distinct clusters for the different regions and their respective bottom water masses bathing the corals. The analysis of relationships between salinity, temperature, δ^{18}O, and especially between δ^{13}CDIC and DIC shows that DIC is a parameter with high sensitivity to the mixing of bottom water masses. It varies distinctively between sites with living reefs/mounds and sites with restricted patchy growth or dead corals. Results suggest that DIC and δ^{13}CDIC can provide additional insights into the mixing of bottom water masses. Prolific cold-water coral growth forming giant biogenic structures plot into a narrow geochemical window characterized by a variation of δ^{13}CDIC between 0.45 and 0.79 ‰ being associated with the water mass having a density of sigma-theta of 27.5±0.15 kg m-3.

Facies and diagenesis of palustrine and sebkha carbonates: implication for reservoir properties; the Defens and Gineste Formations (Late Jurassic, Provence, SE France)

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The Defens and Gineste Formations deposited on the Upper Jurassic carbonate platform of the Southern Provence Basin (SE France) are constituted by the stacking of numerous shallow water elementary depositional sequences. They often crop out in excellent exposures over more than 50 m laterally. These sequences as a whole express an overall marine flooding over a major unconformity related to a long lasting stratigraphic hiatus (Kimmeridgian?) corresponding to an emersion. Dissolution, fracturation, karstification, and dolomitization of the underlying Vallon de Toulouse Formation emphasized this unconformity. Most sequences are dominated by peritidal facies from palustrine and sebkha environments. The thickness (around 100 m) of these very shallow water carbonates shows that their stacking was controlled by positive accommodation. However, we assumed that facies and diagenetic changes within an elementary depositional sequence resulted from autocyclic evolution of the environmental parameters that drove carbonate production, accumulation and preservation. Most of the diagenetic features originated from marine and meteoric eogenesis and shallow burial mesogenesis (*sensu* Choquette and Pray, 1970). These features are: (i) early lithification of facies related to microbial activity; (ii) well-expressed stratiform dolomitization, affecting preferentially the near-emerged to clearly emerged facies, and also the subtidal facies. Downward pervasive dolomitization is of variable intensity within an elementary sequence and linked to the presence of bioturbation and/or initially permeable granular facies; (iii) meteoric dissolution and cementation expressed as voids, molds, pendant and meniscus cements and microspar cements. Replacive dolomite coupled with meteoric dissolution has improved reservoir properties. Conversely, early meteoric cements and burial cements are responsible for the main part of porosity reduction. Drastic reduction of reservoir properties is likely caused by late blocky calcite during the later exhumation of the carbonate series. Thus, the sedimentary and eogenetic processes are probably responsible for acquisition and preservation of most carbonate reservoir properties. From this point of view, the grainy and bioturbated facies are the most affected by downward seepage dolomitization, thanks to their initial good reservoir properties allowing the diagenetic fluids to pass through. Conversely, sedimentary and eogenetic processes could have sealed poor reservoir properties despite the later beneficial impacts of mesogenesis and telogenesis. As an example, early lithification due to microbial-mediated diagenesis had preserved some facies against the effects of subsequent diagenetic fluids. Moreover, even if suitable dolomite-bearing environments remained during all the time of deposition, dolomitization did not occured necessarily. Two major factors controlled this process: (i) the possibility of dolomite fluids to invade underlying facies and to overprint the early stage of diagenesis such as early lithification; (ii) the ability of the environment to generate brines, mainly the climatic conditions such as precipitation, water circulation and evaporation and the local morphological depositional setting. Finally, reservoir properties in the Defens and Gineste Formations seem to be mainly tied to high-frequency depositional sequences, directly controlled by the environmental conditions.

Choquette, P. W. and Pray L. C. (1970) Geologic nomenclature and classification of porosity in sedimentary carbonates. AAPG Bull., 54, (2): 207-244. Glossary of porosity terms appended.

Biomineralization and diagenesis in red coral: nano to macroscale 3-D architecture of present-day and fossil red coral

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Recent years have seen a growing interest in the biomineralization processes of carbonate sedimentary particles that are largely biologically produced or induced. The most obvious biominerals are those that form skeletons to provide support or protection but biominerals in turn bring information about crystallization of minerals in sediments. Thus, crystals may form abiogenically, organisms may mediate in extracellular crystallization, or mineral matter may be secreted, with protein, as a skeletal material. Deciphering the 3-D architecture of biominerals and the mechanisms of their construction is difficult because ordering is often hidden and difficult to reveal. As a consequence, few biomineral 3D structures are fully resolved. This is true for the morphological and chemical features and even more for crystallographic aspects. Here we describe present-day red coral skeleton, *Corallium rubrum* (Linnaeus, 1758) (Cnidaria; Anthozoa; Octocorallia) and Pleistocene fossil samples collected by F. Kézirian. Red coral is composed of a solid red, mostly inorganic, axial skeleton coated with living tissues. Different techniques have been used to characterize the physical and chemical structure of the red coral calcitic skeleton. A section normal to the axis of the skeleton shows a medullar zone surrounded by a circular domain composed of concentric rings. Growth rings are revealed by the cyclic variation of organic matter (OM) and Mg/Ca ratio. These growth rings are annual; thus, both OM and Mg/Ca ratio can be used to determine the relative age of the red coral colonies. Growth rings display wavelets. The internal structure of each wavelet results from the stacking of layers with tortuous interfaces. Interfaces between layers may display sharp discontinuities indicative of interruption of the mineralizing process. Thus, the red coral acts as an astute crystallographer, assembling its skeleton as a delicate arrangement of a hierarchy of magnesian calcite crystals with well-defined orientations relative to their near and far field neighbors. SEM and TEM studies show that each layer is made of fibers. Fibers are superstructures made of submicrometer units. HRTEM studies show the submicrometer crystalline units made of 2–5 nm nanograins. Submicrometer crystalline units and polycrystalline fibers are both characterized as mesocrystals. The red coral skeleton is thus a hierarchically organized organic-inorganic composite (8 levels of organization) with porosity, structural and compositional order on length scales from the nm to the cm. The red coral fossil samples are stratigraphically dated Pleistocene (ca 2 Ma) and relatively well preserved. The multistructural study of these samples led to evaluate how and to what extent fossilization transformed or erased the microstuctures. These samples lost their red color and we show how intense transformations preserved (or not) some characteristic features related to environmental forcings (growth rings, chemical oscillations, isotopic changes). A comparison of the chemical features (major and trace elements, stable isotopes) and structural features of these samples with the ones of the present day red corals will be presented and show the patterns that were preserved in the fossil red coral and those that were erased. This study contributes to a better understanding of how chemical or physical patterns can be used as proxies of environmental forcings. This study raises the important question of the relative part of biocrystallization and diagenesis in the formation of sedimentary rocks.

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Vielzeuf D., Floquet N., Chatain D., Bonnete F., Ferry D., Garrabou J., Stolper E.M. (2010) Multilevel modular mesocrystalline organization in red coral. American Mineralogist 95, 242- 248.

Three-dimensional alluvial architecture of an exhumed fluvial system: Cerro Barcino Formation (Cretaceous) of the Cañadón Asfalto basin, Patagonia Argentina

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The Albian Cerro Barcino Formation of the Cañadón Asfalto Basin (Argentina) is a fluvial succession deposited during a thermal subsidence stage of the basin evolution. The unit mostly crop out as a near-horizontal succession infilling structural relief crated during a previous rifting stage of Late Jurassic age. The study area is located 50 km SW of Las Plumas locality (Chubut Province), few kilometers northward of Meseta del Curioso. There, exceptional plan-view exposures of large and small-scale fluvial sandbodies allowed characterizing a number of WNW-ESE sinuous ridges that conforms a 2-5 km wide and 13 km long channel-belt that belong to the Las Plumas Member of the Cerro Barcino Formation. Using satellite images, low-sinuosity and high-sinuosity fluvial channels were identified; point-bar deposits, chute channels, pool-riffle patterns and abandoned meandering channels were interpreted. The fieldwork consisted in obtain thickness data of channels and unit bars, characterization of a variety of macroforms and paleoflow measurements. Channels are single (0,3-1,5 m thick) or multi-storey (up to 5,5-6 m thick), their infill is dominated by conglomerates and sandstones with a general fining-upward trend. Conglomerates are composed by well-sorted, acid to intermediate volcanic and tuffaceous clasts. Cut and fill structures are common. Channel fills often contain lenses of burrowed siltstones, suggesting at least important variations in the paleodischarge. Distal floodplain deposits are composed either by massive or laminated, reddish tuffaceous siltstones, frequently deeply burrowed. Lens-shaped or lobate sandbodies up to 0,5 m in thickness and few meters wide encased in tuffaceous fine-grained rocks represent the proximal floodplain deposits. Individual channels are up to 120 m width and can be followed downstream by up to 5 km. A total of 1282 measurements of channel orientations were obtained from satellite images dividing the axes of each mapped channel in straight segments of 100 m long; mean orientation of channels is 285°-105°. Paleocurrent data (n=547) were obtained from cross-bedding, displaying a WNW mean vector (287°). Meandering sandbodies are wider at bends than in crossing, they are characterized by the occurrence of point bars that reflect several episodes of lateral migration. Point-bars of single-channel rivers suggest translation and expansion of meanders during the cross-channel and down-channel migration. Where preserved, consecutive point-bars are separated around 450 m. Chute channel are up to 70 m in width and 350 m in length. Sinuosity of single meandering channels is up to 1.90, obtained from the ratio between the length of the channel and the length of the valley. Low-sinuosity fluvial channels can contain either alternate bars (consecutive alternate bars are separated around 150 m) or braid bars that separate channel-fill deposits (braided channels). Both styles cannot be separated *a priori* from satellite images, and their distinction is based on detailed architectural data of selected low-sinuosity sandbodies. The coeval occurrence of braided, low-sinuosity and meandering fluvial styles in the channel-belt implies temporal or spatial variations in discharge and/or slope conditions. The obtained paleoflow direction of the channel-belt allow inferring that the main depocentre of the Las Plumas Member should be located WNW of the study area; lithological composition of gravel fraction suggests that Jurassic volcanic rocks located 80 km ESE of the studied outcrops probably represent the source area. Although the results of this study are preliminary, the aim of the authors in that once completed the analysis of the data set, the data of physical dimensions, scale, orientation and other geometrical data (e.g. width-thickness ratio) could help to improve the knowledge of the yet poorly explored Cañadón Asfalto basin, whose potential for hydrocarbons has been recognized for long time.

Upper Cretaceous - Paleocene phase of extensional reactivation in the Golfo San Jorge basin (Patagonia, Argentina): paleoearthquakes and fault-growth model during marine and continental sedimentation

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The tectonic evolution of the Golfo San Jorge basin shows a phase of normal faulting reactivation during the Late Cretaceous - Paleocene. This study comprises the description and interpretation of Paleocene soft-sediment deformation structures and normal faults in the north part of Golfo San Jorge basin. Tectonic data include subsurface and outcrop information. The Upper Cretaceous - Paleocene sedimentary record of the basin includes the marine Salamanca Formation (Maastrichtian - Early Paleocene) and the continental Río Chico Formation (Late Paleocene). Both units contain soft-sediment deformation features and evidence of contemporary tectonics, which include: 1) sediment-filled fissures, hosted in muddy marine sediments of the Salamanca Formation ("Fragmentosa" Section), where the sandy infill of the fissures took place from above; 2) synsedimentary normal faults in the uppermost levels of the Salamanca Formation, with vertical throws rarely exceeding 1 m; 3) fault-graded beds in the "Banco Negro Inferior" (marine-continental transition), which show a deformed sequence with small-scale normal faults at the bottom and intraformational breccias on top; and 4) liquefaction pillars, "V" or funnel-shaped, with vertical extension of up to 5 m and preserved into fluvial channels of the Río Chico Formation. Deformed strata are bounded by undisturbed horizons and some of these features can be correlated along 60 km of exposures. The suite of soft-sediment deformation structures is considered a secondary evidence of synsedimentary paleo-earthquakes (seismites). A total of 170 normal faults and 26 extensional/hybrid fractures were measured in the Salamanca Formation. Mesoscopic normal faults (< 1 meter of displacement) are the more common tectonic features. Minor faults often show domino patterns, whereas the greater are mostly planar or lightly listrics. The deformation of the hanging block consists of antithetic fault systems, drag-folds and rollover-folds. Fault-planes and fractures commonly contain gypsum veins 1-3 cm in thickness. Fault planes display slickensides and slickenlines without lateral component (pitch = 90º). The paleostress analysis was realized using mesoscopic tectonic structures, determining NE-SW principal extensional directions ($\sigma 3=49°$). The trending of large-scale (subsurface) and mesoscopic normal faults are not coincident; while the first inherits the orientation of pre-existing structures, the second responds to the Lower Paleocene paleostress-field. Displacement - length ratio of described normal faults are smaller than the theoretical relationship, being considerated as sub-displaced normal faults. In the study area, seismic energy appears to be related to the reactivation (and upward propagation) of Jurassic and Cretaceous normal faults during the Late Cretaceous - Paleocene. Liquefaction structures have been genetically related to seismic events of magnitude larger than 5 (M>5). Conventional tectonic models used to explain the evolution of normal faults suggest simultaneous increases in length and maximum displacement. However, an alternative growth model supposes an early increase in fault length by inheritance of previous faults, mostly applicable to reactivation of normal fault systems (Walsh et al., 2002). The constant fault-length growth model explains these low values of displacement - length ratio when the fault-length is reached earlier by inheritance of previous faults. In addition, empirical relationships between earthquake magnitude and fault rupture area/length allowed to estimate paleoearthquake magnitudes M>5, matching with previous results from soft-sediment deformational structures.

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Early Cretaceous anoxia

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The Early Cretaceous greenhouse world witnessed different episodes of pronounced paleoenvironmental change, which were associated with substantial shifts in the global carbon and phosphorus cycles. They impacted the growth of carbonate platforms on the shelf and lead to the development of widespread anoxic zones in deeper water. A first phase (the "Weissert event") occurred during the Valanginian, which is indicated by a positive shift in the $\delta^{13}C$ record, widespread platform drowning, and evolutionary change. The spreading of anoxic conditions was limited to marginal basins and the positive change in carbon isotopes is linked to the storage of vegetal carbon in coal deposits rather than to organic matter in marine sediments. A second phase (the "Faraoni event") of important environmental change is observed near the end of the Hauterivian, where short and repetitive episodes of anoxia occurred in the Tethyan realm. This phase goes along with a decline in platform growth, but is barely documented in the $\delta^{13}C$ record. A third and most important episode (the "Selli event") took place in the Early Aptian, and resulted in the widespread deposition of organic-rich sediments, a positive $\delta^{13}C$ excursion and the disappearance of Urgonian-type carbonate platforms. Often considered to represent short and singular events, these Early Cretaceous phases are in fact preceded by periods of warming, increased continental weathering, and increased nutrient throughput. These preludes in environmental change are important in that they put the three Early Cretaceous episodes into a longer-term, historic perspective.

Sedimentology of the wetlands in the Mixteque River, Rangel Municipality, Mérida Venezuela

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The wetland system valley bottoms of the Mixteque micro basin is located in the region of the Andes in the Sierra Nevada National Park, southeast of Mucuchíes Mérida Venezuela, and has an area of 7.6 hectares, which represents 5% of the Mixteque micro basin. This study aimed to characterize principal from the standpoint of geomorphological and sedimentological point of view, as well as watershed and wetlands in it, emphasizing in the largest wetland. The methodology used in this study includes: analysis of satellite imagery (Landsat 7 and SPOT 5), morphometric study of the watershed of the Mixteque creek, analysis of sediment grain morphology, extraction and stratigraphic analysis of sediment cores, geophysical analysis using the electrical method and finally a characterization of the fine fraction X-ray diffraction. The use of satellite images showed that high Andean wetlands are very responsive to near-infrared bands, becoming usually red, green and dark brown. The morphometric analysis indicated that the watershed of the creek Mixteque wetlands are in a band that encompasses approximately 100 meters above and below-average height of the basin, while the dominant morphology is between angular and subangular grains. The environment of sedimentation of deposits under consideration, ranging from deposits of proglacial lacustrine deltaic up to proglacial lacustrine bottomsets, existing in some instances, vertically oriented clasts within a sediment wedge, evidence of the existence of permafrost shortly after the deposition. From electrical soundings was obtained broadly distributed deposits, four layers can be distinguished, first, a layer of organic matter, successfully completing more than two meters in the center of the wetland, the second layer gravels of low power, the third, containing dirty sand and may reach a thickness of over one meter, at last saturated clays found in fresh water, in which its thickness was not determined. Finally, the study of the fine fraction of DX, said that the minerals present are the same as are found in fresh rocks that serve as source of inputs, it also failed to recognize large amount of organic matter that ultimately absorbs large quantities water, due to the incipient formation of clays because of the poor typical evolution of inseptisoles soils.

The Fara Formation in the Sultanate of Oman: the upper slope sedimentary record of a carbonate-siliciclastic system in the Late Precambrian

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The Fara Formation crops-out in a limited area in Wadi Bani Awf in a tectonic window in the Oman Mountains. The Fara Formation lies disconformable on the Pre Cambrian Buah Formation and its upper contact forms an angular unconformity with the Middle Permian Khuff Formation. The Buah Formation is present in the Oman Mountains and extensively in the subsurface and outcrops in the South Oman Salt Basin. Sediments of the Buah represent mostly inner ramp facies with restricted evaporitic conditions, meter-size stromatolites and algal-boundstone intraclast conglomerates. Only 11 km west from inner ramp deposits, the Buah Fm in Wadi Bani Awf represents outer ramp deposits that include dark laminated mudstones with phosphatic grains, flow deposits of coarse oolitic grainstones, large slumps and mega breccias of the collapsed ramp. The breccia deposits reflect the increasing local instability in the western ramp as the topography evolved into a platform margin by end of the Nafun Group and beginning of the Ara Group deposition. This instability was driven by volcanic activity as evidenced by the occurrence of tuffs and debris flows that mark the beginning of deposition of the Fara Formation. Three members are distinguished within the Fara Formation. The basal member (FAI) represents a transgressive cycle dominated by dolomites, cherts and tuffs. The base of the member is characterized by dolomitized turbidite packstone deposits and debris flows with thrombolitic boulders and phosphatic clasts that are overlain by finely laminated black cherts. The cherts are interlayered with early dolomitized turbidite flows that display ubiquitous soft sediment deformation. Towards the top of the member, oligomictic mass flow deposits of meter-sized concretions of laminated microbial boundstones indicate low sedimentation rates and downslope transport linked to pulses of platform uplift. The second member (FAII) represents a period of high instability with continuing tectonic uplift, increase in the occurrence of tuffs, platform cannibalization and progradation of clastic sediments. At the base of this member a sequence boundary occurs where laminated shales and tuffs are incised by channelized meter-size boulder breccias, conglomerates and stacked channels of high-density turbiditic sandstones. This clastic sequence represents the first reported occurrence in the Ara Group at 547 M.a., earlier than the age assigned to the Angudan unconformity in the early Paleozoic. As the clastic progradation continued, the amount of carbonate decreased until the system became siliciclastic dominated. By the end of member FAII, water depth reached lower shoreface-tidal conditions with shales and fine grained sands interlayered with tuffs and lapilli layer events. It is in this section where the first reported trace fossils in the Ara occur, indicating more favourable local conditions for colonization around 542 Ma. The uppermost member, FAIII represents a new transgressive cycle with renewed occurrence of cherts and thin stacked fine grained turbidites deposited in outer-shelf upper slope. Overall, the Fara Formation outer-ramp to upper slope sediments appear to reflect the tectonic evolution from a passive margin in Nafun times to a back arc setting that dissected the basin into several depocenters with variable sea floor topography and restricted circulation. Basin morphology in the Fara times could have resembled a gulf with a northwards predominant transport direction. Carbonate sediments were derived from the east and south while clastic sediments indicate a more distal source from a fluvial system to the south or west. Tremors were associated to volcanism and were an important process to source carbonate in the upper slope through liquefaction, slumping and turbiditic flows of laminated microbial sediments.

Microbial structures in dolomites of the Bocaina Formation: a possible evidence of primary dolomite in Neoproterozoic

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Dolomites are common carbonate rocks especially found in Precambrian record and frequently associated with microbial structures, but rarely found forming in modern carbonate environments. Due to the fact of the dolomite could not be precipitated in physic-chemical laboratory experiments, at normal temperatures and pressure of sedimentary environments, the origin of dolomite has been an enigmatic topic of the sedimentary geology knows as "The Dolomite Problem". Several models have been proposed to explain the dolomite formation as secondary rocks, associated to dolomitization of limestone by post-deposition fluid circulation. The discovery of a primary dolomite formation in specific modern sedimentary environments, like sabkhas in Abu Dhabi (UAE) and hypersalines lagoons in Lagoa Vermelha (Brazil) and in Coorong region (Australia), by microbial mediation, opened a new way to understand the dolomite genesis and apply theses modern environments as analogues for the Precambrian dolomites. In these moderns ecosystems is observed the importance of participation of sulfate-reducing bacteria and metanogenesis process in the overcome the thermodynamic and kinetic barriers to dolomite precipitation. The Bocaina Formation (Ediacaran), at the base of the Corumbá Group, outcrops in the SW of Mato Grosso do Sul state (Brazil), near Paraguay and Bolivia boundary. The Corumbá Group occurs over the Rio Apa Block, at south of the Amazon Craton, and represent a south part of the Paraguay Mobile Belt (Brazilian-Pan-African orogenesis). The Bocaina Formation is 30 to 80 meters thick and extends for more than 200 km since the Serra da Bodoquena to Corumbá city. This unit is represented by dolomites with abundant stromatolites, ooids and oncolites, which are evidences of shallow and restrict water environment. The primary sedimentary structures of these dolomites are very well preserved, partiality silicified. Phosphorite rocks are found at the top of this unit and are interpreted as a product of upwelling currents. The occurrence of tepees structures and pseudomorphs of gypsum crystals are evidence of evaporitic conditions during sedimentation of the Bocaina Formation. Petrographic investigations show rhombohedral crystals of dolomite which grew in the boundary of coated grains, demarcated by a thin layer of organic matter. This process was described in the literature as result of microbial degradation of cyanobacteria sheaths, which are naturally enriched with magnesium. The enzymatic proteins breakdown, during organic matter decomposition releases ammonia that promotes elevation of pH and alkalinity levels for the precipitation of dolomites. In portions where sheaths have been totally degraded, it is possible to see dolosparite without microbial origin evidence. Carbon isotopic data of the Bocaina Formation's dolomites, with the evidence of organogenic process, show $\delta^{13}C$ PDB-V positive values, between 0.95 e 3.15‰. This value could indicate metanogenic dolomites due addition of interstitial fluids enriched in ^{13}C isotope present in CO_2 generated by reduction of carbonate during metanogenesis process. The field evidence, petrography, and isotopic data show a clear microbiological contribution to the dolomite of the Bocaina Formation and support interpretation of these dolomites as primary, induced by microbial benthic communities which dominated these Precambrian environments.

Geophysical logging in recent (Cenozoic) and ancient (Devonian – Palaeozoic) carbonate mound systems

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Recent carbonate mounds localized in deeper slope settings on the continental margins clearly play a major role in the dynamics of mixed siliciclastic-carbonate and/or carbonate-dominated continental slopes. During IODP Expedition 307, the 150 m tall Challenger mound in Porcupine Seabight (Belgica mound province, SW of Ireland) was drilled aboard the R/V Joides Resolution. The mound is built from top to bottom of cold- water coral fragments embedded in an alternating biogenic (carbonate-rich) to terrigenous (siliciclastic) matrix (Foubert and Henriet, 2009). This creates a cyclicity which is considered to be driven by glacial- interglacial changes. Magnetostratigraphy and datings show that the mound started to grow between 2.70 and 2.50 Ma. The mounds in the Belgica mound province are surrounded by drift sediments. Geophysical core logging (magnetic susceptibility, natural gamma radiation, gamma- ray attenuation density, P-wave velocity) and geochemical core logging (relative X-ray Fluorescence (XRF) scanning) have shown the potential of these records to correlate different holes within Challenger Mound. Only by a thorough comparison between the different holes it was possible to get a 3D-image of a whole recent mound body. Moreover, the systematically logging of different carbonate mounds along the European continental margins (from northern Norway until the Moroccan margin), makes it possible to compare the signatures of different cold- water coral carbonate mounds in different and distinctive settings. The use of geophysical techniques (such as magnetic susceptibility) might also provide a key to compare signatures in recent and ancient carbonate mounds. During this case study, records of magnetic susceptibility (MS) in ancient (Devonian, Frasnian, Belgium) and recent (Cenozoic, NE Atlantic, SW Ireland) mound systems are compared. In both recent and ancient mounds, magnetic susceptibility values are reflecting the changes in facies. An important observation in recent mounds is that the susceptibility pattern from the mound itself cannot be recognized in the surrounding sediments. The last can be explained by the fact that the mounds record more time than the surrounding sediments. So the record in the mound covers not exactly the same record in the off-mound regions, which make mound systems unique time recorders. On the other hand, extensive carbonate production within the mound habitats could dilute the detrital minerals. In ancient mound systems, the susceptibility pattern in the mound was compared to time lateral equivalent shallow water platform sediments. Also in these records, it appeared that the susceptibility signals within the mound is different than the record off-mound. A clear cyclic pattern of the magnetic susceptibility curve within the mound sediments was recognized in both cases and this cyclic evolution is most probably a proxy for palaeo-environmental changes. Magnetic susceptibility allows relatively good correlations of sections within the same mound and also between different mounds (Foubert and Henriet, 2009; da Silva *et al*., 2009), but are difficult to compare with surrounding drift and/or platform sediments. This fact evidences that carbonate mounds are unique palaeoclimatic archives which are not necessarily preserved in the surrounding sediments.

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The early diagenetic behavior of cold-water carbonate mound in deep environments: imprints of dynamic and open systems

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Sub-recent cold-water carbonate mounds localized in deeper slope settings on the continental margins can not be any longer neglected in the study of carbonate systems. Recent studies emphasize the importance of early diagenesis overprinting the primary environmental record (e.g. aragonite dissolution) (Foubert and Henriet, 2009) in such systems. However, the extent of early diagenetic and biogeochemical processes shaping the petrophysical nature of mounds is until now not yet fully understood. Understanding the functioning of a carbonate mound as biogeochemical reactor triggering early diagenetic processes is necessary for the reliable prediction of potential late diagenetic processes. Early differential diagenesis overprints the primary environmental signals, with extensive coral dissolution and the genesis of small-scaled semi-lithified layers in the Ca-rich intervals in Challenger Mound, drilled during IODP Expedition 307 aboard the R/V Joides Resolution (Foubert and Henriet, 2009). The low cementation rates compared to the extensive dissolution patterns can be explained by an open-system diagenetic model. Moreover, Pirlet *et al.* (2009) emphasizes the occurrence of gypsum and dolomite in another mound system (Mound Perseverance) in Porcupine Seabight, which might be also related with fluid oxidation events in an open system. Along the Moroccan margins, fluid seepage and fluxes in pore water transport affect the development of mound structures, enhancing extensive cold-water coral dissolution and precipitation (Foubert *et al.*, 2008). However, only cold-water coral alteration but no obvious relation between cold-water coral growth and seepage is observed. The early diagenetic processes as observed in Challenger mound and in mounds along the Moroccan margins are compared with other drilled mound structures. Recent carbonate mounds provide indeed an excellent opportunity to study early diagenetic processes in carbonate systems without the complications of burial and/or later meteoric diagenesis. Refining the geochemical signatures of the sediments helps to quantify the effects of early diagenetic processes, which change the geophysical and petrophysical characteristics of a carbonate mound and have an impact on the preservation of primary environmental signals.

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Sedimentology of the ejecta layer from the 1.85 Ga Sudbury impact event: tsunami or base surge deposition?

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At 1850 Ma an extraterrestrial object struck the southern edge of Superior Craton in the area that is now Sudbury, Ontario, Canada, propelling an immense amount of material into the atmosphere. At the time of the collision a sedimentary basin on the edge of Superior Province west of the impact site had undergone a regression leading to subaerial conditions developing in its northern portion, and possibly the entire basin. The ejecta blanket landed in this setting, was possibly reworked by a series of tsunami waves and fifteen million years later was buried by sediment of the transgressing ocean. To date over twenty outcrop and core sections through the layer have been found. It is extremely laterally variable, ranging from totally absent in some sections to tens of meters in thickness in others. Sections within a few hundred meters of one another can be composed of different material with contrasting textures and sedimentary structures. Common components of the deposits are: 1) pebbles to boulders of underlying lithologies, 2) granule- to pebble-sized devitrified glass, 3) 3 to 25 mm accretionary lapilli (here-after termed lapilli), 4) unshocked quartz and feldspar grains, and 5) shocked quartz grains with various planar features including PDFs. The two most typical types of successions are: 1) up to 7 meters thick boulder conglomerates with devitrified glass +- lapilli, and 2) thin (averaging approximately 50 cm) graded sand- to granule-sized material containing embedded lapilli. The thick successions commonly overlie fractured bedrock and typically contain large rotated blocks of the bedrock. Models suggest this area would have experienced an earthquake of approximately magnitude 10, quite capable of producing these effects. The overlying disorganized pebble to boulder conglomerate contains clasts up to 3.5 meters in length that are commonly in matrix support, but in some areas are in clast support. Pebbles of devitrified glass can be mixed throughout the matrix or may appear only in the upper half of the conglomerate. In some areas the conglomerates are organized as a series of stacked lenses that decrease in size upwards with small lenses near the top filled with the first appearance of lapilli. In other areas lapilli are scattered between the disorganized boulders of the massive deposit. Parallel laminated lapilli in clast support or massive lapilli in clast or matrix support can overlie the conglomerate. Rarely approximately one meter of clast-supported, trough cross-stratified lapilli, with possible antidunes overlies the conglomerate. Alternatively, in places it is overlain by a massive layer of devitrified glass pebbles or a thick succession of massive or large-scale cross-stratified sand-sized material. These thicker successions appear to fill depressions. The thinner units overlie intact bedrock, which apparently was swept clean of the earthquake debris. These thinner units commonly show grading, consisting of either: 1) one or more successions that are normally graded from sand and granules, with lapilli, to silt, or 2) are reverse graded then normally graded with the granules and lapilli concentrated in the middle of the tens of centimeters thick unit. Sections in the northern portion of the basin show some evidence of being emplaced by a base surge, whereas the normally graded units in the south may be tsunami deposits. Other sections are equivocal. Further study is required to decipher depositional mechanisms.

Anatomy of an Archean limestone platform: the Steep Rock Group, Canada

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Carbonate platforms capping oceanic islands and plateaus are not uncommon in the modern ocean, but are rare in the Archean rock record. The carbonate assemblage at Steep Rock Lake in northwestern Ontario (Wilks and Nisbet, 1988) is one of the oldest examples of a thick and extensive limestone platform. Up to 500 m of Mesoarchean-Neoarchean (~2800 Ma) limestones overlie 3000 Ma tonalitic gneiss that was eroded by a paleochannel network backfilled with fluvial sandstones and conglomerates (Fralick *et al.*, 2008). The lowest meters of the limestone contain tonalite sand and gravel, but the remainder of the succession is dominantly calcite, with layers of iron carbonate. The limestone has locally been replaced by massive iron carbonate, and is overlain by iron formation. The limestones typically show thin (cm-dm) light-dark grey bands that commonly include fine, fenestral, wavy laminated, and radial crystal fan fabrics, together with thin persistent sheet-cracks, possibly coarse- grained layers, and brown iron carbonate horizons. Some crystal fans were probably the deposits originally described as the supposed fossil Atikokania Walcott. Cryptozoon and digitate stromatolite horizons, 10-30 cm thick, are present in lower-middle parts of the succession. The uppermost ~70 m is dominated by large domes with well-defined regular cm-dm alternations of crystal fans and cuspate fenestral fabric (fenestrate microbialite; Sumner and Grotzinger, 2000). The domes are persistently elongate, suggesting current-influence, and up to 5 m in length, 2 m in width and 1.4 m in height. Inter-dome sediment is usually lacking. Twenty-seven samples from various lithofacies were analyzed for major and trace elements and carbon isotope ratios. Carbon values range from delta 0 to 2.7, consistently being lightest in the columnar stromatolites and heaviest in the crystal fans. Strontium values are highest in the crystal fans. Heavier isotopic ratios could reflect evaporitic loss of light carbon, leading to aragonite crystal fan precipitation. Low strontium contents indicate that the non-crystal fan carbonates were deposited as calcite, except for the columnar stromatolites that are dolomite and may have been deposited as dolomite in the low sulfur Archean ocean. Columnar stromatolites also have the lowest carbon isotope ratio and high concentrations of iron and manganese, suggesting less saline conditions and better connection with the open ocean during their formation. The dominance of calcium carbonate would be consistent with lower levels of ferrous iron in a sub-oxic zone created by photosynthetically released oxygen in shallow water above a chemocline. The emerging picture is of a shallow marine shelf where dominantly aragonite and calcite deposition kept pace with relative sea-level rise throughout platform development. Very shallow depth limited the incursion of iron- and manganese-rich open ocean waters, permitting development of sub-oxic conditions and increased salinity that promoted calcium carbonate precipitation. Platform development terminated as deeper water conditions advanced and iron formation deposition ensued.

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Controls on carbonate deposition in subpolar settings: insights from the Permian System of Australia

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Ancient carbonate rocks that formed in subpolar settings contain critical information about past climate and environment, but have received little study because they are not abundant and typically represent only a minor component of high-latitude sedimentary systems. The marine siliciclastic-dominated Lower-Middle Permian System of Australia includes a spectrum of low volume but well-preserved carbonate deposits that accumulated at palaeolatitudes of ~50 to 70°S during the cold-climate regime of the late Paleozoic ice age. We examined the stratigraphic context, facies, and biota of these limestones to (1) develop criteria for recognition of Paleozoic carbonates with cool/cold-water affinities, and (2) explore the value of such deposits as palaeoenvironmental archives. In general, the carbonate factory may be characterised as a heterozoan association dominated by brachiopods, bryozoans, pelmatozoans, and bivalve mollusks with minor corals and foraminifera. Large benthic foraminifera such as fusulinids typical of coeval warm-temperate palaeoenvironments are absent. Comparison of deposits in Western Australia (WA), Queensland (QLD), New South Wales (NSW), and Tasmania (TAS) reveals significant spatial variations in biotic diversity, which is interpreted to reflect differences in palaeoceanographic setting. Carbonates containing the highest diversity fauna are found in the Perth and Carnarvon Basins of WA, which in Permian time formed a narrow, sediment-starved seaway that opened northward into the Palaeotethys Ocean. In eastern Australia (QLD, NSW, and TAS), sediments accumulated along a 2000-km-long margin that faced the Panthalassan Ocean. Here, carbonates occur as isolated pods that mantled topographic highs in the seaward parts of basins, where siliciclastic input from the craton was minimal. These deposits show strong pole-ward gradients of increasing ice-rafted debris, increasing skeleton size, decreasing invertebrate diversity, decreasing epifaunal calcareous benthic foraminifers, and a reduction in crinoids. These spatial variations are evident in stable isotope data, which suggest significant gradients in temperature and nutrient supply. Across Australia, the predominant depositional motif is deepening upward, with locally cross-bedded grainstones and rudstones giving way to progressively muddier carbonate facies and, ultimately, spiculitic offshore shales. When integrated with the Permian glacial record of Australia, a clear temporal pattern emerges, with carbonates accumulating at the onset of three discrete periods of deglaciation and sea level rise in late Sakmarian, late Artinskian, and Wordian time. The deepening-upward pattern indicates that carbonate factories in these high-latitude settings were unable to keep pace with rising sea level brought about by large-scale deglaciation. The relative scarcity of limestones overall further demonstrates that because of slow growth rates, these high-latitude heterozoan carbonate factories were easily overwhelmed by terrigenous influx and so operated only under specific conditions. Results help to establish a facies model for high-latitude marine carbonate systems of the Palaeozoic and highlight the potential of such deposits as palaeoenvironmental archives in otherwise siliciclastic-dominated settings.

Diagenesis in a cold-water coral mound: pathways, products, and implications

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Modern cold-water coral mounds are increasingly considered as potential analogs for carbonate mound systems that are prevalent in the geologic record. Assessing the potential of cold-water coral mounds as models for ancient counterparts, however, requires knowledge of the full range of biogeochemical processes involved in both the development and preservation of such systems. This study explores pathways and products of diagenesis in Challenger Mound, a giant cold-water coral (*Lophelia pertusa*) mound of Pleistocene age, which lies on the continental slope off southwest Ireland. A comprehensive sampling scheme allowed integration of petrographic data with geochemical analyses of sediment and pore water. Throughout the ~155 metre-high mound, sediments form metre-scale fining-upward cycles of silty coral floatstone-rudstone and bafflestone grading into wackestone. The sediment remains largely unlithified, with rare calcite cement occurring primarily in intraparticle pore space. Whereas calcitic grains appear unaltered, aragonitic grains are microbored, corroded, fragmented, and incorporated into the sediment matrix. Aragonite dissolution is attributed to organic matter oxidation at/near the sediment-water interface and, at greater depths, to the initial stages of bacterially mediated sulphate reduction, when alkalinity production is outpaced by the generation of H+. Pore water profiles indicate that undersaturated waters are diffusing toward the mound interior from two centres of sulphate reduction, one located in the upper 10 m of the sediment column and a second that lies below an erosional unconformity that marks the base of the mound. Continued aragonite dissolution is expected to gradually lower the diagenetic potential of the Challenger Mound and delay lithification until deep burial, when solution-compaction processes come into play. Despite a fundamental role in predestining the final taphonomic and textural characteristics of Challenger Mound, the processes described here are expected to leave little trace in the geologic record due to a lack of early cementation and calcitisation of aragonitic allochems. Assuming that similar processes have been active throughout the Phanerozoic, results imply that the palaeontological record of carbonate mounds may be biased toward calcitic organisms.

Oligocene extension to Miocene contraction in the Aluminé Basin, Neuquén, Argentina

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The accumulation of Upper Oligocene to Upper Miocene basaltic lava flows, pyroclastic fall and flow deposits and sedimentary sequences in the Norpatagonian Andes record extensional and contractional episodes of basin formation related to the orogenic evolution of the Andean chain. The Aluminé Basin is located close to the main Andean cordillera at 39° SL. It is limited to the west and east by N-S blocks involved in the inversion of pre-cenozoic extensional faults. Geochronological (Ar/Ar on plagioclase from basalts), structural and sedimentological data from the volcaniclastic succession that fills the Aluminé Basin provide new information about the stratigraphic evolution of the transition from extensional to contractional basin. The sequence started during the Upper Oligocene (26 Ma) in an extensional regime that produced the space for the accumulation of up to 500 m thick of the Rancahue Formation. This unit can be subdivided in 5 lithofacies: O1 (basaltic lava flows and associated coarse clastic sequences); O2 (lapilly tuffs); O3 (conglomerates with intercalated sandstones); O4 (pebbly sandstones) and O5 (sandstones with channelized conglomerates). The superimposition of these lithofacies indicates a west to east high gradient volcano-sedimentary environment derived from the huge Oligocene volcanic activity at the axis of the cordillera. Block inversion during the Upper Miocene (9.4 Ma) with westward vergence produced the tilting of the Oligocene Sequence and generated a thick skinned piggy back intramontane basin filled by the Chimehuín and the Tipilihuque Formations. These units reached no more than 200 m thick and are composed of 3 main lithofacies: M1 (massive sandstones with intercalated conglomerates); M2 (cross stratified conglomerates and sandstones with reworked pyroclastic sediments) and M3 (basaltic lava flows). The association of these lithofacies indicates an alluvial environment with pyroclastic influence with eastward provenance, drowned by basaltic lavas. Evidence of erosion on the Rancahue Formation and unconformable contact with the upper succession implies a hiatus of ~ 10 Ma between both tectosedimentary units.

New data for the Upper Cretaceous of the Alter do Chão Formation in the central region of the Amazon Basin - Brazil

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The Alter do Chão Formation is a widely distributed clastic stratigraphic unit Cretaceous in age, outcropping in the middle Amazon Basin, overlying the Paleozoic sequence. The lithology of this formation consists of friable clayey sandstone, red, pink and white siltstone and claystone. This formation seems to have been deposited in a fluviatile, deltaic and lacustrine environments from the middle Albian to the Terciary. Rossetti et al. (2006) showed evidence of marine influence for the deposition of this formation. New data of the environmental characteristics of the Alter do Chão Formation are related in this contribution.. In an outcrop of this formation, exposed on the left bank of the Amazon River close to the Meeting of the Waters and to the city of Manaus, three facies associations that represent different sub-environments of deposition occur: a siltstone facies on the base, a very fine laminated sandy facies in the middle and a coarse sandstone facies on the top. The basal, red clayey siltstone on the lower position are silicified, compact and suggests a very slow, constant sedimentation in a still, aqueous environment, probably a lake. The very fine sandstone, that is present only in a limited area of the outcrop, shows very well developed climbing-ripple laminations, emphasized by their difference of color white and red. Assymetrical and rhomboid current ripples occur on the top of this bed attributed to a floodplain environment. The coarse, white-gray sandstone overlying on the red siltstone shows tabular cross bedding at the base that changes to trough stratification on the top. This suggests a deposition of a channel bar in a braided river system as the origin of this sandstone. This sandstone also produced some overload structures in the contact zone with the siltstone. But. a very remarkable and important observation is the occurrence of some trace fossils in the upper part of the silty bed. They are giant burrows, vertical, boot shaped, the largest is 80 cm deep, with a diameter of 28 cm for the round upper section.. The larges one is filled with the same red material of the surrounding rock. The filling of the others, 1 or 2 meters away is coarse sandstone. It is difficult to identify the animals that produced these burrows, it seems they were some species of vertebrates, maybe they could be associated with some Theropoda, whose teeth were investigated by Price (1960) from the some formation, located not very far from the studied outcrop. Our data seems to confirm a fluvial and lacustrine environment during the deposition of the Alter do Chão Formation.

Tropical and subtropical regional wetlands: a neglected depositional system

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Modern wetland environments have attracted much attention in the last decades and have been recognized for their pivotal role in providing wildlife habitats, food web support, various hydrologic functions, and biogeochemical recycling within standing water (i.e., lentic) ecosystems. Five per cent of the Earth's surface is currently occupied by wetlands, and paleowetlands likely occupied a comparable geographic distribution since the Devonian. However, ancient wetland deposits are beset with: (1) significant "wetland" terminology confusion; (2) misidentification issues; (3) simply relegating these deposits as "pond", "palustrine" and "fluvio-lacustrine" in origin; or (4) simply ignoring them. Although the wetland concept is originally ecological, the physical environment that supports these ecosystems is dynamically different as compared to rivers, lakes or coastal environments, in terms of hydrology, geomorphology and sedimentology, with a limited understanding of sediment dynamics and storage. Facies models of coastal, lacustrine and fluvial systems include environments that can be considered wetlands: coastal deltaic and alluvial plains; estuarine supratidal marshes, swamps and mangroves; riverine and flood plain wetlands; palustrine belts surrounding lakes, and peats. Beyond that, sedimentary geology seems to lack robust facies models that explain recent and ancient wetlands, in terms of sedimentary dynamics, processes and products. A type of continental wetland well developed at tropical and subtropical latitudinal belts, characterized regional scale extensions (thousands squared kilometers) in topographically low and plain areas that is herein proposed to be considered as a separate depositional system. Seasonality is the main dynamic control on hydrology, sedimentation, and ecological functions, with a landscape usually characterized by a patchy mosaic of subenvironments composed by ponds, small lakes, channels, sloughs, hummocks of vegetation, waterlogged soils, and inundated plains with herbaceous and tree vegetation (marshes and swamps). Examples of these continental wetlands include the Florida Everglades (U.S.A.), the Pantanal do Matto Grosso (Brazil), and the Las Tablas de Daimiel (Spain). These large depositional lentic systems should have recognizable fossil equivalents, and the Morrison Formation (Upper Jurassic, Colorado, U.S.A.), and La Huérguina Limestone Formation (Upper Barremian, Iberian Ranges, Spain) are herein proposed as records of this type of wetland depositional system. Regional stratigraphic, sedimentologic, paleontologic, and isotopic data from the Morrison Formation indicate that regional groundwater discharge maintained shallow, hydrologically open, well-oxygenated, perennial freshwater carbonate wetlands and lakes during the Late Jurassic despite the semi-arid climate in the western US. Water that originated as precipitation in uplands to the west of the Morrison depositional basin infiltrated shallow regional aquifers that underlay the basin. This regional groundwater system delivered water into the otherwise dry and evaporative continental interior where it discharged to form a freshwater carbonate wetland succession in the distal reaches of the basin. La Huérguina Formation records continental sedimentation in the myriad of small distensive basins into which the Southwestern Iberian Basin (East-Central Spain) was divided by a Lower Cretaceous intracontinental rifting phase. The most prominent feature of La Huérguina is the tremendous variety of facies, mostly carbonate, that record sedimentation in lakes, ponds, limnetic, palustrine and periphyton dominated wetlands, sloughs, ephemeral and permanent channels, or paleosols. The paleogeographic distribution and relationships of the facies resemble a mosaic and match the type of geographical distribution of environments that systems like the Everglades and the Pantanal do Matto Grosso (Brazil) show.

Upper Jurassic-Lower Cretaceous subtropical karstification in the South-western Iberian Ranges, Spain: characterization of the deposits associated to a regional unconformity and their paleoclimatic implications

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The Iberian Ranges are a NW-SE-trending mountain chain that covers an extensive area at the eastern half of the Iberian Peninsula. The ranges were generated by the tectonical inversion of the Iberian Basin, an intracratonic extensional basin formed during the Late Permian - Early Triassic that remained active throughout the Mesozoic until the Alpine Orogeny. During the Upper Jurassic and Lower Cretaceous, the Iberian Basin (placed at the Western Tethys realm) was located at latitude 25-30ºN. The divergent belt of low pressures probably produced warm subtropical seasonal climatic conditions Jurassic sedimentation at the basin consisted mostly of shallow marine carbonate platforms. Those peritethysian platforms started to emerge in the western part of the basin by the beginning of the Malm, and underwent a long-lasting period (*ca*. 30 m.y.) of subtropical karstification before the Cretaceous, although in some areas karstification went on during Lower Cretaceous continental sedimentation and strongly influenced it. The main feature of this karstification was the development of a paleorelief characterized by collapse breccias and small dolines. Some tectonic instability probably induced the remobilization of thick lateritic bauxite deposits formed on the alumino-silicate rocks exposed on the continent during the Jurassic. The bauxite deposits filled the dolines and covered the rest of the Jurassic carbonate platforms generating an important alteration surface characterized by the remobilization of iron ions and the formation of exotic minerals and textures. The studied sediments correspond to well preserved intense red karst bauxites filling three small dolines (200 m diameter and up to 20 m deep) situated along a paleogeographic fault in the central part of the Serranía de Cuenca (Southwestern Iberian Ranges). The deposits show clastic texture and distinct stratification. The episodic deposition is highlighted by well preserved roots in paleosol crusts. The mineralogy of the deposits is characterized by a high content in sedimentary clays (60-85%), relatively low amount of Fe_2O_3 (between 8 and 22%) as goethite and haematite, and the presence (between 8 and 22%) of the aluminium-rich minerals diaspore and bohemite. Carbonate minerals are totally absent in the lower part of the deposit but the calcite content increases rapidly to 58% just a few meters below the base of the overlying Cretaceous limestones. Bauxites are among the best palaeoclimatic indicator rocks, representing tropical, wet climatic conditions (Bardossy and Combes, 1999). Moreover, karst bauxite deposits follow tectonic unstable belts and have particular palaeogeographical significance, since they are usually pericontinental deposits, related to medium to low sea level (Bardossy and Combes, 1999). The studied bauxitic deposits are some of the oldest bauxites that typically developed on the tectonically mobile Tethys belt, since most of the deposits from France, Italy, Hungary, Croatia, Bosnia, Greece and Turkey are of Middle Cretaceous age. The studied deposits provide valuable plaeogeographical and paleoclimatic information on the continental environments developed on the Tethys margins of the Iberian Basin, during a non-subsident long period that otherwise would remain unknown.

Bardossy, G. and Combes, P.-J. (1999) Karst bauxites: interfingering of deposition and palaeoweathering. In: Palaeoweathering, Palaeosurfaces and Related Continental Deposits (Eds. M. Thiry and R. Simon- Coinçon), IAS Spec. Publ., 27, 189-206.

Sedimentary evolution of the neoproterozoic BIF bearing Jacadigo Group, SW-Brazil

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Neoproterozoic iron formations constitute intriguing sedimentary successions. Its reappearance after about 1Ga in the geological record is commonly attributed to great climatic and geotectonic changes at the end of the Proterozoic Eon. The Jacadigo Group is inserted in this context and contains one of the largests sedimentary iron and associated manganese deposits of this period. At the south of Corumbá, Mato Grosso do Sul state, Brazil, there are huge topographic elevations made of the Jacadigo Group's neoproterozoic sedimentary deposits. Those mountains are known as Maciço do Urucum. The basal unit named Urucum Formation is composed by siliciclastic rocks with maximum thickness of 200 to 300 m. The sucession continues with mixed GIF (granular iron formation) and siliciclastic deposits for approximately 100 m, and more 300 m of almost only BIFs (banded iron formations). In the surroundings of Maciço do Urucum there are carbonatic rocks from Corumbá Group, mainly from Bocaina and Tamengo formations. Integrated facies and paleocurrents analysis produced interpretations concerning the tectonic mechanisms responsible for generation of accommodation spaces, sedimentary basin orientation, filling styles and iron formation depositional models. Five depositional systems of the Jacadigo Basin were interpreted: (I) alluvial fan system; (II) lacustrine system; (III) fluvial braided system; (IV) main water body system and (V) rimmed carbonate platform system. Those systems were classified in three tectonic system tracts. The first three depositional systems are made of continental siliciclastics and refer to the rift initiation and early rift climax; the main water body system corresponds to the mid rift climax; and the carbonate platform to the post rift. The post rift is characterized by the rimmed carbonate platform interpreted for Bocaina formation, Corumbá Group, deposits. The spatial distribution of the depositional systems and associated paleocurrent patterns indicated a WNW-ESE orientation to the master fault zone of Jacadigo Basin. This interpretation implies the correlation of Jacadigo Group and Chiquitos-Tucavaca aulacogen instead of Paraguai Belt, as proposed before. The neoproterozoic units distribution at the geotectonic context of Chiquitos-Tucavaca aulacogen and Paraguai belt corroborated the adjacent position of Jacadigo Basin to a triple-junction, supposedly a plume generated uplift. Rocks of Jacadigo Group and Morro do Puga, usually interpreted as glacial deposits, are interpreted here as sedimentation response to tectonics with no necessary relation to glacial processes.

Bio-chemostratigraphy of the Upper Cretaceous shallow-water carbonate units of the “Serra del Montsec” (Pyrenees, Spain)

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The "Serra del Montsec" is an east-west mountain ridge extending for more than 50 km south of the Pyrenees, between the Tremp and the Ager basins. During Late Cretaceous times this area was a shallow and wide platform at the southern margin of the Pyrenean Basin, a gulf extending between the Iberia (Galician off-shore , NW Spain) and European plates (“Bassin de Beauset”, SE France), and opened to the Atlantic ocean (Bay of Biscay). Shallow carbonate and siliciclastic-carbonate platforms developed on both sides of this deep basin. During the Pyrenean-Alpine Orogeny (latest Cretaceous to Oligocene) the carbonate platform and adjoining basinal units were fragmented, detached from their substrate and displaced northwards and southwards along the Pyrenean axis. Reconstructing the position of the ancient margin and the evolution of the related depositional systems through time, as well as correlating shallow-water, mainly carbonate deposits, with their deep-water equivalent is a very complicated task. The biostratigraphy of the shallow water carbonate units is largely based on Larger Foraminifera and rudists. Several biozones can be defined documenting a nearly complete stratigraphic record from Cenomanian to Maastrichtian. However, the chronostratigraphic age of the biozones is poorly constrained. In this work we have studied different localities in a west to east transect across the “Serra del Montsec”. We used Sr-isotope stratigraphy (SIS) to improve the stratigraphic resolution and chronostratigraphic dating. Whenever possible, we analysed samples from stratigraphic levels located at the base, in the middle part and at the top of each formation. Our database consists of over 100 low-Mg calcite fossil shells (mainly rudists, some brachiopods, a few ostreids and unidentified bivalve fragments). We analysed also some matrix and cement samples in order to gain insight on the diagenetic path. Multiple subsamples have been collected from each stratigraphic level in order to test the internal consistency of data. Accurate cleaning techniques were applied as well as a whole suite of petrographical and geochemical analyses in order to select the best preserved samples. The numerical ages obtained with SIS allowed us to constrain the chronostratigraphic age of the Upper Cretaceous lithostratigraphic units of the “Serra del Montsec” and to produce an integrated bio-chemostratigraphic scheme for the ranges of larger Foraminifera and rudist assemblages.

Microbial mound facies, diagenesis and reservoir properties: an example from the Triassic of Sicily (Italy)

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The upper Triassic sequence of the Hyblean foreland (SE Sicily island, Italy) represents a petroleum system proven efficient in the Mila and Irminio oil Fields. The thick dolomitic peritidal platform (Sciacca Formation) underwent an extensional phase that produced two main areas: a persistent carbonate platform, characterized by euxinic lagoons (Noto Formation, the main source rock) to the north and a deep euxinic intraplatform basin to the south (Streppenosa Formation, the secondary source rock). On the tectonically controlled platform margin, a complex sedimentary association was observed in the production and explorative well cores of the area. Seismic interpretation and well data indicate that microbial mounds (Mila Member of Noto Formation) grew on a NE-SW oriented ridge that separated the restricted euxinic lagoon facies of Noto Formation from the slope and euxinic basin deposits of Streppenosa Formation. Mila Member coalescent mounds are made of laminar and small columnar stromatolites, microbialitic laminae, mudstones with ostracods, peloidal packstones and associated carbonate breccias. The reservoir properties of the Mila Member are improved by hydrothermal dolomitization that is locally present in the area. Brecciation, zebra structures, saddle dolomite cements and intercrystalline porosity characterizes the dolomite reservoir. Stable isotopes indicate the influence of organic carbon during diagenesis and dolomitization ($\Delta^{13}C$ PDB in microbialites around -10 ‰, in dolomites around -7 ‰). The fluid inclusion microthermometry of the dolomite cements points to homogenization temperature of about 70-90 °C and two populations of salinity ranges which suggest a mixing of two main fluids: one of low salinity (from sea water to 7%) probably the formation fluids, and the saline brine (up to 20% wt NaCl), probably expelled from the Streppenosa shales. The Ramam analysis detected the presence of hydrocarbons entrapped during the growth ot the dolomite crystals. The study demonstrates that the hydrothermal dolomitization and karst improve considerably the reservoir characteristics of microbial mounds.

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Variations on heavy mineral indexes (RZi and THi) in a tropical fluvial system: the Ribeira de Iguape river case, Southeastern Brazil

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The heavy minerals analysis (HMA) has been applied to the determination of sedimentary provenance of sands and sandstones. The advantages of the HMA include the great variety of heavy minerals (>2.85 g/cm3) and their ubiquitous occurrence in sandy sediments. The application of the HMA to provenance studies supposes that heavy mineral suites have specific parent rocks. However, the heavy mineral assemblages within sediments are not controlled only by the mineralogy of source rocks. Processes acting during the transport of sediments, such as hydraulic sorting and mechanical abrasion, as well as weathering or diagenetic dissolution can also change the heavy minerals suites. Heavy mineral indexes based on pairs of minerals with similar density and shape and similar physical and chemical stabilities, such as rutile and zircon, have been used to highlight aspects of provenance. But, few studies address the relationship between the variations of these indexes in active depositional systems with known sources of sediments. The objective of this research is to evaluate changes in heavy mineral indexes measured in fluvial sands from known source rocks. For this, 32 samples of channel sands were collected in a portion of the Ribeira de Iguape river (southeastern Brazil). Transparent and non-micaceous heavy mineral grains in the fine sand fraction were identified and counted through a cross-polarized microscope. The heavy mineral indexes RZi (rutile/(rutile + zircon)) and THi (tourmaline/(tourmaline+hornblende) were determined through the counting of 100 grains. The THi comprises minerals with similar hydraulic features, but with different physical and chemical stability. Thus, it was used to assess the relative importance of sediment transport on heavy minerals while the RZi is supposed to be more dependent of provenance. The Ribeira de Iguape river drains an area formed by a great variety of metamorphic (greenschist to granulite facies) and granitic igneous rocks. It is one of the largest river to flow into the southeastern Brazilian coast, being an important source of sediments for the coastal depositional systems. The studied sector of the river presents meandering morphology and orientation of the main channel varying from NE-SW to NW-SW. The most abundant heavy minerals found in the studied samples were epidote, staurolite, garnet, zircon, apatite, hornblende, sillimanite, apatite and rutilo. The RZi ranges from 8 to 28% while the THi varies between 23 and 83%. The THi increases downstream, indicating the concentration of tourmaline in relation to hornblende. Then, we can interpret significant influence of the sediment transport on the THi. Despite it is not suitable for provenance purposes, the THi can be used as an indicator of sedimentary reworking. The absence of correlation between changes in the source rocks along the river and the RZi suggests homogenization of the fluvial sediments. This pattern also indicates little influence of the sediment transport on the RZi. The range in the RZi observed in the Ribeira de Iguape river sands fits with values obtained in high reworked coastal sediments (RZi from 10 to 46%) present at the river mouth (the Ilha Comprida barrier). Thus, the RZi could be employed as a fingerprint of the Ribeira de Iguape river sediments. Rutile is most common in high temperature and high pressure metamorphic rocks, such as amphibolites and granulites, while zircon is widespread in many metamorphic (as inherited grains) and acid igneous rocks. Therefore, the variation of RZi could represent the relative contribution of high grade metamorphic rocks as a source of sediments. The THi and RZi can be used to respectively describe sedimentary reworking and provenance. Both indexes could be used as a proxy in sandy sediments as well as to discriminate sandy sediments with similar sedimentary facies, especially when age datings or fossils are not available.

Comparison between sedimentation models in two warm climate eolian sand sheets: The modern Las Salinas (W Argentina) and ancient Marília and Adamantina formations (Late Cretaceous, SE Brazil)

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An eolian sand sheet is characterized by flat or gently-undulating sandy surface that lacks dunes with slip-faces; it is common in arid and semi- arid areas in both hot and cold climates. The inhibition of dune formation can be influenced by vegetation, high ground-water level, coarse- grained sediments, armoured or cemented surfaces, and a scarce supply and availability of sediments. The morpho-depositional surface of an eolian sand sheet can either be stable and subject to pedogenic or unstable such that it is affected by deflation or sedimentation process. In order to evaluate and compare the models of sedimentation in the two analyzed areas, the first question that arose was why in the ancient case study the paleosols represent more than 66% of the thickness of the geological record and in the modern case the evidences of pedogenesis are lacking? To answer this question, a model based on phases of stability and instability of the morpho-depositional surface is proposed. The Las Salinas sand sheet is a flat area located near the city of San Juan, W Argentina. The climate is characterized by a mean annual temperature of 18ºC, a mean monthly precipitation of ~160 mm, and a mean monthly wind speed of 4 m/s. The topographic surface is covered by scarce xerophytic vegetation, which does not inhibit the transport and deposition of sand. The Las Salinas sand sheet is formed in a retroarc basin, characterized by high subsidence rates, which is located in the foot of the uplifting Pie de Palo Complex. The exposed sedimentary succession is 5 m thick, and it is characterized by very fine- to medium-grained sand with thin interbedding of muds. Wind ripple and megaripple bedforms are extensively distributed on topographic surface, and they can form small coppice dunes on the downwind side of brushes. The sedimentary succession reflects types and distribution of the observed lithofacies on the topographic surface, then suggesting the same succession of depositional mechanisms. The Late Cretaceous succession is composed of fine- to medium-grained sandstone and secondarily of mudstone and conglomerate. The succession, ca 220 m thick, was formed during the Late Cretaceous in an intracratonic basin, whose accommodation space is due to thermal and lithostatic subsidence. The sedimentary succession is constituted of an interbedding of paleosols and deposits. The deposits are formed by climbing wind-rippled stratifications interbedded with thin strata of mudstone. The paleosols constitute 66% of the succession, and were classified into four orders: Aridisols, Alfisols, Vertisols, and Entisols, with the first predominant. The Aridisols are characterized by well developed Bt, Btk, Bk and Bkm horizons; they suggest semi-arid climate conditions, and stability of the topographic surface for a time >>103y. The Late Cretaceous succession points out alternating phases of stability of the eolian sand sheet in semi-arid climate with consequent pedogenesis and instability in arid climate with eolian erosion and sedimentation. The Las Salinas area is in evident phase of instability. Any trace of soil development was observed either on topographic surface or in the sedimentary succession. The precipitation rates are similar to those calculated from the Aridisols of the Late Cretaceous succession, and the vegetation cover and animal burrows testify a rich biological community on Las Salinas surface. The main conclusion that can be draw is that possibly three factors effectively controlled the different models of sedimentation in these two studied areas: climate, availability of sediment, and accommodation space. The climate results to be the major controlling factor when the other factors are low, whereas when the availability of sediment and accommodation space is high, the climate results to play a secondary role.

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Mineralogical distinctions between Bt and Bk Aridisol horizons developed on eolian sand sheet deposits (Marília Formation, Late Cretaceous, Brazil)

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In the eolian sand sheet succession of the Late Cretaceous Marília Formation, SE Brazil, four paleosol orders were identified: Aridisols, Alfisols, Vertisols, and Entisols. The Aridisols are the most frequent paleosol order, representing more than 84% of the studied profiles. They form profiles 0.3 to 7 m thick, whose complete sequence of horizons includes A/Bt/Btk/Bk/C(or Ck). The aim of this study is the mineralogical characterization of the Aridisols and the distinction between whole-rock samples and clay minerals that occurs in Bt and Bk horizons. The mineralogy of horizons was determined by X-ray powder diffraction (XRD), for whole and oriented samples. Oriented samples of <2 µm fraction were carried out to identify clay minerals. For each sample (glass mounting), three x-ray diffractograms were obtained, following the sequence: 1) Air-dried, 2) ethylene glycol-solvated, and 3) heating at 550ºC. Petrographical analyses of six samples from parent material showed that it is a sublitharenite composed of monocrystalline quartz (76.1%), basalt fragments (13.7%), polycrystalline quartz (3.7%), opaque minerals (2.5%), fragments of calcareous nodules eroded from previous paleosols (1.5%), feldspars (1%), and metamorphic fragments (1.5%). X-ray patterns of 10 samples from parent material showed that the main minerals are quartz, calcite, dolomite, feldspar, and hematite, and the clay minerals are principally mica, followed by smectite and small proportions of palygorskite. The mineralogy of Bt horizons is composed of quartz, feldspar, calcite, dolomite, and hematite, and the main clay mineral is smectite, whereas Bk horizons show the mineral assemblage composed of quartz, dolomite, calcite, feldspar, and hematite, in which the palygorskite is the main clay mineral. Mica is only recognized in trace amounts in Bt horizons. The association of palygorskite and smectite is very common in soil horizons of semi-arid and arid environments, because these clay minerals have similar stability fields. The significant increase of palygorskite in Bk horizons when compared to it is small proportions in parent material can be related to it is pedogenic formation through neoformation or transformation of 2:1 minerals. The transformation of 2:1 clay minerals mainly mica and smectite to palygorskite in solutions high in Si and Mg and low in Al and K is a possible mechanism to explain its origin by non-inheritance processes. The presence of calcite in these horizons would favor in situ formation from soil solution. The smectite in Bt horizons is believed to be formed from 1) neoformation of soil solution, and 2) transformation of other clay minerals. The increased in soil-available moisture in these horizons, leading to a relatively more leaching environment for the release of K from micaceous minerals, in the calcareous environment characterized by high pH, high Mg content and high Si mobility might provided favorable conditions for the formation of smectite trough transformation. The presence of interstratified mica-smectite in some horizons could be an indication of an intermediate stage of mica transformation into smectite. The results revealed that the soil-available moisture played the major role in the distribution pattern of palygorskite and smectite clay minerals in the analyzed Bk and Bt Aridisol horizons, respectively. Although mica may form pedogenically from K fixation in pre-existing smectites under hot and dry conditions, its trace amounts in Bt horizons is interpreted as inherited from parent rocks, because mica constitutes the principal clay mineral of parent material, and its presence in these horizons is mainly of detrital origin.

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Preliminary results from IODP Expedition 317: Canterbury Basin Sea-Level Transect, New Zealand

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Integrated Ocean Drilling Program Expedition 317 (4 November 2009 – 4 January 2010) was devoted to understanding the relative importance of global sea level (eustasy) versus local tectonic and sedimentary processes in controlling continental-margin sedimentary cycles (Expedition 317 Scientists, 2010). The expedition recovered sediments dating from the Eocene to Recent, with a particular focus on the sequence stratigraphy of the late Miocene to Recent, when global sea-level change was dominated by glacioeustasy. Drilling in the Canterbury Basin, on the eastern margin of the South Island of New Zealand, takes advantage of high rates of Neogene sediment supply, which preserve a high-frequency (0.1-0.5 m.y. periods) record of depositional cyclicity. The Canterbury Basin provides an opportunity to study the complex interactions between processes responsible for the preserved stratigraphic record of sequences because of the proximity of an uplifting mountain chain (Southern Alps) and strong ocean currents. Upper Miocene to Recent sedimentary sequences were cored in a transect of three sites on the continental shelf (landward to basinward, Sites U1353, U1354, U1351) and one on the continental slope (Site U1352). The transect provides a stratigraphic record of depositional cycles across the shallow-water environment most directly affected by relative sea-level change. Lithologic boundaries, provisionally correlative with seismic sequence boundaries, have been identified in cores from each site. Mid-Pliocene to Recent heterolithic facies contrast with underlying sediments, which are more homogeneous. This trend probably reflects increasing Plio-Pleistocene eustatic amplitudes. The sedimentary record will be used to estimate the timing and amplitude (using backstripping) of global sea-level change and to document the sedimentary processes that operate during sequence formation. Sites U1353 and U1354 provide significant, double-cored, high-recovery sections through the Holocene and late Quaternary for high-resolution study of Milankovitch-scale (100 ky) glacial cycles in a continental shelf setting. Continental slope Site U1352 represents a complete section from modern terrigenous slope sediment, through to hard Eocene limestone, with all the associated lithologic, biostratigraphic, physical, geochemical and microbiological transitions. The site also provides a record of ocean circulation and fronts during the last ~35 m.y. The early Oligocene (~30 Ma) Marshall Paraconformity was the deepest target of Expedition 317 and is hypothesized to represent intensified current erosion or non-deposition associated with the initiation of thermohaline ciculation in the Southern Ocean. Expedition 317 sequence stratigraphy is generally correlative with previous ODP drilling of sedimentary sequences for sequence stratigraphic and sea-level objectives, particularly that on the New Jersey margin (Legs 150, 150X, 174A, and 174AX) and in the Bahamas (Leg 166), but includes an expanded Pliocene section. Expedition 317 also complements ODP Leg 181 drilling, which focused on drift development off eastern New Zealand. Expedition 317 involved operational challenges for JOIDES Resolution, including both shallow-water, continental-shelf drilling and deep penetrations. As a result of successfully overcoming these challenges, Expedition 317 set a number of records: 1) deepest sediment hole and deepest hole drilled in a single expedition (Hole U1352C; 1927 m), 2) deepest hole on the continental shelf (Hole 1351B; 1030 m), 3) shallowest water depth for a site drilled by JOIDES Resolution for scientific purposes (Site U1353, 84.7 m water depth) and 4) deepest sample taken by scientific ocean drilling for microbiological studies (1925 m at Site U1352).

Expedition 317 Scientists (2010) Canterbury Basin Sea Level: Global and Local Controls on Continental Margin Stratigraphy, IODP Preliminary Report, 317, 133 pp. doi:10.2204/iodp.pr.317.2020.

Paleoclimate considerations of the Palo Pintado Formation (Upper Miocene), Salta Province, Argentina

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Fossil and sedimentological investigations were undertaken in the Palo Pintado Formation (Payogastilla Group, Upper Miocene), southern Calchaquí Valley. Strata comprising 1,387 m of clastic deposits interspersed with some pyroclastic beds are well exposed in the Quebrada El Estanque. Based on stratigraphic and sedimentological features, we introduce new paleoenvironmental interpretations: the strata consists of an intermediate class between low and high sinuosity rivers forming a wandering fluvial system sand-gravel with small lakes. Channel and overbank deposits can be distinguished within this river system. Accumulations within channels are composed of gravels bars (GB) and sandy bedforms (SB). Overbank deposits are represented by: a) crevasse channels, b) small crevasse channels (CS) and c) floodplain (FP) deposits. The floodplains were drained during the dry season, or during longer time intervals, as suggested by desiccation cracks and gypsum in thin beds. The marshy subenvironment is developed by the shore of small lakes which are in colmatation process. It also constitutes the final filling stage of the lagoon trays, inside the flooding plains. Different levels of pelitic green and brown beds of the Palo Pintado Formation were analyzed (using X-ray diffraction), to be used as a base for provenance and paleoclimatic data. The basal strata are predominantly illite associated with quartz and albite. Intermediate levels are composed of saponite-illite, quartz and muscovite, while the top is composed of illite-montmorillonite, quartz, albite and Fossil and sedimentological investigations were undertaken at the Palo Pintado Formation (Payogastilla Group, Upper Miocene), southern Calchaquí Valley. Strata comprising 1,387 m of clastic deposits interspersed with some pyroclastic beds are well exposed in the Quebrada El Estanque. Based on stratigraphic and sedimentological features, we introduce new paleoenvironmental interpretations: the strata consist of a transitional type between low and high sinuosity rivers forming a wandering fluvial system sand-gravel with small lakes. Channel and overbank deposits can be distinguished within this river system. Accumulations within channels are composed of gravel bars (GB) and sandy bedforms (SB). Overbank deposits are represented by: a) crevasse channels, b) small crevasse channels (CS) and c) floodplain (FP) deposits. The floodplains were drained during the dry season, or during longer time intervals, as suggested by desiccation cracks and gypsum in thin beds. The marshy subenvironment is developed by the shore of small overfilled lakes. It also constitutes the final filling stage of the lagoon trays, inside the flooding plains. Different levels of pelitic green and brown beds of the Palo Pintado Formation were analyzed (using X-ray diffraction), to be used as a base for provenance and paleoclimatic data. The basal strata are predominantly illite associated with quartz and albite. Intermediate levels are composed of saponite-illite, quartz and muscovite, while the top is composed of illite-montmorillonite, quartz, albite and clinochlore. Generation of incompletely altered clay minerals, such as illite and smectite (saponite and montmorillonite), are produced by hydrolysis in a temperate-humid climate. Description of the Palo Pintado Formation sedimentary paleoenvironment suggests a scenario that may have hosted known paleocommunities. The aqueous subenvironments (lagoons, swamps and rivers with slow to moderate current flow), gave shelter to the aquatic and marsh flora and fauna. The riverbanks and floodplains developed along a forested hydrophilic riverbank. In the other side of the floodplain the structures associated with abandoned channels are transitional to savannas and grasslands. The high frequency and good preservation of aquatic pteridophytes and pelecypods, developed in aqueous lenticular bodies, together with the good stratification of the riparian forests along with epiphytes, suggest stable communities that persisted for a long time. Some of the recorded plant taxa are presently living in tropical regions and some types of molluscs developed under a humid and hot or warm temperate climate (18ºC – 28ºC). Considering that both the spatial distribution and paleobotany (Barreda *et al*. 2007) of the analyzed fossils correspond to a Neotropical latitude, it is possible to establish that the paleocommunities developed under a tropical climate with warm and humid subtropical low seasonality, in the Late Miocene (between 10.29 ± 0.11 Ma and 5.27 ± 0.28 Ma). This study suggests that climate of the Palo Pintado Formation was more humid than previously proposed, and xeric vegetation was less represented than it is today.

Barreda, V. Anzótegui, L.M., Prieto, A.R., Aceñolaza, P., Bianchi, M.M. Borromei, A.M., Brea, M., Caccavari, M., Cuadrado, G.A., Garralla, S., Grill, S. G.; Guerstein, R., Lutz, A.I., Mancini, M. V., Mautino, L.R., Ottone, E.G., Quattrocchio, M, Romero, E.J., Zamaloa, M.C. and Zucol, A. (2007) Diversificación y cambios de las Angiospermas durante el Néogeno en Argentina. En: Asociación Paleontológica Argentina. (Eds. S. Archagelsky, T. Sanchez, y E, Tonni). Ameghiniana, Publicación Especial 11, 50º Aniversario, 173-191.

Sedimentological and climatic control in the clay minerals distribution in the fluvial deposits of the Palo Pintado Formation (Upper Miocene), Salta Province, Argentina

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During the Upper Miocene a continental succession of the Palo Pintado Formation, about 800 m thick, was deposited in Calchaquí river. Palaeoenvironmental interpretation of these deposits was obtained from sedimentological and palaeontological data in the earlier studies which consist of an intermediate class between low and high sinuosity rivers forming a wandering fluvial system sand-gravel with semiperennial small lakes. The cycles are composed of conglomerates and sandstones, which are channeles (gravels bars and sandy bedforms) and overbank deposits (crevasse channels and small crevasse channel) and claystones in the floodplain deposits. The conglomerates at the base of the Palo Pintado Formation, shows pebbles of slate and phyllite, and in less proportion granite and pegmatite that increase to the top (from 0% to 60%). The quartz is the principal component in the sandstones with monocrystalline grains (plutonic origin, Qm= 50-83%) and policrystalline. Quartz displaying undulatory extinction (low grade metamorphic origin, Qme= 0-16%) is observed in lower proportions. The polycrystalline quartz (Qp= 45-3%) is constituted by two or more crystals with sutured contacts (metamorphic origen) and straight contacts (plutonic origin). Other relevant detrital grains are the potash feldspars (K): orthoclase with high kaolinitization grade and microcline which appears rounded or subrounded, fresh grains. The plagioclase generally altered, can be identified by its polysynthetic, multiple twinning. The lithic components are metamorphics: gneisses, schists, slate, phyllite, a few volcanics fragments and sandstones. Then, X-ray diffraction analyses were carried out on 27 samples of claystones. Clay minerals identified are illite, interstratified illite-smectite, smectite and kaolinite. The mineralogical composition (< 2mm) of clay includes non-clay mineral too: quartz, plagioclase and calcite. Illite and smectite associated with quartz and plagioclase appears more in the base of Palo Pintado Formation. The middle and the top levels are composed by smectite, illite and kaolinite with quartz, plagioclase, calcite, siderite and paligosrkite. Added to this, incompletely altered clay minerals such as illite and smectite are formed by bialitisation (hydrolysis) in warm-dry climates. The clays formed under these conditions are produced by preexistent minerals degradation in the soil, with loss of elements: Ca, Mg in less propotion Si and Fe. The interaction between the mineralogy constituted by phyllosilicates and alkaline waters loaded in magnesium would be responsible for the smectite formation. To conclude, the Upper Miocene deposits were derived from Upper Neoproterozoic basement (Puncoviscana Formation and La Paya Formation) and Ordovician granites and pegmatites. The clay mineral assemblage of these source-area rocks is mostly smectite, interstratified illite-smectite, illite and kaolinite. The weathering of these materials under high temperature and rainfall favored improved the condition of the clay minerals hydrolysis and the kaolinite formation. Clay associations reflect both the influence of the climate and the lithology and composition of source areas. The clay minerals have been generated during a long period of time and under climatically stable conditions, under warm and humid state with low seasonality, more humid than other contemporary regional formations.

An Epiphyton-like bacterial colony within the muddy facies of a Pleistocene to Recent thermal complex near Viterbo (Canino, Western-Central Italy)

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Epiphyton like bacterial colonies preserved within carbonate mud interbedded with crystalline crusts have been found in thermal deposits formed since the Pleistocene in the area of Canino comprised in the volcanic district of Viterbo (Western-Central Italy). The lime mud enclosing the well preserved non calcified, organic remains and less frequent ostracod shells, represents the infilling of rather large pools delimited by crystalline dams. Its fabric is a typical clotted micrite which suggests the activity of bacterial biofilm (EPS) entrapping microcrystalline calcite grains, at the bottom of the shallow basin. The colonies consist of isolated hollow sub-cylindrical/cigar shaped bodies scattered in the matrix, each of them has no connection with the other colonies nor with any surface liable to be encrusted. This particularly suggests that the colony lived in the water column floating free or docked at the bottom by a mucilage cord; similar to some present-day forms occurring in large thermal pools. The hollow cigar-like colony (up to 7mm long and 1mm wide) consists of bush-like dendritic thalli disposed radially often with a verticillate pattern. The fan- or club- shaped branches (20 to 40µ in diameter) are commonly segmented and locally apparently hollow. In transverse section the colony take the form of a composite chambered thallus. This organization is reminiscent of the Paleozoic Epiphyton colonies and suggests a possible affinity of the two forms: the marine Paleozoic bacterial colony may have lost its ability to calcify its outer sheaths, and the floating colonies, although living in thermal waters saturated with calcium carbonate, were unable to produce a micritic coating.

Travertine and Calcareous tufa: distinctive fabrics and related isotopic signatures

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The petrologic features and isotopic signatures of the recent carbonates known as Travertines, deposited by flowing waters around thermal spring systems, have been compared with those of the Calcareous tufa derived from flowing waters of meteoric/karstic derivation. The two types of calcareous deposits made of calcite, more rarely of aragonite, show specific petrologic features reflecting the physico- chemical conditions of the depositing fluids. Growing evidence indicates that the biologic contribution to the carbonate precipitation is effective only in the fluvial/palustrine system where macrophytes prosper. In the hot waters of thermal springs, often rich with dissolved poisonous gas as H_2S, conditions of life are extreme and the organisms involved, mostly heat-loving bacteria, appears to play a passive role of support. The depositional fluvial/palustrine system, characterized by a luxuriant vegetation directly controlled by climate, is fed by carbonate-rich cool waters mostly flowing from karstic springs, or in some cases from diluted and cooled, originally thermal waters. Calcareous tufa consist of lenticular, poorly bedded to massive, porous chalky limestone made up of dominantly microcrystalline calcite containing bacterial colonies, peloidal aggregates, phytoclasts and remains of invertebrates associated with stromatolitic, phytohermal buildups. The depositional conditions of the thermal system is controlled by the temperature and rate of cooling/degassing of supersaturated waters emerging from deep geothermal/hydrothermal circuits where hot waters charged with HCO_3- of meteoric and hypogean derivation, are able to dissolve high quantities of carbonate and/or evaporitic bedrock. Carbonate deposits form edifices varying in shape from suspended channels to cones and ridges. In the proximal part of the system they are built by peculiar crystalline crusts (feathers, crystal fans) whereas in the distal part bacterial/cyanobacterial mats, calcified-bubbles and paper-thin rafts dominate. Travertine form well bedded, often finely laminated bodies of compact limestone, commonly lacking any trace of biologic involvment in the carbonate precipitation. The critical elaboration and revision of the stable isotopes signatures so far obtained from actively forming calcareous tufa and travertine, sampled in "living" models of deposition, shows that the $d^{13}C$ and $d^{18}O$ values of rock and related parent water fall in distinct fields of distribution reflecting the physico-chemical proprieties of the two depositional systems.

Paleogeographical and sedimentological analysis in the Eocene rocks, Central Andes of Venezuela: a new perspective

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In Mérida State, Venezuela Ghosh and Odreman (1987), defined the San Javier (Paleocene late to Eocene) and Mucujún (Miocene-Pliocene) formations. The San Javier Formation is composed by 800 m of shales, sandstones, bioturbed glauconitic sandstones and fossiliferous limestones deposited in barrier islands, inlet barriers and nerithic environments. The Mucujún Formation is composed by 610 m of mottled shales and mudstones with carbonaceous material thought to have been deposited in proximal fans, representing braided distributary, meandering fluvial, and floodplain environments. Additionally the authors mentioned an unconformity between these formations based on paleontological and palynological data. In the San Javier Formation (Hunter, 1972) described two palynomorphs, one of them Cicatricosisporites dorogensis has been restricted to the Middle Eocene (Jaramillo & Dilcher, 2001) of Colombia, the other, Verrucatosporites usmensis was cited in the Middle Eocene of Cuba (Graham *et al.*, 2000). Additionally, Ghosh and Odreman op cit., assigned incorrect ages to the San Javier Formations based on Macoma sp, cosmopolitan bivalve of the Paleocene-Oligocene, and Coniscala sp, a Paleocene gastropod only present in the northern hemisphere. To the Mucujún Formation, Ghosh and Odreman op cit. assigned a Miocene-Pliocene age based only on the palynological observations of Fasola and Ramos. These palynomorphs (Psilatricolporites operculatus, Retitricolporites guianensis, Perisyncolporites pokornyi, Clavaticolpites daimoni, y Jandufouria seamrogiformis) are restricted to the Middle Eocene of Cuba and Colombia (Graham *et al.*, 2000; Jaramillo & Dilcher, 2001). In the San Javier Formation, Cerrada & Toro (2007), identified delta plain environments with meandering fluvial systems with some tidal influence. They recognised three sequences, the first with fine to medium shaley sandstones interbedded with fisile shales, the second sequence with fine to medium sandstones interbedded with bioturbated light gray shales and glauconitic quarzitic sandstones, and the third sequence with shaley sandstones where shales are interbedded with medium to coarse sandstones, heterolitic beds and dark gray oxide shales. In addition, in the Mucujún Formation, Troconis (2005) used facies associations, architectural elements and lithosomes, to identify a prograding flood plain with meandering barriers and a limited braided river influence. In addition, Cerrada & Toro (2007) in their diagenetic study of the San Javier Formation, indicate an intermediate diagenesis and later telogenesis. Finally, Rincón & Laya (1999), in a tectonic analysis of the San Javier Formation, did not find important differences on the structural influence on the strata in relation to the overlying Mucujún Formation. Our field observations do did not find an unconformity between the San Javier and Mucujún formations, additionally it is not possible to define field stratigraphical relations between these formations, besides, intermediate diagenesis identified in the San Javier Formation by Troconis (2007) is similar to the high compaction in the sandstones of the Mucujún Formation identified petrographically. Also, the sedimentological analysis of Troconis (2005) and Cerrada & Toro (2007) allow the identification of a paleoenvironmental relationship between the meandering fluvial deposits of the Mucujún Formation and the deltaic influence of the San Javier Formation. In addition, in Maracaibo Basin was defined five supersequences (Parnaud *et al.*, 1995), one of them, D supersequence, which included Middle Eocene rocks deposited in estuarine-deltaic and coastal-fluvial enviroments, e.g.Mirador and Misoa formations. Finally, the field observations, the biochronological, paleoenvironmental, diagenetic and structural data, allow us to propose a paleogeographical relationship between the San Javier and Misoa formations, and the Mucujún and Mirador formations.

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X-ray fluorescence core scanner for quantitative geochemical logging of sediment and soil cores: instrumental calibration and application to Barcelona quaternary sediments

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On-line analysis of soil or sediment cores by XRF core-scanning (XRF-CS) has become increasingly popular due to the possibility to obtain chemical information on a fast non-destructive way. The main disadvantage of XRF-CS relative to conventional geochemical analysis is the difficulty to convert spectral data to precise and accurate elemental concentrations. The main aim of the present work is to enlarge the knowledge about the quantitative possibilities of XRF-CS through the use of well-known certified reference materials (CRM). Instrumentation: We used an Avaatech© XRF core-scanner instrument, equipped with an Oxford 100Watt generator, a water cooled Rh-target X-Ray tube, operating at 10-50 kV and up to 2mA. Several primary filters can be used to reduce the photon flux impinging the sampling area and improving the peak/background ratio. The length and the width of the X-ray beam can be determined independently to irradiate variable areas (0.1 to 10 mm length; 2-15 mm width). The X-ray pathway close to the irradiated area is Helium-flushed, avoiding low energy absorption by air and therefore increasing light element detection. A solid-state detector and a multichannel analyzer are used for the collection and discrimination of energies corresponding to elements from Mg to U. Materials and methods: Twelve CRM's of different types of sediments and 4 CRM's of soils were used to investigate the possibility of obtaining calibration models for different elements existing in these materials. The specimens for calibration were prepared by pressing to obtain a flat surface. All the samples were analyzed at 10, 30 and 50 kV, using current of 2 mA. Spectral data was studied by means of WinQXAS code software (IAEA, 2006). Although element intensities mainly depend on the element concentration, they are also influenced by the energy level of the X-ray source, the counting time, and the physical properties of the sediment, mainly the mass absorption coefficient of samples (MAC). Therefore to precisely know the content of one element we need to correct the received intensity at detector by the MAC. We used the intensity of the scattered (Compton and Rayleigh) lines from the X-ray tube as a means of normalization, making the quantitative result independent of tube ageing or any other factor affecting the primary beam intensity. The ratio of the Compton and Rayleigh scattered intensities are used to estimate the variation of the average atomic number in the sample. Results: Good calibration lines at 10 and 30 kV for several elements such as S, K, Ca, Ti, Mn, Fe, Br, Zn, Rb, Sr, Zr and Pb are obtained. At 50 kV good calibration lines for heavy elements such as Br, Zn, Sr, Zr, Pb and Ba are showed. All these calibration plots exhibit Pearson's coefficients over 0.99 and the obtained equations can be considered for application to real samples on pure quantitative mode. For other elements (Al, Cu, Ni, As) calibration lines only report fitting values ranging 0.85 to 0.95, thus implying that values for these elements should be considered as semiquantitative. After instrument calibration, we analyze 40 samples from a sediment core located in the Sagrada Familia square (Barcelona city, Spain). The sediment core exhibit two main different lithological units. The upper one is composed of continental clays and silts, with some gravel and carbonates levels, whereas the lower unit belongs to the marine Pliocene and is composed of marls and sands.

Chemostratigraphy and U-Pb age constraints of Mesoproterozoic carbonate successions of the Río de la Plata Craton, Uruguay

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A belt consisting of volcanosedimentary successions exhibiting greenschist-facies metamorphism is exposed in the Nico Pérez Terrane, eastern Río de la Plata Craton (RPC) in Uruguay. The Parque UTE Group (PUG) consists of basic volcanics and gabbros at the base (1492±4 Ma, U-Pb on zircon), carbonates in its middle part, and interbedded carbonates, shales and acid volcanics (1429±21 Ma, U-Pb on zircon) at the top. The overlying Mina Verdún Group (MVG) is made up of rhyolites and acid pyroclastics at its base and top, and *Conophyton*-bearing limestones and massive dolostones in the middle (Poiré and Gaucher, 2009). Lapilli-tuffs at the base yielded a U-Pb LA-ICP MS zircon age of 1433±6 Ma, showing that the MVG immediately post-dates the PUG (Gaucher *et al.*, in press). A $\delta^{13}C$ curve obtained for the whole succession is characterized by steady and moderately positive values around +1 to +2‰ VPDB, punctuated by two negative excursions. The lower negative excursion (-1.8‰) occurs at the base of the PUG and immediately post-dates basic rocks dated at 1492±4 Ma (Chiglino *et al.*, in press). The upper negative $\delta^{13}C$ excursion, down to -3.5‰ VPDB, encompasses the top of the PUG and base of the MVG. Two U-Pb ages around 1430 Ma confidently define the absolute age of this negative excursion. A positive $\delta^{13}C$ plateau around +2‰ VPDB characterizes the remainder of the MVG. Geochemical discriminant criteria, such as Mn/Sr vs. $\delta^{13}C$, $\delta^{13}C$ vs. $\delta^{18}O$ and $\delta^{13}C$ vs. Sr concentration indicate that isotopic signals represent near-primary values (Chiglino *et al.*, in press). The chemostratigraphic and U-Pb data help constrain the global $\delta^{13}C$ curve of marine carbonates, showing that oscillations of modest amplitude begun already at ca. 1.5 Ga. Carbonates of the Mataojo Formation of the Nico Pérez Terrane show $\delta^{13}C$ invariance around 0‰ (Chiglino *et al.*, in press) and are younger than 1802±59 Ma (U-Pb age of youngest detrital zircon). Thus, the transition from isotopic stasis to modest secular variations must have occurred between 1.8 and 1.5 Ga. Deformation and metamorphism of Mesoproterozoic successions of the RPC occurred between 1.25 and 1.20 Ga, as shown by K-Ar, Ar-Ar and U- Pb ages. This tectonic event affected most of the RPC, and led to the accretion of the Nico Pérez Terrane to the remainder of the RPC along the Sarandí del Yí megashear. In a broader context, these ages strongly suggest the involvement of the RPC in the tectonic collage ultimately leading to the accretion of Rodinia (Gaucher *et al.*, 2009).

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Fluid migration models in Cretaceous fluvial sandstones bodies. San Jorge Basin, Argentina

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The San Jorge Basin has been producing gas and oil since 1907 and its production has reached more than 150Mm3 of oil from 1999 to 2009. The hydrocarbon plays belong to Cretaceous rocks related to lacustrine, delta and fluvial deposits. The main hydrocarbon reservoirs are formed by fluvial channels and bars, which consist in fine to coarse sandstones with trough cross stratification as the principal sedimentary structure. These channel belt deposits present 2.5 to 4.0 m thick, 100 to 350m width and, low sinuosity (1.2 to 1.5); though some cases of high sinuosity (2.0 and 2.5) were also recorded. The major sandstone bodies (in thickness and width) overlie the top of a thick mudstone deposit (around 50m); these sandstone bodies also show the highest sinuosity, which decreases upward. In order to propose a fluid migration model, more than 400 samples belonging to seven sandstone bodies were taken from outcrops. The measurements of porosity and permeability were carried out in laboratory from 350 samples (in cubes of 1.000 cm^3) and the characteristic of the porosity was analyzed in 50 petrographic thin sections. The sandstone bodies show heterogeneous distribution of porosity and permeability, fluvial bars are more homogeneous in their petrophysical features than channels are due the fact that, in some cases, channel tops are made up by fine sediments related to avulsion and abandonment processes. The classic traps in these oil fields are structural and combined, but stratigraphic traps were observed in some particular anticlines (where the paleocurrent directions are normal to structural dip). Oil migrated along synthetic and antithetic faults and many of these faults show a strike slip component. In general, the porosity measured in laboratory varies from 8 to 24.9% and the permeability was less than 1 mD. The permeability is affected by sandstone composition, e.g., a high proportion of volcanic rock fragments, and the different kind of cements which were observed in petrographic thin sections. It is difficult to propose a single fluid migration model because, even in near oil fields, the tectonic plays a strong control in the dimensions, sinuosity of sandstone channel belts. Besides, petrographic studies show how volcaniclastic materials are affecting the primary porosity and permeability of sandstones closed to transpressive or trastensive faults areas. Hence, two different fluid migration models were proposed for major sandstone bodies according to their relation with synsedimentary tectonic activity: 1) sandstone bodies related to strike slip faults or shear stress areas are poor reservoirs; 2) sandstone bodies distant to strike slip faults or shear stress areas are better reservoirs.

Intrabasinal syntectonic control in Cretaceous fluvial deposits. San Jorge Basin, Argentina

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The San Jorge Basin is the oldest oil basin in Argentina, the main hydrocarbon reservoirs are Cretaceous rocks belonging to Chubut Group. This Group shows different sedimentary environments: lacustrine, delta and fluvial deposits at the base (Pozo D-129 Formation), followed by volcaniclastic deposits (Castillo Formation) and fluvial deposits at the top (Bajo Barreal Formation). The Chubut Group show many examples of syntectonic control in both outcrops and subsurface deposits. The fluvial channel patterns are very sensitive to the floodplain slope changes, due to extra- and/or intra-basinal syntectonic activity. Systematic mapping of channel sandstone bodies in different sections of Chubut Group show an alternating of quiet and active tectonism, as abrupt changes in the channel sinuosity (2.0 to 1.2) as in the floodplain width (tens of kilometers to less than 1 km), which indicate insights of transversal tectonism regard to paleocurrent directions. The fluvial architecture studies in outcrops also suggest changes in the lateral and vertical stacking of sandstones, which are mainly related to floodplain narrowness defined by tectonic paleovalley and changes in the sediment supply rates. The faults are oriented WNW-ESE and NW-SE, consequently transpressive and transtensive movements were contemporaneously active during Middle Cretaceous. A huge amount of volcaniclastic and piroclastic material were distributed from these shear systems affecting the local slope and sedimentation rates of floodplains. The tectonic control defines three kind of fluvial channel movements, sandstone reservoirs and porosity – permeability quality: 1) free migration, high sinuosity channels (floodplains: 5 – 10 km width), good to very good poro-perm quality (channels are distant from faults supplying of volcaniclastic materal); 2) partial migration, channels were control by a single fault, more or less parallel to paleocurrent directions, good poro-perm quality; and, 3) restricted migration, narrow channels (floodplain = tectonic valleys, less than 1-2 km width), poor poro-perm quality (close to faults supply volcaniclastic material).

Depositional systems variability in relation to accommodation space subtraction and creation of tectonic origin: examples from different marginal belts of the Apennines and the Alps (Italy)

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The sedimentary basins related to the Alpine retroforeland were controlled by the complex relationships which took place, since latest Oligocene, in relation to the counter-clockwise rotation of the Apennines due to the opening of extensional back-arc basins. The foreland basin developed in relation to the collision of the European plate with the African (Adria) promontory. This process ultimately led to the development of a common foreland comprised between Alps, Apennines and Dinarides. The Apenninic segment became progressively more active and laterally moved indenting into the Alps. Since middle Miocene, the increasing Apenninic deformation provided flexural tilting and accommodation space shifting in time towards N and NE. The basin-fill organization and its relation to changes in structural style were deciphered through the integration of subsurface and outcrop data on the basis of seismic- and sequence-stratigraphy principles, respectively. Large-scale unconformity-bounded stratigraphic units, whose stacking pattern was controlled by changes in the rate of tectonic subsidence and whose boundaries were generated by basin-modification phases, were recognized and mapped at the basin scale. Two basic types of bounding surfaces are recognized: relative sea-level falls of tectonic origin and drowning-platform unconformities framed into long-term relative sea-level rise time intervals. The former are associated to phases of regional space subtraction mainly recorded along the thrust belt and the peripheral bulge, generally due to low or negative subsidence rate and often expressed by forced regression wedges at the basin margins. The latter are associated with major space-creation phases mainly recorded in the foredeeps and outer ramps, due to increasing rates of regional subsidence and expressed by the downwarping of basin margins. The architecture of stratigraphic units and the nature of bounding surfaces are primarily controlled by the accommodation/sediment supply ratio. In low accommodation time intervals and/or local tectonic settings dominated by space subtraction, forced regression wedges develop, consisting of flood-dominated fluvio-deltaic systems associated with shingled shelfal lobes and changing basinward to intra-slope and/or basin-floor turbidite systems. In these cases, tectonic elevation, steep gradients, subaerial/shallow-water erosion and wet climate play a major role. Conversely, the genetic relationships between drowning-platform unconformities and turbidite systems in high accommodation time intervals and/or local tectonic settings dominated by space creation, suggest that tectonic oversteepening, shelfedge failures and large scale subaqueous erosion along the slope (via multiple retrogressive slump scars, submarine canyons and gullies), become more effective in delivering sediments basinward. Selected examples will be discussed, not based on a priori models but rather relying upon objective data including the specific structural styles proper to each basin or portions of them. 3D seismic volumes and their sedimentologic-stratigraphic calibration demonstrated to have been a fundamental tool to describe various types of erosional surfaces, their stratigraphic meaning and the depositional architecture of basin margins. Our results effectively contributed to develop predictive models and to realistically characterize exploration play concepts and reservoir architecture.

Lacustrine carbonates: facies and origin

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Lacustrine carbonates are defined here as carbonates that were deposited subaqueously with no subsequent aerial exposure. Their depositional patterns and types were assessed through a literature database representing over 250 lakes and lake basins worldwide. Carbonate deposition in lakes proceeds through (1) biogenic mediation, including high productivity of micro- and picoplankton, macrofauna shell formation, and encrustations on any substrate, (2) concentration through evaporation, (3) eolian input, and (4) water-borne clastic input. The use of stable isotopes of oxygen, carbon, and strontium as well as the recognition of diagenetic alternation in lacustrine carbonates aid in the reconstruction of climate, hydrology, and lake evolution. Classification of lacustrine carbonate facies is based on position in relation to the lake shoreline and mode of deposition. The five facies types identified are: (1) laminated carbonates, (2) massive carbonates, (3) microbial carbonates, (4) marginal carbonates, and (5) open-water carbonates. Important fauna and flora associated with carbonates include ostracodes, gastropods, bivalves, charophytes, diatoms, and insects. Laminated carbonates are composed of laminae that can be regular to irregular in thickness and continuous or discontinuous with varying percentages of carbonate material deposited in the profundal zone to nearshore. Suspension settle-out from overflows to interflows of sediment plumes and whiting events as well as plankton contribute sediment. Massive carbonates are structureless fine-grained carbonates. They can contain faunal and floral remains and can be mudstones, wackestones, grainstones, and marlstones. This facies is interpreted as bioturbated sediment from nearshore to offshore areas. Microbial carbonates can be found in the other four facies and are characterized by microbially-induced sedimentary structures, including coated grains, stromatolites, microreefs, microbial crusts, tufa mounds, and bioherms. These microbial elements occur within the photic zone and carbonate build-ups are associated with groundwater influx along shorelines and faults. Marginal carbonates are characterized by sedimentary structures, grains, or intraclasts indicating current or wave action. This facies can include ooid banks, coquinas, and ripple cross- laminated to trough cross-bedded intraclasts, coated grains, shells, and carbonate silts and sands. Open-water carbonates are defined as bedload deposition from underflows, turbidites, and debris flows with grain sizes from silt to gravel. In addition, slumps and contorted sediment also indicate subaqueous movement of sediment material after deposition. Lacustrine carbonates accumulate in all climates and in any tectonic situation. They are found in underfilled, balanced filled, and overfilled lake types. Carbonate rocks (limestones, dolostones, and marble) and calcium-rich rocks (basalt or carbonatite) need to be available for weathering in the watershed, including the subsurface, in order to produce carbonate sediments in lakes in the first place. Tectonics and climate control the distribution of carbonates through (1) the input and output of ions and minerals through surface water, groundwater, rainfall, and wind; (2) the morphometry of the lake; and (3) the temperature ranges and seasonality of the catchment location. Facies distribution is dependent on the input mode of calcium-rich waters and carbonate clasts in addition to lake circulation patterns and stratification. For example, bioherms or tufas can be associated with Ca-rich groundwater input along lake margins or dominant river input of carbonate clasts or Ca-rich water can transport sediment and precipitates towards the lake depocenter. Clearly, the amount of Ca-rich rocks in the watershed, including the subsurface, determines the volume of carbonate sediments in a lake. A classification of carbonate-producing lakes based on the percentage of carbonate source rocks in the watershed is proposed. Dominantly carbonate lakes contain carbonate sediments from the littoral to profundal zone; the source areas for these lakes are composed of a significant percentage of carbonate rocks (more than 60-70% of provenance). Partially carbonate lakes contain carbonate sediments in some areas of the lakes closest to input Ca-rich sources with 40-60% of carbonate-rich provenance. Sparsely carbonate lakes show less significant carbonate accumulation within lakes because of minor carbonate source rocks (<30-40%). The source area for the Green River Formation, for example, included Late Paleozoic marine carbonates in the watershed surrounding the basin, probably comprising more than half of the source rocks. Lake Baikal, the deepest lake in the world, does not have significant carbonate accumulation within its sediments, only thin-shelled molluscs. The mountains surrounding the lake contain only marbles that compose perhaps less than 30% of the possible source rocks. Provenance studies, inferred hydrologic regime, tectonic situation, detailed facies studies, and stable isotope analyses in addition to paleoclimatic studies are crucial in discerning carbonate accumulation patterns in continental settings, especially in lakes and on floodplains.

Sedimentary controls on carbonate accumulation on the floodplains of siliciclastic perennial rivers

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Genesis of carbonate lakes on siliciclastic floodplains of perennial fluvial systems has been difficult to interpret. The presence or absence of carbonate deposits in many nonmarine settings has been used to document arid vs. humid depositional paleoconditions. Models for carbonate lake formation include aridity, spring deposition, or both coupled with reduced siliciclastic input. All these mechanisms can be shown to be hydrodynamically and sedimentologically unrealistic when considering perennial river hydrology. For continental deposits, provenance generally determines the type of sediment that accumulates. Long-term isolation from siliciclastic input is also an important criterion for promoting carbonate accumulation within a siliciclastic environment. River systems with carbonate provenance that contain perennially protected areas on their floodplain would be ideal localities to accumulate and preserve lake carbonates. Two types of perennial rivers that contain significant lakes on their floodplains are meandering and anastomosing systems. Secluded areas that allow carbonate precipitation over long periods within meandering river systems do not seem likely to exist. Such systems contain abandoned river channels on their floodplains, also known as oxbow lakes, where carbonate lakes could potentially form. Vegetation has been thought to shield areas on a meandering floodplain to allow carbonate precipitation over long periods. Flooding events and sedimentation in meandering systems, however, normally cover the entire low-lying floodplain regularly, including oxbow lakes and other depressions. In addition, many former channel lakes have hydrologic connectivity to the main channel, especially during flooding. Plant and tree communities within a perennial meandering environment actually are themselves controlled by flooding patterns. Large vegetated areas can slow down the velocity of floodwaters, inducing mostly siliciclastic sedimentation instead. The other major type of perennial river system, anastomosing, seems to be the best candidate for the formation and preservation of carbonate lake deposits. Hydrodynamic features promote the existence of isolated areas on the floodplain for the precipitation of carbonate. Concave- upward interchannel flood basin areas mostly receive dissolved and suspended load during floods, because of relatively high levee systems in an aggradational system. Bedload only enters these areas mostly as crevasse splays. Anastomosed river channels are in general stable over long periods and preservational potential of interchannel lake areas is high. To test the hypothesis that carbonate lakes generally form within anastomosing river systems with carbonate provenance, a database of these perennial river systems in the geologic record was compiled to examine carbonate lake deposits in association with perennial siliciclastic floodplains and source rocks. Classification of river systems was after Gibling (2006). Overall, 178 river deposits from the geologic record were examined, but only 136 contained enough pertinent data to be compiled into the database. Of these, 57 were found to be ancient anastomosing river systems associated with carbonate lake deposits. These entries also had carbonate-rich provenance. Anastomosing river systems without carbonate lake deposits added up to 66 entries, but these had little to no carbonates exposed in the source area. No anastomosing river deposits contained a carbonate provenance without carbonate lake deposits. Only thirteen meandering river deposits were found in the literature. This limited sample size indicates that these river sediments have a low preservation potential in the rock record. None of these river systems contained floodplain carbonate even though four examples had significant carbonate source rocks. Overall, carbonate lake deposits were found to be associated with anastomosing river systems within watersheds containing carbonate rocks. Anastomosing rivers possess flood basins that receive mostly suspended and dissolved load that are conducive to lake development. Stable channels create relatively high levees in an aggradational system allowing for isolation of flood basins from bedload for long time periods, except during crevasse splay events. Meandering systems seem less likely to form carbonate lakes because there are no areas secluded from siliciclastic input over any significant period, including oxbow lakes. The presence or absence of continental carbonates is not a reliable indicator for paleoclimatic interpretation.

Gibling, 2006. Width and thickness of fluvial channel bodies and valley fills in the geological record: A literature compilation and classification. Journal of Sedimentary Research, 76, 731-770.

The isotopic and chemical signature of surface sediments from the Puna-Altiplano area

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The Puna-Altiplano plateau (PAP) is considered along with Patagonia an important current and past source of aeolian materials exported from southern South America (SSA) to surrounding areas such as the Pampean region, the Southern Ocean or the Antarctic ice. The PAP is a high elevated basin (3750 – 4000 m) that extends over 1000 km and it is ~200 km wide. The climatic condition of this region is closely associated to the upper air circulation determining easterly zonal flow aloft supporting increase moisture conditions (<5% of the time), and mostly westerly winds prevailing in middle and upper troposphere causing dry conditions from May to October. In the Puna sector, the region reaches the highest elevation (average 4400 m) and at the latitude of ~25°S it is crossed by the subtropical jet stream (tropospheric westerly). This stream reaches its maximum intensity during winter and early spring, allowing the development of huge storms which deflate large amounts of sediments. We present here a preliminary data on chemical (REE) and isotopic (Sr, Nd and Pb) composition of sediment susceptible to be deflated from PAP area. Surface sediment samples were taken in a N-S transect from Uyuni (19°39' S, 68°11' W, Bolivia) down to Campo Carachi (27°1'S, 66°18' W, Catamarca, Argentina) from different geomorphologic environments: ephemeral lakes, lowland areas, edges of salt flats, alluvial fans, dunes, etc. In order to define the geochemical signature of different areas of the PAP, chemical and isotopic sediment compositions were compared with geochemical data of different lithologies present in the study area. Although cases with allochthonous signature are observed, in general the geochemical signature of the analyzed sediments is consistent with local rock units. We find that the "macro-regional" signature determined along the N-S transect is heterogeneous. This is promising as it would enable the identification of different PAP areas in sediments provenance studies of different paleoclimatic records. Furthermore, we present more evidence that besides the Patagonian region, the PAP area could be another source of aeolian material in the SSA contributing to the Pampean loess accumulation and transport to Antarctica.

Human impacts on Old World deltas

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Deltas are vulnerable sedimentary landforms at the land-sea interface that are influenced by both terrestrial and marine processes and heavily impacted by human activities. Recently river damming has reduced the amount of sediment reaching the coast. However, human alteration of landscapes has been ongoing ever since the advent and expansion of agriculture. Combining field data and modeling, I discuss how human activities have significantly influenced the formation of the modern Old World deltas. Within a relatively stable eustatic sea level can the growth of these deltas be attributed to climate change, land-use impacts, or both? The reverse i.e., the effects of Holocene deltaic landscape changes on ancient, historic and current civilizations will also be discussed (e.g., Europe Neolithic, Romans, Moors, Indus Civilization, India, as well as modern preindustrial vs. industrial). Understanding the historic and future morphologic change in deltas has become increasingly important as sea levels rise and sediment loads feeding deltas continue to be sequestered behind dams in the hinterland. Traditionally deltas have been densely populated while providing disproportionately high ecosystem services and resources to society. In regions that have been affected by humans, deltas can serve as a record of climate and land-use changes across large watersheds. If human activities were in part responsible for the development of the world's deltas, this would provide an important context for understanding how humankind will manage these resources over the coming centuries, particularly as climate changes and humans continue to alter these landforms.

Late Holocene environmental reconstruction of Lake Issyk-Kul (Rep. Kyrgyzstan)

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Lake Issyk-Kul is an endorheic mountain lake located at 1608 m a.s.l., in the northern Tien Shan ranges, in the Republic of Kyrgyzstan, Central Asia. It has an area of 6236 km^2, a length of 180 km, a width of 60 km, and a maximum depth of 668 m making it the fifth deepest lake in the world. The lake is monomictic, brackish (6 g/l), oligotrophic to ultra-oligotrophic (2 – 3.8 µg/l of phosphorous), and it has high values of dissolved oxygen (6.5 – 7.5 mg/l at the bottom of the lake). In August 2000, a gravity 150 cm long core (C142a, 42°34'312" N - 77°20'030" E) was recovered at 150 m of water depth at the central northern shore of the lake. This core was characterized using X-Ray Fluorescence (XRF) core scanner (measurements every 300 µm), X-Ray Diffraction (XRD) every 3 mm, and elemental (TC and TN) and isotopic composition ($\delta^{13}C$ and $\delta^{15}N$) of bulk organic matter every centimeter. The preliminary chronological framework was constructed with 4 AMS ^{14}C dates. Statistical analyses (clusters, Principal Component (PCA) and Redundant (RDA) Analyses) were employed to identify and isolate the environmental forcings that have triggered the input, distribution and deposition of sediments within the lake. The core records the last ca. 4,000 cal. yrs BP and, during this time its primary productivity has steadily increased (higher values of TC and TN). $\delta^{13}C$ and $\delta^{15}N$ values suggest that the main primary producer are blue-green algae. The last ca. 100 years, the primary productivity has experienced a dramatic increase. Furthermore, PCA on XRF data also highlights that more than the 50% of the total variance is related to changes in primary productivity (the first eigenvector (EV) is tied by the opposition of the terrigenous - organic matter geochemical indicators). This EV shows that the primary productivity oscillated at decadal and centennial frequencies. The main forcing of these primary productivity fluctuations seems to be temperature changes linked to both solar activity (11 years Schwabe cycles) and anthropogenic global warming.

Spatial and temporal changes in geometry and distribution patterns of sheet-like turbidite sandstone beds and bed-sets in a forearc submarine-fan succession of the Mio-Pliocene Kiyosumi Formation on Boso Peninsula, central Japan

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A sheet-like turbidite package formed within a deep-marine sedimentary system represent a thick sedimentary successions that can be correlated over a wide area. Unraveling the geometry and distribution patterns of the each component bed and bed-set within a sheet-like turbidite package is critical for better understanding of spatiotemporal changes in the formative processes of sheet-like turbidite successions and of the estimation of volume and interconnectivity of widespread reservoir sands and sandstones. Here, we studied spatial and temporal variations in geometry and distribution patterns of sheet-like turbidite sandstone beds within a submarine-fan succession of the Mio-Pliocene Kiyosumi Formation on Boso Peninsula, central Japan. The formation, as much as 850 m thick, represents a small sand-dominated submarine-fan system developed in a forearc basin. On the basis of mapping of several key tuff beds, we conducted bed-by-bed correlation of sheet- like turbidite sandstone beds within a 20–45 m thick package composed of 83 sheet-like turbidite sandstone beds in the middle part of the formation. The compensation-index value of Straub *et al.* (2009), which represents the exponent of the power-law trend in the decay of the standard deviation of accumulated thickness of each component turbidite sandstone bed and is an indicator of stacking pattern in a sedimentary successions, is 0.67 in the studied succession. This value is interpreted to represent that the stacking pattern of each bed is characterized by mixture of random and compensational stacking patterns. In addition, migration patterns of the thickness-weighted depocenter of each sheet- like turbidite sandstone bed relative to its underlying bed show repetitive sequential changes: the migration distance show repetition of increase- and-decrease patterns from the base to the top of the studied interval. These patterns permit subdivision of the studied interval into five bed- sets. The compensation-index value in the stacking patterns of bed-sets is 0.94, and the value indicates that the compensational stacking patterns were dominant in the stacking of the bed-sets. The values of migration distances of the thickness-weighted depocenter of each bed- set relative to its underlying bed-set are, in general, smaller than those of the migration distances of the component beds. The increase-and-decrease sequential patterns in the migration distances of depocenter of each bed and compensational stacking patterns of the bed-sets are interpreted to document the repetitive sequential changes of (1) the development of topographic lows and (2) the infilling and flattening out of these lows. The latter processes may have resulted in a sea-floor condition required for unrestricted flowing of turbidity currents, which developed the former topographic condition. The largely stable position of depocenter of bed-sets may be due to balanced interplay between forearc tectonics and compensational stacking of turbidite sandstone beds.

Straub, K.M., Paola, C., Mohrig, D., Wolinsky, M.A. and George, T. (2009) Compensational stacking of channelized sedimentary deposits. J. Sed. Res., 79, 673–688.

Stacking processes of sheet-like turbidites in a forearc submarine-fan succession: a case study from the Mio-Pliocene Kiyosumi Formation on Boso Peninsula, central Japan

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Sheet-like turbidites formed within deep-marine sedimentary systems are tabular in shape and correlated over a wide area. Unraveling the stacking patterns of sheet-like turbidites in deep-marine sedimentary records is critical for better understanding of the sediment dispersal patterns of a single flow event in time and space, and of the estimation of volume and interconnectivity of widespread reservoir sands and sandstones. Using three-dimensional exposures and the mapping of abundant key- tuff beds, a submarine fan succession of the Mio-Pliocene Kiyosumi Formation on Boso Peninsula of central Japan provides an ideal opportunity to investigate high-resolution definition of geometry and distribution patterns of sheet-like turbidite sandstones. The formation, as much as 850 m thick, represents a small sand-dominated submarine-fan system developed in a forearc basin during the period between 4 and 5 Ma. In this study, 29 sections were measured for a 10–15 m thick package, which is composed of 11 sheet-like turbidite beds in the upper part of the formation. We conducted bed-by-bed correlation for elucidating geometry and stacking patterns of the sheet-like turbidite sandstone. The estimated value of compensation-index of Straub *et al.* (2009), which represents the exponent of the power-law trend in the decay of the standard deviation of accumulated thickness of each component turbidite bed and can be used as an quantitative indicator of stacking patterns in a sedimentary successions, is 0.95 in the studied succession. This value is interpreted to represent that the stacking pattern of the studied succession is characterized mainly by compensational stacking patterns. Migration of thickness-weighted depocenters of each sheet-like turbidite sandstone bed relative to the underlying bed show mainly in the northeast-southwest direction. Major palaeocurrents in the studied succession is in the east-southeast direction and are nearly orthogonal to the migration direction of the depocenters. Therefore, the migration patterns of depocenter of each bed in the studied succession are characterized by sideways shifting in the loci of sediment distribution. Such sideways shifting in the loci of successive beds are probably caused by the subtle morphological influence of the sea-floor condition formed by the preceding flow events on the trajectory of succeeding turbidity currents.

Straub, K.M., Paola, C., Mohrig, D., Wolinsky, M.A. and George, T. (2009) Compensational stacking of channelized sedimentary deposits. J. Sed. Res., 79, 673–688.

Comparative diagenesis of last interglacial coral terraces from Mayaguana, West Caicos and Providenciales Islands (SE Bahamas). Implications for reservoir geology

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Petrographic and mineralogical investigations of coral samples collected from three upper Pleistocene reefs located on neighbouring islands in the SE Bahamas reveal striking disparities in diagenetic alteration, likely related to differences in regional hydrogeological setting, that profoundly modify the reservoir properties of these coeval rock bodies. Mayaguana, West Caicos and Providenciales Islands are situated within a 100 km radius in the SE Bahamas, the latter two islands further standing on the same platform. The western sector of each of these islands comprises one large fossil bank-barrier reef forming a low terrace and dating from the last interglacial period (Marine Isotope Stage 5e). Acropora palmata, Montastrea annularis and Diploria strigosa are the predominant coral species in all of these build ups. With the aim of reconstructing sea-level history during the last interglacial, we have collected several coral samples from each of these terraces, examined their petrographic characteristics with a polarizing microscope, quantified their mineralogical composition by XRD analysis, and dated them with the U-series TIMS technique. Coral specimens gathered from Mayaguana, Providenciales and the southern tip of West Caicos are usually well preserved. Coral skeletons still consist of fibrous aragonite and further display preserved calcification centers. Corallites are empty, except for rare vadose silt and internal micritic sediment. Percentage of calcite varies between 0 and 6%, with only three samples out of eleven containing more than 4% of this mineral. U-Th ages range from about 128 to 105 ka. In contrast, coral specimens collected from the central part of the West Caicos reef, near Boat Cove, display a significant degree of diagenetic alteration. In coral skeletons, fibrous aragonite has been partly to wholly replaced by coarse neomorphic spar and calcification centers have been dissolved. Corallites are commonly filled by coarse, blocky, low-Mg calcite cement. Percentage of calcite varies between 6 and 100% in the six collected samples, and U-Th ages range between about 120 ka and an infinite age. Amino-acid ratios measured from the reef sandy matrices are similar at all sites and correlate with the last interglacial. The higher degree of diagenetic alteration observed in the central part of the West Caicos reef can thus not be explained by an age difference. The three studied reefs are less than 100 km apart and all crop out in the western portion of a small island. The observed disparities in diagenetic alteration can thus not be explained by differences in regional or local climate conditions. The Providenciales and Mayaguana reefs are directly capped by a thin calcrete that could have blocked the percolation of meteoric waters, protecting the corals from diagenesis. However, 14C dating of these crusts gave an age of 3 ka, suggesting they played a minor role in the weathering history of the underlying reef. A large inland lake, Lake Catherine, lies to the east of the central part of the West Caicos reef. It pinches out towards the S and has no equivalents on the other islands. This lake has fairly normal salinity waters nowadays, but following episodes of high lake level, such as after hurricanes, fresh to brackish water could have drained through the reef and enhanced diagenetic reactions (neomorphism, cementation, dissolution), modifying the reservoir properties of this rock body. Furthermore, when sea level was lower than present, some 14 to 10 ka ago, Lake Catherine was a large, flat area susceptible to retaining fresh water for a while, before it drained through, and diagenetically modified underlying and adjoining deposits. This study shows that closely spaced, coeval, and compositionally identical rock bodies, such as reefs, can acquire different reservoir properties due to differences in regional hydrogeological setting, which must be considered in oil exploration and reserve estimations.

Formation and diagenesis of hardgrounds associated with carbonate platform drowning: a case study from the Hauterivian of Switzerland

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Incipient and final carbonate platform drowning phases of Early Cretaceous age have been recognized throughout the northern Tethyan realm. The resulting drowning unconformities often represent multiphase and very complex surfaces, which were formed in an interplay of physical, chemical and biological erosion, and cementation by different mineralogies. In the western Jura mountains and the Helvetic Alps of Switzerland, the carbonate platform that developed during the Early Cretaceous underwent several phases of retreat and subsequent drowning, especially in the Early Hauterivian, where heterozoan ecosystems characteristic of mesotrophic conditions ceased abruptly, and are topped by a well-expressed condensation phase, known as the Uttins or Lidernen hardground in the Jura or the Alps, respectively. Several approaches were applied to samples from the western Swiss Jura, in order to understand the chronology of diagenetic processes that lead to the formation of the hardground. First, in-depth analysis by means of optical microscopy allows the identification of at least ten diagenetic stages for the formation of the Uttins hardground. After the deposition of the grains (1) and their micritisation (2), dissolution and neomorphism affect bivalve debris and oolites (3). Then, an early phase of cementation in phreatic environment in highlighted by isopachous rims (4); it may be followed in time by syntaxial cement overgrowths (5) and mechanical compaction (6), resulting in sutured contacts between grains. An equant spar drusy mosaic is occluding the remaining porosity (7), and may predate a dissolution phase depicted from the corrosion of bivalve and echinoid remains located 1mm under the surface of the hardground itself (8). The latter is cemented by dolomite, phosphates, iron oxyhydroxydes and silica (9), and this indurated surface is subsequently perforated and encrusted by oysters (10). Transgressive clays containing rare ammonites and more frequent bivalves are infilling the perforations (11). Finally, pressure-dissolution features and microstylolites are developed by a later compaction phase (12). Whereas eogenetic and telogenetic processes are rather easily discernable (phases 1 to 5 and 8 to 11, respectively), the attribution of phases 6 and 7 to the mesogenetic realm is more arguable, and require more investigation; equant spar drusy mosaic development may occur either in near-surface meteoric as well as in burial environments. Microsampling of this cement and analysis of its oxygen-isotope signature may help in differentiating between the aforementioned diagenetic environments. On the other hand, a further observation of the thin sections by means of cathodoluminescence may help in refining the chronology of cementation; in particular it may clarify the relationship between early isopachous cement, syntaxial overgrowths and possible dolomitization, and reveal a more complex, polyphased history for the equant spar drusy mosaic. The finding of this hardground in several localities of the northern Tethyan margin suggests a common mechanism for its formation, and in particular its linkage with sea-level change. Moreover, the identification of meteoric cements would support the correlation of the Uttins hardground with a major sequence boundary characterized by an emersion phase, which contributed to the demise of this carbonate platform.

Deciphering between palaeoclimatic signal and hydrothermal overprint: Example from the Early Aptian of the Bir Oum Ali area, Northern Chotts Chain, Tunisia

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Oceanic Anoxic Events (OAEs) developed during the Early Cretaceous. They are characterised by the deposition of organic-rich facies and are quite often associated with perturbations in the carbon cycle. In the Early Aptian, the OAE1a gathered these characteristics, and is also associated with crisis in marine biota (e.g., nannoconid crisis). In the Northern Chotts Chain of southwestern Tunisia, exposures of the Berrani and the Orbata formations are unique and superb, mainly because of the lack of vegetation and the continuity of outcrops; using benthic foraminifera, these formations are dated to the Barremian and Early Aptian (Bedoulian), respectively, and may thus constitute an archive of the OAE1a in proximal environments. They were indeed deposited in the inner part of a carbonate platform that developed at that time on the southern Tethyan margin, as testified by sedimentary features such as herringbones stratifications, as well as the proportion of siliciclastic and evaporitic sediments, which suggest the proximity of the land and enhanced restriction. However, intense hydrothermal activity occurred in this region of Tunisia, and may be linked to fluid circulation during burial diagenesis under an Albian-Cenomanian sedimentary cover. Dolomitization and mineralisation are rather frequent phenomena affecting, in particular, the karst developed at the top of the Berrani formation. On the other hand, such diagenetic features may have had an impact on the carbon isotope signature. Mineralogical study by means of X-ray diffraction has been performed to assess the influence of these late diagenetic processes, and thus to test the validity of the $\delta^{13}C$ evolution, that could subsequently be correlated with other coeval records. When preserved, original clay-mineral assemblages have been used to reconstruct palaeoclimates, and that may help explaining thick successions of salt observed in the Bir Oum Ali area, as well as blooms of orbitolinids and algae dated to the upper Bedoulian (ca. D. deshayesi – D. furcata ammonite zones).

Sedimentary processes over a mudflat in an intertidal area at Passagem Channel - Vitória Bay, southeastern Brazil

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Intertidal areas are considered to be very important ecosystems and also act as buffer zones to the coast. This work has investigated intertidal morphological changes and how it relates to prevailing hydrodynamic conditions. Sediment transport rates and bed level changes were measured over a mudflat in an intertidal area at Passagem Channel - Vitória Bay, Vitória–ES, SE Brazil. Bed level changes were measured through accrectional poles during two years, while tidal currents where obtained using an ADV (Acoustic Doppler Velocimeter) Sontek/YSI 10 MHz. Current measurements were taken at 15cm above the bed, one day during a spring tidal cycle. Suspended particulated material (SPM) were determined by calibrating the acoustic backscatter signal from the ADV by using in situ collected water samples. Data have revealed that higher values of tidal current speed (around 0.07 and 0.05 m/s) were mesuread at the end of the flood phase and beginning of the ebb phase. SPM transport pattern were determined using SPM concentration and current direction. During flood phase, the main direction of SPM transport was shoreward (N). However, before the end of this phase a veering of the flow was observed probably due to a strong precipitation at the study area. Because of the rain, the mudflat water level increased and the flow was forced towards to the main channel. During ebb phase the main direction of SPM transport was toward the channel (S). The long-shore component indicated mouthward direction during the ebb phase, which may indicate the importance of secondary transport that occurs in mudflats areas due to higher bed friction. This pattern has been discussed by many authors elsewhere (Quaresma, 2004; Price & Townend, 2000). Analysis of SPM rates showed that the concentration during the flood phase was greater than ebb phase indicating that part of it was trapped at the mudflat system (about 70%). Tidal currents appear to be transporting SPM from the main channel onto the mudflat. As a consequence, the overall predominant SPM transport was towards to the mudflat. The morphological variation pattern strongly corroborates to the SPM transport direction, as bed accretion was observed on the mudflat. During the study, an important anthropogenic activity has influenced the local hydrodynamic pattern. About 1km south from the site of measurements (mouthwards), the city council started to build a new bridge (Passagem Bridge). Dredging and the installation of pillars have induced a great deal of bed ressuspension, and because of the construction, the channel was narrowed. This interference on the bed and on the hydrodynamic conditions has directly affected the mudflat morphology and sedimentology. Higher rates of bed accretion were determined and a higher content ratio of silt/clay was observed. Finally, it was observed that mudflat morphodynamics is naturally controlled by tidal current patterns, leading to bed accretion, but can also be very sensitive to anthropogenic interferences.

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Modern microbialites in a high-altitude Andean lake of Catamarca Province (Argentina): an analogue to Precambrian sedimentary environments and carbonate microfabrics

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While stromatolites are considered the mineralized record of microbial life on Earth, stromatolite-like structures can also be the product of abiotic processes. Because stromatolites are the result of interacting physical, chemical and biological processes they contain a spectrum of signatures ranging from biotic to abiotic. The study of fossil microbial life is challenging because of the lack of modern analogues for Precambrian stromatolite microfabrics as well as the frequent overprint of secondary alteration onto geologically ancient materials. Here we report on modern microbial mats, mineral precipitates and stromatolites located in Laguna Negra (LN), a high-altitude (~4200 m) Andean lake of Catamarca (Argentina). These develop in a volcano- sedimentary setting under extreme environmental conditions, and show stromatolite microfabrics similar to those observed in the Precambrian record. The high UV-radiation influx, extremes of temperature, salinity and water activity strongly limit eukaryotic life and microfabrics are primarily controlled by microbial and environmental processes. These features make LN an excellent natural laboratory to study microbe- mineral interactions in an analogue to Precambrian environments. LN has an area of ~8620 km^2 and is located at the southeast end of the Laguna Verde Complex (LVC), a series of rapidly evaporating lakes in the Puna Andean region of the Catamarca Province (Argentina). LN is a shallow (~1 m) hypersaline lake (salinity 285.6 ppt) with a low-sulfate (100 mg/L) calcium-sodium-chlorine rich brine (19 g/L, 90 and 198 g/L respectively). LN waters are slightly acidic (5.5-6 pH units) and have moderate alkalinity (690-930 mg/L). The detrital sedimentary cover consists of silty to sandy immature siliciclastic sediment and mineral precipitation is represented by both carbonate and evaporite deposits. Carbonate deposits, typically calcite, cover an area of ~298236 m^2 and consist of stromatolites/oncolites and mineral crusts associated with microbial mats. At a macro-scale the stromatolites/oncolites and the associated mineral crusts are represented by millimeter to decimeter-scale laminar crusts, discs, flattened domes, columns and mounds; these can contain vertical columnar growth as well as lateral extensions. At the micro-scale the mounds, discs and flattened domes show a generally concentric pattern of laterally continuous irregular, wrinkled lamina with a thickness of 50- 100 µm. The lamination consists of dark micritic to microsparitic carbonate interlaminated with irregular to regular translucent lamina, composed of either individual or stacked micro-laminated botryoids or isopachous fibrous crusts. The lamination form both convex-upward micro-domes as well as mini-columnar convex-upward structures. Fluorescence microscopy shows organic matter, putative microbial remains, suggesting mineral precipitation associated with microbial mat activity. Lamina accretion is controlled by mineral precipitation and trapping and binding of detrital sediments is minor. Stable isotopes analyses (δ^{13}Ccarb and δ^{18}Ocarb) of stromatolite lamina show a positive co-variation trend and extremely heavy carbon isotope values (between 13‰ and 4‰) that could be assigned to a Rayleigh distillation process associated to evaporation and fast CO_2 degassing. Strong fractionation due to biological activity can also be an alternative hypothesis that needs to be tested The laminated micro-textures found in LN stromatolites/oncolites notably resemble those commonly recorded in well-preserved Precambrian stromatolites suggesting similar processes during lamina accretion. The mineralizing microbial system in Laguna Negra is a unique natural laboratory where a spectrum of ongoing biotic and abiotic process and potential biosignatures can be studied and tested improving our ability to interpret the sedimentary record.

REE of Neoproterozoic phosphate concretions and their diagenetic implications: Tandilia System, Argentina

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Two phosphogenetic events are recognized in the Neoproterozoic Tandilia System based on the preservation of concretionary phosphate P2O5 abundances ranging between 25 to 35%. The older of the two is atop the quartz-arkosic facies association of the Villa Mónica Formation (Gómez Peral *et al.*, 2005). The age of this unit is until controversial since it was considered Tonian-Cryogenian for stromatolite assemblages (Poiré, 1993) and Ediacarian regarding acritarch assemblages (Gaucher *et al.*, 2005). Further investigation on micropaleontology of the phosphate concretions is considered in order to assess the age of these rocks. The younger phosphate level is at the base of the Cerro Negro Formation (Ediacarian) in association with a widespread karstic surface. In both cases these phosphate concretionary levels are related to relative sea level fall probably as a result of glaciations. Total REE contents in phosphate concretions range from 311 to 1010 ppm in the Villa Mónica Formation and from 290 to 1471 ppm in the Cerro Negro Formation. These values are comparable with averages reported for similarly-aged phosphogenetic events worldwide. Cerium is unusually enriched in the Villa Monica samples (Ce/La vary from 2.3 to 3.2), which may be attributed to either diagenetic alteration or an increase in the detrital component. All samples show a progressive depletion in REE abundance patterns, and positive Eu anomalies (ranging from 1. to 1.4). Eu anomalies may be considered as real since there is no positive correlation between Ba and Eu. The overall REE results suggest reducing conditions in deep marine environments, which may be related to stratification of seawater in the Villa Monica basin. In the Cerro Negro samples Ce/La varies from 1.3 to 1.9, implying little enrichment in Ce, and negative Ce anomalies (Ce/Ce*) range from -0.15 to -0.18; no Eu anomalies are observed. These results are consistent with oxic sea water conditions in mixed platform (marls, silty sandstone – mud limestones) facies. Ce/Ce* are typically accepted as primary signatures if there is no correlation between LaN/SmN and when these ratios are above 0.35. In our sample set five samples show LaN/SmN slightly lower than 0.35. Furthermore, diagenetic processes may result in the correlation between Ce/Ce* and DyN/SmN, and positive correlation between Ce/Ce* and REE contents. These correlations do not appear and REE abundances likely reflect paleoseawater redox conditions. This study suggests that marine depositional conditions where phosphates accumulated were very different in these two discrete stratigraphic levels. The REE patterns from selected unaltered samples of the Villa Mónica Formation indicate a marine depositional environment with anoxic characteristics which could be linked with a stratified ocean probably related to the Cryogenian. On the other hand, phosphate concretions of the Cerro Negro Formation are associated with oxygenated seawater more characteristic of Later Ediacarian-Lower Cambrian oceans.

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Gómez Peral, L., Poiré, D.G., y Canalicchio, J.M., 2005. Clastos fosfáticos en la Formación Villa Mónica, Neoproterozoico inferior, Sistema de Tandilia, Argentina. XVI Congreso Geológico Argentino, III: 125-132.

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C-O isotopes of the Ediacarian Loma Negra Formation in Barker area, Tandilia System, Argentina: diagenetic implications.

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The Neoproterozoic sedimentary succession of the Tandilia Basin is exposed in Olavarría and Barker areas and composed of the Villa Mónica, Cerro Largo, Las Aguilas, Olavarría and Loma Negra formations (Sierras Bayas Group) and the Cerro Negro Formation. On top of the Loma Negra Formation a regional unconformity, Barker Surface, was related to an important sea level fall which could be linked to Gaskiers glaciation, however no negative C isotopes excursions were observed. Carbon and oxygen isotopic data, combined with a detailed diagenetic study, obtained from undeformed and unmetamorphosed limestone, provide a new record of isotopic stratigraphic variations useful for regional and global correlations. The age of Loma Negra Formation (~580-590Ma) was suggested from $\delta^{13}C$ and 87Sr/86Sr trends and supported by *Cloudina*. In the Barker area this unit is composed almost exclusively of greenish (lower section) and black (upper) micritic limestones originated by suspension fall-out in open marine ramp and lagoonal environments. The $\delta^{13}C$ values range from +2.2 to +3.6‰ and $\delta^{18}O$(V-PDB) values vary from –7.4 to –13.5‰. All C- and O- isotope are very close with those reported for the Olavarría area, and show similar excursions. Furthermore, such data are very consistent with Late Ediacarian carbonate successions from SW Gondwana. The sequence is divided in three sections based on stratigraphic distribution of O isotope values and petrography. Section 1: are 6m of greenish micritic limestones with $\delta^{18}O$ values from -13 to -10‰. Section 2: 13 m of black micritic limestones with $\delta^{18}O$ values between -7.4 and -9.2‰. Section 3: the uppermost 5m of the black micritic limestones reflects a stronger influence of ^{18}O depleted meteoric fluids with -13.7‰. A similar distribution was previously recognized in the Olavarría area. For instance, in this work we remark that the $\delta^{18}O$ stratigraphic excursion shows a regional connotation in the Tandilia System. Diagenetic regimens identified in this unit comprise an early marine diagenesis with micritic peloidal cement and authigenic pyrite. Meteoric diagenesis is divided in two episodes: 1) with dissolution-vein generation (i); recrystalization; sparitic LMC cementation (I) and opal and chert cementation, 2) include intense carbonate dissolution (karstic and vuggy), precipitation of silica cements (opal and chert); replacement of calcite by chert. Early to intermediate burial diagenesis is related to neomorphism; chemical compaction and stylolitization; dissolution-vein generation (ii); LMC cementation (II); transformation of opal A to opal CT and chert to micro and mesoquartz. Carbon isotope data for the Loma Negra Formation is considered as near-primary seawater signal and consistent with secular variation curve for Late Neoproterozoic. $\delta^{13}C$org and $\Delta\delta^{13}C$ of organic matter in addition to Mn/Sr, Fe/Sr, Ca/Sr and Rb/Sr reported previously support this consideration (Gómez Peral *et al.*, 2007). $\delta^{18}O$ negative excursions could be in relation with the incursion of diagenetic rich 16O fluids linked with decrease in pH and intense dissolution of carbonate for S1 and S3; however typical trends expected for exposed surfaces with negative $\delta^{13}C$ are not observed. In S2 O- isotope values are related to mayor preservation of the primary texture.

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Paleoseismic and paleoclimatic controls on the sedimentary record of Los Zerpa Palaeolake, Mérida Andes, Venezuela: a new geochemical approach

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On the central region of the Merida Andes, Venezuela, the sedimentary record of Los Zerpas valley contains intramorenic glacio-lacustrine deposits formed during the last glacial retreat. During the sedimentation of this paleolake two controls operated: (i) climate-induced episodes of clastic infilling and; (ii) seismo-tectonic perturbations resulting from the recent activity of the Boconó Fault. The lacustrine facies, therefore, consist of laminated sequences (rhythmites) interstratified with turbidites formed by gravity-flow deposits. The specific control determining gravitational deposition can be differentiated as a distinctive homogenite-type layer related to seiche effect or resuspension of sediments, that are present in the seismoturbidite type subsequences; this layer, however, is absent on climatically-induced turbidites. Here, we identify, characterize and compare the geochemical signatures of different depositional events recorded on the lacustrine sequence of Los Zerpa valley. A section of the sequence (1 m) containing both, rhythmites and gravity flow deposits was continually sampled at high resolution (5 mm) and up to 2 mm in the turbidites in order to determine, by using inductively coupled plasma optical emission spectrometry, the chemical attributes (Al_2O_3, SiO_2, TiO_2, Fe_2O_3, MnO, CaO, MgO, K_2O, Na_2O, Ba, Cu, Cr, Sr, Zn y Zr) that characterize the turbidites and the climatically-induced chemical sign of the sequence. Elemental relations within mud-clay to sand clastic facies were clearly differentiated throughout a multivariable statistical approach and more likely result from the mechanics of fluid flow in the paleolake during gravity flows, a process conditioning also the vertical arrangement of subfacies. The chemofacies and sub-chemofacies identified show a clear correlation among the seismoturbidites (T1 and T2). A comparison of their chemical attributes with those of the climatic induced turbidite (T3) led to distinguish the different depositional controls. This approach allows us to determine a link between the physical sedimentary and the elemental fractionation processes, provided that the control on sedimentation results in specific chemical fingerprints. Through multivariable analysis of the rhythmites we recognized two chemofacies representing physicochemical changes in the lacustrine system from suboxic to oxic conditions and associated to: (i) a mud-clastic facies and; (ii) a quartz-clastic facies, respectively. These variations were caused by changes in the source for clastic particles and climatic variation. Granulometric distribution (Carrillo, 2006) and the K/Al correlation indicate that clay minerals are indeed formed under chemical meteorization, supporting a climatic origin. In addition, the SiO_2 and Zr plot when compared with the granulometry distribution shows a cyclic pattern, similar to the Gleisburg cycle, related to warm and high precipitation periods. Although both climatic influences and the seismotectonic effects were well characterized in Los Zerpa palaeolacustrine deposits, our results indicate that these processes can occur overlapped; the presence of the seismoturbidite T1 within the suboxic chemofacies is an important clue that unravels the effect of tectonic activity on the development of redox variations during deposition. Overall, these findings highlight the use of chemostratigraphy as an important information source and therefore as a strong tool to differentiate the causes of gravitationally-induced processes.

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A high-resolution, continuous climate record of the Lateglacial-Holocene in northwestern Colombia, derived from palynological and geochemical proxies

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Because climate oscillations in the Lateglacial-Holocene period occurred under conditions similar to those of today, they can contribute more efficiently to our understanding of contemporary climate change than do the events of the last glacial period. High-resolution records of climate change in the tropics are particularly important because it is where climate events like the El Niño-Southern Oscillation (ENSO) and the migration of the Intertropical Convergence Zone (ITCZ) take place. This research investigates a continuous, Lateglacial-Holocene, sedimentary sequence cored in the wet zone of the Páramo de Frontino at an altitude of 3,460 m amsl. This high plateau is located at the northwestern termination of the Colombian Western Cordillera. It is strategically situated close to the Pacific and Atlantic oceans, because it is susceptible to receive dry influences from the Caribbean zone, meanwhile it is exposed on its western side to the influence of El Niño. The wet zone occupies a glacial depression which is 14 m deep in its centre. The sedimentary infill consists of a 12.5 m thick organic-rich interval made of peat, organic, organo-mineral and diatomeous muds, with several intercalations of diatomites and volcanic ash. The mineral fraction becomes more important in the lower part of this interval, where oxidized horizons and paleosoils are encountered. This organic- rich interval spans the last 17,000 years. Over thirty ^{14}C datations provide an excellent age model and show the absence of hiatuses in the sequence. Below this section, a still-undated varved sequence probably corresponds to the Pleniglacial. Both high-resolution palynology and geochemistry (XRF) have been used as paleoecological tools. Palynology provides a proxy for vegetation changes which can be related to temperature and water level variations in the wet zone. Variations in the concentration of some elements (Fe and Ti, among others) are a proxy which provides a direct, high-resolution measure of rainfall and runoff from local watersheds. The migration of vegetation belts can be interpreted in terms of temperature variations and compared with Lateglacial-Holocene global climate events. In the Lateglacial, the studied site registered the warmer Bølling-Allerød interstadial and the colder period of the Younger Dryas. The latter is followed by the rapid Early Holocene warming and by a well-expressed Holocene thermal maximum lasting until ca. 6,000 cal yr BP, within which the 8.2 kyr colder event is well marked. During the late part of the Middle Holocene and the Late Holocene, significant temperature changes are interpreted, in particular a warmer phase centered at ca. 3,000 cal yr BP and a cold interval centered at ca. 1,500 cal yr BP. Fe and Ti contents show significant variations throughout the Lateglacial- Holocene period, and can be compared with palynological constituents used as humidity-indicators. The Lateglacial appears as very humid, followed by an even more humid interval which is time-equivalent to the Younger Dryas. A very rapid change to much drier conditions marks the time period equivalent to the Preboreal. The Holocene thermal maximum period shows an overall increase in precipitation. Precipitation decrease significantly over the last 4,000 years. During the Middle and Late Holocene, variations in Fe and Ti show strong similarities with those observed in the Cariaco Basin and can be related to the migration of the mean ITCZ position, providing evidence of global connections among regional climates.

Growth of modern tufa: experimental approach

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Factors controlling the growth rate of tufa and its textures have still been the matter of controversy although in recent years tufa has attracted increasing interest as a useful palaeoclimatic proxy. The field experiment was conducted in order to check what factors influence the growth rate and textures of modern tufa (Gradziński 2010). The study was carried out in Slovakia and Poland. Four recently growing tufa sites were chosen for the complex study. Three sites are fed by infiltration water; however the water in one of them – Karwów – is characterized by long residence time. The fourth site situated in the village of Lúčky is supplied with the mixture of deep circulating and infiltration waters. To assess the tufa growth rate tablets were installed in the places of tufa deposition. Two pairs of tablets were placed in each study site. Each of them comprised one tablet made of limestone and one made of copper. The tablets were installed in summer 2002. One pair was changed seasonally, while the second one was exposed approximately throughout 14 months. The weight of each tablet was checked before and after the experiment. The chemical composition and temperature of parent water were also monitored. Freshly deposited tufa samples were studied under the petrographic and SEM microscopes. The experiment clearly shows that the tufa grows substantially faster on a limestone tablet than on a copper one. Since copper inhibits microbial colonization it strongly suggests that organisms may cause the faster and more efficient growth of tufa. The dependence of the tufa growth rate upon SIcalc. of parent water was also noted. Moreover, in fast-flowing setting the tufa growth rate was faster than in the neighbouring sluggish-flow setting which was fed with the same water. The fast-growing tufa displays crystalline texture or is composed of highly encrusted filaments of algae or cyanobacteria. The former texture results from the inhibition of microbial colonization while the latter is an effect of faster growth of micro-organisms forced by quick crystallization of calcite on their cells. The slow growing tufa exhibits mainly micritic textures. The clear yearly sequence of textures has not been detected. However, some textures, for instance clotted micrite with numerous diatoms, are common in winter, whereas encrusted algal filaments are abundant in spring and summer. The faster tufa growth detected in summer of 2003 was influenced by exceptional warm and dry weather in Central Europe at that time. Among all the studied sites the faster net rate of tufa growth was noted in the Lúčky waterfall site (3.6994 mg/cm2/day). It proves that chemistry of parent water is the main agent governing the tufa growth. It is additionally confirmed by the substantial net rate of tufa growth in the Karwów site (1.0124 mg/cm2/day) which was fed by water of high residence time. The tufa growth rate is also faster in mild microclimate of the Háj site than in more severe mountain microclimate in the Zázrivá site. It suggests that this process is also influenced by local climatic conditions.

Gradziński, M. (2010) Factors controlling growth of modern tufa: results of a field experiment. In: Tufas and Speleothems: Unravelling the Microbial and Physical Controls (Eds H.M. Pedley and M. Rogerson), Geolog. Soc. Spec. Publ., 336, 143-191.

Interpretation and analysis of sandstone bodies of the Castillo and Bajo Barreal Formations (Cretaceous) in the Cañadon Vasco Oil Field, Golfo San Jorge Basin, Santa Cruz, Argentina

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The Cañadón Vasco oil field is located in the southern border of the Golfo San Jorge Basin (Argentina); near to the oil field, the Ballena Hill shows extensive fluvial deposits belonging to Bajo Barreal Formation. Thus, a stratigraphic correlation between them was proposed by using seismic data. The Ballena Hill and the Cañadón Vasco oil field show a strong tectonic control by a NW-SE normal fault reversed during Late Cretaceous. The resistivity imaging logs allowed identifying sedimentary structures, thicknesses, contact hierarchies, measure paleocurrent directions and other details (e.g. biotubation, intraclasts, root fragments and grain size). These data were compared with cutting samples and outcrops data in order to improve the sedimentological model for Bajo Barreal and Castillo Formations (Cretaceous). The integration of cutting samples (grain size and color) and resistivity image logs allowed obtaining a stratigraphic log. Twelve sandstone bodies belonging to Bajo Barreal and Castillo Formations were analyzed following this method and ten litho-facies were defined from this study. The litho-facies assemblages were assigned to channel, crevasse channel, channel bar, splay and floodplain deposits. The sandstone bodies thickness, trough cross stratification and paleocurrent directions were used specific equations to obtain the channel belt width. The sandstone bodies were also associated with the SP and resistivity wire-logs to define a group of electro-facies. Finally, seismic horizon slices related with the sandstone bodies studied were also analyzed as intent to merge litho– and electro-facies assemblages and seismic geoforms. As paleocurrent directions coming from image logs as seismic horizon slices are coincident in to point out several changes in the channel pattern and sinuosity. Most noticeable change occurs for those strata belonging to the lower section of Bajo Barreal Formation (informally named “tobácea section”). The sinuosity increases from 1.15 to around 2 and the channel belt wide reaches 500 m. The sedimentary model of electro-facies may apply to wells (in the same or another oil field) without assistance of image logs but with available 3D seismic information.

Early Pennsylvanian foreland basin evolution in the Appalachians, Virginia, USA: a record of episodic tectonic phases

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The early Pennsylvanian, Lower Breathitt Group of the Pocahontas Basin of southwestern Virginia, USA preserves a record of sedimentation during the initial phases of foreland basin subsidence in advance of the Alleghanian orogeny. Facies patterns, paleocurrent data and detrital zircon geochronology indicate that sediment was derived from low-grade metamorphic and Grenvillian-Avalonian terranes of the Alleghanian orogen towards the southeast and, in part, from the Archean Superior Province to the north. Sublithic sandstone bodies and associated facies were deposited within a southeast to northwest-oriented transverse drainage system. Quartzarenite bodies define strike-parallel elongate belts along the western periphery of the basin. These mature sandstones were sourced from intensely weathered parts of the orogen and craton and were deposited by longitudinal, northeast to southwest-flowing braided rivers. An extensive subsurface and surface dataset permits analysis of episodic changes in the sedimentology, stratigraphic architecture, and composition of the Lower Breathitt Group siliciclastic sedimentary rocks. The record demonstrates that the longitudinal and transverse drainage systems alternated through time possibly in response to episodic thrust loading and unloading. Regional isolith maps of early Pennsylvanian interval formations (Pocahontas, Bottom Creek, Alvy Creek and Grundy formations) indicate significant eastward thickening that suggest asymmetric tectonic subsidence of the early Pennsylvanian foredeep. This increase in proximal accommodation space inhibited progradation of the transverse river system and restricted its lithic sediment load to the most orogen-proximal part of the basin. Tectonic-induced limits on transverse river system sediment supply allowed a longitudinal trunk river system to flow along the axis of the foreland basin nearer to the orogen. As eustatic base level rose, increased load-induced tectonic accommodation permitted sand-starved, marine-influenced shale units to be preserved regionally above tabular quartz arenite bodies. Following episodes of thrust-loading, lithic sands were flushed from proximal, intermontane basins and filled transverse alluvial braidplains that prograded into the medial and distal portions of the foreland basin. The stratigraphic trend of tabular quartzarenite bodies overlain by thick marine shales followed by a sublithic sandstone wedge is repeated three times in the preserved sedimentary record of the Pocahontas Basin. Similar in-phase relationships between depositional patterns and tectonic processes have been suggested for the development of Cenozoic deposits in the Indo-Gangetic foreland basin of western Pakistan and northern India (Burbank, 1992). This work refines paleogeographic and paleotectonic reconstructions at the onset of the Alleghanian Orogen and contributes to general models for the sedimentary evolution of foreland basins.

Fluvial environments at Lake Pebas' southern margin (SE Solimões Basin, Western Amazonia, Brazil; Middle/Late Miocene)

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In Miocene times a vast system of interconnected lakes and wetlands evolved in Western Amazonia, which is subsumed as "Lake Pebas". This enormous inland water system shaped north-western South America for millions of years and acted as considerable dispersal barrier for terrestrial taxa between the Guyana shield and the northern Andes. Aquatic biota like molluscs and ostracods faced spectacular speciation events within this long-lived wetland and provide model cases for studying evolutionary processes linked to, e.g., ecological changes or geographical isolation. Whereas the general development of this amazing ecosystem is well established, several fundamental questions concerning palaeogeography, depositional environments and stratigraphical correlation remain a matter of impetuous debate. Marine intercontinental pathways between the western Caribbean and the Parana Basin through Amazonia are proposed and discussed. Likewise, the frequency, timing and effects or even the existence of marine ingressions into the sedimentary environments of this huge and hardly accessible region is still disputed. In the course of an Austrian-Brazilian project dealing with the evolutionary pattern of a widely occurring and biostratigraphically important ostracod lineage (Cyprideis), several outcrops around Eirunepé (Juruá region, Amazonas state, Brazil) were sedimentologically investigated to obtain basic data of the sedimentary environment. The outcrops are located along the cut banks of the Juruá (Pau D'Alho, Morada Nova, Aquidabã, Remanso) and the Tarauacá River (Torre da Lua, Barro Branco), a few kilometres east respectively south of Eirunepé. The total thickness of the Solimões Formation, which consists of deposits of "Lake Pebas", is estimated to range in the order of several hundreds of metres in that area. However, due to restricted outcrop conditions in Amazonia surface investigations are limited to the uppermost few decametres of Neogene sediments and lateral facies architecture studies are restricted as well. Detailed facies analyses are still missing in this region, which is supposed to be located at the south- eastern margin of "Lake Pebas". The sedimentary record of observed outcrops comprises channel-fills of different orders and origin and sediments of flood basin settings. Fine- grained abandoned channel-fills are documented as well as sandy-silty crevasse-channel and point bar deposits. Within the overbank environment successions of greenish to pale red coloured, intensively mottled paleosols with root casts occur frequently, occasionally also calcrete horizons can be found. Sandy or pelitic layers, rich in carbonaceous matter (including tree trunks) and vertebrate remains refer to swampy environments within the floodplain. Massive to poorly laminated pelites with plentiful mollusc faunas indicate the formation of shallow floodplain lakes or are associated with abandoned channel-fills. Alternations of rhythmically stratified laminated clays/silts and ripple- bedded sands partly represent fine-grained point bar sediments and crevasse-splay deposits. Altogether the investigated sections document various subenvironments of a suspension-load dominated fluvial system. Based on these results, the development of an extensive, deep and stable lake can be excluded as well as any marine influx.

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Stratigraphic architecture of combined fluvial-wave dominated deltas in the Eocene Central Basin, Nathorst Land, Spitsbergen

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One of the most widely applied classification schemes used in the study of modern delta systems are the one proposed by Galloway (1975), where deltas, based on their dominant controlling processes, are classified as wave-, tide- or fluvial dominated. Many workers have adopted this scheme for describing internal facies architecture and stacking pattern within ancient deltaic systems. In recent years, many studies have pointed out that the internal architecture of many ancient deltaic deposits is far more complex than what could be expected from the various classification schemes. The Eocene succession of Spitsbergen comprises a series of more than 25 eastward-sloping coastal-plain to basin-floor clinothem-complexes reflecting the infill of a small foreland basin that formed as a response to the development of the West Spitsbergen fold-and-thrust belt. The clinothems record the east- and basinward accretion of the Eocene shelf margin. The main driving mechanism for the shelf margin accretion was sediment delivery from fluvial systems draining the uplifted fold-and-thrust belt. These fluvial systems prograded into a wave agitated basin (Helland-Hansen, 2010) and are recognized as deltas on the shelf and shelf-edge segments of the clinothems. This study focuses particularly on the deltas and the adjacent shoreline systems that formed on the shallow shelf, thus documenting facies architecture and sand body geometries of combined fluvial-wave dominated shelf-deltas and associated wave- dominated shoreface deposits. From the analysis of several sedimentological sections (including a well core) from Nathorst Land, central Spitsbergen, the following facies associations were recognized and interpreted to represent the shelf-deltas: offshore transition, shoreface (lower to upper), foreshore including both beach- and barrier complexes and mouth bar complexes (fluvial to wave dominated). In addition, the following associations are interpreted to represent the coastal plain located landward of the deltas: estuaries and tidal inlets, distributary channels (both single- and multi-storey), interdistributary bays and lagoons, and flood plain. The associations representing the shelf-deltas and the shorelines are typically arranged in upward- coarsening successions from offshore transition at the base to foreshore and occasionally fluvial distributary channels, or more rarely tidal inlet channels on the top. The successions are typically separated by marine flooding surfaces and pinches out in a basinward direction, thus forming lateral extensive sandstone tongues that can be regarded as regressive parasequences. The overlapping nature of the sandstone bodies and the varying number of parasequences recorded within the system, points to frequent delta-lobe switching (Helland-Hansen, 2010). Even though autogenic mechanisms strongly influenced the lobe switching, allogenic forcing factors like tectonic activity related to uplift and denudation must not be excluded in a foreland setting where these parameters affects both the size of the drainage basin (sediment availability) and the frequency of avulsions. The complex stratigraphic architecture of the system makes regional correlations difficult, as sequence stratigraphic surfaces like flooding surfaces might only represent local episodes of lobe abandonment and subsidence, and fluvial incision surfaces (sequence boundaries) represent normal regression where terminal distributary channels eroded down into the underlying delta front.

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Helland-Hansen, W. (2010) Facies and stacking patterns of shelf-deltas within the Palaeogene Battfjellet Formation, Nordenskiöld Land, Svalbard: Implications for subsurface reservoir prediction. Sedimentology, 57, 190-208.190-208

The 20th century hydroclimatic changes in central Argentina recorded in the sedimentary deposits of Laguna Melincué

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Understanding the role played by the middle latitudes of Southeastern South America (SESA) during climate change situations has become a topic of growing interest among the scientific community. In this sense, the sedimentary record of Laguna Melincué (33°S-61°W), an alkaline shallow lake located in the Argentinean Pampean region, provides the opportunity to disentangle past and present hydroclimate variability across the subtropics of SESA. The instrumental and historical records of Laguna Melincué show important surface and water level fluctuations throughout the 20th century. Changing P-E ratios in this portion of SESA are ruled by the variability of the South America Monsoon like atmospheric circulation system. The high sensitivity and rapid response of Laguna Melincué in front of recent hydrological balance variability highlight the significance of its sedimentary record to analyze Holocene paleoeoclimates in SESA. The multiproxy analyses of sedimentary cores allow the recognition of alternating high lake-level facies (organic matter- rich), deposited during positive hydrological balances and low lake-level facies (carbonate-rich), indicative of negative balances. The hydrological reconstruction suggests an initial arid period during the first decades of the 20th century, followed by alternating humid and dry phases. A dramatic shift to wetter conditions (registered on both, sedimentary and instrumental records) started during the decade of 1970 and it is still present. When the last 100 years record of hydrological variability in Melincué is compared to other lacustrine records across the Pampean region (e.g. Mar Chiquita, Lagunas Encadenadas) synchronous water level fluctuations are recognized. The observed in-phase hydrological behavior across the Pampas points toward the influence of the South America Monsoon on the last 100 years of hydrological changes and supports the hypothesis of this mechanism controlling Holocene hydroclimate variability in SESA.

Paleoprecipitation and seasonality records from paleosol geochemistry of the late Paleozoic Paganzo Group, NW Argentina

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Paleosols of the late Paleozoic Paganzo Group preserve a record of late Pennsylvanian climate amelioration following the demise of the well- documented mid-Carboniferous glacial event. A stratigraphic interval of predominantly plinthic paleosols intermixed with argillic horizon-bearing paleosols occurs in the late Pennsylvanian Patquia Fm. over a broad region of the Paganzo Basin. Fluvial channel incision associated with plinthites within the stratigraphic interval suggests a peneplain or piedmont-like geomorphology and allows for regional determinations of paleoclimate to be assessed and independently verified. Major element geochemistry and paleosol morphology of late Pennsylvanian paleosols indicate a monotonous record of mean annual precipitation (MAP) punctuated by significant decreases in MAP preceding maximum marine flooding surfaces. An analysis of climatic seasonality, however, indicates relative stability in the temporal patterns of precipitation and evapotranspiration potential implying consistent atmospheric circulation trends for the high-latitude region of southwestern Gondwana during the late Pennsylvanian. Despite the relatively stable seasonality, the variability in MAP may indicate latitudinal shifts in the high-pressure polar fronts. Quantitative estimates of net primary production for the studied paleosols are consistent with a mesic soil temperature regime, which is general agreement with quantitative estimates of summer temperatures from pedogenic goethite isotope geochemistry. Carbon isotope geochemistry of goethite collected from plinthites in the studied stratigraphic interval implies seasonal flooding of the paleosols, which is consistent with the proposed geomorphic template and estimated climatic seasonality. Moreover, the carbon isotope values and mole fraction of goethite-associated carbonate suggest a maximum partial pressure of atmospheric CO_2 of 675ppmv under a mesic temperature regime. However, due to hysteresis effects on soil CO_2 during flooding our estimates of atmospheric CO_2 point to lower values approaching pre-industrial levels. Taken together, the qualitative paleopedology and sedimentology and the quantitative geochemistry of late Pennsylvanian paleosols in the Paganzo Basin indicate a substantial departure from climates suitable for the maintenance of tidewater glaciers documented in the mid-Carboniferous and reveal a quasi-stable climate similar to mid- latitude continental regions under interglacial or perhaps greenhouse climate conditions.

Late glacial and deglacial history of northernmost Ungava as revealed by Pingualuit Crater Lake (Nunavik, Canada) sediments: new insights from a Late Pleistocene subglacial lake

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The Pingualuit crater was formed by a meteoritic impact ca. 1.4 million years ago in the terrestrial Canadian Arctic. The Pingualuit Crater Lake (depth = 270 m) promises to yield a continuous unique sedimentary sequence covering several glacial/interglacial cycles due to its geographical position at the center of successive North American ice sheets and its morphometry (shape and depth). Hydraulic potentials were computed using LGM (Last Glacial Maximum) ice-surface elevation and bed derived from a digital elevation model. The modeling results indicate the existence a subglacial lake at least during the LGM. Here, we discuss the radiocarbon-based stratigraphy and facies of a 9 m- long core retrieved from the deep basin of the lake and present a multiproxy reconstruction of the last glacial and deglacial history in northernmost Nunavik (Québec, Canada). Three organic-rich layers with lower magnetic susceptibility and density are sharply contrasting with the rest of the core, mainly consisting of grey sandy silts containing several angular rock fragments. Image analysis of thin sections indicates that these intervals contain finer grains with a higher circularity index, suggesting a lower degree of erosional activity. The long and elongated grains testify to the short distance transport. The organic intervals also reflect more reduced environments, as suggested by the increase of some geochemical proxies (Mn/Ti, Cu/Rb) as revealed by ITRAX core scanning. Lower $\delta^{13}C$ values associated with higher TOC contents reflect an increase of productivity related to ice free conditions during warmer periods. Yet, the coarser material- comprising most of the core- is showing a large range of microstructures frequently recognized in till and glacigenic sediment flow deposits. While the uppermost organic-rich core section represents late Holocene sediments, the lower organic interval is dated around 30 000 yr BP and overlies highly deformed material likely deposited by basal meltout from the Laurentide Ice Sheet suggesting deglaciation of the area just before the late Wisconsinan LGM advance. This could possibly be related to a partial opening of the Hudson Strait at this time. The radiocarbon ages and microfacies analysis suggest that the coarse material was deposited under subglacial conditions. The middle (central) organic-rich layer reflects the early postglacial period and overlies another basal meltout deposit reflecting the onset of the last deglaciation. Around 6600 yr BP, the subglacial lake became a proglacial lake characterized by finely laminated meltwater silts (<1-2 mm) containing injection structures and followed by compact clayey material. A sharp increase in productivity around 6000 yr BP is indicated by higher TOC content and lower $\delta^{13}C$ values, reflecting the final deglaciation of the lake during the Holocene Thermal Maximum. Finally, fecal pellets were observed in thin sections, indicating the presence of Arctic Char in the lake as early as 5400 yr BP.

Provenance of the Upper Oligocene- Lower Miocene Amagá Formation (Antioquia, Colombia) and its tectonic implications

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The Amagá Formation (Upper Oligocene – Lower Miocene) is a lithostratigraphic unit outcropping into a series of basins at northwest of Colombia. Into the unit, three allomembers can be differentiated: Lower, composed of conglomerates, sandstones, mudrocks and coals, bounded at base by an unconformity and at top by a disconformity, its thickness averages130 m; Middle, constituted of sandstones, coals and mudrocks, bounded at its top by a disconformity, reaches about 350 m in thickness and Upper, composed of sandstones and mudrocks, bounded at its top by an unconformity with the Combia Formation (an Upper Miocene – Lower Pliocene volcano sedimentary unit), with more than 1000 m in thickness. Paleoenvironmentally the base of the unit has been interpreted as originated from proximal to distal parts of humid alluvial fans. The upper part of Lower Allomember was associated to braided streams whereas the Middle Allomember was generated by meandering systems. The Upper Allomeber probably was deposited by low sinuosity streams. The existence of alluvial fans toward base suggests that basins were tectonically controlled at their origin; the presence of the basal disconformity in the Middle Allomember can be linked to a rejuvenation associated to an uplift of source area; a similar interpretation can be postulated for the disconformity between the Middle and Upper Allomembers. Accordingly, can be concluded that the main control upon sedimentation is tectonics, which creates the accommodation that makes possible the accumulation of sediments in the different environments. The aforementioned interpretation agrees with the analysis made from the petrographic study. Following the provenance diagrams of Dickinson (1985) a general evolution in relation with the stratigraphic position can be established. At the Lower and Middle Allomembers exist a transition from craton interior to quartzose recycled orogen and transitional recycled orogen; this fact can be explained taking into account that deposition was associated with differential movements along strike slip faults and consequently the sediments came from different tectonic settings. At the Upper Allomember the tectonic provenance corresponds to lithic recycled orogen and transitional arc, in the beginning linked to an uplift of the unit because of presence of intraformational supply and finally associated with a magmatic activity related to a subduction zone located to the west (Pacific Ocean). The integrated analysis of paleoenvironments and tectonic provenance lead to propose that the Amagá Formation was deposited into pull apart basins generated by movements of faults belonging to the Cauca – Romeral Systems Fault at Northwest of Colombia.

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Ordovician oolitic ironstones of Morocco

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Ordovician period was characterized by a great production of oolitic ironstones especially in the margin of the Gondwana. Morocco that belongs to the North Gondwana platform is a privileged place to study these Ordovician oolitic ironstones and to understand their significance. Particularly in the Anti-Atlas domain is where they can reach great thickness and considerable extension in outcrops of an excellent quality. In addition they occur in very known successions on stratigraphic and sedimentologic levels The oolitic ironstones of Floian- Katian period occur in the structural domains of: Western Meseta, High Atlas and Anti-Atlas. These exceptional deposits that underline the major unconformities of shallow marine siliclastic sequences are excellent markers for paleogeographic reconstructions and basin analysis. Sedimentological study allows to precise their sedimentary facies and environments, their mineralogical composition and texture, the sources of their components and the allogenic and autogenic factors that controlled their formation and sedimentation. The Ordovician oolitic ironstones display 8 petrofacies on the basis of their composition and texture : 1)Ferruginous mudstone with scarce ooids and pseudooids, 2) Oolitic greywacke displaying in situ ooids in pore spaces, 3) Grain supported oolitic ironstones with cement and /or matrix, 4) Ferruginous cemented microconglomerat with scarce ooids, 5) Microconglomerat with oolites and matrix, 6) Sandy ironstones containing scattered oolites in a greywacke matrix, 7) Muddy ironstones containing scattered oolites in a clay matrix and 8) Glauconitite containing glaucony with accessory ooids, clastics and cement and /or matrix. On the other hand, they range into two typical facies sequences: a tide estuarine sequence and a storm dominated offshore sequence that may contain a glauconitic term at various levels. Their formation is made at least in two successive stages, characterized each one by a transgressive/regressive cycle. During the first stage, a relative sea level lowstand induced fluvial incision into previously deposited storm dominated shelf sediments and sufficient input of fresh water carrying important concentration of iron from leaching of Precambrian shield which contain crystalline rocks and banded iron formations. During subsequent sea level rise these incised valleys evolve into estuarine environment. The oolitization can be developed in quiet conditions by intrasedimentary accretion from ferruginous mud in subtidal mudflat. The formation of ferruginous ooids is favoured by a combination of specific physico-chemical conditions associated with gradual starvation. The ooids may be reworked into various sediments prior to their final accumulation. During the second stage the ferruginous ooids are carried from their place of origin by tidal currents and concentrated in accreting cross bedded bars or sandwaves and during storm events, they can be transported into deeper parts of the basin by waves and currents. The preservation of these deposits was favoured by local subsidence.

Sedimentary record of Upper Ordovician glaciation in Moroccan North Gondwana margin

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The upper Ordovician sediments of Morocco occur in well-exposed successions in all structural domains, especially in the Anti-atlas where the stratigraphic framework is well established. These successions which have been deposited in the North Gondwana margin are a privileged place to precise the record, the duration, the dynamic and the evolution of the upper Ordovician glaciation. Detailed sedimentological studies (facies analysis, petrography, exoscopy and mineralogy) and sequential stratigraphy of the most representatives Upper Ordovician successions (64 successions) in the structural domains of: Western Meseta, Eastern Meseta, Central Morocco, Rehamna, Jebilet, Middle Atlas, High Atlas and Anti Atlas, allow: 1) to recognize unequivocal evidences of this glaciation in successions of Sandbian, Katian and Hirnantian age such as: glacial features and surfaces, glacial sediments and glacial facies, and 2) to precise the depositional systems and the glacio eustatic control. They also provide an increased understanding of the Upper Ordovician glaciation dynamic, timing and evolution. Lateral and vertical paleoenvironmental evolution suggests that: 1) there was at least two ice sheet separated by epeiric seas: the “Mesetian basin” and the “Atlasic basin” and 2) the thermal regime of the glacier was variable in time and space. The glacial phenomena was not restricted to the Hirnantian period, glacial history started at the boundary of Middle Ordovician and Upper Ordovician and extend until the Lower Rhuddanian. During Sandbian and Lower Katian, the regime of the glacier is characterized by a series of ice front retreat and advances as the ice cover changed from cold based glacier to subpolar marine ice sheet. During the upper Katian, there was probably an intensifying of cold climate and evolution into a stationary deeply frozen glacier. The waning began during theHiranantian, the glacier was a temperate oceanic type and melts progressively with a series of ice front retreats and advances.

The Upper Ordovician cold carbonate mounds and associated deposits of Eastern Anti-Atlas (Morocco): facies, depositional models and control

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The eastern Anti-Atlas (Tafilalt and Maider) display exceptional and unique upper Ordovician series that are really different from the other Moroccan upper Ordovician siliciclastic successions. In the Alnif areas, the upper Formation of Tiouririne that overlies conformably the middle Ordovician storm dominated delta and offshore siliciclastic succession, is composed of three depositional sequences. The lower one is a tide and storm dominated littoral and shelf siliciclastic sequence including carbonate mounds. The second one is a fan delta sequence made up of a muddy level sharply overlain by a spectacular conglomeratic horizon where the nature of the sediment and the facies indicate reworking by gravity flow processes of the underlying carbonate formation and glacial sediment discharges. The upper one is composed of glaciomarine sediments and tide dominated delta sequence and is overlain by the tide and glacial dominated littoral sequence of the 2nd Bani Formation. In the eastern Tafilalt, the upper Ordovician successions where the 2nd Bani formation was not identified, are characterized by a low thickness and extent and a high content of carbonate and bryozoans. The biostrome of bryozoan limestones of Khabt El Hajar is considered as the laterally variant of upper Formation of Tiouririne and corresponds to the oldest outcrops in this area. The facies sequence suggests deposition in cold peritidal mixed siliciclastic / carbonate high energy littoral setting, adjacent to a carbonate platform. Evidence of glacial action is strongly suggested by the existence of fields of dessication polygons, soft sediment deformations, frost shattering, topography in ruins and the existence of glacial sediments. The facies and the trend of these depositional sequences reflect a complex history of this part of the Moroccan North Gondwanan platform under the interplay between tectonics and the upper Ordovician glaciation. The eastern Anti Atlas that corresponded to a storm and / or tides dominated epeiric siliciclastic sea with E-W to ENE-WSW trending isopachs, during the lower and middle Ordovician such as the whole “anti -atlasic basin”, recorded major paleogeographical changes during the upper Ordovician. An extensional tectonic event related to the reactivation of the pan African faults movements according to NE-SW direction leads to the creation of a trough of NW SE direction between two ramp type platforms where the sedimentation developed under the control of the glaciation (Change in the climate and glacial mass, sea level fluctuations and glacial discharges) and tectonic controls. The eastern Tafilalt platforms developed on previously (lower and middle Ordovician) submerged areas and the Maider platforms took place on the previous siliciclastic shelf. During phases of sea level rise, the water depth over the ramps allows the development of bryozoan mounds and the sedimentation in peritidal zones that were alimented by biogenic gravels and sand derived from subtidal areas and siliciclastic sediments derived from glacial discharges. Phases of sea level fall result in the stop of bryozoan mounds build up, their degradation by mechanical erosion and their accumulation with the sediment discharges from the Saharan ice sheet in fan delta systems in the trough.

Seasonal variation of sedimentary environments in Geunso Bay at the west coast of Korea

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The western tidal flats of Korean Peninsula are directly influenced by monsoons. Affected by waves in winter and tidal currents in summer, the seasonal change of sediment characteristics comprises deposition and/or erosion. Geunso Bay in the mid-west of Korea is a semi- enclosed bay with a mean tidal range of about 6 m. The tidal flats are largely developed all along the side of the bay. In this study, we attempted to understand the seasonal variations of sediment characteristics caused by sedimentary processes, through monitoring sedimentation rates on Geunso tidal flat and comparing with other tidal flats of the semi-enclosed bay type. The sedimentation rate at two transects was determined for a year by periodically measuring the changes in depth between the surface and plate. The surface sediments for sedimentary analysis were sampled at 45 stations in February and August 2009. The grain-sized distributions were determined by using standard sieving and Sedigraph 5100. The inclusive graphic method was used to determine sediment type, mean, sorting, skewness and kurtosis. The surface sediments in Geunso Bay were classified into five sedimentary facies. In winter, surface sediments on tidal flat were mainly composed of poorly-sorted muddy and silty sand. The tidal flat near the shoreline was consisted of sandy mud. The sub-tidal flat was dominated by the silty sand sediments. In comparison sedimentary facies in winter with those in summer, muddy sand sediments on tidal flat extended to sub-tidal area and sandy mud sediments in the western part extended to southward tidal flat. The annual sediment accumulation rate was encountered up to 51.7 mm/year in Line W. In Line E, the sediments were deposited within 800 m from shoreline and were eroded 800 – 1800 m from shoreline. The seasonal variations of sedimentation showed that the accumulation was dominated during spring and winter at Line W, whereas the deposition was occurred within 800 m from shoreline in summer and in autumn at line E. The hydrodynamic measurements at the bay mouth indicated that suspended-sediment concentrations at the bay mouth were relatively higher (10-40 mg/l) in winter and spring; on the other hand, they were lower (about 10 mg/l) in summer (KORDI, 2007). The relatively high supply of suspended materials into the bay resulted to show various sedimentary facies on tidal flat in winter. The seasonal variations of sedimentation on the Muan and Hampying tidal flats showed that the deposition was occurred in winter and the erosion was occurred in summer (Ryu *et al.* 2004). In comparison seasonal variation of sediment on Geunso tidal flat with those on Muan and Hampyong tidal flats, there was a similar pattern at Line W but the contrast tendency was shown at Line E in winter. The direction of the tidal currents was flowed into the northeast in flood and was flowed out of the southwest in ebb currents. The main channel was occurred to the east of the bay. During winter, the suspended and eroded sediments near the main channel (Line E) were transported and were deposited in the western part of the bay (Line W). During summer, the eroded tidal flat was occurred by the tidal currents in an insufficient supply of suspended sediments. The winter waves played a limited role in the seasonal variation of sedimentation due to an open bay mouth to the southwest. According to these features, the supplied suspended- sediment and circulation pattern of tidal current should be important for seasonal variation of sediments on tidal flat in Geunso bay.

KORDI (2007) Assessment on the flux at the sediment-water boundary and ecological role of intertidal flat. BSPE97703-1925-3, 332pp.

Ryu, S.O., Lee, H.J., Chang, J.H. (2004) Seasonal cycle of sedimentary process on mesotidal flats in the semienclosed Muan Bay, southern west coast of Korea: culminating summertime erosion. Cont. Shelf Res., 24, 137-147.

Shallow-marine sediment depocentres off the Rio de la Plata (Uruguay): formation dynamics and use as environmental archives

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The formation of fluvially derived shallow-marine depocentres mainly depends on a) the amount of available riverine sediments, and b) the interplay of the hydrographic energy system with the regional and local shelf topography. These shelfal depocentres appear commonly fully detached from the river point source and represent the main sinks of fine-grained terrigenous material on continental shelves. Such laterally defined mud centers build up in stationary position over millennia during intervals of stable sea level, but they might also occur as short-living, rapidly lateral-translating sediment bodies during transgressive and regressive dynamics. Recent research aims at discovering the value of such depocentres since these deposits record the environmental changes sensitively in terms of unraveling sediment input as well as shelf dispersal mechanisms, both controlled by climatic conditions and their changes. Off the giant mouth funnel of the Rio de la Plata (Uruguay), the continental shelf is impressively dominated by strong ocean currents. However, a S-N elongated channel-like 30-m deep depression of the seafloor, which might have formed as the palaeo-valley of this major river system during times of lower sea level, acts as an important sediment trap for fine material from the river source. This exceptional mud depocentre rests well-protected in 70 m water depth as a 5.5-m thick channel fill. Deposition started shortly after initial drowning of the shelf in the run of the rising deglacial sea level and shows a continuous mud accumulation until today, thus containing palaeo-environmental information for the entire Holocene. By combining stratigraphic, granulometric, geochemical, isotopic and micropalaeontological methods on two sediment cores, we intend to decipher the history of a) terrigenous sediment supply (fluvial runoff intensity) and of b) material distribution mechanisms (shallow-water current system). By transgressing from the North, sea level caused a southward-directed time-transgressive initiation of mud formation inside the palaeo-valley structure. This formation was associated with a jump in sedimentary facies from high-energy tidal to open-marine mud deposition in the depression's center, together with a gradual lateral shift from sand bars to mud facies at the depression's seaward margin. The fluvial sediment supply seems to have increased in steps over the past millennia with subordinate fluctuations and with the highest input in recent times. Influence and changes of the oceanographic regime are only to minor extent recorded within this deep depression. By combining this particular sediment archive with a number of locally defined depocentres, likewise covered by sediment cores, on the middle to outer shelf and on the uppermost slope (see related Abstracts of Lantzsch *et al.*, Bender *et al.*, Chiessi *et al.*) we intend to achieve to a comprehensive picture of the sedimentary system and the controlling forces since the Last Glacial Maximum with particular regard to changes in sea level, volume of sediment supply, location of sediment input, persistent vs. event-like oceanographic control, and climatic implications as superior factor. Moreover, future research will address the volumes of fine-grained material retained in the river mouth funnel and in the offshore channel depression, and compared to the volume of material which is transported northward across the shelf. In addition, the signals inferred from the mudbelt cores will be compared to those obtained from sediment cores taken from coastal lagoons of SE Uruguay to investigate possible links between ocean and coastal processes in Holocene times.

Integrated ichnological-sedimentological characterization of a mixed river-wave influenced asymmetric delta lobe: Upper Cretaceous Belly River Formation, Alberta, Canada

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The Upper Cretaceous (Campanian) basal Belly River Formation in central Alberta, Canada provides one of the first documented subsurface examples of an ancient asymmetric delta lobe. The interval comprises a series of offlapping deltaic wedges, with Cycle G a lobe characterized by both wave and river influence. Cycle G is penetrated by numerous cores, making it ideal for a detailed study focused on the facies characteristics of a mixed river-wave influenced delta lobe. Facies mapping and stratigraphic correlation demonstrates a striking asymmetry in facies distribution. Analysis of 56-cored intervals shows that Cycle G can be differentiated into two mappable facies associations (FA1 and FA2). FA1 comprises uniformly coarsening-upward successions with abundant wave- and storm-generated sedimentary structures (e.g., HCS and oscillation ripples). In contrast, FA2 forms variable and markedly heterolithic coarsening-upwards successions, dominated by current-generated structures, convolute bedding, normally graded layers, structureless siltstones, dark claystone drapes, synaeresis cracks, and rare sediment-gravity flow deposits. Both facies associations yield sporadically distributed trace fossil suites attributable to stressed expressions of the *Cruziana* Ichnofacies. Nevertheless, the relative abundance and diversity of ichnogenera constituting the suites differ markedly. FA1 contains moderate- abundance and moderate-diversity trace fossil suites, with bioturbation intensities ranging from BI 1-5. Successions possess moderate to abundant numbers of *Planolites, Chondrites, Helminthopsis, Cosmorhaphe, Teichichnus, Thalassinoides, Rosselia, Macaronichnus* isp., and fugichnia, as well as fully marine forms such as *Phycosiphon* and *Rhizocorallium*. FA2, on the other hand, records low-abundance and very low-diversity suites dominated by facies-crossing deposit-feeding structures, as well as very low bioturbation intensities (BI 0-1). Facies-crossing elements such as *Planolites, Teichichnus, Thalassinoides*, and *Chondrites* dominate the suite. The integration of ichnological and sedimentological characteristics highlight pronounced changes in the processes controlling sediment accumulation in Cycle G. FA1 represents deltaic conditions dominated by wave and storm processes with little impact of river sediment influx. FA2, by contrast, records abundant evidence of river-generated processes (e.g., buoyant mud plumes, salinity fluctuations, elevated deposition rates, and hyperpycnal flows) and their associated physico- chemical stresses. The published asymmetric delta model exactly predicts this scenario. The homogeneous coarsening-upward successions of FA1 lying to the SSE reflect the higher sand contents and stronger wave influence expected along updrift portions of the delta. Reduced river influence is manifest by higher BI values and greater trace-fossil diversities. Vertical dwelling structures of inferred suspension-feeding infauna are more common in FA1 owing to reduced water turbidity. In contrast, FA2 is markedly heterolithic, reflecting river-induced stresses characterizing positions downdrift (NNW) of the distributary mouth. Physico-chemical stresses are reflected by the prevalence of soft-sediment deformation structures, graded mudstone layers, synaeresis cracks, organic-rich claystone drapes derived from both hypopycnal and hyperpycnal processes, exceedingly low BI values, and low-diversity facies- crossing trace-fossil suites. Structures of inferred suspension-feeders are virtually absent in FA2 successions, attributed to abundant buoyant mud plumes and elevated water turbidities. The pronounced spatial distribution of FA1 and FA2 coupled with their positions relative to the distributary mouth complex is consistent with stratigraphic architectures expected in asymmetric mixed river-wave influenced deltas.

Turbiditic, clay-rich event beds in fjord-marine deposits caused by landslides in emerging clay deposits -paleoenvironmental interpretation and role for submarine mass-wasting

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Distinct, clay-rich beds are common in fjord-marine deposits in Trondheimsfjorden near the outlet of the Nidelva river. Their characteristic light grey colour makes the beds easily distinguishable from the surrounding brownish, bioturbated, muddy fjord sediments. The clay-rich beds commonly display a clear stratification in clay, silt and very fine sand. The beds are interpreted as originating primarily from large quick-clay landslides upstream along the Nidelva river. Such events resulted in a sudden increase in the supply of fines to the fjord from disintegrating landslide debris and heavily loaded effluent plumes, possibly favouring hyperpycnal flow. The beds can be divided into a clay-rich lower section, reflecting an initial surge with high concentrations of suspended mud, and a sandier upper section reflecting pulses of higher energy. This development can be explained, e.g., by a lowering in the flow s supply of mud, an increasing activity of deltaic sediment gravity flows due to a higher availability of e.g. sand in the landslide-affected river, and by flooding and/or breaching of landslide dams. The typical, stratified beds are interpreted as the result of one quick-clay landslide, whereas exceptionally thick, less organised, stratified beds are possibly the result of several large and/or complex landslides. Radiocarbon dating of mollusc shells has helped to establish a chronology for major terrestrial landslides in the area. Their frequency increases towards the end of the Holocene. This is explained by a progressively deeper incision of rivers during glacioisostatic rebound, possibly combined with a change to a wetter climate. The marine core record displays deformation structures and hiati representing submarine mass-wasting events, and supports the evidence that the clay-rich beds are weak layers in the fjord-marine stratigraphy. Their inherent weakness may be explained by their composition, immature texture, loose fabric and contrasting permeabilities in the deposits. Slide-prone layers similar to the clay-rich beds described here may be found in other comparable fjord-marginal settings and are considered to be of importance for geohazard assessments.

Radar structure of a Gilbert-type delta affected by rock-slope failure, Bødalen, Western Norway

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The valley of Lake Lovatnet (Western Norway) has been subjected to several rock-slope failures during historical times with fatal consequences due to the associated tsunamis. A Gilbert-type delta at the mouth of the Bødalen valley, a major tributary to Lake Lovatnet, was repeatedly affected by these tsunami waves. A recent GPR survey on the delta plain, however, shows that it has also been directly affected by neighbouring rock-slope failures. This is supported both by the presence of an exposed talus formed by large blocks along the valley's side and by a promontory observed in the lake bathymetry, possibly representing failed material. A seismostratigraphic analysis of recently acquired airgun data and 3.5 kHz (pinger) single channel seismic profiles in the deeper part of the lake near the Bødalen delta shows a succession of repeatedly mass-wasting activity, identified as large rock avalanches, debris-flows and associated turbidites. It is the purpose of this presentation to describe the 3D organization of the Bødalen delta using GPR, which shows a remarkable penetration down to 70 m depth, and to correlate the event to geophysical data from the lake. Several internal structures are recognized from GPR within the rock-failure affecting part of the delta. They include irregular reflections interpreted as landslide debris, a scoured surface that likely formed during the impact, and large-scale sigmoidal reflections possibly representing bedforms or small-scale migrating deltas formed during a healing phase post-failure. Traces from the rock fall event are no longer visible on the present-day delta plain. Correlation with lacustrine seismic data, that provide an important record of slope stability and mass wasting events for this region, help to constrain the age of the event of interest for geohazard studies as well as for investigating sediment budgets.

Geomorphology and evolution of a sand apron, One Tree Reef, southern Great Barrier Reef

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Sand aprons are ubiquitous sedimentary deposits found in coral reef environments that play a crucial role in the evolution, structure and function of coral reefs. These deposits are highly mobile features that migrate into back-reef areas smothering live coral, creating new substrates and generally altering the ecological functioning of reef systems. A thorough understanding of their geomorphology and migration rates is crucial when assessing Holocene reef processes and future reef structure. Despite this, relatively little is known of the sediment morphodynamics of sand aprons, with modern processes inferred or assumed from geomorphologic, geological or hydraulic studies. Current knowledge of sand apron processes suggests that they are continually prograding throughout their evolution, from initial deposition to total infill of the reef lagoon. This does not take into account the potential for morphodynamic equilibrium and feedback which may have a crucial role in governing the evolution of sand aprons and reef environments in general over decadal to millennial scales. One Tree is a lagoonal reef in the southern Great Barrier Reef (GBR) with two algal rimmed windward margins each associated with sand aprons. This study focuses on the evolution of a well-formed and perennially submerged sand apron on the southern windward margin of One Tree reef. The energy regimes in the GBR are dominated by southeast swell, with the sand apron orientation and migration apparently governed by refracted swell waves working in concert with tidal currents, local wind waves and biological processes. Methods include GIS analysis of aerial photos and satellite images (WorldView-2) between 1977 and 2009 to determine large scale morphological change of the reef flat and sand apron. Fieldwork measurements include hydrodynamic surveys of waves and currents using acoustic Doppler velocimeters (ADV) and pressure transducers; as well as topographic and bathymetric surveys using state-of-the-art real time kinematic global navigation satellite systems (RTK-GNSS). Sediment samples are analysed using textural parameters generating sediment transport paths on the sand apron. Initial field results indicate short-term sediment transport towards the lagoon. However, longer term GIS assessments show little gross net migration of the sand apron over three decades, indicating a period of stability or moprhodynamic equilibrium. This contrasts with established models that assume continuous sand migration into the lagoon and raises questions regarding the sediment transport paths, magnitudes and coupling of the sand apron and associated reef morphologies. Present work includes measurement of physical processes acting on the reef platform and sand apron; this complements existing data and allows for a greater understanding of the morphodynamic feedback, equilibria and thresholds of the sand apron. Final outcomes of this work will include the standardization and comparison of coral reef morphodynamic states.

Modelling seabed disturbance regimes on the Australian continental shelf: applications for environmental management

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Physical sedimentological processes such as the mobilisation and transport of shelf sediments during extreme storm events give rise to disturbances that characterise many shelf ecosystems. The intermediate disturbance hypothesis predicts that biodiversity is controlled by the frequency of disturbance events, their spatial extent and the amount of time required for ecological succession. A review of available literature suggests that periods of ecological succession in shelf environments range from 1 to over 10 years. Physical sedimentological processes operating on continental shelves having this same return frequency include synoptic storms, eddies shed from intruding ocean currents and extreme storm events (cyclones, typhoons and hurricanes). Modelling studies that characterise the Australian continental shelf in terms of bed stress due to tides, waves and ocean currents were used here to create a map of ecological disturbance, defined as occurring when the Shield's parameter exceeds a threshold of 0.25. We also define a dimensionless ecological disturbance ratio (ED) as the rate of ecological succession divided by the recurrence interval of disturbance events relative to the portion of disturbed area within a defined frame of reference. The results illustrate that on the outer part of Australia's southern, wave-dominated shelf the mean number of days between threshold events that the Shield's parameter exceeds 0.25 is several hundred days. On the inner shelf, and particularly close to the coastline, the number of days decreases to tens of days or less. This spatial pattern mirrors the bathymetry and exposure to the prevailing swell direction; i.e. the minimum recurrence period between events is in the shallowest water depths and the coastal locations most exposed to the swell. On the cyclone-dominated northwest shelf of Australia, the recurrence period between threshold events is of the order several hundred to a thousand days. Seasonal swell from the southern Indian Ocean probably also contributes to the disturbance regime. In many locations the threshold Shield's parameter is most likely only exceeded during cyclones. Cyclones impact this region on average 2.5 times a year, but the effects at any particular location are likely to be felt less frequently, depending on the precise track of the cyclone across the region. Information provided by our modelling studies is essential to marine managers charged with the design of marine protected areas (MPAs) and other conservation measures aimed at protecting and preserving biodiversity in the oceans. Benthic ecosystems that have evolved in response to different physical disturbance regimes need to be managed differently. Ecosystems in equilibrium with a long recurrence interval and that have long ecological successions are also expected to be slower to recover from anthropogenic disturbances. Further studies are needed to compare model output and measures of shelf disturbances to the spatial and temporal variations associated with shelf ecological successions.

Morphology and sedimentation processes in the Rio-Antirrio Strait, Central Greece

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The Rio-Antirrio Strait separates the Corinth Gulf to the east from the Patras Gulf to the west, in central Greece. The Strait is part of the Rio graben, which acts as a transfer zone between the extending Patras and Corinth grabens, and exhibits high rates of continental crustal deformation accompanied by high seismic activity. It has a depth of about 62 m and is characterized by very powerful surficial and near-bed currents. Multi-beam and high resolution seismic data, which were collected during a recent fiber optic cable survey, illustrates in unprecedented detail the rugged seafloor of the Rio-Antirrio Strait and sheds light in the sedimentation processes. The Strait deeper than the 20 m isobath can be separated in three parts. The seafloor along the southern part, closer to Rio, is covered by an almost layered deltaic lobe, built by seasonal rivers that drain at the coast. This lobe wedges out towards the 60-65m water depth, exhibiting an erosional truncation surface. The central part of the Strait has a peculiar low relief (less than 1 m) morphology and is barren of a recent sedimentary cover. This is due to the strong currents that sweep the seabed, exposing older sedimentary strata or very coarse material on the seafloor. Locally, sand shadows which are formed behind seabed obstacles and erosional surfaces are distinguished. However, the most prominent feature is a well-developed channel that is directed towards the east and seems to be connected (or is the continuation) with another channel that is directed towards the west. These channels are probably formed due to the erosive action of the intense bottom currents in the strait or may be the remnants of lower sea level rivers that maintain strong current flows. Yet, the different levee levels of the eastern channel may possibly indicate that it is fault-controlled and supports current flows and transportation through an existing conduit. This probable fault emerges at the centre of the surveyed area, it has an almost E-W orientation, a vertical throw of less than 13 m and its sidewalls are locally affected by small slides. Small flute marks in the surrounding area are also the result of the intense current activity. At the north side of the strait, close to Antirrio, an intense anomalous relief appears on the seafloor as a result of the outcropping of folded and faulted strata, which is probably of Pliocene or Pleistocene age. Faults of an ENE-WSW direction shift the older outcropping sedimentary layers. The most prominent fault has a throw less than 5 m and creates a small ramp. The ramp is in general barren of recent sediments and has an even relief. The intense current activity along the northern part of the Strait is expressed by the lack of a recent sedimentary cover and the occasional presence of sand waves and sand dunes. These have a maximum elevation of about 3 m and they develop over an area of hard substrate, where only homogeneous sand pockets and lenses occur. Occasionally, sand shadows behind seafloor obstacles can be recognized. The Rio-Antirrio Strait is subject to intense erosion by very strong seabed currents of up to 1 m/s since the last 9ka. These powerful currents controls the sedimentation as well as the morphology of the Strait and result in (a) sediment erosion that transports material to both the Corinth and Patras basins, (b) the formation of erosional surfaces and bedforms and the maintenance of erosional channels both eastwards and westwards and (c) the lack of a recent sedimentary cover along a big part of the Strait, having as a consequence tectonically deformed basement outcropping at the northern side of the Strait. The trend of the transverse and longitudinal bedforms implies, in general, an E-W current activity with small direction alterations.

Acoustic anomalies and related morphological features in the Kalloni Gulf, Lesvos, Greece

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The Kalloni Gulf is a large embayment of the Lesvos island (N. Aegean Sea). It has an almost NE-SW orientation, it is about 20 km long and less than 20m deep and it connects with the Aegean Sea through a strait less than 2 km wide and 25 m deep at its southwest end. The Gulf receives river discharges from several, mostly seasonal streams, which drain the surrounding basins formed on alluvial and coastal deposits, lavas, magmatic conglomerates and ignimbrites. Previous studies have shown the presence of a plethora of well-developed mounds on the seabed, which are, probably, of biogenic origin. The aim of this contribution is the detection of the geological characteristics of the surficial sedimentary cover using high resolution 3.5 kHz seismic data in order to examine possible controls on the mound formation. The surficial sediments of the Kalloni Gulf have been found to form a sequence of layered sediments (maximum thickness ~14 m in the centre of the gulf), which overlies almost concordantly an earlier sedimentary unit. The unconformity is a relatively high amplitude and continuous reflector in the seismic profiles and is probably attributed to the Holocene / Pleistocene boundary. Acoustic anomalies, such as turbid zones and plumes and enhanced reflectors are observed within the Quaternary sequences and imply the presence of gas within the sediments. The Holocene-Pleistocene boundary seems to act as a gas accumulation horizon, as indicated by its local high reflectivity, although it can not always restrain upward migration of the gas; thus, gas plumes are often seen with the Holocene sediments. The gas is believed to be of biogenic origin, although additional hydrothermic sources cannot not be ruled out. The seafloor also shows a microrelief with small and shallow depressions of about 1 m deep that resemble to pockmarks; a similar relief can be observed in certain locations along the Holocene-Pleistocene boundary. Low relief intra-sedimentary doming is also observed in the seismic records being possibly due to the expansion of the sediment-trapped gases. The main morphological feature of the Kalloni Gulf is the presence of a plethora of mounds that develop primarily at its central part. Seabed sampling has shown that the mounds consist mainly of bivalves of various sizes and they correlate well with some of the most productive scallop-fishing locations in the gulf. The mounds are both symmetrical and asymmetrical and have a high relief, relatively to the surrounding seabed, of the order of 1-3 m, although mounds up to ~5 m in height have also been observed. The highest mounds are located at the centre of the gulf in water depths less than 16 m, and are either arranged in clusters or are isolated. An interesting finding is that most of the higher mounds appear to develop in connection with the surficial depressions. Seepage of methane has been reported to be related to areas with high concentration of bivalves and other benthic life. Mound development may also be influenced by the oceanographic conditions prevailing in the gulf, although they are considered to be mostly geologically- controlled. It must be noted, that the tectonic regime of the gulf may also play a role, since earthquake epicenters are distributed along the gulf axis, where most of the acoustic anomalies were observed; this indicates that possible micro-fractures may serve as gas migration pathways. Future interdisciplinary research is planned to include a more detailed geomorphological mapping and sediment coring in order to study mound origins and rates of development during the late Holocene as well as their influence in water circulation and sediment distribution.

Timing of sedimentation and provenance study using combined U-Pb and Lu-Hf isotopes on turbidites from the late Neoproterozoic - early Paleozoic basement of NW Argentina

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In recent years combined U-Pb and Lu-Hf isotope data on detrital zircon have been widely used for the investigation of sediment provenance, and crustal evolution processes. U-Pb geochronological data on zircon grains from sedimentary rocks are very important tools to identify provenance components, to provide maximum depositional ages, to correlate different sedimentary sequences and to identify major magmatic events in the source regions. The Lu-Hf data on the dated zircon grains provide a window into the nature and source of magmas generated during the different magmatic events. In the last decades the evolution of the pacific margin of West Gondwana during Neoproterozoic and Early Paleozoic times has been widely debated and several models were proposed. The tectonic significance of Neoproterozic-early Cambrian low grade metaturbidite sequence known as the Puncoviscana Formation s.l. outcropping extensively in Eastern Cordillera and easternmost Puna of NW Argentina, is considered to be instrumental to unravel the tectonic history of the western margin of Gondwana. Three key areas, believed to be representative of the temporal and spatial evolution of the NW Argentina Neoproterozoic-Paleozoic metasedimentary basement were selected: (i) the Tastil area in Eastern Cordillera, (ii) the El Niño Muerto Hill in the Puna-Eastern Cordillera boundary, and (iii) the Río Blanco Valley in Calchaquíes Valleys. A combined LA-ICPMS U-Pb and Lu-Hf isotopic study of zircon grains from metasediments and associated igneous rocks from the three localities has been carried out. The maximum depositional ages (MaxDA) for each turbidite sequence, is given by the U-Pb age obtained on detrital zircon grains, whereas the minimum depositional age (MinDA) is constrained by the U-Pb age of differents igneous rock that intrude the sequences. The obtained results allowed us to distinguish three turbidite sequences, previously mapped as Puncoviscana Fm. s.l: i) turbidites exposed in the Tastil area, with a MaxDA of 562 and a MinDA of 534 Ma (Tastil granodiorite), were deposited in a syn-orogenic setting and not in a long-lived passive margin as previously suggested ii) turbidites of the El Niño Muerto Hill with a MaxDA of 496 and a MinDA of 483 Ma (El Niño Muerto dacites), were deposited during Late Cambrian to Tremadocian times in a N-S elongated narrow basin located between the Pampean belt and the Arequipa-Antofalla terrain, and iii) the turbidites of the Río Blanco Valley have a MaxDA of ca. 463 Ma. Their association with contemporaneous E-MORB/OIB type basalts and the dominantly Famatinian provenance of zircon population, suggest that these sediments are post-Caradoc, deposited in an extensional basin to the east of the Famatinian arc. The Hf isotopes indicate that i) three major periods of magmatic activity may be recognized in the sources of the detrital zircon grains: i) A Paleoproterozoic (2.0 Ga) event characterized by reworking of Archean crust; ii) a juvenile Mesoproterozoic/Neoproterozoic boundary (0.95 to 1.2 Ga) event, and iii) a Late Neoproterozoic to Early Paleozoic (0.75 to 0.46 Ga) magmatism, indicating reworking of Mesoproterozoic to Paleoproterozoic crust. Our data suggest that the western margin of Gondwana underwent a dynamic tectonic evolution from Neoproterozoic to Early Paleozoic times, controlled by subduction processes and accretion of two continental terrains. On the basis of geochronological and geological constraints we suggest that the accretion of a minor block occurred between 550 and 535 Ma, whereas the Arequipa-Antofalla terrain collision occurred after ca. 480 Ma. These tectonic processes controlled the rapid deposition of syn-orogenic turbiditic sequences, their rapid denudation and synchronous magmatism.

Surviving diagenesis: deposition and preservation of fossiliferous clay beds in the Pliocene Citronelle Formation of southern Alabama, USA

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The Citronelle Formation is an important siliciclastic unit that crops out from eastern Texas to western Florida in the southeastern USA. Despite its areal extent, it is poorly documented, particularly as far as age- resolving criteria are concerned. The Citronelle Formation consists of quartzose sand and gravel units interbedded with clay beds that are interpreted to have been deposited in fluvial to marginal marine depositional environments somewhat similar to those characterising the northeast Gulf of Mexico today. The 60 m thick formation is typically heavily stained and coated with iron oxide-hydroxide minerals and is, in places, well indurated. Across much of the Alabama Gulf Coast, a fairly consistent stratigraphy of red sandy gravel, disconformably overlying interbedded quartzose sand and clay lenses, conformably overlying thick clay occurs. The lower clay unit is usually pink in colour and appears to be massive with few sedimentary structures and no biota or trace fossils. Past researchers have found some macrofossils within the Citronelle Formation (e.g., remains of vertebrates in gravel beds), but abundant biostratigraphically useful materials were thought to be absent. Consequently, constraining a stratigraphic age of the Citronelle Formation was difficult. In the early part of the 20th century, Matson and Berry (1916) identified plant fossil-bearing clay beds near the type section of the Citronelle Formation which established a Pliocene age for this interval of the strata. They also concluded that the depositional setting was similar to that now occurring along coastal Alabama. The plant bearing beds were unlike similar lithologies exposed in other Citronelle outcrops. They were gray-brown in colour and contained relatively well preserved primary lamellae and abundant ichnofossils. Careful examination of other Citronelle outcrops suggests that these laminated plant-bearing intervals are much more common in the region than previously recognized. Moreover, they contain a more diverse and important Pliocene flora than documented by Matson and Berry (1916). Important plant macrofossils include several taxa still important in the region today, such as *Betula nigra* (River Birch), *Quercus viriginiana* (Live Oak), and *Liquidambar styraciflua* (Sweet Gum); taxa no longer occurring in the area today but still found in North America, such as White Pine (*Pinus* Subgenus *strobus* sp.); and some now occurring only in Eurasia, such as *Trapa* (Water Caltrop) and *Pterocarya* (Wingnut). An outcrop close to the modern Gulf Coast shoreline also contains *Ophiomorpha nodosa* trace fossils and a new estuarine mussel. The sporadic distribution of fossiliferous clay beds in the Citronelle Formation is probably due to several geological variables. It is likely that the majority of them were simply deposited in isolated, more anaerobic sub-facies of an overall fluvial-estuarine depositional system such as an oxbow lake or a coastal flood basin. Similar environments exist in the modern Mobile River delta-bay complex today. However, our work leads us to believe that the isolated disposition of the fossiliferous clays may also have a diagenetic explanation. In places, the same oxidizing groundwater responsible for staining and cementation in coarser lithologies has clearly overprinted portions of the plant-bearing clays. With few exceptions (e.g., rare leaf imprints), all evidence of the original plant content was lost and the colour of the clay was altered to match the majority of clay beds in the Citronelle Formation. This raises the interesting possibility that the fossiliferous clay beds in the Citronelle are simply preserved remnants of a much more extensive depositional unit which is gradually being destroyed by meteoric diagenesis.

Matson, G.C. and Berry E.W. (1916) The Pliocene Citronelle Formation of the Gulf Coastal Plain and its flora. US Geol. Surv. Prof. Paper. 98-L, 167-208.

Salt Mountain Limestone in southwestern Alabama, USA: sedimentology and diagenesis of a Late Paleocene reefal carbonate formation

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The Salt Mountain Limestone is a predominantly muddy, subsurface stratigraphic unit in southern Alabama, but has long been known to contain important reefal buildups, particularly beneath southeastern Alabama, where it is an important source of drinking water. Very limited surface exposure occurs in one isolated location in southwestern Alabama along the up-thrown side of a normal fault associated with an underlying salt dome (Louann Salt). This 40 m thick section comprises intervals of white to cream-colored fossiliferous floatstone, framestone, and grainstone interbedded with packstone and wackestone. Fossil content is diverse and includes corals, coralline algae, molluscs, sponges, benthic foraminifera and numerous other less abundant invertebrates. Previous studies have recognized *in situ* corals up to 1 m in diameter and solitary sponges and sponge networks many cm across (Bryan, 1997); however, precise identification of much of the biota is difficult, in part due to diagenetic overprinting and recrystallisation. At this outcrop, thin-section petrography is the most important diagnostic tool for both sedimentological and paleontological analysis. Despite these difficulties, Bryan (1997) was able to identify *Stylophora ponderosa* and *Actinacis alabamensis* as the dominant coral framework constituents in the Salt Mountain Limestone outcrop and confirmed previous conclusions the formation was deposited on a tropical to subtropical shallow marine shelf. The shelf lay east of a major deltaic complex in what was then the Mississippi Interior Salt Basin. The amount of cementation and porosity in the Salt Mountain outcrop is variable. Some parts of the exposure are friable and recessive due to limited cementation or extensive secondary dissolution. Microkarst features are common across the outcrop further complicating recognition of reefal constituents. Other parts of the exposure are well indurated, resulting in laterally continuous scarps and blocks. In the present study we are attempting to identify, map and quantify cement phases in relation to other diagenetic events in the Salt Mountain Limestone. Elucidation of Salt Mountain diagenesis where it is exposed at the surface may facilitate development of groundwater resources hosted by the unit in the subsurface. To date, we have identified several meteoric phases of calcite cement. Most of these meteoric cements are intergranular drusy non-ferroan spars. Later phases of pore-filling calcite that grew within naturally porous skeletal allochems (e.g., corals) may be zoned and/or more ferroan. This suggests that pore-water chemistry changed subtly and repeatedly during a prolonged episode of calcite precipitation.

Bryan, J.R. (1997) The Salt Mountain Limestone of Alabama. Part 1: Introduction to the Salt Mountain Limestone. Tulane Studies Geol. Paleo. 30, 3-20.

Perseverance of a lacustrine environment during the late Pleistocene in the mostly ice covered fjord region of Southern Patagonia

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Laguna Parrillar is a large fresh-water body located in the centre of the Brunswick Peninsula in the fjord region of Southern Patagonia (53°S) in Chile. The lake is a key locality for constraining Late Pleistocene palaeoclimate variations in the terrestrial Southern Hemisphere. Lake sediments from Laguna Parrillar may be used to determine the relative position, strength and cyclicity of global atmospheric circulation systems (e.g. Westerlies) which affect the large parts of the Southern Hemisphere and changes in millennial scale climatic variations. Laguna Parrillar is located outside the Last Glacial Maximum (LGM) moraine limits in what Bentley *et al.* (2005) classified as a pre-last-glaciation weathering zone. LGM ice-sheet reconstructions do not demonstrate the presence of ice on the elevated (294 m a.s.l.) and exposed inland position of the lake. Therefore, Laguna Parrillar could have remained ice free during the LGM and a high-resolution, pre-LGM sedimentary record is potentially preserved in the lake deposits. A 7-m-long sediment core was collected out of this 25 m deep lake in order to reconstruct local climatic variations. The sediments were studied in a non-destructive way using a Geotek MSCL scanner to track changes in magnetic susceptibility and density. Subsequently the core was described in high detail and scanned in high resolution by an AVAATECH XRF scanner. Furthermore changes in water and organic matter content of the sediment were determined. The first meter of the sediment is highly variable, the other 6 meters are very nicely laminated with extremely thin laminae in the second meter, whereas thicker, glaciogenic-type laminae occur in the remaining 5 meters. The AMS 14C dates reveal a core bottom age of ~40,000 cal yr BP. Therefore the initial hypothesis of the possible preservation of pre-LGM sediments is confirmed, and the lake thus represents one of the oldest lake records in the glaciated part of Southern Patagonia. The Holocene sediments are disturbed by wind action, related to the strong Westerlies roaring through this area. However, changes in the degree of sediment disturbance can be observed and the sediment therefore possibly recorded variations in Westerly wind intensity. During LGM and pre-LGM times the nicely laminated sediments suggest an environment that was much less affected by wind mixing.

Very stable climatic conditions during the Holocene in South Central Chile (Lago Villarrica)

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Lago Villarrica (39°S) is one of the lakes that were created by glaciers with a piedmont lobe in the Region de La Araucanía in South Central Chile. The lake basin originated from glacial valley overdeepening and the formation of large frontal moraine ridges during the Late Quaternary glaciations. The large, elliptical lake has a maximum depth of 167m. A 14-m-long core was collected on a ca. 80-m-deep plateau in the western, shallower and more sheltered part of Lago Villarrica. The intention of the present study was to distil a climate signal from the hemipelagic sediments deposited on the plateau. The results of the AMS 14C dates situate the sediments of this core in a Holocene time frame, with a base-of-core age of ~10000 cal A BP. This implies a very high sedimentation rate (ca. 1.5 mm/a), especially considering the core location which is rather distant from riverine or other near coastal processes. The only non-hemipelagic sediments present in the core are tephra layers, which were probably deposited from air-fall ashes erupted out of the nearby Villarrica volcano. The non-volcanic sediment present in the core reveals a very nice sequence of laminae that are very rich in diatom frustules. The high amount of diatom remains and the near lack of terrigenous material entail a lake with a high productivity. In order to unravel the climatic signal recorded in the lake sediment parameters for terrrigeneous and biological input were analysed. This was done using a sedimentological approach describing the sediment core in high detail, measuring the sediments' magnetic susceptibility and density, the water content and its grain size. Also geochemical techniques were used such as an XRF scanner, LOI 550°C and 950°C analysis, δ13C measurements and a biomarker study on changes in the TEX86 and BIT proxy. On a biological level, the diatoms were analysed. Combining the results of all these parameters it can be concluded that the Holocene climate remained stable over a long period of time in this. Of all proxies, the diatom record documents a signal of ecological and limnological variations in the lake environment while other proxies remain unchanged.

The input of paleoclimatic constrains to paleohydrological analyses in a meandering system

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Paleohydrology is a discipline which allows quantification of the parameters of ancient fluvial systems from limited observations in the field or from cores. The fluvial systems comprise spatial parameters that range from the scale of the channel geometry to that of the drainage area; and temporal ones that reflect parameter evolution through time. For modern systems, several authors have developed mathematical relations between the different hydrological parameters relating the geometric parameters (channel geometry, sinuosity, river length, drainage area) to the flow ones (bankfull discharge, mean annual discharge) and environmental ones (sediment load, substrate cohesion). Adjustment of fluvial systems with respect to the climatic fluctuations have also been identified since long time leading to the establishment of some climate related laws, mainly at the scale of the drainage area. Climatic-dependant paleohydrological quantifications, taking into account fluvial style, are still needed for the analysis of ancient sedimentary records. We present the results of a paleohydrological study based on a well constrained fossil meandering system and on hydraulic equations specifically developed from modern systems flowing under similar climatic conditions. Field analysis has been conducted on an Oligo- Miocene meandering fluvial system outcropping in the Barrême basin (Grès verts member, SE France). Sediment source, based on mineral assemblage, indicates a basin length of 60 to 120 km (paleosource located in the Embrun-Ubaye area or in the Briançon area). Paleoclimatic restitutions point to a subtropical climate with alternating seasons (MAT from 15 to 20°C and MAP between 1000-1500mm/yr). The channel geometry is reconstructed from point bars height as no channel section could be measured in the field. Point bar heights have been measured along four intervals, providing a stratigraphic record of the channel depth variations. Point bar heights have been converted into bankfull mean water-depths, taking into account compaction and channel depth variation with curvature. Reconstruction of the spatial parameters from channel geometry to drainage area are based on equations specifically developed from modern sandy meandering streams confined to similar physiographic domains (south and south east coastal plains and piedmont of the United States; southern coastal plains of Australia). When compared to the general relations, the developed formulas provide more restricted estimations of the bankfull discharge, river length and drainage area. The resulting parameters are a mean bankfull channel width of 37.5 ± 5 m, a mean bankfull discharge of 140 ± 49 m3s-1, a river length of 90 ± 18 km with a drainage area of 1070 ± 362 km². The basin length is to be shorter than the river length taking into account some sinuosity. The estimation from the paleohydrological study points to a source in the Embrun-Ubaye area. The stratigraphic evolution of the point bar heights and the resulting estimation of the drainage area show large alternating variations that cannot be merely attributed to gain or loss in the catchment area, suggesting a climatic control. Considering a stable drainage area, and using modern catchment scale climatic parameters, we estimate the amplitude of precipitation changes around 400 mm. Such value is comparable to that proposed from palynological restitutions during the late Oligocene-Early Miocene. It is proposed that the first increase in precipitation recorded the climate warming of the end of the Oligocene and the following drop in precipitation, the first cooling of the early Miocene that is followed by a new increase in precipitation.

Petrography and diagenesis of silicified aragonitic bivalve shells, Lower Cretaceous limestones, Dorset, UK

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Studies of silicification in calcareous fossils have reported a conservative range of quartz textures and fabrics, such as radial and fabric-selective chalcedony, equant microquartz and granular mesoquartz. Most published observations relate to silicification of calcitic or calcitised fossils. In contrast, Lower Cretaceous bivalves in partly silicified mollusc-ostracod limestones from Dorset (southern England) were replaced whilst still aragonite and they display some unusual petrographic characteristics. Specimens were collected from chert lenses within the Purbeck Formation at Durlston Bay and Worbarrow Tout on the south Dorset coast, England. The shelly limestones, from the Cherty Freshwater and Intermarine Members, are dominated by the euryhaline bivalve Neomiodon sp. and also contain freshwater gastropods and ostracods. All thin sections cut from the chert nodules were prepared to standard 30-micron thickness, using conventional epoxy glue for mounting the rock slices and fixing the cover slips. Additional polished and uncovered thin sections from selected samples were examined in optical cathodoluminescence (CL) and with a CL detector on a scanning electron microscope. They were also examined in photoluminescence (PL) using incident blue light of 425 nm. The silicified aragonite bivalves from the Purbeck Formation display a much wider range of replacement textures and fabrics than those typically reported in the literature, and in particular share some features in common with neomorphically calcitised bivalves Replacive quartz is typically pale to dark brown owing to the presence of organic inclusions from the original skeletal tissue. The quartz may exhibit fibrous or equant textures, and frequently both in the same shell. The organic inclusions commonly define “ghost” skeletal microfabrics such as growth bands, but in they may also outline growth zones of the quartz crystals, or alternatively be concentrated in bundles of fibrous quartz nucleated around the outer periphery of the shells. Replacement quartz is very dark brown in optical CL and unzoned in SEM-CL, but where rich in organic inclusions it displays a faint green luminescence in PL. An unusual characteristic of quartz in the silicified bivalves is that is displays anomalously high birefringence, up to low second-order interference colours. Neither its brown colouration nor the anomalous interference colours are seen in silicified matrix (microquartz) or pore- filling cements (chalcedony and macroquartz) of the same samples. It is therefore likely that thin films or oriented inclusions of organic matter trapped in the quartz have caused the increase in birefringence. The same may be true of neomorphically calcitised bivalves, but difficult to detect against the already high birefringence of calcite. Where growth zoning is shown in the replacement quartz it demonstrates that crystals nucleated at the margin of the shells and grew inwards. This supports a force-of-crystallisation mode of silicification where replacement took place across an ultra-thin solution film and calcium carbonate only dissolved in the immediate vicinity of the growing quartz crystals. The preservation of skeletal microfabrics is compatible with this and further suggests that quartz precipitated directly at the expense of aragonite, without an opal-CT intermediate stage. Ostracod tests in the samples tend not to be silicified, or are replaced by microcrystalline quartz. Pore-filling quartz cements in the silicified limestones exhibit fibrous and sparry textures, including radiating fans of normal and zebraic length-fast chalcedony. The distribution of organic matter and residual carbonate in the shells is being examined by etching polished surfaces in concentrated HF and dilute HCl respectively, and examining them in a scanning electron microscope. Results of these experiments will also be discussed.

Cemented ammonite chambers: a biogeochemical “Time Capsule” of Jurassic marine mudrock diagenesis

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The chemical diagenesis and pore fluid evolution of marine mudrocks is frequently reconstructed from carbonate cements in concretions or “beef” veins, but these tend to archive only part of the history. In contrast, the passive and progressive cementation of ammonite chambers may record evidence of microbial processes characteristic of very shallow burial through to thermal processes that accompany deep burial. We report preliminary results of a study of Jurassic ammonites from the Cleveland Basin in NE England. Ammonite-bearing calcitic nodules were collected from the Toarcian age Whitby Mudstone Formation, near Whitby in Yorkshire. These ammonites are well known from fossil shops worldwide as their excellent preservation and pyritic sheen make them popular with collectors. However, little attention has been paid to the chamber filling cements. In simple terms one or more pore-lining brown cement fringes are followed by several void-filling, yellowish to colourless sparry cements. The brown cements superficially resemble biofilm-related bacteriogenic precipitates in septarian concretions (e.g. Hendry *et al.* 2006). In detail, a complex cementation sequence is present, which varies between and within individual ammonites. The full cementation history only becomes apparent when images from standard light microscopy, staining, cathodo-luminescence (CL), photoluminescence (PL) and backscatter scanning electron microscopy (BSEM) are compared. The combined petrographic data also provide a context for interpreting surprisingly diverse stable isotope compositions from apparently identical cement stages. Earliest cements are minor Ca-phosphate and geopetal or microstalactitic pyrite. Brown fibrous Mg-calcite cements display unusual botryoidal fabrics, heterogeneous distributions, and inconsistent chemical zonations when observed using the different techniques. We interpret these cements as having precipitated within bacterially-mediated biofilm microenvironments prior to burial. However, localised ultra-fine-scale alteration to ferroan calcite and microdolomite took place deep burial and high heat flow. Consequently, the early cement $\delta^{18}O$ values range widely from -4.1 to -14.0 ‰ V-PDB, and $\delta^{13}C$ values mostly fall between -8.3 and -14.4 ‰V-PDB. Subsequent sparry cements include highly zoned dolomite, ferroan calcite and siderite. The calcite is locally intergrown with authigenic kaolinite, which also partly replaces the ammonite shells. Cement sequences vary from chamber to chamber, probably reflecting the extent to which cementation and compaction controlled pore fluid access during burial. The $\delta^{18}O$ and $\delta^{13}C$ values of these sparry cements cluster around -14.0 and -10.5 ‰ V-PDB respectively. Ammonite shells have $\delta^{18}O$ values overlapping those of early and late cements, reflecting the observation that most of the carbonate cements at least locally infill or replace the former skeletal aragonite. The lowest $\delta^{18}O$ values (up to -17‰ V-PDB) come from the calcitic nodule matrix surrounding the ammonites. This is perplexing as nodule lithification should have been early, to prevent crushing of the shell chambers during burial. The preliminary results document a prolonged diagenetic history, only parts of which have been recorded from previous study of concretions in the Whitby Mudstone Formation. Unusual early cement fabrics may be physical artefacts of biofilm-mediated diagenesis, and further work will search for microbial remains within them. The strongly ^{18}O-depleted late cements provide substantiation for independent estimates of > 2.5km subsidence for the Lower Jurassic of the Cleveland Basin.

Hendry, J.P., Pearson, M.J., Trewin N.H. and Fallick, A.E. (2006) Jurassic septarian concretions from NW Scotland record interdependent bacterial, chemical and physical processes of marine mudrock diagenesis: Sedimentology, 53, 537-565.

Epigenetic dolomitisation and hydrothermal mineralization of Lower Carboniferous platform carbonates on the Isle of Man (Irish Sea Basin)

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During investigations of late diagenetic dolomitisation in Lower Carboniferous limestones of the Isle of Man, an extensive sphalerite- bearing and dolomitised breccia deposit was found. Petrographic, cathodoluminescence (CL), fluid inclusion, stable isotope and modelling techniques have been used to constrain the origin of the Zn deposit and its relationship to the diagenetic history of the carbonates. The Carboniferous succession exposed in the south of the Isle of Man comprises up to 415m of Mississippian (Arundian – Brigantian) ramp and shelf carbonates with intercalated volcaniclastics and hemipelagites. These unconformably overlie and are locally faulted against Lower Palaeozoic metasediments. A variety of lithofacies indicate settings that varied from deep offshore to shallow, wave-washed shoals and mud mounds. Dolomite is present through much of the succession; sometimes partial, stratally confined and fabric selective, but more commonly in discordant zones of pervasive dolomitisation that have sharp contacts to undolomitised limestone. Some of the contacts coincide with faults or fractures, but not all do. The dolomite weathers dark brown in contrast to the grey limestones, reflecting a ferroan composition. Associated veins and vugs are filled by non-planar (frequently "saddle") dolomite or ankerite cement. Characterisation of the dolomite fabrics and investigation of sedimentary versus structural controls on their distribution are ongoing. Within the Asbian aged Balladoole Formation a highly fractured and dolomitised exposure contains an extensive but previously undocumented breccia zone rich in sphalerite with subordinate galena and quartz mineralisation. The host dolomite and associated vein filling cements resemble those elsewhere in the succession, notably in the immediately overlying Bowland Shale Formation and the Arundian aged Derbyhaven Formation exposed about 5 km distant. This suggests a genetic link between ore-forming fluids and limestone burial diagenesis. Replacement dolomitisation of the host Carboniferous limestones took place from warm (105-115°C) evolved marine pore fluids (ca. +0.5 to +6.0‰ V-SMOW) that approached oxygen isotopic equilibrium with the host rock. The dolomite is dull red-purple in CL. The localised breccia records four distinct stages punctuated by mechanical deformation. Quartz was the first precipitate, followed by zoned sphalerite, and two further CL-zoned quartz stages. The last of these accompanied non- luminescent ferroan dolomite that cements the breccia and is similar to that seen in veins and vugs elsewhere in the dolomitised and undolomitised succession. Fluid inclusion and oxygen isotope data indicate that initial mineralising fluids were hydrothermal (>300°C), high salinity (20-45 wt% NaCl equiv.) brines, of likely basement origin (ca. +5.5 to +11.5‰ V-SMOW). Subsequent fluids were cooler (105-180°C) and less saline (8-20 wt% NaCl equiv.), reflecting interaction of the basement brine with evolved Carboniferous marine pore waters as the hydrothermal system waned. The Zn-rich breccia deposit found in the Balladoole Formation is the first significant concentration of ore sulphides found in Carboniferous limestones of the Isle of Man. Associated dolomitisation is more widely represented by late stage vein and vug-filling cements, but the extensive replacement dolomitisation of the limestones was an earlier event. It took place from warm, evolved marine pore waters prior to overprinting by saline, basement-related hydrothermal fluids that gained access to the overlying carbonate rocks along faults.

Direct numerical simulations of particle sedimentation in a model estuary

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The details of freshwater mixing with ambient brine in estuaries as well as the transport of suspended particles to the ocean are not fully understood. The transport mechanisms of natural sediment and pollutants are of special interest because up to ten billion metric tons of sediment are transported annually by rivers to continental shelves which is of great importance for the marine environment. In most cases, the particle-freshwater mixture is lighter than the saltwater near the estuaries, such that the river plumes are positively buoyant. The particles can thus be transported over relatively large distances with the freshwater current. The expansion of the particle plume is only limited by the particle settling which dominates over the horizontal transport with growing distance to the river mouth. From many field observations it is concluded that particles settle faster than predicted by pure Stokes settling of disaggregated constituent grains, because they reach the ground already relatively close to the river mouth. The traditional explanation for the enhanced particle settling is a flocculation of individual particles since larger effective aggregate diameters lead to larger Stokes settling speeds. More recent studies attribute the increased effective particle settling velocity to the positive influence of turbulence. In genuine estuaries turbulence is mostly generated by the kinetic energy due to the freshwater inflow, wind stresses, tides and/or other ambient seawater currents. Even the potential energy of the particle suspension in the buoyant freshwater current may contribute to an enhanced settling. The enhancement of particle settling due to turbulence has been demonstrated in various (rather idealized) laboratory experiments and in some numerical simulations. The aim of the present work is to study the settling enhancement in a laboratory-scale model estuary using a highly accurate numerical model. It allows a well-controlled, idealized simulation as well as a detailed analysis of the flow and the particle settling process. We solve the Navier-Stokes equations resolving numerically all relevant time and length scales, which range from small interface thicknesses or turbulence eddies to large Kelvin-Helmholtz-type vortical flow structures. Thus we perform Direct Numerical Simulations (DNS) which require no turbulence modeling. However, genuine river flows are out of reach of such simulations due to the extreme numerical effort necessary at the pertinent parameters. Some alleviation will be possible by Large-Eddy Simulations which are planned for the future. In our numerical model we treat the salinity and the particles as Eulerian concentration fields such that two advection-diffusion equations need to be integrated in time along with the incompressible Navier-Stokes equations. Since flocculation was observed in neither of the experimental studies we will not take this feature into account and focus on the settling enhancement due to turbulence. We performed a number of high-resolution DNS with different parameter settings. The largest simulation employs 7.2 billion grid points in space and about 570000 time steps. We analyze the flow development and the sedimentation process which can be separated into an initial temporal transient and a subsequent statistically-steady-state regime. We find that the particle settling enhancement is most pronounced in the transient regime where we temporally observe increases of up to 800%. In the statistically steady-state regime the settling enhancement drops to 20-60%. These numbers agree well with experimental findings.

Carbonate mounds re-visited

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Studies of carbonate systems in the Modern ocean have – from the very dawn of Ocean and Life sciences – inspired and fuelled analyses of systems of the Past. The voyage of the Beagle (1831-1836) and Darwin's subsequent book The structure and distribution of coral reefs (1842) no doubt inspired Karl Theodor Liebe's early identification of the Zechstein 'Corallenriffe' and 'Bryozoenriffe' in Orlatal, north of the Schiefergebirge (1853), and moved in Belgium in 1881 Edouard Dupont towards an early comparison between Devonian carbonate mounds close to Philippeville and 'Keely Atoll', described by Darwin in the Indian Ocean. The voyage of the Challenger (1872-1876), which laid the base of modern oceanography, and the preparatory cruises of the Lightning (1868) and the Porcupine (1869) contributed to the first tentative comparisons between the 'carbonate ooze' of the modern ocean and the Jurassic and Cretaceous chalk of the cliffs of Folkestone, or even Carboniferous limestones in Belgium. The bryozoan mounds drilled in the Great Australian Bight by ODP Leg 182 were considered possible modern analogues for the Late Cretaceous to Danian cool-water carbonate ramp with bryozoan mounds in the Danish basin. However, the unveiling of extensive provinces of thousands of giant, deep-water carbonate mounds in Porcupine Seabight and Rockall Basin, west of Ireland, and the subsequent discovery of carbonate mound provinces off Morocco, have unchained an unprecedented research effort, which opens new opportunities for re-visiting carbonate mound systems of the Past. The wealth of new data and opportunities allows us to reflect upon a real strategy of comparative analysis between modern and ancient systems: drilling both at sea and on land, sampling continuous records with comparable resolution, moving from 1D to 3D imaging at various scales, pushing the frontiers of proxies to identify and understand marine environments in deep time, exploring modern and ancient ecosystems in a holistic way to unravel the diversity, functionality and interactivity of both the metazoan and the microbial actors, analyzing the balance and interplay between carbonate and siliciclastic fluxes in space and time, analyzing the role of fluids in early and late diagenesis, etc. This effort will be most rewarding where the academic scientific community joins forces with the industrial research world, which presently addresses mound-type carbonate settings of industrial interest. This is the central objective of the COCARDE network (Cold- Water Carbonate Reservoir Systems in Deep Environments).

A multidisciplinary approach towards understanding the formation of sinuous deep-marine channels

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Submarine channels and channel complexes constitute an important element of deep marine reservoirs worldwide. Exceptional seismic resolution subsurface datasets from West Africa provide a unique laboratory for studies of deep water depositional systems. These data display a wide range of depositional bodies (architectural elements) with different geometries, including; single, sinuous and straight channels with varied vertical and lateral stacking patterns, levees and overbanks, depositional lobes and a wide scale range of mass transport complexes. These architectural elements are spread on a basin slope setting and are present at different levels in the stratigraphy. The complexity and unique internal architecture of the individual channel/channel complex reservoirs makes prediction of lithology, as well as development of production drainage strategies a challenging issue that demand a multidisciplinary approach. Standard seismic interpretation and volume attribute maps have been used to delineate overall geometries and architectural elements. In addition, more sophisticated interpretation techniques, such as true 3D volume interpretation in time and strata domain has been applied to detect individual geobodies. Well logs and – cores together with significant input from outcrop analogue studies (e.g. sinuous channels in Elazig Basin, Turkey) are used to calibrate seismic data. Heterogeneities occur at all scales, and grain size, -shape and - orientation may be critical in defining hydrocarbon flow units. These factors will obviously also affect the elastic properties within the reservoir. Preliminary studies show that, in pure media, grain shape may exert a stronger control over elastic properties than grain size. Innovative seismic techniques are used to deduce reservoir properties from seismic velocities. The overall shape of sinuous channel complexes, their internal geometries and lithology result from repeated erosional and depositional processes. To gain a better understanding on the physics behind these processes, laboratory tank-experiments have been run in parallel with computer based simulations of turbidity currents. The tank experiments show that the relationship between flow thickness and topographic relief is critical in determining whether flows will erode or deposit sediments. Computer simulation makes it possible to build geological models and construct turbidity currents with known measures on both substrate and flow properties. This enables further refinement on what factors are most critical for the development of reservoir geometries.

Partially buried giant mounded drifts in the Argentine continental margin: origins, and global implications for the history of thermohaline circulation

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Partially buried giant-drifts, characterised as asymmetrical giant mounded elongated contourite drifts, are located at the base of the slope on the southernmost sector of the Argentine continental margin. They are described based mainly on the bathymetric and multichannel seismic reflections profiles database. Its genesis and evolution in the Argentine basin is decoded and its implications in a crucial area for geologic and palaeocenographic reconstruction between the Atlantic and Antarctica are discussed. Buried giant drifts are located below the present active Contourite Depositional System (CDS), with a north trend at the base of the slope at 5300-5400 m water depth. Its summit outcrops at present sea-floor, generating a bathymetric jump which represents an important change in the slope gradient trend at the base of the slope. The occurrence of giant-drifts leads to the following considerations: • Giant-drifts were generated in an open deep marine environment. Two major drifts are identified south and north of a large seamount (El Austral Seamount): the southern drift and the northern drift. The southern drift is about 40-50 km wide, 250-300 km long, with a sedimentary thickness of 830-950 m. The asymmetrical external shape is characterised by a steep west side and an east gently-dipping smooth side. Here, internal reflections prograde eastward. Meanwhile, the northern drift is about 35 km wide, and 767 m thick. Here, the giant- drift has an opposite geometry if compared with the southern zone, with a steep east side and a west gently-dipping smooth side. Here, internal reflections prograde westward. • The seismic facies of the giant-drift show very weak to transparent acoustic response with discontinuous reflections and abrupt changes in the seismic facies. Some high amplitude reflections with greater lateral continuation (but affected by many faults), are evidence that large-scale cycles of drape deposition and erosion have combined to form the giant-drift. • We infer that the southern drift was generated by the southward flowing of Antarctic Bottom Water (AABW), which was initiated after the Eocene-Oligocene boundary until middle Miocene. The drifts are inferred to record a major paleoceanographic change between the middle to very late Miocene, and the regional hydrological model changed in part as a result of the initiation of North Atlantic Deep Water (NADW) circulation in the southern hemisphere. That water mass conditioned the formation of Lower Circumpolar Deep Water (LCDW) in Antarctica and the deepening of AABW circulation in the Argentine Basin, which has been the major controlling factor of sedimentary processes in the lower slope and abyssal plain since middle Miocene to present. • From middle Miocene to present day a new oceanographic scenario is therefore established, being responsible for: a) the partial burial of the giant-drifts and b) a new margin morphology with the development of present day morphosedimentary features within the Contourite Depositional System generated by the northward flowing of the Antarctic water masses. • Some seismic facies are good indicators for gas hydrates, fluids and free gas occurrence within the giant-drifts. Therefore the giant- drifts should have a good potential interest for energy resource exploration in future, and consequently constitute a good example of the possible economic importance of contourite deposits in deep marine environments. Our results are an example of how large contourite drifts present in the deep marine environment can provide evidence for the reconstruction of palaeoceanographic changes, and help to explain Thermohaline Circulation and climate in the past.

The Ototara Limestone – bryozoan reefs built upon submarine volcano platforms

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The Waiareka-Deborah volcanics, and associated sedimentary and intrusive rocks forming the Eo-Oligocene marine Alma Group (Gage, 1957), occur in a triangular area of ~180 km2 with one side parallel to the present coastline of North Otago, South Island, New Zealand. The group includes well-preserved remnants of small monogenetic, intraplate volcanoes; strata comprise mainly tholeiitic basaltic rocks with a substantial proportion of mid- to high-alkali basalt, both of which form deposits complexly interdigitated with the bioclastic Ototara Limestone. A number of small Surtseyan volcanoes (estimated volume of all together a few tens of km3) formed in a shelf setting. Pillow lavas, hyaloclastite breccias and various pyroclastic and reworked volcaniclastic rocks interfinger with limestone, diatomite and mudstone. The deposits' age ranges from Late Eocene to earliest Oligocene, spanning New Zealand's Kaiatan, Runangan, and earlier Whaingaroan stages (~37 - ~32 Ma). This is a study of physical sedimentology of the bioclastic limestones, their stratigraphic relationships with primary and reworked Eo-Oligocene marine volcaniclastic strata, and relationships among rates and styles of sediment accumulation, marine organisms at depositional sites, marine currents, volcanism and palaeo-environments. The continental shelf eruptions produced new topography in a setting remote from land, providing a source of new sediment and new shoals within the photic zone. Substantial limestone sequences associated with the volcanics suggest that new topographic highs were sites of enhanced biological activity, supplying biogenic sediment to the surrounding shelf. Growth of volcanoes on the shelf would also have affected ocean currents, sediment supply, and scouring in the vicinity, influencing the development of unconformities. Iron and other nutrients from erupted basaltic debris may have enhanced local ocean fertility. Stable-isotopic studies of the calcareous sediment will provide information on the oceanic water masses during this pivotal period in the evolution of the Southern Ocean and the southeast-central part of the largely submerged Zealandia landmass. The research will inform interpretations of palaeo-oceanography and basin development, and the relationships between marine organisms, sediment accumulation, volcanism and ocean currents for the Eo-Oligocene continental shelf of northeast Otago and in other temperate shelf volcanically active settings.

Rare earth elements in authigenic methane-seep carbonates record pore fluid composition during early diagenesis

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The rare earth element (REE) and yttrium (Y) content of methane-derived authigenic aragonite phases (i.e. microcrystalline, cryptocrystalline, and botryoidal aragonite) from an active cold seep on the Makran accretionary prism was analysed by means of solution- and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The REE+Y contents vary for each aragonite variety. Early precipitated microcrystalline aragonite yielded the highest, subsequently formed cryptocrystalline aragonite intermediate, and late botryoidal aragonite the lowest total REE+Y concentrations. The shale-normalised REE+Y patterns reflect early diagenetic pore fluid compositions during precipitation: Microcrystalline aragonite shows higher contents of middle rare earth elements (Sm, Eu, Gd, Tb, Dy), reflecting REE patterns of anoxic pore water. Cryptocrystalline aragonite exhibits a seawater-like REE+Y pattern (light REE depletion, negative Ce anomalies, and positive La anomalies), but higher total REE+Y concentrations than expected from seawater-derived precipitates, indicating that REEs derived mainly from pore water with minor seawater influence. Botryoidal aragonite is characterised by seawater-like REE+Y patterns at initial growth stages, followed by an increase of light REEs with crystal growth, which reflects altering pore fluid compositions during precipitation. Conventional sample preparation, involving micro-drilling of carbonate phases and subsequent solution ICP-MS, does not allow to identify such subtle changes in the REE+Y composition of individual carbonate phases. To be able to reconstruct the evolution of pore fluid composition during early diagenesis, an analytical approach is required that allows to track the changing elemental compositions in a paragenetic sequence as well as in individual phases. High-resolution analysis of authigenic seep carbonates from the Makran accretionary prism by LA-ICP-MS reveals that the pore fluid composition not only evolved in the course of the formation of different aragonite phases, but also changed during the precipitation of individual phases.

Submarine slope degradation and aggradation, the construction of external and internal submarine levees, and the evolution of submarine fans: learnings from the Karoo Basin, South Africa

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Two slope channel-levee systems exposed in the SW Karoo Basin, South Africa, provide insights into how submarine conduits evolve and fill. Mapping these systems down-dip and across strike for 10's of km allows their evolution within a fuller depositional architecture to be understood. Correlation of closely spaced measured sections and mapping demonstrate that one channel-levee system (Unit C) is incised by a younger channel-levee system (Unit D). Adjacent to the Unit C channel system are constructional external levees that confined the channels. The Unit D channel system also has external levees, but the component channels are confined by a >100m deep asymmetric composite erosion surface beneath the base levee surface. In Units C and D, a hierarchy of channel-fills and channel complex-fills are identified that follow a common fill motif. A complicated stratigraphy in the oldest channel-fills is due to disorganised stacking, which is followed by a more organised horizontal stacking pattern (lateral migration) with repeated cut and fill. The youngest channel-fills stack vertically (aggradational) and preserve more sand-prone channel axes and are partially confined by internal levees. Down-dip these systems transform into less confined systems with increasing distributive characteristics. Commonly identified at the base of external levee successions are thick sandstone beds, which are interpreted as frontal, or precursor, lobes. Furthermore, overlying deposits exhibit an overall upward and lateral fining and thinning trend that indicates decreasing flow spill through time. To account for these observations a conceptual model is presented where, as the external levee is constructed, flows at that point on the slope profile are increasingly confined and therefore increasingly efficient in bypassing sediment farther into the basin. Therefore, external levee successions and erosional confinement form during periods of increasing sediment supply (slope degradation and basinward growth of submarine lobes). The time of most efficient sediment supply is when the flows are most confined. Ultimately the channel belt will aggrade, driven by decreasing flow magnitude and frequency, and/or lowered channel gradient (slope aggradation and landward stepping of submarine lobes). The excess accommodation developed by entrenchment and/or external levee construction promotes the development and preservation of internal levee deposits. In this model, external levees form during waxing conditions, and internal levees form during waning conditions, which are likely tied to relative base level cycles.

Generation of hypopycnal and hyperpycnal flow in saline ambient fluid with density contrast

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Density currents are one of the ways of transport of sediments into the sea, due to the connection of fluvial systems with large ocean basins, via deltas, canyons and deep-water fans. Density currents entering the sea (or a lake) are classified following the density contrast between the current mixture and the ambient fluid. Density currents that are denser than the ambient fluid are called hyperpycnal flows; if less dense, they are called hypopycnal flows. In literature, sustained currents have received less attention than short-lived catastrophic currents, and few studies have been concerned with both saline ambient and a wide range of grain sizes. This work aims to simulate density currents in a saline ambient, testing different density contrasts between the current and ambient fluid and verifying the minimum density required for the formation of hyperpycnal flows (considering different densities of ambient fluid). Sixteen currents were simulated with different density contrasts between flow and ambient fluid. The experiments were conducted in an elongate glass tank with an auxiliary reservoir to prepare the mixtures. The ambient fluid was composed of saline water at different densities (1010, 1015, 1020, 1025 and 1030 kg/m³) while the currents were composed of a mixture of water and sediment (mineral coal with density 1190 kg/m³) at densities ranging from 1002 kg/m³ to 1026 kg/m³. The sediments were very poorly sorted, with an average size of 55 µm. All experiments were recorded with a digital video camera and from the video footage the thickness of the currents and the front velocity of the flow along the channel were measured. After the experiments, the deposits were sampled for grain sizes analysis. The experiments showed the generation of hypopycnal flows for density currents below the threshold of 1005 kg/m³. Above this limit, both hypopycnal and hyperpycnal flows were generated in all flows. The difference between the flows was the run-out distance from the source, the thickness of the hyperpycnal flow and the position of the lofting-point for hypopycnal flows. The concentration and the density contrast play an important role. During the low density experiments (< 1005 kg/m³) the currents mixed rapidly along the vertical just after their entry into the saline environment (proximal zone). However, with a small increase in sediment concentration (> 1005 kg/m³) the currents showed a higher resistance to entrainment of ambient fluid (mixing process). This resistance is attributed to the increased number of suspended particles, which causes changes in the support mechanism and depositional process. In this sense, even a density current slightly less dense than the ambient fluid was capable of generating hyperpycnal flows. Regarding the grain size distribution of the deposited sediment, it was noticed that the maximum run-out distance achieved by hyperpycnal flows matches up well with deposits of very fine sand (< 62 µm to 125 µm). Beyond that distance, all sediments deposited would have been transported by hypopycnal flows. The physical modelling approach allowed us to make a first step towards understanding the origin, time- space transport and deposition process of hyperpycnal and hypopycnal flows. Additionally, the use of contrasting densities of ambient fluid and density currents composed of grains within a large size range reproduces natural processes more reliably. The wider implications of the experimental results will be discussed.

Facies and environment constraint for the molar-tooth structure in Neoproterozoic carbonate, Eastern Liaoning, Northeastern China

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The Neoproterozoic sedimentary succession in the Eastern Liaoning Province of Northeastern China is mainly composed of carbonates with megascopic fossils of *Cloudian*, and *Sinotubulites* (Grant, 1990; Chen and Sun, 2001). In an ascender order, it is composed of the Changlingzi Formation, Nanguanling Formation, Ganjingzi Formation, Yingchengzi Formation, Shisanlitai Formation, Majiatun Formation, Cuijiatun Formation and Xingmincun Formation. The estimated geological age for the succession is about 0.8-1.0 Ga (Liu *et al.*, 2006). The enigmatic Molar-tooth structures (MTs) reported in Mesoproterozoic- Neoproterozoic carbonates worldwide appear frequently in the Nanguanling, Yingchengzi and Xingmincun Formations as well. The Nanguanling Fm. is composed of rhythmic calcarenites, lamina marls and micrite, and occasional intercalations of fine calcirudites. Erosion surface, cross bedding and hummocky bedding and graded bedding in this formation simply indicates that the sedimentary environment is shallow subtidal. Most of the MTs appear in argillaceous limestone or lamina marls, but the allochthonous MTs present in calcarenites and calcisiltites. The lower part of the Yingchengzi Fm. consists of fine dolomites, dolomitic limestones and rhythmic micrites and muddy shales with fine calcirudite interbeds. Erosion surfaces, hummocky cross bedding and graded bedding suggest that it was formed in shallow subtidal. The upper part of this unit is presented by rhythmic deposition of calcarenites or calcisiltites, ferruginous argillaceous limestones and micrites interpreted as sediments formed in shallow subtidal to peritidal settings. MTs is abundant in micrite and little was recorded in ferruginous argillaceous limestones. The Xingmincun Fm. is mainly composed of calcarenites or calcilutites, marls and micrites. Erosion surfaces, cross bedding, hummocky cross-bedding and deformed beddings, fine calcirudites and occasional hardgrounds suggests deposition in a shallow Subtidal environment. In this unit, MT occurs mainly in lamina marl. Isotopes tests of MTs's hosting rocks shows that carbon isotope in MT-bearing rocks in the formations of Nanguanling, Ganjingzi, Yingchengzi and Xingmincun is about 3-5‰ and higher than the horizons of rare MTs. Oxygen and Sr isotopes are -7‰ and 0.7056- 0.7074, respectively.

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Stratigraphy, facies analysis and historical planform change of the Platte River of south-central Nebraska, USA: implications for models of alluvial stratigraphy

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This paper summarizes the first comprehensive stratigraphic investigation of the central Platte River sand body near Grand Island, Nebraska, combining internal architecture, real-time morphological changes, and an understanding of its context within the ~ 50m thick Platte River incised valley fill. During the Holocene, the Platte River entrenched 6-8 m down into Pleistocene alluvial deposits, forming a laterally coalesced array of migrating braided channel belts collectively 20 km wide. The most recent of these belts has undergone changes in morphology to a contracting anabranching system due to a decrease in flow and increase in vegetation cover. Channel morphology within the channel belts has been quantified using aerial photography, Soil-Survey data, and topographic maps. Ground-Penetrating Radar (GPR) data were used in conjunction with sequential aerial photographs to determine the internal architecture of the abundant, partially vegetated macroform bars. The chronology of alluvial surfaces was determined using cross-cutting relationships and Optically Stimulated Luminescence dating techniques. The Holocene incised valley fill preserves two major, climatically controlled surfaces, 4 ka and less than 700 a in age, respectively. The older surface is interpreted to record entrenchment and the onset of an aggradational phase, while the younger surface is associated with degradation. The Holocene fill is 6-8 m thick and lithologically heterogeneous (dominantly sand with lesser gravel silt, clay). While previous studies have emphasized formation of transverse bars in the studied portion of the Platte River, no such features were found during the current field campaign. The absence of large, mobile bars is most likely due to increased levels of stabilization by vegetation over the past 30-40 years. Large, compound barforms investigated during the study were found to be complexes of shallow channel fills, and are in fact exposed channel surfaces that have been partially stabilized by vegetation. Macroform features with evidence of lateral and downstream accretion are, however, preserved in the lower Platte River, closer to the confluence with the Missouri River. Human activities upstream of the central Platte River have led to a decrease in water discharge and sediment load. This decrease, coupled with encroachment by the invasive reed Phragmites, has led to contraction of channels (river channel area has decreased by 46% and channel width by 366% in the study area over the period 1938-1999) and the establishment of mid-channel islands. These islands, which fix secondary channels in place, are responsible for imparting the anastomosing character to the present-day Platte River. Analysis of sequential aerial photographs has facilitated the linkage of GPR reflectors to the transient positions of mid-channel islands, and clearly implicates both barforms and channel bedforms in their formation. Therefore, the mid-channel islands comprise sections of abandoned and vegetated channel bedforms and barforms, rather than, as assumed by previous models, merged unit bars with laterally accreted surfaces. Vegetated mid-channel islands in the central Platte River may be similar to macroforms found in other braided stream systems that have been affected by the encroachment of vegetation. The historical changes in the Platte river geomorphology and sedimentology may therefore have relevance to studies of the abandonment phase of ancient alluvial successions.

Allocyclic and autocyclic controls on Pleistocene – Holocene lacustrine deposits: Pueyrredón Lake, Santa Cruz, Argentina

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Pueyrredón Lake is located 150 m asl at the northwest end of Santa Cruz Province in Argentina, extending into Chile as Cochrane Lake. Pueyrredón Lake is bordered by the Colorada Range to the northwest, San Lorenzo Massif and Belgrano Hill (2305m) to the southwest, and San Lorenzo (3706m) and Chivas (1804m) Hills to the south and west. Four lacustrine deposits surrounding Pueyrredon, Posadas, and Salitroso Lakes were identified at different altitudes during field surveys. These deposits were found at 180-190, 200, 310, and 400 m asl. They are mainly composed by siltstones and mudstones varying from 1 to 10 m in thickness, and contain fine parallel lamination, convolute strata, gastropods, and fossil teeth. Underlying these fine-grained deposits are massive siltstones and sandstones with randomly placed, angular to subangular pebbles at altitudes of 180-190 and 310 m asl. These massive coarse-grained deposits reach 1.5 m in thickness and are interpreted as diamictites. Sedimentologic logs were measured along the exposures of the fine-grained deposits to characterize lateral and vertical facies changes. Lithologic samples were analyzed in the laboratory to determine grain size variation and mineralogy using a magnifying glass (x80) and a petrologic microscope. Data indicate that three fan deltas entered Pueyrredon Lake from the southern ranges. These fan deltas show variations in their radii through time with partial control from wave erosion. The largest fan delta is located far away from the Andes, indicating deep erosion elsewhere. These fan deltas along with neighboring alluvial fans exhibit large terraces at certain levels indicating perhaps either tectonic or glacial control in their formation. The fine-grained deposits at 400 m asl show convolute lamination, flame structures, and intensive synsedimentary faulting and folding which may indicate tectonic influence. The different altitudes of these sedimentary deposits were mapped with Ilwis software using Landsat 7 ETM and SRTM (Shuttle Radar Topography Mission) in order to create a Digital Elevation Model. This model shows that Pueyrredón, Posadas, and Salitroso Lakes were connected, perhaps during the last glacial period.

Habitat of Norwegian methane-derived carbonates – an overview

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From their first discovery inside a pockmark at 124 m water depth (wd) in the North Sea (Hovland *et al.*, 1985), to finding them in an emerging fjord delta sequence in Northern Norway, Norwegian methane-derived authigenic carbonates have been found over a range of locations and habitats. These include: - A submerged beach deposit at Gullfaks (180 mwd, Hovland and Judd, 1988) - "Eyed pockmarks" at Tommeliten (77 mwd, Op sit) - Clustered pockmarks at Troll (310 mwd, Forsberg *et al.*, 2007) - Complex pockmarks and gas hydrates at Nyegga (760 mwd, Mazzini *et al.*, 2006) - On "Seep mounds" at Nyegga (760 mwd, Ivanov *et al.*, 2010). - The upper 40 meters of a glacio-isostatic uplifted late Quaternary glaci-fluvial delta in Ullsfjord, Northern Norway. They manifest the continuous seepage of methane-charged porewater, where the methane is normally derived from a mixture of biogenic and thermogenic methane. They range from coarse sandstone and gravels to silty mud-cemented rocks. In size, they range from decimetres to great slabs of more than 25 cubic metres (Hovland *et al.*, 2005).

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A large deep-water coral reef and associated unit-pockmarks, off Norway

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A relatively large, composite (ca. 500 m long, 100 m wide and 25 m high) deep-water coral reef, DWCR, was recently discovered in association with numerous unit- pockmarks (Hovland *et al.*, 2010). This "Fauna reef" was named after one of the vessels used during the investigations, the "Edda Fauna". The area is located 07º 53' E and 63º 54' N, SW of the well-known Sula Reef Complex (Freiwald *et al.*, 2002; Hovland, 2008). Unit-pockmarks are small (<5 m diameter, up to 1 m depth) circular depressions in fine-grained (silty clay) sediments, suspected formed by buried gas that reacts to cyclic tidal and storm-wave action by pumping out nutrient-rich sediment porewater (Hovland *et al.*, 2010). A total of 233 unit-pockmarks and the large Fauna reef occur within the rectangular area measuring 920 m by 245 m, mapped with high resolution (0.2m by 0.2 m gridding) ROV-mounted multi-beam echosounder. Whereas 79% of the mapped unit-pockmarks are evenly scattered up-stream of the prevailing current at the Fauna reef, the rest of the unit-pockmarks are scattered up-stream of a much smaller DWCR. This latter one (ca. 50 m long, 30 m wide, 7 m high) is, however, located on the outer rim of a large normal-pockmark crater of ca. 180 m diameter and 16 m depth. Previous seafloor investigations in this region have revealed DWCRs closely associated with normal-pockmarks of up to 200 m width and 12 m depth. Such pockmark-related reefs occur at the nearby Haltenpipe Reef Cluster (HRC, Hovland and Risk, 2003) and at the Kristin and Morvin hydrocarbon fields (Hovland, 2008). The large limid bivalve Acesta excavata is very common on these latter reefs, where they are frequently attached to the hard corals dwelling inside normal-pockmarks (Hovland, 2008). Because the Fauna reef is such a large structure, it was expected that this common, large bivalve would also occur on the reef. However, despite a thorough search, it was found to be totally devoid of A. excavata. The only explanation we can offer for its absence is that the bivalve probably needs periodically turbid water for its vital functions. As a preliminary conclusion, we, therefore, suggest that the bivalve is not present because the water on the Fauna reef is too 'clean', i.e., it lacks periodic turbidity. Generally, the concentration of light hydrocarbons (methane – pentane) within the sediments of unit-pockmarks is found to be higher than in the background, surrounding sediments (Hovland *et al.*, 2010). We, conclude that unit-pockmarks do not provide turbid water, but they provide the necessary seep-related nutrients, pumped into the water column, to stimulate down-stream coral growth and reef development.

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Evaporite anomalies in the Red Sea – evidence for hydrothermal formation of salt?

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Large accumulations of salt are found along both sides of the 2000 km long Red Sea. Many of these accumulation features are difficult to explain in terms of the conventional solar evaporation ('evaporite') model (Hsü *et al.*, 1977). These features are: 1) Up to 7 km thick salt deposits on both flanks of the Red Sea (Searle and Ross, 1975; Gaulier *et al.*, 1988; Ehrhardt *et al.*, 2005); 2) Relatively thick salt deposits inside the central graben; 3) Dense, hot brines inside some of the central graben deeps (Atlantis II Deep, Conrad Deep, etc); 4) Up to 40 km long walls and ridges of exposed salt in the north (Mart and Ross, 1987); 5) Deep, ponded sediment bodies (layered salt?) located between these ridges; 6) Tall walls of salt adjacent to the Conrad Deep central graben; and 7) Large flows of salt in the Thetis Deep (Mitchell *et al.*, 2009). A new conceptual model (Hovland *et al.*, 2006) predicts that the majority of these salt bodies are formed subsurface as a result of hydrothermal circulation of seawater into the high-temperature and high-pressure (HTHP) domain of supercritical water. This hypothesis is supported by a numerical model, which has been run for the Atlantis II Deep of the Red Sea. Although hydrothermal processes are previously known to have contributed to the formation of salt volumes of geological significance, the basic processes involved have not been seriously addressed; i.e. (1) precipitation of salt when seawater attains supercritical conditions; and (2) salt precipitation by subsurface boiling of seawater; and (3) precipitation of salt as a part of the serpentinization process. Only water (OH) is being absorbed in the serpentinization process, which leads to the formation of brines and also to potential precipitation of salt under favourable conditions, away from the serpentinization zone. It is concluded that accumulation of salts may be a process closely associated with hydrothermal activity, and that it is more abundant than hitherto realized. Whereas such salts are lost in mid ocean spreading hydrothermal systems, they are protected by sediments and ponded high-density brines in the restricted deep spreading centres of the Red Sea. According to Cochran (2005) the Red Sea is the closest active analogue to the rifting and rupturing of continental lithosphere, which has formed most "Atlantic-type" continental margins. If this is the case, we think the key to understanding the huge subsurface salt accumulations and other salt-related structures in rifted margins is to understand the hydrothermal circulation of seawater and brines occurring inside the Red Sea deeps.

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Sedimentary record of subaerial volcanic activity in shoal-marine deposits of the Prague Basin (Ordovician,Třenice Formation, Bohemian Massif)

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The Třenice Formation represents initial deposits of the Prague Basin. Sediments of this Tremadocian unit are represented by coarse-grained siliciclastics of marine origin. Their thickness ranges from few to 70 metres and three main facies associations have been recognized: (1) Graded conglomerates are formed by cobbly to pebbly, clast-supported polymictic and quartz conglomerates. The conglomerates are interpreted as a transgressive coastal lag that was accumulated during sea ingression into the area of the Prague Basin. (2) Cross-bedded and massive sandstones are represented by lithic sandstones. Uncommon fauna is dominated by linguliformean brachiopods such as Hyperbolus feistmanteli. It indicates shoal-marine origin of the sediments. Shells are transported and fragmented.The cross- bedded sandstones facies is interpreted as a record of dunes with significantly sinuous crests in the shoreface environment. The massive sandstones are interpreted as proximal tempestites. (3) Volcanigenic clastics are represented by conglomerates and sandstones with clasts of vesicular rhyolites and volcanic glasses and are intercalated within the shorface deposits. Locally ignimbrite and basalt clasts occur within these sediments. The conglomerates are matrix-supported, without sedimentary structures and they are interpreted as a record of cohesive debris flows and high-density turbidity currents. The volcanigenic sandstones are characterized by horizontal lamination of millimeter to centimeter scale, locally with ripple bedding on top surface of layers and they are interpreted as record of turbidity currents. The occurrence of volcaniclastic intercalations documents a synsedimentary volcanic activity. Preservation of non-resistant volcanic glasses argues for short-distance transport. Subaerial origin of the volcaniclastic material is supported by absence of hyaloclastics and by lithological similarity of the volcaniclastics to products of subaerial volcanic complexes adjacent to the Prague Basin. The original volcaniclastics were subsequently resedimented by subaerial and shoal-marine processes and finally deposited due to debris flows or turbidity currents in shoreface environment. Thus, the Třenice Formation represents sedimentary record of interaction between shallow-marine processes and synsedimentary subaerial volcanic activity.

Utilizing ichnology and sedimentology to decipher slope channel processes and evolution, Tres Pasos Formation, Chilean Patagonia

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A 300 m-thick sandstone-dominated outcrop in the Upper Cretaceous Tres Pasos Formation (Magallanes Basin, southern Chile) comprises ubiquitous channelform architectural elements in the lower slope position of a well-mapped high-relief slope clinoform system. The channelform bodies are up to 25 m thick and 300-400 m wide, primarily composed of thick-bedded sandstone attributed to rapidly collapsing high- concentration turbidity currents. Channel-fill deposits also include exquisitely exposed, but local (only 5-10% occurrence), fine-grained facies. The ichnology and sedimentology of these thin-bedded units provide insight into (1) the processes that were responsible for the initiation and filling of channels; and (2) the paleoenvironmental conditions prevalent during their evolution. Intra-channel fine-grained facies are dominated by thinly interbedded graded deposits attributed to: (1) a drape phase associated with high- energy gravity flows that largely bypassed the channel setting and sedimentation from successive waning low concentration turbidity currents; and (2) deposition on inner levees. Drape units are typically finer grained and thinner bedded, with minimal direct evidence for erosion (e.g., mudstone rip-up clasts, flutes); beds are characterized by a high proportion of trace fossils attributed to grazing just beneath the seafloor. Inner levee deposits are subdivided into axial and marginal end-members. In general, direct evidence for relatively high-energy currents (e.g., thicker beds, cross-stratification, rip-up clasts) is more prevalent in inner levee deposits closest to the channel axis. Here, evidence for erosion on the seafloor is recorded by passively filled Diplocraterion up to 1 m long, which were excavated into an exhumed firm substrate (Glossifungites Ichnofacies). Burrowing strategies are more diverse in thin-bedded turbidites adjacent to the distal channel margin where deposition of nutrient-rich sediment was substantial yet current energy was lowest within the channel environment. Slope channels of the Tres Pasos Formation initiated through the incision of a conduit by high-energy flows recorded by the deposition of widespread drape deposits, which mantle basal erosion surfaces. Channels filled as turbidity currents deposited fine-grained-dominated inner levee units at the channel margins, and thick-bedded sands in the channel axis. Periodic outsized flows passed through the channel, recorded by drape units interbedded with inner levee strata. Ichnological and sedimentological characteristics permit differentiation of inner levee and drape facies, leading to honed depositional reconstructions for the slope channels studied. The analytical approach taken can be used to decipher key fine-grained facies in deep-water units in outcrop and drillcores, with potential applications including the subsurface recognition and prediction of channel deposits in hydrocarbon exploration and development.

Strontium and carbon-isotope based chronostratigraphy of Barremian-Aptian northern Tethyan platform drowning

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The chronostratigraphy of platform drowning in the northern Tethys and the Early Aptian oceanic anoxic event (OAE 1a) is controversial. No consensus exists, whether the OAE 1a black shales must be attributed to the Deshayesites weissi or the Deshayesites deshayesi zone. However, a relation between biotic perturbations and environmental changes linked to OAE 1a (e.g. the disappearance of coral-rudist reefs in the Helvetic Alps; Föllmi *et al.*, 2008), has been postulated. In the central and southern Tethyan realm (Istria, Oman), OAE 1a is likely expressed as transient mass occurrence of microencrusters (Lithocodium-Bacinella) and coeval demise of characteristic mid- Cretaceous framework-builders (rudists, corals; Immenhauser *et al.*, 2005, Huck *et al.*, 2010). These observations raise the question whether northern Tethyan platform drowning is coeval to microbial bloom periods in the central and southern Tethys? With respect to this issue, well constrained age data are surprisingly scarce and controversial. The goal of the present research project is to: (i) compile a chemostratigraphic framework for the northern Tethyan platform drowning (Haute-Savoie, ESE France), (ii) shed light on the temporal constraints of platform drowning versus pelagic black shale deposition versus microbial blooms. In the context of this research initiative, three Barremian to Aptian shoal water sections in the Subalpine Chains were investigated applying high-resolution chemostratigraphy (C + Sr) and detailed sedimentological analysis. The lower part of the studied proportion of the sections comprises rudist-rich limestones and intercalated oncoidal beds (incl. Bacinella). The upper part consists of well-washed peloidal-foraminiferal grainstones alternating with Orbitolina-rich horizons. In the uppermost part, pulsed shedding of silt- sized siliciclastics is recorded and sections are finally truncated and capped by the Helvetic Garschella Formation (platform drowning). Rudist shells are mostly well preserved and relatively common. Therefore, outer low-Mg calcite of pristine rudist shells is used for strontium-based age assignment. The resulting numerical ages - combined with high- resolution carbon isotope stratigraphy - are used for the comparison with Tethyan δ13>/sup>C records. C-isotope stratigraphy of the sections reveals the recognition of chemostratigraphic segments that are in accordance with isotope curves from other Tethyan (platform) sections. The tentative Barremian-Aptian boundary is located above the Orbitolina-rich beds, marked by a distinct negative excursion (spike) that can also be observed in other Tethyan sections (Sprovieri *et al.*, 2006). Strontium isotope stratigraphy indicates that the platform drowned shortly before the onset of OAE 1a (< 124.6 Ma +/- 0.4 Ma; ~ Deshayesites weissi zone). This points to an almost coeval nature of pelagic black shale deposition, Oman and Istrian Lithocodium-Bacinella facies and platform demise in the northern Tethyan realm (French & Helvetic Alps).

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Volcaniclastic turbidity current depositional facies and architectures indicate potential mode of emplacement and provide insights into the flow behaviour

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Numerous dedicated coring expeditions to the Canary archipelago and surrounding deepwater depocentres have resulted in excellent core coverage. Volcanic islands naturally provide over-steepened edifices and flanks that can become destabilised and fail, producing large volume landslides and associated turbidity currents. In addition climatic barranco outwash events produce sediment accumulations that can also destabilised and fail, producing localised deposits. Another style of volcaniclastic deposition involves failures of volcaniclastic material draping seamounts, which produce turbidite currents with the potential to be basin-wide in magnitude. There are three primary examples of major flank collapses recorded as turbidites, including: El Golfo, Icod and Las Playas II events. A common feature of the facies architecture of the turbidite deposits of these events is the vertically stacked interbedded sands and muds. Grain-size and geochemical evidence suggests that this facies can signify multistage collapses mechanisms at source. These large-volume multistage collapse events are in stark contrast to large volume siliciclastic events, which occur as single-stage events. The stacked multistage signature in the turbidite record is not ubiquitous to major flank collapses. Indeed, events of smaller magnitude which are not tied to such collapses also show this facies. These smaller events can be linked to collapses of terminal barranco accumulations, which destabilise and failure. However, the mechanism of these smaller scale failures can be deemed to be multistage. There are also a number of deposits represented by coarse-grained massive sands capped by a grain-size break and a limited mudcap. This facies architecture can be attributed to either proximal bypass or a record of a surging behaviour in the flow (Mulder & Alexander, 2001). These have attributed to barranco outwash events and/or small scale single failures. The development of turbidity current associated bedforms (parallel laminations, cross laminations, and convolute laminations) appears to only be present in large volume surge-like flows that have develop a long enough flow bodies (Mulder & Alexander, 2001). In contrast shorter duration, lower volume events may not possess the length of flow body required to develop bedforms. Sylvester and Lowe (2004) quantified the grain-size ranges and mud content over which turbidity current associated bedforms were found to develop in Oligocene turbidites in the East Carpathians. The analytical technique is applied to these modern volcaniclastic sediment systems where grain-size analysis can be quantified by use of a laser-diffraction particle analyser. This study aims to assess some of the controls on sedimentation, bedform development and facies association with particular flow behaviours.

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Chaos in the abyssal: processes affecting distal abyssal plain sedimentation on the northwest African margin

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The quiescent environment of the abyssal plain is thought to be the site of deposition of distal turbidites with sheet geometries (Rothwell *et al.* 1992). However, flume experiments have shown that decelerating turbulent flows are not mechanically simple and can produce an array of depositional facies owing to mud content, grain size, flow velocity and sedimentation rate (Sumner *et al.*, 2008). This study aims to demonstrate an array of these complexities that govern the distribution of sediment in the deepwater realm. Indeed, a newly discovered process has been found to profoundly influence the distribution of mudcap thicknesses of distal turbidites. The volcaniclastic turbidites associated with the geologically recent El Golfo and Icod landslides show unusual dispersal patterns, in that they appear to record multistage failures at source. The vertically stacked sequences of interbedded turbidite sands and muds in the Icod turbidite, Agadir Basin, demonstrate individual failures in a multistage event. This is based on basal grain-size data and geochemical heterogeneities. The inter-event suspension deposits from these succinct failures demonstrate processes of topographic interaction and proximal erosive removal. Another major control on the distribution of the Icod volcaniclastic turbidite is post-depositional remobilisation of the thick mudcap that was initially deposited. Mudcap isopachs of the Icod turbidite show excess thickening on the southern margin of the Agadir Basin. The mudcaps also show contorted laminations of silt within an ungraded clay matrix. Grain-size analysis shows that this contorted facies represents the grain-sizes and distributions associated with laminated muddy silts (Bouma Td) and graded muds (Bouma Te). A model for a process of remobilised mudflow is proposed here: 1) Deposition from a decelerating turbidity current commences, depositing massive sands (Ta), parallel laminated sands (Tb), and ripple laminated sands (Tc). 2) Convolute laminated clay-rich sands develop, where flocculated clays trap water and instigate overpressure during burial. The application of shear stress to the developing ripples results in plastic deformation and convolution of the original bedforms. 3) Deposition of planar silty clay-dominated laminations (Td) proceeds, again with the development of overpressure due to accumulation rate and nature of impermeable clays involved. 4) Commencement of graded clays (Te) further develops overpressure to a critical point. Upon Te deposition, overpressure diffuses vertically through the coarser Tc interval and builds up in the Td interval. 5) Failure commences in the Td interval due to the action of bed shear stress and gravitational potential on the basin margins, facilitated by the development of overpressure. 6) The mudcap comprising the Td and Te intervals are remobilised as a laminar mudflow. There is little energy in the flow to overcome cohesive forces, enabling preservation of silt laminations as plastically deformed contortions and larger silty clasts. The remobilised mudflow deposits at the base of slope on the basin margin. This study shows that distal turbidite deposition involves a complex interplay of many mechanisms that can profoundly influence the final architecture of the deposits. This study also highlights a previously undocumented flow process of remobilised mudflow. This process can be potentially categorised amongst other processes that develop the hybrid bed or cogenetic linked debrite facies.

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Can distal turbidites record the associated landslide mechanism at source and tsunamigenic potential?

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The northern flank of Tenerife has been prone to multiple mass wasting events, including the Icod landslide dated to ~160,000ka (Watts & Masson, 1995). The Icod landslide has generated a turbidite of 208km3 volume. The turbidite is recorded over an area of >350,000km2 through the Moroccan Turbidite System, deepwater northwest African margin. Not only has the turbidite flowed up-gradient through the Agadir Basin, but shows an atypical depositional architecture consisting of a stacked sequence of graded sand and mud intervals. This 'sub-unit' architecture can be construed as representing a retrogressive failure mechanism at source (Wynn & Masson, 2003). Evidence from mineralogy, subunit bulk and volcanic glass geochemical, grain size data and event volumes support a multistage retrogressive failure. This evidence can rule out earthquake induced multi-provenance processes and flow reflections. The implication is that this major flank collapse has propagated as a series of failures, rather than failing as a single block slide. Indeed there are seven spatially correlated events within the Icod turbidite. The bulk chemistries for these intervals has been ascertained using standard ICP-AES and ICP-MS methodologies and supplemented with more novel techniques such as ITRAX µXRF. These bulk signatures show an evolutionary trend, becoming increasingly evolved, with a progressively higher content of phonolitic glasses. Major element chemistries of the glasses show that material from the Diego Hernendez Formation have been failed. The glasses were analysed using standard SEM EDS, but also supplemented by using a tabletop SEM EDS (TM1000) and µXRF using the Eagle III. The uppermost failures do not include any highly altered glasses or minerals, which indicate that the Cañadas III edifice was not failed in the Icod landslide. Given that the edifice was not involved in the flank collapse and the high volume of volcanic glass it could be speculatively stated that the wall of the Las Cañadas caldera does not represent the landslide scar. The reduced volumes of the deposits, reduction in grain-size and calculated time lags for the events, indicate that the tsunamigenic potential for these failure events in greatly reduced. Thus distal turbidites prove a vital constituent when studying landslide processes. In regards to completing hazard assessments of marine regions such as oceanic volcanic islands or continental margins, the study of turbidites provide vital insights. This investigation also highlights the importance of a multidiscipline approach to the study of turbidites.

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Application of Sulphur isotopes in evaporates to reconstruction of depositional history of the South Caspian Lower Pliocene Succession

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A 7 km thick hydrocarbon-rich Lower Pliocene terrigenous succession (Productive Series) consisting of rhythmically bedded fluvial- and deltaic-lacustrine sediments was deposited in the land-locked South Caspian basin as a result of interaction between fluvial and lake processes. The rapidly fluctuating basin together with a great sediment supply caused a very rapid environmental change, the understanding of which is an important task. Results Sulfates (gypsum) belonging to various stratigraphic units are characterized by specific sulfur isotopic compositions in the Pontian- Holocene interval. This allows the use of isotopic composition as a correlation parameter on one hand, and on another, as an indicator of the paleogeographic conditions and mode of sulfate genesis. The latter advantage is due to the fact that gypsum is formed as a typical end member in known environments. Typical marine (Pontian) deposition yields a characteristic δ34S equal to 21.71‰; under conditions of a closed, desalinated modern Caspian Sea, δ34S varies within 7.00‰– 10.1‰; and in avantdelta parts of the modern Volga, δ34S is equal to 5.00‰. On the basis of these indications, the depositional setting of Early Pliocene deposits in the investigated part of the South Caspian basin might be characterized in the following manner. During sedimentation of the Kirmaki Suite, the studied deposits accumulated in a lacustrine setting with mineralization (δ34S 11.2‰) close to the salinity of the modern Caspian Sea, and later in a delta front environment (δ34S 3.46‰–6.84‰). Sediments of the Post Kirmaki Clayey Suite accumulated in a brackish basin, the salinity of which was probably higher than that of the modern Caspian Sea (δ34S 11.06‰–13.08‰) with strong salinization at the end of this suite deposition (δ34S 29.27‰–31.26‰). Higher in the Lower Pliocene section, in the lower part of the Balahany Suite and Sabunchi Suite, there was a return to a deltaic environment, and sedimentation again took place within a delta front and fresh lake (δ34S 5.41‰–7.06‰ and 3.84‰–6.43‰, respectively) analogous to the end of Kirmaki Suite. The Surahany suite differs from all other suites of the Productive Series by having the greatest distribution of gypsum in quantity and in variety within the range of its morphological and aggregate forms: bed and disseminated gypsum, interlayers, veins and veinlets. The numerous records of bedded gypsum have been explained by researchers as a result of strong salinization of the basin. However, our data testify that sulfates separated from the Surahany Suite deposits are characterized by an abnormally light sulfur isotopic composition (δ34S –4.56‰ to – 0.47‰). Moreover, for all 30 of the studied samples, the values of δ34S are negative except for one sample. These analytical data point to the epigenetic nature of gypsum in the Surahany suite. This conclusion is also confirmed by the identical match in isotopic composition of sulfur in the bedded gypsum with that of gypsum from the vein bodies observed in the Surakhany suite in Yasamal Valley (Absheron peninsula, South Caspian basin) and the Babazanan outcrop (Lower Kura depression, South Caspian basin). The genetic homogeneity of vein and bed gypsum is proved by the same tendency of their sulfur isotope composition change along the section These data are very important for an understanding of the changes in depositional environment throughout the Lower Pliocene, and the prediction of composition of these sediments in the deeply subsided unexplored parts of the basin.

Outcrop study of the South Caspian Pliocene HC producing unit: basinward environmental changes and reservoir characterization

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The principal South Caspian reservoir unit, the Lower Pliocene Productive Series (PS), is outcropping in many parts of the basin. However, the best outcrops providing a deep insight into sedimentology, reservoir architecture and reservoir properties of this succession are located on the Absheron peninsula (Azerbaijan). This work presents investigations conducted in the Yasamal Valley outcrop (Absheron peninsula) of the upper portion of Productive Series that serves as an excellent analogue of offshore fields. These investigations give us a valuable clues to: (i) understanding the onshore sedimentary environment and predicting basinward changes; (ii) finding solutions to stratigraphic issues; (iii) estimating the role of sea level and sediment supply changes in PS stratigraphic architecture; (iv) evaluating changes in reservoir properties within an environmental framework. Abundant evidence of subaerial exposure (e.g., red shales, root traces) in the lowermost portion of Yasamal succession (lower Balakhany X subsuite) confirm sedimentation in a terrestrial environment dominated by delta plain setting with shallow sparse single channels. Upward the section in the upper Balakhany X subsuite a transition to the delta front environment is observed. Centimeter to several meter thick laterally continuous sandstones with abundant ripple lamination combined with flow ripples and antidunes prevail here. Such sand beds are considered to be formed by hyperpycnal flows. These sand bodies are characterized by good lateral but restricted vertical communication. N/G ratio for delta plain sediments is 30-35% (lower Balakhany X) and for delta front sediments is 60-65% (upper Balakhany X). Strong permeability variation from few mD to 800 mD has also been recorded. Further upward the section in the overlying Balakhany IX subsuite a gradational change toward a more distal facies is observed with the decreasing of sediment grain size, N/G ratio and permeability. This subsuite is deposited in lacustrine conditions as suggested by the appearance of gray lacustrine shale horizons. Very low N/G ratio (20%) and poor permeability (few mD) are typical for this subsuite, which may be considered as a local seal and barrier to fluid flow. In the overlying Balakhany VIII subsuite a dramatic environmental change occurrs. This succession is dominated by stacked thick channel belt sands with excellent vertical and lateral communication as well as very high N/G ratio (90-95%) and permeability (up to 1800 mD). Rare mud clast horizons do not create a barrier to HC fluid flows. Downstream accreting midchannel bars are also common. Based on the stratal architecture of studied onshore sediments we can assume the extension of these sand bodies toward the basin. An important question is: what are the driving forces of such rapid environmental changes – sea level fall or dramatic changes in sediment supply? Numerous facies changes within proximal and distal environment recorded in the studied outcrop play an important role in reservoir architecture and properties.

Sequence stratigraphy and geochemical signature of subsurface Late Ordovician Red River Formation, Williston Basin, USA

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The Upper Ordovician Red River Formation, Williston Basin, North Dakota is an overall shallowing (and "brining") upward supersequence composed of three third order depositional sequences. The supersequence formed within the intracratonic basin, in the interior of the very broad and shallow, tropical, arid carbonate shelf that developed along the western passive margin of North America. By analyzing ~2,500 ft (760 m) of cores and combined neutron porosity- bulk density logs from 15 cores, three large, 25 to 80 ft thick 3rd order depositional sequences are identified that can be traced regionally over western North Dakota. The transgressive systems tracts of all sequences consist of subtidal, lagoonal facies of predominantly skeletal mudstone-wackepackstone with abundant burrow mottling. The lower two sequences (sequences 1 and 2) have early highstand systems tracts composed of porous, peritidal laminated dolomites, whereas late HSTs consist of supratidal anhydrites. The late HST of Sequence 3 consists of peritidal laminites; anhydrite is present only in the basin depocenter and pinches out laterally. Lowstand systems tracts are not preserved in the Williston Basin because of its updip position on the broad shallow shelf. The mean δ18O value for limestone is -6.1‰ PDB. The mean value for oxygen isotopes of dolomite whole rock is -4.87‰ PDB, i.e., on average dolomites are 1.26‰ heavier than limestones. Such a small positive shift in oxygen isotope values between dolomite and limestone suggests that the dolomites picked up a slightly lighter signature due to burial (9,000 to14,000 feet). The low strontium content (33-308 ppm) resembles Plio- Pleistocene Bahamian dolomites of inferred marine origin. The Red River dolomite isotope values overlap the strontium compositions of the Tertiary dolomites, but the oxygen isotopes are much lighter (5.5 to 10‰), reflecting light oxygen isotope values of later Ordovician marine calcites, and some recrystallization of the dolomite in the presence of isotopically more negative burial fluids. The high Mn2+ (mean value 151 ppm) and high Fe2+ (mean value 1082 ppm) in the dolomites indicate that the pore waters were reducing and that a significant source of iron and magnesium was present; these values support the idea that some of the early dolomites have been overprinted with burial. The positive excursions in carbon isotopes and their possible relation to North American carbon chemostratigraphy are tested.

Transgressive, deepening-upward peritidal carbonate platform parasequences: importance of animal and plant bioturbation as climatic indicator

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Meter-scale carbonate parasequences (cycles) are common on peritidal carbonate platforms, especially those that were formed during greenhouse climates. Most peritidal parasequences are upward shallowing, regressive parasequences; others are symmetrical transgressive-regressive parasequences, while a third group are dominantly transgressive parasequences, that lack a well defined regressive cap. This study focuses on these transgressive carbonate parasequences using examples from the Early Cretaceous of the Adriatic carbonate platform, Croatia. The 230-meter-thick succession of Hauterivian to Lower Barremian platform-interior peritidal parasequences was deposited on the tectonically stable interior of the large, Bahamas-size-and-type Adriatic carbonate platform. Prominent, common subaerial exposure surfaces marked by breccia and shale are concentrated near third-order sequence boundaries and likely represent short cooling periods associated with sea level drops on a Hauterivian-Early Barremian greenhouse platform. The studied transgressive parasequences in the Hauterivian-Early Barremian are dominated by subtidal facies. They consist of, from base to top: (a) microkarstic emergence surface, locally with granule-to-pebble-size angular clasts in lime mudstone or dolomitic green shale; facies of underlying cycle are commonly rooted with leached mollusks infilled with green shaly dolomite; (b) transgressive fenestral laminites, locally with green shale stringers (relatively rare) or transgressive microbial-lump and pisoid wackestone-packstone to floatstone, or thin dark-colored, coarse ooid rudstone with broken-and-rehealed ooids (may be capped by erosional/hardground surfaces); (c) subtidal peloid muddy carbonate with gastropods, clams, benthic foraminifera and calcareous algae, with peloid-filled burrows and branching, cm-wide, green shaly dolomite-filled branching root-traces; (d) capping emergence surface, may be planar or irregular erosional and extending down beneath the surface as shaly dolomite filled subhorizontal v-shaped cracks and/or filled irregular cavities. Some parasequences are completely dolomitized. Transgressive parasequences are characterized by lack of microbial and fenestral laminite caps and extensive bioturbation in the upper part of marine mudstone unit by plants and burrowers beneath the upper parasequence boundary. These features may be an important climatic indicator; it is likely that the increasingly humid conditions on the platform allowed macrophytes and burrowers to colonize the shorelines, inhibiting formation of laminated intertidal-supratidal facies.

Sediment sequence reflecting the sudden drainage of Baltic Ice Lake to Yoldia Sea level in southern Finland during the Younger Dryas/Holocene transition

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During the late Weichselian deglaciation of the Scandinavian Ice Sheet (SIS), a meltwater lake occupied the Baltic Sea basin in the front of the retreating ice margin. This large proglacial lake, named as Baltic Ice Lake (BIL), had a gradually rising water level until its final drainage, which occurred at the end of Younger Dryas climate event, about 11600 calendar years ago. After the drainage, water level was stabilized to the ocean level, and brackish water gradually arrived at southern part of the Baltic Sea basin, marking the beginning of Yoldia Sea phase. The sudden 27-meter base level drop affected strongly sedimentation processes in different parts of the basin depending on the water depth: intensified denudation of newly exposed shore areas lead to deposition of cover sands, and waves started to erode shore terraces at lower levels. Shallow-water sedimentation increased due to the re-deposition of earlier, poorly compacted sediments. In deeper waters, turbidite currents activated leading to large-scale sediment deformation structures. Already earlier, the BIL drainage was considered to have created a key horizon for basin-wide correlations. So called “catastrophe varve” was deposited, originally representing a zero year in the Swedish and also Finnish varve chronologies. This horizon has been found in southern Finland to form a 10-cm-thick layer separating the clastic, fresh-water (diatactic) clays from the brackish water (symmict) varves above. In this study, sedimentary sequences from three localities in southern Finland were described and photographed in detail and analysed for their grain size distribution and micromorphology. Four sedimentary facies can be recognized: 1) Lowermost, laminated and graded clay and silt representing varves deposited during BIL. 2) Mixed, clay rich layer with small sand pods and slabs representing the drainage event and a period of intensified re-deposition of earlier sediments in the basin, right after BIL water level dropped. This is also referred to as “catastrophe varve” in the earlier literature. 3) Rippled sands and laminated fine sediments with occasional deformation structures representing transition from fresh to brackish water, and accelerated sedimentation due to the newly lowered base level. 4) Laminated silt and clay couplets representing sedimentation in brackish water environment. Correlation of the drainage horizon on the basinal scale has proved to be difficult, and there is a clear discrepancy in chronologies derived from varve studies in different areas within the Baltic Sea. Discrepancy continues comparing radiometric chronology with the varve ages. This can be partly due to inadequately known sedimentary processes in different parts of the basin, thus making the adaptation of the “Zero-varve” –concept problematic. To clarify the effects of drainage event, this study examines in detail the facies changes, which are interpreted to represent the drainage horizon. We attempt to date the horizon for the first time using OSL- luminescence method and discuss its value as a potential basin-wide stratigraphic marker layer.

Depositional processes of the Zhushadong and Mantou formations (Early to Middle Cambrian), Shandong Province, China: role of bold archipelago for tide-dominated sedimentation in the North China Platform during initial flooding

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In order to understand depositional processes and environmental changes during initial inundation of the North China Platform, this study focuses on the Lower to Middle Cambrian succession (Zhushadong and Mantou formations) in Shandong Province, China. Based on detailed facies analysis of seven outcrop sections (Mashan, Runyuquan, Mantoushan, Liantaishan, Shangquancun, Qicheng and Jiulongshan sections), 25 sedimentary facies (13 carbonates and 12 siliciclastics) are identified. These facies are organized into 18 lithofacies cycles and 5 facies associations, representing interplay of carbonate and siliciclastic dominant environments. Facies association A includes alluvial fan lithofacies such as disorganized conglomerate and pebbly sandstone with muddy matrix. Facies association B is characterized by shallowing-upward succession of carbonate and siliciclastic peritidal cycles. Facies association C comprises cross-laminated sandstone and oolite with fine-grained low-energy facies of shoal environments. Facies association D consists predominantly of shoreface sandstone and dark purple mudstone couplets, hummocky cross-stratified sandstone and trough cross-stratified oolite. Facies association E is characterized by cross-stratified and bioturbated sandstone within mudstone of lagoonal environments. These facies associations successively show a transition from an initially inundated tide-dominated carbonate platform to a wave-dominated shallow marine environment. Low-relief emergent bold islands gave rise to active tidal regime in the vast platform without being damped by unidirectional in-and-out flow of tidal currents. Weathering and massive erosion of low-relief unvegetated islands provided siliciclastic sediments which formed peritidal cycles alternating with carbonate facies. Siliciclastic input to the tidal flat was terminated at the middle of the Mantou time when most islands were submerged. This model provides a clue to the question of how the vast Cambrian carbonate platform maintained synchronous sedimentation under a tidal regime during the early stage of basin development in the North China Block.

Hydrocarbon expulsion–related structures and limestones in the upper Messinian Mediterranean Basin (Maiella Mts, Central Italy)

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Brecciated fabrics, coupled with authigenic carbonate precipitation and fluid migration features, affect the carbonatic units developed during the Messinian Salinity Crisis (MSC) of the Mediterranean Sea. Nonetheless, the relationship between the upper Messinian limestones and cold seep scenarios has been only speculated to date: the aim of this work is to test the latter hypothesis, using a suite of sedimentary and geochemical techniques, with special emphasis placed on the fabric-and-facies analyses approach. The “Brecciated Limestones” (BCL) unit cropping out in the NW Maiella Mts (Western Mediterranean area, central Italy), developed in a marginal foreland setting, just above a major basin scale erosional unconformity (the Messinian Erosional Surface, MES). In the Maiella Basin the MES cuts the underlying Lower Primary Gypsum (LPG Auctt.) unit. The BCL unit yielded a natural radioactivity related to authigenic uranium and is mainly characterised by concretioned and autobrecciated limestones, at locations embedded in laminated sediments (host sediment) and locally bitumen-impregnated. The brecciated texture is remarkably scale-invariant. The limestones fabric results from a puzzling framework of microfacies (peloidal, microbial, thrombolytic) and rheologic responses (small scale variations from microbrecciated to fluidized portions). Seep limestones markers were identified: moderate $\delta^{13}C$-depletion (values mainly spanning from -25‰ and -15‰ V-PDB); framboidal pyrite; barite and celestite; tar microinjections; traces of mixtures of Fe, Mn, Ni, Co oxides; lenticular pseudomorphs after gypsum. Organic geochemistry analyses (TOC and rock eval) confirmed their bitumen- injected nature. Fluid flow conduits occur both at the mesoscale and at the microscale. At the mesoscale they show mushroom-like structures, exhibiting facies associations made up by: carbonate nodules; carbonate concretions, bitumen impregnated and brecciated at sites; botryoidal aragonitic cement; bitumen-injected host sediment. These chimneys were detected at locations in the BCL unit and cut the underlying LPG unit as well. Subcentimetric microchimneys, occurring as single tubes or as composite branched features, were collected from the host sediment. Their fluid expulsion nature was established by: a) their striking resemblance to present day or sub-recent counterparts,; b) their strong $\delta^{13}C$ depletion, up to -39 ‰ V-PDB. A catastrophic fluid release consequently occurred in the foreland domain of Adria (Maiella Basin) in upper Messinian times. Most likely, the major drawdown of the Mediterranean Sea could have played a critical role in the fluid expulsion from below, given the contextual high depressurization experienced by the sedimentary column. The fluid flow meso- and micro-conduits and the brecciated facies testify that fluid- rock interaction took place in a partially lithified column. The proposed scenario for the upper Messinian Maiella Basin depicts an upward hydrocarbon-rich fluid migration through the Messinian succession, developed with major fluxes along giant neoformed chimneys and seepage through the host sediment. This event was accompanied by authigenic carbonate precipitation and brecciation. In such a context, localized overpressures can possibly account for brecciation processes.

Textural proxies for fluid-induced brecciation processes in limestones (Messinian, Western Mediterranean Sea)

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Brecciation extensively affects the carbonate units developed during the Mediterranean Salinity Crisis (MSC, upper Messinian), that constitutes an outstanding basin scale desiccation event. The brecciated limestones widely crop out in the Western Mediterranean area, representing a complex unit in terms of genesis and stratigraphy, since it is intimately related to a major basin-scale unconformity. These limestones have been commonly interpreted as evaporitic collapse breccia, resulting in autobreccia, and recently even as the product of mass wasting processes. To date, the relationship between the upper Messinian breccias and fluid migration has only been speculated. Nevertheless, a research addressed to the characterization of the mechanism triggering brecciation, including particle size distribution and fractal analyses, is still required. In order to provide ground-data for this kind of investigations, Messinian breccias from key-outcropping sections located in Italy (Maiella area; Calabrian Arc; Sicily) have been analyzed through an interdisciplinary approach. Sedimentological and fabric observations were carried out at different scales and integrated with natural radioactivity and stable isotopes data. The present study shows that the main textural proxies pointing to fluid assisted processes are represented by the detection of: (a) irregular geometries of the geobodies; (b) primary fabric overprinting; (c) peculiar textural characters of breccias; (d) scale-independent patterns; (e) complex rheology; (f) fabric resembling gas-hydrate infilling sediments. The Messinian breccias are made up of limestones exhibiting high variability in facies and thickness: their geometry varies from a patchy distribution within a host sediment to massive or stratified thick bodies interbedded with pelitic horizons. The carbonate beds consist of locally brecciated marly lime mudstones, cemented and concretioned to different degrees: generally brecciation overprints the primary sediment, but even in the more intensively brecciated beds, relict laminae allow the recognition of the original fabric. Breccias are highly cemented and devoid of gravity segregation, mostly monomictic and clast-supported, with sub-angular grains showing no preferential orientation. Brecciation (and growth of secondary nodules as well) has been observed from the mescoscale to the SEM-scale, resulting in a scale invariant pattern. Interestingly, even in the pelitic beds secondary nodules and microbrecciated portions occur. The primary microfabric, represented by a microbial-clotted and peloidal micrite, locally yields fluidized portions, as shown by chaotic re- orientation of the peloids. Moreover, the co-occurrence of plastic and brittle behavior suggest a complex rheology in an early diagenized sedimentary column. Textures resembling gas-hydrate infilling muddy sediments have also been observed. Secondary processes in the Messinian breccias are finally testified by the occurrence of: micro-to-macro injections, chalcedony, celestite, barite and framboidal pyrite. Both the carbonates and the pelitic fraction show an intense natural radioactivity (up to 63 Cps), mostly related to authigenic ^{238}U. The isotopic data yielded negative $\delta 13C$ values, from slightly negative up to - 40 ‰ PDB. The fabric of the breccias, together with their scale invariant nature and the occurrence of a complex chaotic rheology, point to fluid-related processes taking place in a partially lithified sedimentary column. The contextual formation of authigenic phases and the isotopic data converge to depict a fossil fluid seep environment, where localized overpressure could have triggered brecciation. Given the intense depressurization occurred in the sedimentary column during the upper Messinian huge drawdown of the Mediterranean Sea (up to 1500 m estimated), an upward fluid release could have likely occurred, locally resulting in hydraulic fracturing of the sedimentary succession.

Cements from Bajo Barreal Formation Sandstones, San Jorge Basin, Patagonia Argentina

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Upper section of the Bajo Barreal Formation (Turonian) is composed of fine and medium sandstones which show mainly cross trough stratification but also planar, massive and ripple lamination. Occasionally, a silt parallel lamination is observed at the top of sandstone bodies. The fluvial sandstone bodies are well exposed around La Sin Nombre small Lake, where three stratigraphic logs were described. Besides, architectural descriptions in some representative sandstones bodies, fully exposed, and additional short detailed logs separated by tens of meters each were recorded. The sandstones from Bajo Barreal Formation, show several kinds of cements. These cements play an important role in the porosity-permeability characteristics of the reseorvoirs. Characterizes the cements is the main objective of this work and the fundamental descriptions are presented in this abstract. The older cement is the argileous, which could be present in different ways, such as pore lining rims, sometimes associated to clasts dissolution generated porous, followed by HC filling. In these cases, rests of the cement in the middle of the pore space can be observed. Besides, ribbons of smectitic cement around the clasts, showing differential extinction according to its water content, are present. The width of the ribbon is variable, and also the HC impregnation, which offer different colors from grey to yellowish brown. Small quantities of Kaolinitic cement, sticked on some sides of the grains are present as well. The argileous cement is followed by silica. It can be like fibrous chalcedony, commonly impregnated by HC; like microcrystalline silica with sutured contact that grade into ftanite, often associated to the argileous cement and growing toward the centre of the pore space. Colorless rectangular crystals, with low relief, one direction cleavage, weak birefringence and grey interference color can be observed. Thorough X ray diffraction analysis their composition was determined as Clinoptilolite-Heulandite. Their small crystals are mainly disposed perpendicularly to the grains, but they can also be in the centre of the pore without any arrangement. Sometimes these crystals are partially impregnated with HC. Characteristic but less developed crystals of Harmotome and mordenite are present too. Another cements are the carbonate (calcite) and ferruginous-carbonate (siderite?). They can be the main cements in some sandstones levels. Poikilitic spatic calcite shows an excellent rhombohedral cleavage and sometimes presents polysynthetic twin. Microcrystalline calcite is also present. The calcitic cement can growth with acicular and columnar habits around the grains. It can move away the surrounding grains, corrode their perimeter and brake them, and so modify the fabric. The ferruginous-carbonate cement is present in microgranular aggregates of high relief, redish color, high birefringence, bright interference colors and no well defined relationship neither to the clasts nor to the previous cements. The last cement is represented by occlusive zeolite (Harmotomo?). They are long thin colorless columnar crystals whit low relief and birefringence, grey interference color and parallel extinction. They have suffered dissolution, but no HC impregnation.

Radiaxial fibrous cements: a new look on an old problem

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Ancient fibrous calcites are very common pore-filling fabrics in a wide range of Lower Paleozoic (Cambrian to Ordovician) and Cretaceous depositional environments. They might have been precipitated as a result of elevated pCO2 under mainly greenhouse conditions and high sea level. During Carboniferous and Permian times, when cool and icehouse conditions prevailed, pervasive fibrous cementation are probably related to more local conditions including upwelling and overturn of anoxic, alkaline basinal waters. Fibrous cements are regularly used as non-biogenic archives of marine porewater properties in epeiric-neritic settings. Systematic variations in the orientation of the c-axis within elongated calcite crystals are referred to as ‘fascicular-optic fibrous calcites‘ (FOFC), with divergent axes and ‘radiaxial fibrous calcites’ (RFC), with convergent axes. The petrographic and geochemical origins of this fabric are highly controversial. This controversy is due to the lack of occurrences in Cenozoic strata and the virtual absence of RFC and FOFC in Quaternary limestones. Previous workers presented petrographic evidence that radiaxial calcites are directly precipitated cements rather than the result of a complex replacement of a fibrous precursor. In addition, evidence of scarcely altered radiaxial calcite was given, that is consistent with direct precipitation rather than neomorphism of a fibrous precursor. Marine fibrous cements in the slope deposits of Carboniferous platform systems in Spain display bright green to dull luminescent zonation under epifluorescence microscopy. This points to the presence of relict organic material and raises the question of the significance of organic material for fibrous cement precipitation. The fluorescent banding of the marine cements might be the result of organic material in pore waters settling on the early marine cements, and likely poisoning the crystal surfaces, retarding but not obliterating the crystal growth. It is not known whether cementation inhibition resulted from sulphates, phosphates, or from humic acids. At present, many authors argue for an initially high-Mg calcite composition of these cements based on the presence of dolomite micro-inclusions, or inhomogeneous distribution of Mg within the crystals. Besides the well know marine fibrous calcites, radiaxial fibrous calcites have also been described from marine-meteoric mixing zones, as cements in beach rocks, speleothems and most recently also in rostra of belemnites indicating that this fabric is not limited to the abiogenic marine domain. These recent findings raise very direct and fundamental question regarding the origin and significance of fibrous calcites as archives of marine environmental change. The present contribution aims at providing an overview of RFC research in a process-oriented context and proposes future research based on the outcome of recent work.

The relationship between equilibrium line altitude and latitude as a control on Gondwana Glaciation during the late Paleozoic Ice Age

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Much attention is given to major environmental drivers during the late Paleozoic Ice Age (LPIA). However, the role that the equilibrium-line altitude (ELA) had on initiating or ending glacial intervals is untested. The ELA is the altitude of the line on a glacier that separates areas of annual net ablation from annual net accumulation. The land surface must reside above the ELA for glaciers to form. Therefore, glaciation results from lowering of the ELA during climate cooling or by tectonically elevating the landscape above the ELA. Latitude and precipitation also influence the elevation of the ELA. Here, we speculate on how the ELA may have influenced when and where glaciation occurred during the LPIA. Recent work has shown that glaciers varied in time, space, and volume across Gondwana with glacial events lasting 1-8 million years separated by non-glacial intervals of equal duration. The main phase of the LPIA began in western South America with the growth of small ice centers during the Visean and Namurian. Ice expanded across South America later in the Namurian concurrent with initiation of small ice centers in eastern Australia. The LPIA maximum occurred during the Late Pennsylvanian and Early Permian with growth of numerous ice sheets scattered across Gondwana. Succeeding glacial events represented by small ice centers in Eastern Australia occurred throughout the Permian, ending in the Capitanian. The spatial and temporal distribution of glacial deposits across Gondwana raises questions as to the extent that climate cooling played in initiating and terminating glacial events during the LPIA versus the role played by surface elevation relative to the ELA. In western Argentina, alpine glaciation and glacimarine deposition occurred in fjords cut into the Protoprecordillera, a fold-thrust belt that developed during subduction of Chilenia beneath the Cuyania crustal block. Glaciation likely occurred due to uplift of the range above the ELA. Terminal glaciation in the range occurred during the Namurian just prior to initiation of larger-scale glaciation in eastern South America. Causes for glacial termination in the Protoprecordillera are unknown. However, paleocurrent analysis and clastic petrology of late glacial and post- glacial strata indicate that late Namurian extensional collapse of the range occurred due to a westward shift in the location of subduction. Such collapse likely lowered the orogenic belt below the ELA. During the Late Pennsylvanian and Early Permian LPIA acme, extensive glaciomarine deposits indicate that glaciers reached sea level, corresponding to a lowering of the ELA across Gondwana due to climate cooling. An abrupt contact between glacial and post-glacial deposits across much of the Panthalassan margin records retreat of the glaciers out of the basins and climate warming. Following this glacial episode, 3 additional glacial events are recorded in eastern Australia terminating by the end of the Capitanian. The magnitude of global cooling during these events are debatable as evidence for direct glacial deposition from strata located farther south (than the eastern Australia basins) in Tasmania, Antarctica, and South Africa are unknown despite their location within the Permian South Polar Circle. Throughout these events, the Transantarctic Basin, which resided over the South Pole, was characterized by widespread fluvial coal measure depositions; whereas glaciated eastern Australia lay outside of the polar circle. An absence of glacial deposits within the South Polar Circle indicates an elevated ELA located well above sea level. This suggests that severe global cooling was not the cause of the 3 Australian glaciations, but that conditions specific to eastern Australia drove these late phase events.

Geochemical and diatom sedimentary evolution of the estuarine area of the Chubut River, Patagonia, Argentina

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The Chubut River flows from the Andes to the Atlantic Ocean with only one dam constructed at the Middle valley. The estuarine area is dominated by the aggradation of an alluvial plain induced by a complex of spits that enclosed the inlet in the last 5000 years. The river has reduced its flow since the blocking of the upper basin by terminal moraines during the Upper Quaternary. The last two sea-level highstands have flooded this ria, and aggradation have increased during regressions. The area is of particular interest in regard to irrigation channels practiced since the XIX century. Today, the mean monthly flow is less than 10 m3/s with peaks of 74 m3/s. The dynamics of the estuary is dominated by waves (wave-dominated estuary) as the tidal effects attenuate in less than 5 km. Three vibracorings were collected: a) at Gaiman, an area without any effect of the sea (37 km from the coast); b) at Trelew, at the former avulsion plain of the river (18 km from the coast), and c) at Playa Unión, a saltmarsh located 1 km from the beach. At the core from Gaiman (1.54 m long) fresh-water epiphytic diatoms dominate (*Epithemia sorex, Cocconeis placentula, Ulnaria ulna*) suggesting the aggradation of an alluvial plain. The core from the alluvial plain (2.19 m long) was composed by fine sand with organic matter at the base that evolved into silty layers to the top. Several unconformities and laminae with heavy minerals were detected by their geochemical composition analyzed by micro X ray fluorescence (Itrax XRF core scanner). Fine-sand laminated layers were perfectly detected by their high content in S and Cl. On the other hand, mud layers had a lower content in Mg and Al with increments in Ca and V. The core from the marsh (1.67 m long) was analyzed in terms of the diatom evolution in order to detect Holocene sea-level and salinity effects. The sand flats from the bottom of the core were dominated by *Nitzchia navicularis* (mesohalobous and benthic taxa) and evolved into mixed flats, mudflats and marshes to the top. Sharp contacts have been detected between these facies, with wavy and lenticular bedding characterising the mixed flat deposits. The middle of the sequence is dominated by a coastal marine diatom (*Paralia sulcata*) while the top was dominated by *Pinnularia borealis*, an aerophilous and brackish/freshwater taxa.

Taphofacies from fluvial and alluvial sequences dominated by silt: the Plio-Pleistocene cliffs of Mar del Plata

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Conceptual models are good guides for the interpretation of fluvial and alluvial environments. Primary and biogenic structures are the best descriptors of the different facies. At the Pampian cliffs of Mar del Plata, Plio-Pleistocene sequences, either representing braided or meandering systems, are dominated by silt. Although some tectonics has been accepted most of the paleosurfaces resemble the original landscape, with high preservation of soils and groundwater levels. Based on fossil assemblages, climatic changes have been proposed. However, at the upper formations semiarid conditions with episodic rains would have prevailed. Within this context, several facies could be discriminated. Bottom-channel deposits are characterised by lag gravel and disarticulated bones with evidences of bedload transport. Point-bar facies are less evident than in sandy rivers, but they can be differentiated when primary structures represent variations in the flux. Small channels are differentiated by mesoscale crossbedding, fining-upwards graded bedding and heavy-minerals layers. Levees and crevasse-splay facies are denoted by laminated layers and convolute bedding. Ox-bow lakes are recognised as massive fine-grained strata of limited extension, and characterised by small burrows produced by invertebrates. These environments were subject to rapid sedimentation induced by flood events. At alluvial areas, large biogenic structures (about 2 m diameter and several meters long) dug by large mammals (milodontids) are the more conspicuous evidences of stability in areas not subject to floods or groundwater-level fluctuations. Mesoscale caves, dug by rodents or dasypodids, have been assigned to distal portions of the alluvial plain. Paleosoils are also present in stable areas, with burrows made by worms when the preservation was maximised by ashfalls. Massive layers composed of well-sorted silt are assigned to loess accumulations or consolidated tuffs. A 4 m-depth shallow lake was preserved, spanning from the euxinic bottom to the shore facies subject to floods and droughts. All these facies are subject to pedogenetic transformations and reworking processes. Time averaging varies from 101 to 105 years increasing at transgressive paleocaves that silted slowly by sediment supported by eolian transport or weathering of the top of the cave. To both sides of the Tandilia Range, the accommodation space was different during time. Structural levels (calcrete crusts) controlled the erosive action of channels and the digging capacity of some mammals.

Distinctive fancies organization and geometry of turbidite successions formed at a canyon mouth: An example from the Early Pleistocene Kazusa forearc basin on the Boso Peninsula, central Japan

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A canyon mouth is one of the important components of a submarine- fan system and has been considered to play an important role for the transformation of turbidity currents as a result of hydraulic jumps (e.g., Komar, 1971). Large-scale scours and bedforms have been documented from some modern canyon mouths (e.g., Wynn *et al.*, 2002), and outcrop-scale features of canyon-mouth deposits have also been documented from a few case studies (e.g., Mutti and Normark, 1991). However, depositional and erosional features that characterize a canyon mouth have still been largely overlooked as compared to the other components. Here we investigated facies organization and geometry of turbidites that are interpreted to have developed at a canyon-mouth in the Early Pleistocene Kazusa forearc basin on the Boso Peninsula, central Japan. Turbidite successions formed at the canyon-mouth are thinner than both canyon-fill and middle-fan successions in the southwestern- upslope and the northeastern-downslope areas, respectively. The reduction of stratigraphic thickness in the canyon-mouth deposits is represented by amalgamation of sandstones and pebbly sandstones as a result of bypass processes. The canyon-mouth deposits also show the following distinctive features: (1) Sandstone beds and bed sets show overall lenticular geometry and are commonly overlain by mud drapes of 10–50 cm thick. Mud drapes are massive and contain fewer bioturbation structures than those of hemipelagic mudstones. Clay fabric of mud drapes is characterized by aggregates of clay particles with the long axis of 10–30 µm long, and is different from that of hemipelagic mudstones. Thus, mud drapes are interpreted to represent deposition from fluid mud, which may have formed in response to resuspension of finer-grained sediments at the canyon mouth. (2) Large-scale (5–10 m high) erosional surfaces, which are also overlain locally by mud drapes, are infilled with thick- to very thick-bedded sheet-like turbidites, which do not show any fining- and/or thinning-upward patterns. These large-scale erosional surfaces should be discriminated from channels and are interpreted to be equivalent to scours, which have been documented from some modern canyon- mouths. (3) Concave-up erosional surfaces, which face in the southwestern upslope direction, are overlain by backset bedding up to 3 m thick. The backset bedding is associated with angular to subangular mud clasts of up to 50 cm long. The shape of mud clasts is distinct from that of mud clasts within turbidite sandstone beds. (4) Thick- to very thick-bedded sandstones and pebbly sandstones in the canyon-mouth deposits contain traction carpets in their basal parts. These traction carpets are represented by planar geometry in a cross section parallel to paleocurrents, in local associations with hummock-like forms. In contrast, traction carpets in the canyon-fill successions are characterized by wavy geometry and those in the middle-fan successions are represented mainly by planar geometry. The downslope change in the cross-sectional geometry of traction carpets likely documents flow transformation in turbidity currents at the canyon mouth. The combination of these outcrop-scale and micro-scale features, together with some features proposed by the previous studies, can be used for the characterization of canyon-mouth deposits in ancient turbidite successions.

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Bositra limestones – ancestors of Jurassic radiolarites: An example from the Western Tethys

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The Bositra limestone of Aalenian – Lower Bathonian age crops out in the Krížna unit in the Western Tatra Mountains (Poland). It is underlayed by pelagic red limestones whereas radiolarites overlay them. Four facies were distinguished: (i) Bositra packstones/grainstones, (ii) crinoidal packstones/grainstones, (iii) Bositra-crinoidal packstones, and (iv) Bositra-radiolarian wackestones. The Bositra packstones/grainstones were laid down in a high-energy setting, while Bositra-radiolarian wackestones in calm conditions. Crinoidal packstones/grainstones represent density current deposits. Bositra- crinoidal packstones resulted from intense bioturbation and mixing of crinoidal packstones/grainstones with background Bositra-rich deposits. A topographic gradient affected the lateral facies variation. Taphonomic factors strongly controlled by the energy of the sedimentary environment, ecological factors which caused domination of Bositra bivalves in benthic assemblages and dissolution eliminating non-calcitic bioclasts could lead to formation of the Bositra limestones. Traditionally, overlying radiolarites were linked with deep-sea conditions (below CCD), however study of analogous facies from the Western Tethys suggests that they may have a more complicated genesis (e.g. Baumgartner, 1987; Santantonio *et al.*, 1996). Radiolarites are regarded as deposited in condition of increased nutrients amounts in the water column. Extremely low biodiversity may reflect palaeoenvironmental stress owing to high input of nutrients. Relatively high content of $CaCO_3$ (from 24 to 35% wt) of the studied Tatra radiolarites suggests their deposition above CCD. Eutrophication of the water column and remodeling of the Krížna Basin, which finally led to the deposition of radiolarites seems to be of considerable importance also to the formation of the Bositra limestones. The bloom of Bositra was probably facilitated or even caused by the changes in trophic conditions of the pelagic water-column. Hence, the Bositra limestones may be regarded as the record of an intermediate stage in the basin evolution towards radiolarite formation (Jach, 2007).

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Diagenesis and dolomitization in the Contrin and the Sciliar Formation (Latemar, northern Italy)

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Dolomitization of the Latemar carbonate build-up has been studied by several authors in the past decades, mainly addressing the large scale geometry of the massive dolomite body (e.g. Wilson, 1990) and more refined delineation of the dolomite occurrence and geochemistry (Carmichael, 2006) on the upper Latemar platform. Our research has focused on the dolomitization in the lower platform facies and the underlying Contrin Formation, which had not been studied in detail. Apart from the main massive dolomite body, several dolomitized pipe-like structures occur. The latter crosscut both the Contrin and the Sciliar carbonates (Latemar Formation). The origin of these massive and vertically oriented pipe structures and their relation to crosscutting mafic dikes is part of this ongoing petrographical, geochemical (stable O- and C-isotopes, Sr- & Mg-isotopes) and petrophysical (poroperm) study. Dolomitization in the Contrin Formation does not only occur in a single massive dolomite mass, but also occurs as smaller (10-50 m diameter) bodies, within limestone host rock. At small scale (<0.5 m) the boundary with the adjacent limestone is sharp, but on larger scale it is observed that, close to the dolomite-limestone contact, dolomite patches (>1 m diameter) occur within limestone and vice versa. Different types of dolomite are observed, mainly based on colour and crystal size. The dolomite is typically coarse crystalline and often is very pervasive. However, large vugs (1 cm to 25 cm) exist, which often are horizontally aligned. Locally, the dolomite is also severely fractured, in contrast to the limestone. The surrounding limestone has been severely recrystallized, as testified by its coarse crystalline nature and the complete obliteration of original sedimentary features. Three main diagenetic phases can be recognized associated with the dolomite bodies, i.e. 1) main dolomitization phase defining dolomite bodies. Zoning in dolomite crystals observed within cathodoluminescence suggests multiple fluid pulses. 2) Recrystallization of the original limestone to coarse crystalline limestone. This could be related to the dolomitization phase (e.g. in relation to the exhaustion of Mg in the hot fluids). 3) Inside the existing vugs late baroque saddle dolomite occurs followed by partial calcite cementation. Stable isotope results show little variation in $\delta^{13}C$ (+2.5‰ to +4‰) but large variation in $\delta^{18}O$ (-2,5‰ to -14‰). Stable isotope results of some dolomite bodies are more $\delta^{18}O$-depleted than others suggesting variable temperature during dolomitization. Results of late dolomite and calcite cement phase show a linear trend toward the most depleted $\delta^{18}O$ values (combined with $\delta^{13}C$-depletion). They most likely formed at higher temperatures than their surrounding host rock (dolomite and limestone). The relationship with large and small scale magmatic intrusions (mafic dikes) and the control on the petrophysical and geochemical characteristics is the focus of the current research.

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Stable isotope stratigraphy and diagenesis of the Cretaceous Apulia platform (southern Italy)

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Several quarries in the Murge area were studied to comprehend the karstification processes of the Apulia carbonate platform. The selected outcrops are of different age and depositional setting. Two quarries consist of sub- to peritidal cycles that are Aptian in age. Two other quarries consist of Cenomanian rudist banks topped by a paleosol and overlain by Senonian peritidal beds. Stable isotopes were used to correlate between the different quarries, detect the karstification influence zone within the host rock and understand the specific diagenetical products that are present (speleothems, hardgrounds, …). Micrite samples were analyzed to assess the original stable isotope signature during sedimentation and the overprinting by recrystallization related to meteoric water infiltration. Stable isotope results plot in a narrow δ^{18}O-range (-4,5‰ to -2,5‰) but in a wide δ^{13}C-range (-5,5‰ to +3,5‰), reflecting meteoric diagenetic overprinting. Results from different outcrops plot in different clusters. The Cenomanian rudist banks from different outcrops plot in exactly the same range. Results of the subtidal versus the peritidal Aptian cycles are separated by a δ^{13}C-shift of -1,5‰. In the Cenomanian outcrops several hardgrounds occur. Stable carbon-isotope profiles across hardgrounds show a local positive excursion of +1,5‰ due to early marine cementation, and can be correlated accurately between the outcrops. A paleosol separates the Cenomanian from the Senonian deposits. A distinct negative δ^{13}C-excursion occurs at this level and relates to soil-forming diagenesis. The overlying Senonian deposits are 2 ‰ δ^{13}C more depleted than the Cenomanian rudist banks. Due to the impermeable nature of the paleosol, the Cenomanian deposits were protected from meteoric fluids that could only penetrate where the paleosol was breached by fractures. Several series of samples were taken at the same stratigraphic level, but at increasing distance from karst pockets. The carbon stable isotope results of these samples revealed an influence zone smaller than 1 m around the karst pockets. Inside this zone a decrease in δ^{13}C of 1,4 ‰ occurs that fades away exponentially from the karst cavity. Diagenetic features such as cements and speleothems were analyzed to reveal different phases of cementation and the influence of flow rate within dissolutional cavities (karst pockets, vugs, …). The δ^{18}O results of the cements cover the same range as the micrite samples. The δ^{13}C range stretches from -11,5 ‰ to +3,0 ‰. The sampled speleothems have different morphologies (stalactite, euhedral crystals, crust, …), but their isotopic signature is identical. Therefore they likely precipitated from the same fluid but in different regimes (phreatic, vadose,…). The results of the cements generally plot in 2 groups. One group occurs close to the original limestone micrite composition. These calcite cements relate mainly to precipitates that formed early inside fenestrae and molds, after the dissolution of (aragonitic) bioclasts. However, this phase does not occur in all molds. The second group of cements plot close to the speleothem cluster, but is less δ^{13}C depleted. The latter precipitated from the same fluids as the speleothems but underwent more rock-water interaction. Because these cements precipitated inside small vugs and molds, flow rate likely was lower, when compared to flow rates inside large karst cavities and more interaction with the host rock was possible.

The earliest extensional processes at southern Brazil after braziliano orogeny: the sedimentary record of the Cerro da Angélica Formation

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The nature and timing of the tectonic processes that occurred after the main collisional events of the Brasiliano orogenic system in South America are an important and still unsolved question in the history of formation of Gondwana. This phase spans from 610 to 540 Ma and is characterized by the formation of voluminous granitic plutons and a system of fault-bounded basins extending from southern Uruguay to Southeastern Brazil, where sedimentary and volcano-sedimentary successions were deposited during the Late Neoproterozoic and Early Cambrian. In this context the Ediacaran Cerro da Angélica formation (Bom Jardim Group, Camaquã Basin - SE Brazil) constitutes a rare record of the first stages of basin formation (dated between ca. 605 and 595 Ma), revealing the depositional environments and basin-forming events of a period that elsewhere records only plutonic activity. We present descriptions and interpretations of the sedimentary facies and facies associations of the Cerro da Angélica formation, which comprehends more than 2,000 m of siliclastic rocks, including alluvial fans, formed next to active normal faults, and related ephemeral river and eolian dune field deposits which are overlain by lacustrine facies, including fan-deltas and deep-water facies. A progressive increase in the accommodation space due to the evolution of subsidence rates is interpreted for the studied succession. Similar stacking patterns can be recognized in isolated occurrences, and the correlation of major bounding surfaces lead to a depositional sequences model that has been corroborated by geochronological data. The stratigraphic framework presented here has implications for regional reconstructions of Western Gondwana, recording the first post-orogenic basin after the Braziliano Orogeny, and contributes for the effort of documenting the global sedimentary record of the Neoproterozoic, a period of dramatic climatic and biological changes.

The great Cretaceous transgression: a multi-disciplinary analysis of the Albian/Cenomanian boundary (99.6 Ma) interval in SE France and its palaeoenvironmental significance

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The Cenomanian stage marked the beginning of the Late Cretaceous Epoch, a time of dramatic global sea-level rise, the flooding of continental interiors, and the onset of widespread chalk sedimentation in epicontinental seas world-wide. The base of the Cenomanian stage is defined by the first occurrence of the planktonic foraminifera *Thalmanninella globotruncanoides*, with the section at Mont Risou in the Vocontian Basin, SE France, being designated as the global reference section. We present new data on a complementary section at Vergons, 100 km SE of the stratotype. The Vergons section exposes 60 m of Upper Albian marls overlain by a well-exposed, complete, and highly expanded (400 m thick) Cenomanian hemipelagic marl and limestone succession. The section has been logged, macrofossil collecting and field identification has been undertaken, and bulk-sediment samples collected at 0.5–1 m intervals for geochemical, mineralogical and micropalaeontological studies. Results from the Albian – Cenomanian boundary succession spanning the upper *Stoliczkaia dispar* to basal *Mantelliceras dixoni* zones are reported here. The succession yields ammonites, inoceramid bivalves, planktonic foraminifera, nannofossils, and organic walled dinoflagellate cysts (dinocysts) that provide a series of biostratigraphic marker levels across the stage boundary. Benthonic foraminifera, ostracods and radiolaria are also common. Microfossil assemblages are typical of an outer shelf environment. Key biostratigraphic datum levels recognised include: the last occurrences (LODs) of the Albian planktonic foraminifera *Pseudothalmanninella ticinensis* and *Planomalina buxtorfi*, and the first occurrences (FODs) of the Cenomanian planktonic foraminifera *Thalmanninella gandolfii* and *T. globotruncanoides*. The LODs of the predominantly Albian ammonites *Lechites gaudini*, *Stoliczkaia clavigera*, *Mariella bergeri*, and the FOD of the classic Cenomanian ammonite index species *Mantelliceras mantelli* are recorded. Calcareous nannofossils datum levels include the LODs of *Hayesites albiensis*, *Arkhangelskiella antecessor* and *Watznaueria britannica*, and the FODs of *Gartnerago theta* and *Corollithion kennedyi*. Significant dinocyst markers include the LADs of *Ovoidinium verrucosum* and *O. scabrosum*, and the FODs of *Microdinium reticulatum* and *Rhiptocorys veligera*, accompanying major changes in the overall assemblage composition. Biostratigraphic data are complemented by bulk sediment stable-isotope, elemental geochemical, and clay mineral data. Detailed $\delta^{13}C$ (paired carbonate and organic matter values) and $\delta^{18}O$ (carbonate) curves provide chemostratigraphic criteria for correlation to other European sections. The positive $\delta^{13}C$ excursion of the uppermost Albian and a basal Cenomanian $\delta^{13}C$ minimum are well displayed. Significant changes in clay minerals occur, with predominately smectite-rich illite- smectite, indicative of a warm, humid climate and/or high sea levels, being temporary replaced by kaolinite and illite as the main components of the assemblages in the basal Cenomanian, indicating a period of increased humidity and/or increased detrital input accompanying sea- level fall. Results will be compared with other Albian – Cenomanian boundary successions to better understand the key factors controlling palaeoenvironmental change at the onset of the Late Cretaceous Epoch.

The Cenomanian–Turonian boundary event (Late Cretaceous): marine productivity and climate change during OAE2

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The Cenomanian – Turonian is remarkable for having been the period of both the highest eustatic highstand of sea level and the warmest global climate of Mesozoic – Cenozoic times. Study of this interval offers insight into the operation of the Earth system during a period of extreme global warmth, the potential future of the late 21st Century world. Cenomanian–Turonian boundary (CTB) times, around 93.6 Ma, were a period of dramatic palaeoenvironmental change associated with an episode of significant biotic turnover. The boundary interval is characterized globally by a large positive excursion of $\delta^{13}C$ in marine carbonates, and both marine and terrestrial organic matter, indicating a dramatic change in the dynamics of the global carbon cycle lasting around 450 kyr. The deposition of black shales in basinal and oceanic areas generated one of the World's most important petroleum source rock intervals. Increased primary productivity and sluggish oceanic circulation caused widespread oxygen depletion in oceanic water columns that led to one of very few truly global oceanic anoxic events (OAE2). Organic-walled dinoflagellate cyst (dinocyst) and geochemical records across the Cenomanian–Turonian boundary (CTB) are compared between a NW European Boreal Chalk reference section in southern England, and north Tethyan hemipelagic black shale-bearing successions in the Vocontian Basin, SE France. High-resolution correlation between the sections has been achieved using planktonic foraminifera, calcareous nannofossil, and dinocyst biostratigraphy, integrated with carbon-isotope and elemental chemostratigraphy. The sections show remarkably similar stratigraphic trends despite representing different palaeolatitudes and different biotic provinces (Boreal versus Tethyan), and contrasting lithofacies associations (pelagic chalks and marls versus organic-rich shales and limestones). Dinocyst fertility indexes indicate that an upwelling-driven productivity pulse accompanied a eustatic sea-level fall that preceded the rise in $\delta^{13}C$ values that marks the onset of OAE2. A marine productivity collapse in the Chalk Sea and Tethyan marginal basins during the latest Cenomanian is indicated by the falling absolute and relative abundance of peridinioid dinocysts, believed to be the product of heterotrophic dinoflagellates. This biotic change accompanied transgression and sharply rising sea-surface temperatures, following an Atlantic-wide episode of short-lived cooling. Differences between the magnitudes of changes in the organic-carbon and carbonate-carbon stable isotope ($\Delta\delta^{13}C$) records provide evidence of episodes of falling atmospheric pCO_2 driven by organic-matter burial in oceanic areas. CTB biotic turnover in epicontinental and marginal seas was driven largely by watermass changes rather than oxygen depletion.

Understanding the role of volcaniclastics and sediment/lava interaction in flood basalts and volcanic rifted margins

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Many rifted margins are associated with large volume igneous provinces (flood basalts and intrusions), with significant material preserved both onshore and offshore. In order to fully understand rifting associated with flood basalts and the roles of volcaniclastics, and sediment lava interaction during the onset of flood volcanism etc., it is desirable to build up a picture of the internal architecture of these large volcanic provinces. To this extent, chemostratigraphy can be used on a large scale, particularly onshore but is limited in what it can offer in offshore settings. This is also true of chronostratigraphy, which relies on a well constrained stratigraphy, good sampling and can cover only specific resolutions (~1Ma). However, using a facies and facies architecture approach to classify key packages of volcanic, volcaniclastic and sedimentary rocks is one way in which we can start to understand the onset of flood volcanism, link the onshore with offshore, and can be used complementary with other more classical datasets (e.g. geochemical). Here rock facies are identified into known geometries and physical properties, and their facies associations identified so that we can understand how they stack together through time. Using examples from Namibia and Brazil, we will first focus on examples of sediment lava interaction in the Paraná-Etendeka province, where peperites, dry-peperites, preserved barchan dunes and sand filled topography and fissures can be found within the volcanics. Secondly, examples of volcaniclastics will be introduced from the North Atlantic Igneous province, to explore the role of water at the onset of flood volcanism in wetter environments. Ultimately, with the use of high resolution 3D data collection and modelling, we are able to fully reconstruct 3D earth models of flood basalts and volcanic rifted margins.

Control of relative sea-level on accommodation and coal quality in Upper Carboniferous fluvio-deltaic Four Corners Formation of the central Appalachian Basin, USA

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In peat-forming environments (mires), a continuously rising water-table (base-level), relative to the sediment surface generates the accommodation required for the preservation of peat. If the rate at which accommodation is created outpaces the rate at which peat can be produced, the mire will be inundated by marine, lagoonal or lacustrine conditions. If no accommodation is created, or it is destroyed (base-level fall), peat cannot accumulate, or is eroded and reworked, resulting in depositional hiatus. Because of the sensitivity of plant material to minor changes in hydrology, high-resolution variations in the accommodation rate within the relatively narrow "peat window" result in marked changes in the composition of the accumulating peat, and the resulting coal. The detailed composition and thickness of ten successive coals deposited over c. 1 Ma in the fluvio-deltaic, Westphalian C (Atokan) Four Corners Formation, central Appalachian Basin, USA, were compared with accommodation trends identified from the inter-coal clastic strata. Analysis of strata geometries and stacking patterns in the Four Corners Formation indicate that disctrete coal seam/zones occur in the formation occur within fourth-order (c. 140-210 ka duration) sequences stacked in highstand and late lowstand-to-transgressive sequence sets of two third-order composite sequences. Coals that accumulated in high accommodation fourth-order sequences are thin, high in vitrinite, and typically overlain by, or intercalated with marine and lacustrine sediments. The coals have simple internal organisations, suggesting that they record parts of single, high-resolution accommodation cycles. This evidence indicate that peat accumulation was short-lived and frequently interrupted by flooding events. Coals that accumulated in low accommodation sequences are thick, high in inertinite and resistant peat components such as liptinite, and overlain by, or rarely intercalated with, terrestrial sediments. The coals have complex internal organisations, typified by multiple high-resolution accommodation cycles. This evidence suggests that the coals accumulated over longer periods of time, but were subject to (subaerial ?) oxidation and degradation, causing the preservation of plant material as inertinite, and preferentially preserving resistant peat components. The fact that the thickness and vitrinite/inertinite ratio of the coals correspond readily with the longer-term accommodation setting of the fourth-order sequences within which they occur implies that the dominant control on accommodation in the original peat bodies, was relative sea-level, to which the mire water-tables must have been hydraulically connected. Recognition that the composition and thickness of coal seams vary predictably with accommodation setting has implications for predicting whole-seam quality laterally in up-dip and down-dip portions of basins.

Deposition of organic-rich carbonates in northern and central Tunisia during the early Eocene warm climate

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The organic-rich carbonates of the Bou Dabbous Formation (Fm) from northern and central Tunisia are considered major hydrocarbon sources in North Africa and possibly represent deposition in an open marine setting during the early Eocene warm climate (~56-49 Ma). Despite its importance for the petroleum industry and the interest to our understanding of the formation of organic-rich sediments during conditions of extreme climatic warmth, relatively little sedimentological, chemostratigraphic and biostratigraphic information is available from the Bou Dabbous Fm. Here, we present the initial results of an integrated study that raises the deposition of these organic-rich carbonates and its potential relationship to the warm climatic conditions across the early Eocene. During recent field seasons, we logged and sampled more than 600 m of the Bou Dabbous Fm that also included the uppermost part of the underlying El Haria Fm (Maastrichtian-late Palaeocene), and the lowermost part of the overlying Souar Fm (middle-late Eocene). Consistent with previous studies, we document significant variations in the thickness of the Bou Dabbous Fm among different sites (from ~20 m to ~140 m thick), which may be related to factors such as pre-existing topography, synsedimentary tectonism, and/or eustasy. Also, similar to previous works, lithologies recorded include alternating grey limestones and dark grey to black marly limestones, with common foraminifera and irregular occurrences of bivalves, echinoids, gastropods, phosphatic fish remains, and plant debris. The dark colour of the marly limestones is probably a reflection of their high content in organic matter. These beds are occasionally finely laminated, whereas the limestone beds are massive and show much higher content in bioclasts than the marly limestones. These features may suggest alternating depositional conditions between limestones and marly limestones, at least, with relation to energy levels, inputs from shallower areas, and bottom-water oxygenation. What distinguishes our work from previous studies is that we examined the distribution of the organic richness and its association with relative sea level variations. We found that intervals with more frequent dark grey to black marly limestones occur at the intermediate stage of a highstand system tract. At first glance, this situation may suggest that higher organic matter accumulation was related to an interval of relatively high sediment supply in a prograding regressive system, in which surface productivity, organic carbon export to the seafloor, and its preservation in bottom waters could have been enhanced. Detailed chemostratigraphic and biostratigraphic analyses are underway and will be used to better constrain the timing of the organic-rich intervals, as well as to test hypothesis of enhanced productivity versus sluggish water circulation for the organic richness.

Clay-dominated shelfal deposition across the southern Tanzanian margin during the Late Cretaceous greenhouse climate

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Drilling by the Tanzania Drilling Project in the Mandawa and Ruvuma basins of southern Tanzania targeted intervals with excellently preserved foraminifera and calcareous nannofossils to study Late Cretaceous biostratigraphy and greenhouse climate. Twenty Cretaceous sites drilled between 2007 and 2009 recovered an upper Aptian-upper Maastrichtian composite thickness of more than 600 m. Prior to this drilling, little was known about the sedimentology, stratigraphy, and depositional setting of the Cretaceous sediments in these basins. The main lithologies recovered were thin sandstone units separating much thicker intervals of mudstones in which microfossils commonly show excellent preservation. These lithologies can be grouped into at least 5 lithofacies. Lithofacies 1 is found in the upper Aptian-middle Cenomanian and shows light grey, medium to coarse sandstones and irregular intercalations of siltstones. The thickest sandstones exhibit conglomeratic bases, normal grading, mud clasts, woody debris, and laminated tops, features that suggest energetic events due to turbulent flows. Lithofacies 2 and 4 are observed in the middle Cenomanian-lower Coniacian and exhibit up to ~130 m-thick sections of dark grey to black siltstone and fine sandstone interbeddings, with sporadic organic-rich intervals, inoceramids, and ammonites. Medium sandstone beds (~10 cm thick), with erosive bottom contacts, occur irregularly. Low-energy, fine particle settling was probably the main depositional mechanism for lithofacies 2 and 4, although sporadic bottom currents could have redistributed sand across the area. Soft-sediment deformation is locally abundant in the lower-upper Turonian of lithofacies 2 and may suggest sediment liquidization and slumping. Lithofacies 3 is observed in the upper Cenomanian and is characterised by grey claystones, with common intercalations of brown, cm-thick, medium to coarse, massive sandstones. Like lithofacies 2 and 4, fine particle settling was probably the main depositional mechanism for lithofacies 3, although bottom currents could have been comparatively frequent and introduced up to coarse sand in the area. Finally, lithofacies 5 is found in the Santonian-upper Maastrichtian and exhibits greenish grey siltstones, with locally abundant bioturbation burrows and sandy partings. This lithofacies is also interpreted as the result of deposition by fine particle settling, with relatively high oxygen and/or nutrient levels promoting more active benthic activity than seen in other lithofacies. Together these lithofacies suggest a clay-dominated, open shelf to upper slope setting, which is supported by initial micropaleontological results. Lithologic, biostratigraphic and isotopic analyses are underway and will be used to better constrain the timing of these lithofacies, as well as to test the influence of climatic, tectonic and/or eustatic episodes on the sedimentation patterns. In particular, we hope to determine whether the relatively expanded lower-upper Turonian section of lithofacies 2 was related to a period of increased sedimentation rates associated with (1) a major extensional episode of the tectonic evolution of these basins, (2) intense continental weathering due to Turonian hyperthermal conditions, and (3) a combination of these and/or other factors.

Characteristics of marine authigenic mineral deposits in the south Korea Plateau

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Authigenic minerals have been studied for a long time. Also, authigenic activities are very interesting to understand the biogeochemical conditions in water column and sedimentary layer of recent and past environments (Cha *et al.,* 2005). Marine minerals have long been considered on the point of commercial criteria, especially, of phosphorite, manganese nodules, barite etc. (Libes, 2009). Phosphorite occurs usually on the seafloor less than 1,000 m in water depth below the upwelling zone of highly biological productivity in tropical region (Rona, 2008). This paper is aiming to introduce the investigation on potentiality of mineral deposits such as phosphorite and ferro-manganese oxide boulders in the south Korea Plateau, East Sea. The slopes of topographic highs of south Korea Plateau were surveyed using multi-beam (12 kHz) echosounding system (EM 120, Kongsberg) and BATHY-2000 single channel reflection (5 kHz) profiler (Jones *et al.*, 2002). Rock samples were recovered by dredging along 5 track lines aboard the R/V ONNURI in Feb. 18 to 25, 2010. The samples were soaked in deionized water and ultrasonically-cleaned. Major and trace elements of pulverized samples were analyzed by X-ray fluorescence (XRF) and inductively-coupled plasma-mass spectrometer (ICP-MS) at the Korea Basic Science Institute (KBSI). The precision for major elements was generally better than ± 0.5%, for trace elements 5%. The survey areas A and B are located in the south Korea Plateau, north of Ulleung Basin. Southeastern slope of A is very steep (slope angle, 5 to 15°) with the water depth of 850 m to 2,200 m. Several kinds of rock samples were obtained; granite, tuff breccia, basalt, phosphorite, ferromanganese oxides with various size (5 to 30 cm in long axis). Some of three former are partially or entirely coated with ferromanganese oxide or phosphorite. Ferro-manganese crust (AD-05-A) contains Mn (39.9%), Ba (1.1%), Co (567.0 ppm), Ga (298.2 ppm) and Mo (210.2 ppm), respectively. Phosphorite boulder (BD-05-06) is enriched in P (14.6%) and U (251.3 ppm). Iron oxide-coatings (BD-07-08) are characterized by high content of Fe (2.2-41.7%) and V (208-382 ppm). Phosphorite boulders and phosphorite-coated rock samples are generally distributed in the upper slope area at the water depth of 1,000 to 1,200 m, probably just below the oxygen minimum zone (OMZ). Phosphorus content (14.6% on the average) is higher than that (13.8%) of other oceanic phosphorites [2]. Ferro-manganese nodules/crusts were collected at the deeper water depth than phosphorite. Although sediments are deposited at relatively a rapid rate (0.09-0.13 cm/yr), the precipitation of P, Mn, and Fe seems to have continued on the nuclei such as rock boulders which are exposed to, perhaps, relatively strong currents. Further studies about the formation mechanisms of these authigenic minerals in the Korea Plateau, East Sea with aspects of paleoceanography, biogeochemistry, and sedimentology [3].

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Evidence for normal and forced regressions in the Upper Cretaceous Wahweap Formation, southern Utah, U.S.A.

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Non-marine sequence stratigraphy involves matching changes in alluvial architecture to allocyclic controls such as climate, tectonics and eustasy. Within fluvial sequences, distinct facies tracts (amalgamated, isolated fluvial, tidally influenced and highstand) can be recognised. The Wahweap Formation (Upper Cretaceous of the Western Interior foreland basin, southern Utah, U.S.A.) is a ~400 m thick succession of fluvial to estuarine rocks that is subdivided into the lower, middle, upper and capping sandstone members. This report focuses on alluvial architecture in the upper member and capping sandstone, which are interpreted below to represent deposits during normal and forced regression respectively. The upper member is characterised by a number of thin (typically less than 20 m) amalgamated sandstones which can be traced continuously for a distance of approximately 30 km in a proximal-distal direction. The amalgamated units are separated by mudrocks which have thicknesses of up to 10 m. At the base of the upper member a number of features that indicate tidal influence are present, including inclined heterolithic stratification, flaser bedding and mud-draped foresets. Towards the top of the upper member, tidally influenced features are not present, and instead there are a number of amalgamated channel sandstones which are interbedded with overbank mudrocks. The upper member also correlates with the Claggett highstand of the Western Interior Seaway, and therefore represents the tidally-influenced and highstand facies tracts within a non-marine sequence. The overlying capping sandstone is a thick (up to 100 m) amalgamated sandstone with very little interbedded mudrock and fairly uniform alluvial architecture. The capping sandstone, together with its basinward correlative, the Tarantula Mesa Formation, can be traced for approximately 200 km in a proximal-distal sense. Previous workers have placed a sequence boundary at the base of the capping sandstone and it is interpreted as the amalgamated fluvial facies tract of a younger non- marine sequence than the one which contains the lower, middle and upper members. The amalgamated sandstones of the upper member are suggested to have formed in low-accommodation space settings during the Claggett highstand at a time after the accommodation space generated by transgression had been filled. The amalgamated sandstones of the upper member therefore represent normal regressive deposits. By contrast, the capping sandstone represents an amalgamated fluvial deposit correlative with a lowstand of the Western Interior Seaway at a time when accommodation space was low due to regression. The alluvial architecture of the capping sandstone therefore developed in response to forced regression. Documentation of these different processes in fluvial deposits will aid our understanding of non-marine sequence stratigraphy.

Soft-sediment deformation structures of the Cambrian Gushan and Chaomidian formations (Shandong Province, China): implications for the origin of limestone conglomerates and sequence stratigraphy

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This study focuses on the formative mechanisms of the soft-sediment deformation structures in the Cambrian Gushan and Chaomidian formations in the North China Platform (Shandong Province, China) and their geological implications for the origin of limestone conglomerates and sequence stratigraphy. The North China Platform, a typical epeiric platform, formed on a stable craton, the Sino-Korean Block. It comprises a thick (ca. 1800 m) Cambrian-Ordovician succession of mixed siliciclastic and carbonate deposits. The Gushan Formation (Cambrian 3rd Series) and Chaomidian (Furongian) Formation consist dominantly of carbonate deposits and a minor portion of shale, with a variety of soft- sediment deformation structures such as fissure cracks and “boudin” structures in ribbon rocks and clastic dykes, funnel structures, chaotic laminae, wackestone aggregates, grainstone breccias (types I and II), homogenized oolite, and convolute structures in grainstones. The prerequisite conditions for soft-sediment deformation are the different behaviors of sediments during early diagenesis (i.e., fragmentation of thin lime mud layers, fluidization of argillaceous sediment, and heterogeneous liquefaction of carbonate sands) under external triggering forces (e.g., seismic shock, storm-wave loading, sea-level fluctuation). The Cambrian succession in the North China Platform consists of a number of limestone conglomerates which are closely related to the soft-sediment deformation structures. These limestone conglomerates consist mainly of monomictic or oligomictic clasts of lime mudstone to grainstone and matrix of grainstone and/or marlstone, with a variety of positions of clasts (e.g., horizontal, subhorizontal, inclined, vertical, mosaic-fit, and disorganized). The limestone conglomerates might have been formed by soft-sediment deformation of primary deposits of ribbon rocks and grainstones. On the other hand, a deformed limestone bed (containing Neodrepanura biozone) with various soft-sediment deformation structures occurs extensively (ca. 100 km) in the uppermost part of the Gushan Formation, whose top was truncated with a sharp erosional surface. This deformed bed is overlain by a bioclastic grainstone with the Chuangia biozone. The sharp erosional surface of the deformed limestone bed, accompanied with a substantial erosion of sediments (missing of geological record, the Prochuangia biozone) indicates a new type of sequence boundary in the carbonate platform of an epeiric sea, the subaqueous unconformity.

Sedimentary architecture of a Holocene to Recent micro-tidal barrier island in the Danish Wadden Sea area based on morphology and processes, cores, GPR sections and OSL datings

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The Rømø barrier island is situated in the northern part of the European Wadden Sea. It has been intensively studied on the basis of recent depositional systems and morphology, seven 25 m long sediment cores, 35 km ground penetrating radar (GPR) reflection profiles with a maximum signal penetration of c. 15 m and a resolution of c. 20–30 cm (Nielsen *et al.*, 2009), palaeontological analyses and dating of 70 core samples using optically stimulated luminescence (OSL). The area has experienced a relative sea-level rise of c. 15 m during the last c. 8000 years. The Recent tidal amplitude reaches c. 1.8 m. During strong wind set up the water level increases considerably and the highest measured water level is 4.9 m above mean sea level. The barrier island is c. 14 km long and c. 4 km wide and is separated from the mainland by a c. 8 km wide lagoon. At the northern and southern parts of the island, tidal inlets occur with a width of 400–1000 m and depths of 7–30 m. Salt marsh areas, up to 2 km wide, are fringing the lagoonal coast of the island. Active eastward migrating aeolian dunes cover large parts of the island. The Rømø barrier island system is a very sand rich system as it receives coast parallel transported sand from north and south along the shoreface and is resting on fluvial sand. The combination of cores, GPR and studies of the Recent morphology and depositional processes is a powerful tool to identify palaeo-sedimentary environments (Johannessen *et al.*, 2008). On GPR sections from the central part of the island a series of beach ridges, up to 2.5 m high, often with swales in between are underlying the modern aeolian dune sands. Washover fans, up to 2.5 m thick, are often seen in the GPR sections immediately east of the beach ridges and can be followed c. 250 m eastwards and may have steep slipfaces. Shoreface sands may be followed eastward to beach ridges and show westward progradation. Swash bars are occasionally seen on the shoreface close to the beach ridges. In the northernmost area of the island the GPR sections are dominated by co-sets with westerly and easterly dipping foresets, indicating bipolar current directions (Møller *et al.*, 2008). These sediments were probably deposited in a deep, broad tidal inlet north of the initial barrier island similar to what is observed at the island today. Facies analysis on the cores and correlations between wells show that barrier island sediments and related shoreface sand and lagoonal sediments are up to 20 m thick and overlie Weichselian fluvial sand. The first 5000 years the barrier island aggraded and the last 3000 years it prograded despite the relative rising sea level rise of c. 15 m during the last c. 8000 years. This shows, that if there is a surplus of sand in a tidal area, barrier islands may aggrade even if there is a rise in sea level. If the rate of sea level rise decreases then the barrier island may prograded. With this unique dataset with extremely large amounts of OSL datings from core sediments it has been possible to construct detailed palaeogeographic maps of the barrier island development through time.

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A 150,000 -Year Record of Temperature from Lake Malawi, East Africa

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We now have a paleotemperature record from Lake Malawi (10º - 14º S) that spans the past 150,000 years, based on analyses for TEX86 in the drill core sites in the central and north basins of the lake. This is the longest continuous record of temperature thus far recovered from the African continent. The temperature records for the past 25,000 years are consistent between the two sites, with post-glacial warming beginning around 20 ka, and maximum temperatures centered on about 10-14 ka, 4-6 ka, and the present. The north basin temperature record extends back to 75 ka, and shows little evidence for millennial scale variability during MIS 3, despite XRF scans of the core that clearly indicate Dansgaard-Oeschger – type oscillations in the wind field. Maximum cooling at this site occurred at the end of MIS 4, when the lake cooled 6ºC in 10 ky, arriving at a temperature that was about 2ºC cooler than the LGM, but this appears to be related to upwelling dynamics. The central basin site displays a temperature history that is quite similar to the north basin in the 25 – 75 ka period, with dramatic cooling in MIS 4 but temperatures at this site no colder than those of the LGM. Drilling at the central basin site recovered 380 m of core, of which the upper 90 m have thus far been analyzed for TEX86. Prior to 75 ka, the temperature profile exhibits greater variability, with measurable response to higher amplitude precessional forcing than has occurred since that time. Thus the megadroughts in East Africa that occurred prior to 75 ka appear to have been accompanied by temperature shifts of 4 – 5º C, somewhat greater than the 3.5º C shift that occurred between the LGM and today.

Stratigraphic evolution of the slope to shelf transition; a Permian example from the Laingsburg Depocentre, Karoo Basin, South Africa

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This study represents the first sedimentological and sequence stratigraphic analysis of the shelf to slope deposits of the Permian Waterford Formation in the Laingsburg area, South Africa. Excellent and continuous exposures allow detailed characterisation of the stratigraphic transition from the underlying basin-floor to channelized, submarine slope deposits (Laingsburg and Fort Brown Formations) through a highly unstable upper slope to shelf-edge environment and into a stable shelf setting. The ~900 m thick Waterford Formation can be divided into three sections based on dominant facies and stacking patterns: 1) a lower section (~230 m thick) characterised by 10 - 50 m thick symmetrical cycles of interbedded siltstones and sandstones that coarsen- and thicken-upward and then fining- and thin-upward at the top; 2) a middle section (~200 m thick) of 15 - 30 m thick sharp-topped coarsening upward asymmetrical cycles, which are dominated by a range of soft-sediment deformation features (debrites, slide deposits and foundered beds) overlain by sharp-based sandstones with HCS and unidirectional current ripples, indicative of a mixed influence shoreline; 3) a > 450 m thick upper section of alternating 5 - 15 m thick, sharp topped and sharp based units of massive siltstone and amalgamated sandstones, with only minor soft sediment deformation. Cycles within the Waterford Formation are interpreted as parasequences, bounded by flooding surfaces. Parasequences in the lower Waterford exhibit a progradational lower section of upward- thickening heteroliths, overlain by a backstepping highly bioturbated thinning and fining upward upper portion; The parasequences are interpreted as prodelta deposits with the fining upward top suggesting that the shoreline was not detached landward during initial relative sea level rise, in contrast to the sharp-topped parasequences in the overlying section. Middle Waterford parasequences are interpreted to represent rapid progradation of the delta over the shelf edge, resulting in widespread collapse followed by deposition of a stable mouth-bar and/or shoreface, with sharp tops indicating ravinement processes during transgression. The undeformed upper Waterford parasequences suggest a more conventional and stable shelf depositional setting. Logged sections have been correlated using parasequence flooding surfaces as marker beds, the surfaces of which have been walked out along both limbs of a fully exposed west-east trending syncline for ~25 km in an oblique down-dip section. This has enabled quantification of dip-related changes in facies, thickness and depositional environment, with amalgamated shoreface sandstones thinning and splitting into heterolithic bedsets in an easterly direction over ~20 km. North-south correlations constrain facies variation across depositional strike. The Waterford Formation is dominated by sediment accretion, in contrast to the underlying slope succession (Fort Brown Formation); this resulted in low gradient clinoforms of < 1°, which is consistent with the lack of erosional features observed.

Mapping of the tidal surface sediment distribution using airborne remote sensing

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Tidal channel networks have been considered as an important key in the evolution of tidal flats, thus many studies have tried to reveal the geometry of tidal channels and their relations with surface sediment distribution in the tidal flat (Fagherazzi *et al.*, 2008). Recently, airborne remote sensing with a high spatial resolution has been applied to the tidal surface sediment classification (Mason *et al.*, 2006). It has a great advantage in that we can identify the spectral and textural differences which are represented in the image, thus an achievement of more accurate mapping is possible. In this study, mapping of the surface sediment distribution in a tidal flat was carried out based on field observations and an adjustment of the map using an aerial photo image was attempted. Tidal channel networks were extracted from the aerial photograph and its spatial relations with the sedimentary facies were estimated for the adjustment. Test was carried out in Geunso Bay, Korea, which is characterized by 70 % of its tidal flat being exposed at ebb tide and the shallow water depth of about 2 - 4 m at flood tide. Forty-five sediment samples were obtained by a shipboard grab sampler at flood tide on February, 2009. The samples were classified into three types of facies according to the percentages of grains that are larger than very fine sand (0.0625 mm) after Folk (1968); sand flat (above 70%), mixed flat (30 - 70 %), and mud flat (0 - 30 %). These in situ data were used to generate a sediment distribution map using a krigging method. Tidal channels were extracted from an aerial photo image with 50 cm resolution which was acquired on February, 2008, and the spatial relationship of the tidal channels with the surface sediments was estimated using a fractal and GIS analysis. The specific spatial characteristics of tidal channel networks for each sedimentary facies were identified, based upon which the interpolated map of sediment distribution was adjusted. Mixed flat was characterized by simple channel patterns (1.11 - 1.40 of fractal dimension) of relatively low density (0 - 0.0024 m/m2), while the mud flats showed dendritic patterns (1.18 - 1.71 of fractal dimension) with relatively high channel density (0.036 - 0.06 m/m^2). Based on the observed characteristics, boundary of sedimentary facies was tuned for the surface sediment map induced by in situ dataset. Where tidal channel existed along the boundary of sand ripples, the boundary of mud flats was extended to the area of sand ripples. The area, having the same tidal channel pattern as in the mud flats, which were misclassified as mixed flats was corrected to mud flats. In addition, an additional field work supported the reliability of the adjusted map of sediment distribution. In this study, tuning of the surface sediment distribution in a tidal flat was attempted based upon the tidal channel pattern identified on a high resolution aerial photograph. The differences in tidal channel pattern according to the sedimentary facies in the tidal flat can be successfully estimated quantitatively through the airborne remote sensing, fractal, and GIS analysis. Consequently, the characteristics of tidal channel pattern can be effectively applicable to the mapping of surface sedimentary facies in a tidal flat.

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Stratigraphic complexity in a tidal estuarine reservoir; the McMurray Formation, Western Alberta, Canada

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The Athabasca Oil Sands (Western Alberta, Canada) are one of the largest hydrocarbon accumulations in the world, yet production of these hydrocarbons is problematic due to both the internal complexity within the reservoir and the viscosity of the oil itself. Understanding the vertical and lateral variability within heterolithic channel fill deposits in particular is crucial to create a robust reservoir model and establishing an efficient drainage strategy. The Cretaceous (Aptian) McMurray Formation (Mannville Group) comprises an incised valley-fill succession which records an overall transgression, from fluvio-tidal deposition at the base to wave-dominated shoreface deposits as it grades vertically into the overlying Wabasca Member of the Manville Group. This incised valley was likely created as a result of the interplay between salt dissolution of the underlying Devonian units and subsequent downwards erosion of the McMurray Fm. This study focuses on the tidally-influenced sections of the middle McMurray, which represent the most complex zone in terms of defining sedimentary architecture, connectivity and reservoir properties. Core and wireline log sections have been correlated along a dip-oriented profile (approximately 8 km in length) and along-strike (approximately 5 km in length). Facies are comprised of a complex arrangement of (1) Coastal plain mudstones and fluvial channel-fill sandstones (2) Inclined heterolithic stratified units (IHS beds) (3) Tidal channel-fill sandstones (4) Embayment mudstones and siltstones and (5) wave dominated shoreface/ mouthbar sandstones. Facies are highly variable and tidal channel-fills are frequently punctuated by discontinuous units of inclined heterolithic strata. In addition, the inclined heterolithic units often display highly variable properties including: (i) the ratio of sand-shale (ii) the overall facies thickness (iii) the nature of the vertical transition within IHS sub-facies types and (iv) the intensity of bioturbation. These variations likely reflect spatial and temporal alterations in tidal rhythmicity (semi-diurnal to seasonal fluctuations), degree of fluvial discharge and autocyclic migration of the channel belt. The intercalation of these heterolithic facies is crucial to recognising potential barriers or baffles to flow. Integration of the log data with seismic has revealed two major erosive surfaces, the first of which represents a major sequence boundary and forms the basal Devonian-Cretaceous unconformity. The second, higher-order sequence boundary forms the main incised valley margins. Isolated mudstone breccias and shale units may reflect the reactivation or abandonment of specific channels within the main valley, though these occur below seismic resolution and given the cannibalization within the system, care must be taken in correlating these units between wells. In addition to flooding surfaces recognised from core, these hierarchical surfaces have enabled a chronostratigraphic model to be developed and define distinct reservoir units.

Deepwater carbonate deposition in response to re-flooding of carbonate bank and atoll-tops at glacial terminations

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The late Quaternary has experienced large glacial/interglacial climatic variations and related 10's to 100 meters high-amplitude sea level fluctuations at Milankovich frequencies from 10's to 100 kyr during which carbonate platform tops have been exposed and re-flooded in many occasions. Once isolated carbonate bank and shelf tops are re-flooded during interglacial times, they become important producers of large volumes of neritic sediments (fine aragonite and magnesian calcite), excess sediment being exported by plumes and gravity flows to the adjacent deep sea (Droxler and Schlager, 1985; Jorry *et al.*, 2008). Previous data sets lack resolution to address the linkage between initial bank top re-flooding and first calci-turbidite deposition in adjacent basins. This concept can be tested during the last glacial cycle, because sea level (eustatic) is well established for the last termination and the last glacial cycle. This study focuses on the accumulation of calci-turbidites, the aragonite onset/sharp increase in fine sediments and their timing in deep basins adjacent to carbonate platforms. A particular emphasis is developed on the occurrence of the first gravity flow event and aragonite onset/sharp increase and their linkage to the initial re-flooding of the platform tops during deglaciations. We are using the depositional frequency of calci-turbidite vs. isotopic stratigraphy and mineralogy in order to evaluate the impact of platform top re-flooding on carbonate productivity and export to adjacent slopes and basins, at each glacial/interglacial transitions since the MIS 12 / MIS 11 boundary. Three basins adjacent to isolated platforms in the Bahamas, the Northern Nicaragua Rise, and the Gulf of Papua, were selected to represent pure carbonate versus mixed systems, in quiescent versus tectonically active settings, and various carbonate bank top morphologies, ranging from atoll to relatively deeply and narrowly flooded flat top banks. In spite of these differences, each record illustrates a clear relationship between the timing of platform top re-flooding and initiation of significant carbonate export by gravity flows and low-density plumes into the surrounding basins, which demonstrates the outstanding capability for carbonate banks to produce sediment after a long period of exposure. According to our findings, it appears that intermediate high sea levels during glacial times, e.g. MIS 8.5 at -40 ± 20 m and MIS 6.5 at -30 ± 20 m, had no impact on the calci-turbidite deposition in basins adjacent to the banks. The concept of "re-flooding window" is introduced to characterize the prolific period of time during which bank and atoll-tops are flooded enough to produce large export of bank-derived aragonite and of calci-turbidites in adjacent basins. According to our datasets, the main re-flooding windows have occurred mainly on the last part of the sea level rise at each glacial termination, those periods being marked by some of the highest rates of sea level rise. The analysis of a long-piston core from the earthquakes-prone Walton Basin (Northern Nicaragua Rise) demonstrates that sea level, not seismic activities, played a major role as trigger mechanism for the initiation of gravity flows since the last four glacial/interglacial transitions, and supports the existence of an extra glacial termination during the early portion of the transition from MIS 7.4 to MIS 7.3 (Termination IIIA).

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Turbiditic levee deposition in response to climate changes: the Var Sedimentary Ridge (Ligurian Sea)

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The Var turbidite system located in the Ligurian Sea (SE France) is an intermediate mud/sand-rich system. The particularity of the Var deep-sea fan is its single channel with abrupt bends and its asymmetric and hyper-developed levee on the right hand side: the Var Sedimentary Ridge. This unusual sedimentary construction makes the Var Sedimentary Ridge an appropriate target in order to study the overbank events. Despite numerous studies that have contributed to define the Var system as a reference for turbiditic accumulations along channel-levee systems (Piper and Savoye, 1993; Savoye *et al.*, 1993; Migeon *et al.*, 2000; Migeon *et al.*, 2001; Migeon *et al.*, 2006), no study has focused yet on the late Quaternary turbidite activity of the Var system in the frame of global changes. The absence of high-resolution stratigraphy on the Var Sedimentary Ridge represents a strong gap in the understanding of forcing parameters controlling the deposition of overflows and their frequency for such a reference turbidite system. This study focuses on the establishment of the first detailed stratigraphy of the levee, which is used to characterize the timing of the overbank deposits throughout the last deglaciation. Based on the analysis of four piston cores collected along the Var levee (from 1694 m to 2473 m of water depth), planktic oxygen isotopes and AMS 14C dates are used to calibrate the age model. Late glacial to deglacial turbidite frequencies and depositional rates have been quantified according to the established chronostratigraphic framework. Major results bring out the high variability in the turbidite frequency and in deposition rates along the Var Sedimentary Ridge which depend on two major parameters: the progressive decrease of the levee height controlling the ability of turbidity currents to spill out from the channel onto the levee, and the climatic variations affecting the drainage basin, in particular changes in glacial condition since the late Last Glacial Maximum. Compared to high latitude turbiditic fans, this study confirms that the Heinrich Event 1 corresponds to a global decrease in the turbidite activity of channel-levee systems. The instantaneous record of such a global climatic event into deep-marine environments demonstrates that the ability of turbiditic systems to bear extreme climatic fluctuations affecting adjacent lands and rapid seaward transfers of sediment. The presence of a very narrow continental shelf and a single, large channel-levee system makes the Var Sedimentary Ridge a unique example for characterizing climate-dependent turbiditic accumulations.

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Holocene benthic foraminiferal variability in the cold-water coral and fjord through deposits of the Stjernsund, northern Norway

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Holocene sedimentary records from the Stjernsund have been explored in great detail. Cold-water coral mounds comprising the azooxanthellate scleractinian *Lophelia pertusa* , thrive on top of a late glacial terminal moraine crest at 265 to 230 m water depth. During RV Poseidon cruise POS-325 a series of gravity cores have been taken in an E-W transect across the moraine and from the adjacent proximal fjord basin. The core-record comprises glaciomarine-deposits that are overgrown by Holocene coral mound deposits on the moraine crest, as well as muddy-silty fjord trough deposits. Paleoceanographic and climatic changes in the Stjernsund are investigated through down-core analyses of foraminiferal assemblages, high-resolution radiometric dating (AMS-14C and U/Th), grain size spectra, stable isotopes and Mg/Ca measurements on foraminifera, XRD and bulk carbonate variations. Two well dated cores were selected and investigated for their benthic foraminiferal assemblages (ESF-Project CARBONATE). Core POS-325-472 was recovered from the coral habitat on the moraine crest. It covers a time span between 9.9 and 1.6 ka BP, including several hiati. The frequent hiati are a common characteristic in coral-mound records, which has been observed e.g. in prominent mounds of the Irish Rockall Bank (e.g. Frank *et al.* 2009). The second core (POS-325-482) derives from the fjord basin (479 m water depth). This core is suitable for high-resolution Holocene studies for its continuous sedimentary record that covers the last ~9.8 ka BP. The benthic foraminiferal assemblages in both cores will elucidate the environmental conditions during coral growth and erosion phases. A total of 114 samples were taken every 10 cm for these analyses. About 75 species/genera of benthic foraminifera were identified from both cores. Planktonic species are rare, probably indicating low productivity rates in the surface brackish layer above the marine deeper waters in the fjord. The fauna of the on-mound core is dominated by sessile epifaunal species like *Cibicides lobatulus* and *Discanomalina coronata* that are common in high-energy environments. The occurence of *D. coronata* may be an indicator species for cold-water coral habitats. Its abundance is highest at the 5 ka spanning hiatus. This is probably due to winnowing, which would increase the concentration of hardsubstrate attached species with robust tests. The relative accumulation of this species at the hiatus is may be also due to the erosive processes that destructed foraminifera with less endurable tests like *Patellina corrugata* and *Spirillina vivipara*. Indeed, these two species show their lowest abundance around the same time interval. In the fjord basin the fauna is dominated by *Cassidulina laevigata* and in the first 70 cm of the core also by *Brizalina skagerrakkensis*. Subsidiary species are *Nonionellina labradorica, C. lobatulus*, and *Elphidium excavatum*. *N. labradorica* and *B. skagerrakkensis* are reported as dominant species in deep-water assemblages in arctic and temperate fjords in E Greenland and N Norway (Murray, 2006). Both species are opportunistic and able to survive in oxygen deficient environments. In the on-mound core these species are rare and small sized or completely absent.

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The relationship between dolomitisation, structuration and MVT mineralisation in the Lower Carboniferous, North Wales, UK

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Fracture related burial dolomitisation is an important diagenetic process that can enhance the porosity and permeability of carbonate reservoirs. However, not all burial dolomitisation events result in favourable reservoir characteristics. Predicting the nature and timing of these post- depositional features can often be problematic and relies on an in-depth understanding of the factors controlling fluid migration and subsequent reaction pathways. Where subsurface data is limited, multiscale outcrop analogue studies can provide information on the geometries of the bodies and fault/fracture relationships. This can help us deduce the conditions under which dolomitisation took place. This study is focused upon outcropping Lower Carboniferous fractured carbonates on the Great Orme, Llandudno. The Great Orme provides the opportunity to understand the complex interplay between depositional facies, structuration, dolomitisation and lead-zinc- (copper) mineralisation. The Lower Carboniferous limestone of the Great Orme comprises open marine platform and reef facies that were deposited on the northern margin of the North Wales platform. The platform developed as a rimmed shelf on the footwall highs of titled, fault blocks during an episode of back-arc extension. Dolomitisation is restricted to a small number of discrete pods along this palaeo-platform margin, which coincides with the present day coastline. The dolomitisation is pervasive, replacive and fabric destructive, occurring preferentially within skeletal packstones- grainstones. The stratigraphic distribution and vertical extent of the dolomitisation is strongly controlled by faults/fractures, primary depositional facies and exposure surfaces. Petrographical observations suggest that the dolomite precipitated at elevated temperatures. Cross-cutting zebra dolomite textures are present throughout the dolomitised succession. The zebra bands, 0.5cm in width, alternate between white and pale brown dolomite, which are succeeded by calcite. Petrographically however, it is difficult to differentiate between the replacive and zebra dolomite, the latter often appearing to be syntaxialy overgrowing the former. The exact cause of these features is unclear. Successive Mississippi Valley Type mineralisation (galena, sphalerite and chalcopyrite) cross-cuts the dolomitised succession, in N-S trending veins. The mineralisation, and associated vein dolomite, is interpreted to have precipitated during the Variscan Orogeny, at maximum burial of the platform. During the subsequent uplift of the platform, shallow burial and meteoric calcite cements precipitated in preserved, isolated secondary pore spaces. Diagenetically late copper mineralisation also exploits secondary porosity and reactivated fractures within the dolomite. Isolated secondary porosity is preserved on a micro and macro scale. Where fractures cross-cut the dolomite, adjacent dissolution enhancement is evident. Finally, a second phase of open, E-W orientated, fractures related to Alpine tectonism locally improves porosity. To summarise, faults and fractures provided important pathways for the circulation of diagenetic fluids within Lower Carboniferous carbonates. Furthermore, the primary texture, porosity and composition of the limestones dictated the extent of dolomite replacement. The results of this study have important implications for understanding fluid flow within fractured and dolomitised reservoirs and demonstrate the importance of diagenetic studies for accurate basin analysis.

Controls on Late-Miocene sedimentation along the Mid-Hungarian Mobile Belt in the Pannonian Basin

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The intramontane Pannonian Basin is located in Central Europe, surrounded by the Alps, the Carpathians and the Dinarides. The formation of the basin began in the Early-Middle Miocene by back-arc style rifting, coeval with the late stages of thrusting in the Carpathian belt. The thickness of the Late-Miocene-Pliocene (Pannonian) sedimentary succession under the Hungarian Plain reaches more than 5000 m. The study area is in the central part of the Pannonian basin, along the so-called Mid-Hungarian Mobile Belt. The basin is underlain by a large orogenic collage which is built up by several tectonostratigraphic terrains. The basement of the Pannonian Basin became imbricate nappes during the Cretaceous Alpine collision. The boundary of the two main terrains, the northwestern ALCAPA (Alpine- Carpathian-Pannonian) and the southeastern Tisza-Dacia, and its environs form the Mid-Hungarian Mobile Belt. It is the most significant neotectonic zone of the Pannonian Basin. The structural analysis of the Neogene-Quaternary sediments was supported by sedimentologic and sequence stratigraphic interpretation of seismic, well log and core-sample data. Regional seismic profiles were both oriented in the dip direction, which highlights sediment supply routes into the basin, and strike-oriented. The studied segment of the Mid-Hungarian Mobile Belt consists of a few several tens kilometer long strike slip fault zones. Activity along the Mid-Hungarian Mobile Belt can be characterised by four periods, sedimentation, the size and shape of facies zones of each development period were controlled by tectonics. The paper deals with the third period during the Late-Miocene when the main thermal subsidence occured in the life of the basin and the majority of the sedimentary succession was settled. During this time (12.6–6.2 Ma), while the eastward motion of the ALPACA was strictly restricted, the Tisza-Dacia unit was able still to move eastward and an estimation of 8- 10 km magnitude of Late Miocene strike slip is made for the Szolnok segment of the Mobile Belt. The Tisza–Dacia unit collided with the European platform during the Late-Miocene (Pannonian s.l. 11.5–6.2 Ma), and the intra-Carpathian stress field changed to the present stress field. During the Late Miocene sediments were transported from NW into the studied part of the Pannonian Basin. The main route of sediment supply was perpendicular to the strike of the Mid Hungarian Mobile Belt. The delta system could keep up with the (Pannonian) lake level rise so aggradation occured. Then the structural style changed and at SB Pa-4 (appr. 6.8 Ma) a strong base level drop occured driven by the onset of inversion in the coeval marginal areas of the basin. Sedimentation continued at a lower base level from that time. Coincidence of relative base level drop, rejuvenation of tectonic activity along the Mid-Hungarian Mobile Belt and presence of deltaic vs. shoreface facies zones being parallel with the Mobile Belt resulted giant incised canyon system in the Alpár area. The canyon system incised several hundred meters in the preexisting aggrading substrat, loosing topographic expression headwards and downdip. The individual valleys range from 5 to 10 km, with smaller tributaries. The valley depth is greatest (600-700 m) around their confluence. The canyons are filled with clay marls, and are overlain by fluvial sediments, suggesting a significant transgression in between. The canyon system is related to a large releasing bend and/or extensional duplex of the Mid-Hungarian Mobile Belt. To conclude the results, during this time sedimentation in this part of the basin was controlled by the strong interaction of tectonics, sediment supply from the uplifting hinterland and climate.

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Thick and massive phreatic calcrete hardpans in the geological record as indicators of the former presence of long-lasting evaporitic basins

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Quaternary sediments around salt lakes in central Australia host thick and massive phreatic calcrete hardpans that can exceed 10 m in thickness and that are characterized by the almost total mineral replacement of most of their host sediment by calcite [1-3]. Studies in these modern settings make it clear that their formation is directly related to the mixing of fresh and salty groundwaters in the periphery of hyper-arid evaporitic basins [2]. Although quite rare in the geological record, similar types of calcrete were recently identified in the Tournaisian (lower Mississippian) succession of Arran (southwest Scotland), and in the Viséan (upper Mississippian) successions of eastern Canada [4,5] and Kintyre (southwest Scotland). The petrogenetic link to evaporitic basins is harder to establish in ancient successions due to the poor chances of evaporite preservation during events of deformation, uplift and erosion. For instance, none of the three above-mentioned occurrences of such calcretes are adjacent to known exposures or subsurface occurrences of evaporites. However, through large scale stratigraphic correlations in Viséan successions across eastern Canada, phreatic calcrete hardpans in the provinces of eastern Quebec and northern New Brunswick were eventually demonstrated to be time-equivalent to large and up to 1 km thick evaporite deposits in southern New Brunswick and Nova Scotia [5], confirming the hypothesis that such calcretes may be used to infer the former presence of an evaporitic basin in their vicinity. Available data suggests that the Tournaisian and Viséan occurrences of southwest Scotland may also be petrogenetically linked to the former presence of evaporitic basins, although this connection remains to be more firmly demonstrated. Finally, a few occurrences of dolomitic equivalents of such calcretes in late Paleogene to Neogene sediments of Kuwait [6,7], in Upper Triassic sediments of central France [8], and in Paleogene sediments of southern France [9], are all associated to salt lakes or restricted marine bodies, further supporting the reliability of such link.

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Major controls on the Holocene São Francisco River delta evolution

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Standard Penetration Test boreholes drilled in the São Francisco River delta plain showed that deltaic Holocene progradation began around 8 cal. ka. This was probably the result of the decrease in rates of eustatic sea-level rise by that time. After 8 cal. ka, other factors had exerted a more effective influence on the delta evolution, particularly, the morphodynamic adjustment among longshore drift, coastline orientation/bathymetry and fluvial discharge. Infilling of the original embayment formed during the maximum of the Holocene transgression was completed by about 4.7 cal. ka, when a straight shoreline was present. Since that time, shoreline progradation gave origin to a well developed deltaic cusp. Longshore drift simulations showed that the embayed coastline of 8 cal. ka favored a convergence in the longshore drift, which resulted in a rapid infilling of the bay. When the coastline straightened by 4.7 cal. ka, NE-SW net longshore drift was dominant. Afterwards, a deltaic cusp formed due to the influence of the river. Presently, the net longshore drift still has a NE-SW direction, but its intensity was greatly reduced. The net longshore drift prevailing nowadays indicates that the shoreline orientation is near an equilibrium state. Longshore drift simulations were performed using the same wave climate for the three scenarios (8, 4.7 cal. ka and present) and the results were corroborated by morphological indicators of longshore drift found in the delta plain, such as recurved spits. This suggests that the observed changes in the net longshore drift during the Holocene were due entirely to mutual adjustments between coastline orientation and paleo-bathymetry. These morphodynamic adjustments were the main factor controlling deltaic evolution during the last 8 cal. ka. Equally important was the fluvial discharge, which has acted as a hydraulic groyne enhancing the formation of the deltaic cusp since 4.7 cal. ka.

Depositional style and evolution of coarse-grained clastic sediments in the Permocarboniferous NE-German Basin

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The initiation of the intracontinental Central European Basin System (CEBS) was characterized by intensive volcanism, and by accumulation of coarse-grained clastic sediments at the basin margins and some single sub-basins. Generally, a lack of information on the depositional facies of conglomerates and conglomeratic sandstones of different stratigraphic formations can be recognized. George and Berry (1993, 1994) dealt with Permian coarse clastics of the Southern North Sea area with respect to the facial evolution. They observed a cyclic deposition of Upper Rotliegend sediments resulted in a model of deposition controlled by climate cycles. They distinguished "wet" and "dry" fan deposits in the overall arid climate. A detailed facies analysis by Kallmeier *et al.* (2010) focusing on conglomerates and conglomeratic sandstones was carried out on more than 3800 m of drill cores from seven wells of Rotliegend sediments in the NE-German Basin. Two different stratigraphic formations were investigated in the German study area: Grüneberg Formation (Lower Rotliegend) and Parchim Formation (Upper Rotliegend II). The Grüneberg Formation is dominated by conglomerates of a monomict andesitic clast composition whereas the conglomerates of Parchim Formation display a polymict composition (Kallmeier *et al.* 2010). Seventeen lithofacies types (LFT) have been distinguished and grouped into six lithofacies associations (LFA): (1) Alluvial fan association, (2) Alluvial plain association (with fluvial), (3) Aeolian association, (4) Playa association, (5) Lacustrine association and (6) Volcanic association. Alluvial fan association represents the dominant assemblage of conglomerates and conglomeratic sandstones and is dominated by cohesion less fluid gravity flow deposits (hyperconcentrated flows and stream flows) (Kallmeier *et al.* 2010). Recurring LFA 1 successions (coarsening-thickening-upwards, fining-thinning-upwards or massive sequences) were interpreted as different stages of fan evolution (as revealed by evolution of Maximum Particle Size and Bed Thickness). The progradational/retrogradational cycles of the studied alluvial fan systems document combined local tectonic movements and influence of local climatic changes. The dominance of water-rich mass flow processes together with sedimentary structures such as dewatering structures and outwashed tops suggests the presence of wet-type fans and plains under semi-humid to semi-arid seasonal climates. Sediments under investigation show variation in clast composition subsequent to deep erosion processes on basin margins and changes of source areas. Synsedimentary normal faults and clastic dykes have been interpreted as indicators of tectonic activity of grabens itself and its frames. However, our data did not allow for a clear distinction between climatic and tectonic signals.

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Provenance of Carboniferous to Jurassic sediments of the Central European Basin System (CEBS): preliminary implications from combined single grain and bulk analyses

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The Central European Basin System (CEBS) represents a poly-history basin that evolved after the Variscan Orogeny across Central Europe. Basin initiation was accompanied by substantial volcanism in Upper Carboniferous/Lower Permian times and continued in basin growth up to Triassic/Jurassic times with an extension from Central England to East Poland and from South Germany to South Sweden. In the early stage of basin development from the Upper Carboniferous to Lower Triassic the sedimentary basin fill was predominated by various Variscan source areas to the South. In strong contrast to this the basin fill of the stage from the Upper Triassic to Jurassic was experienced by remarkable changes to Fennoscandian source areas to the North. Up to now, the provenances of sediments have been reconstructed mainly based on analyses of heavy mineral assemblages but because of selective dissolution the results are limited. Preliminary investigations on cathodoluminescence (CL) of Permian sandstones revealed promising results as quartz can be considered resistant against selective dissolution (Zinkernagel and Zimmerle 1988). Due to recent improvements, CL of quartz grains enables bulk analyses on the provenance of quartz sandstones (Götze and Zimmerle 2000). Since, K/Ar-dating techniques have been applied to preliminary bulk analyses of detrital micas qualitative provenance analyses are enabled (Paul *et al.* 2008). Own preliminary CL investigations on Permian sediments from NE Germany revealed significant compositional differences between Lower Rotliegend conglomerates and Upper Rotliegend II conglomerates and sandstones pointing to changing Variscan sources (Kallmeier *et al.* 2008). In order to enable high-resolution provenance analyses of siliciclastic sediments we propose to combine bulk analyses on CL of quartz with single grain analyses on Ar/Ar ages of detrital micas using the LA-ICP MS technique. The challenges of high resolution provenance analyses of Upper Carboniferous to Jurassic sediments from the CEBS are to distinguish different Variscan sources (e. g. Vindelician, Bohemian) as well as different Fennoscandian sources (e.g. Caledonides, Fennoscandian Shield).

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Salt tectonic and karst control of lignite accumulation traps in the continental Paleogene-Neogene succession of Poland (Central Europe)

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The large lignite deposits of Paleogene-Neogene age, common in the Polish Lowland area, are frequently (41 of considered 77 deposits) located above, nearby and in-between the salt diapirs - distinguished deposit types as follow: (a) in overdiapir depression, (b) in marginal diapir depression/"pocket" and (c) in interdiapir depression (Kasiński *et al.*, 2009). Halotectonic activity (salt uplift in the domes and salt ouflow from the interdome area due to tectonic relaxation) lasted from the Oligocene to the Late Neogene created the local depressions (suitable accommodation space for accumulation traps) favoured the phytogenic matter accumulation. But differentiated intensity of halotectonic processes of studied diapirs produced the more or less complete and thick succession of Paleogene-Neogene sediments with lignite seams. Parallel subrosion and karst phenomena, affected the top salt of diapirs and their caprocks, created both the subrosion depressions for intense phytogenic accumulation (Mieburg, 1980) as well as they deformed the former lignite- bearing sediments above the dome. Very thick lignite seams with large resources are characteristic for the fine (in area) deposits just above the diapirs (their total area is 2.9% of whole area of studied lignite deposits but their resources – 8.7%). Lignites in the marginal diapir depressions ("pockets") are relatively thin and their total area is 13.3% of all deposits with 8.6% of whole resources. Total area of deposits from interdiapir depressions is 33.9% but their resources are 17.6% of whole lignite reserves. Concluding, the depressions above the diapirs, created by complex processes (halotectonic uplift, subrosion and karst) seem to be a favourable area for phytogenic matter capture and protection, finalized with generation of thick lignite seams a few times thicker than those located in areas outside diapirs.

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Geometry and microstructures of muddy turbidites in the Plio-Pleistocene deep-water successions on the Boso Peninsula, central Japan

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Muddy turbidites have commonly been reported from distal turbidite environments, and some distinctive criteria for their recognition in ancient deep-water successions have been proposed. In particular, the discrimination between muddy turbidites and hemipelagites is crucial for clarifying event- and background-sedimentation processes in fine- grained deep-water successions. Although muddy turbidites have also been documented from deep-water successions in association with sandy turbidites, geometry and distribution patterns of muddy turbidites have not yet clearly been understood, compared with those of sandy turbidites. Furthermore, although microstructures of fine-grained sediments seem to be crucial for the recognition of muddy turbidites from a limited volume of sediment samples, microstructures of muddy turbidites have been overlooked, except for a few case studies. Here, we investigated distribution patterns, lithofacies organization, and microstructures of muddy turbidites, which are associated with sandy turbidites developed in base-of-slope and submarine-fan environments in the Pliocene and Early Pleistocene forearc-basin successions on the Boso Peninsula, central Japan. On the basis of bed-by-bed correlation of sandy and muddy turbidites, with the aid of mapping of volcanic ash beds in the deep-water successions, we found that depocenters and distribution patterns of muddy turbidites were deflected rightward relative to paleocurrent directions of associated sandy turbidites. These deflections are interpreted to have been affected by the Coriolis force, which may have acted on the tail of turbidity currents, rather than by bottom currents. Muddy turbidites consists of lower coarser-grained and upper finer- grained portions, herein called coarse- and fine-muddy turbidites, respectively. Coarse-muddy turbidites show normal grading and commonly gradationally rest on the Bouma D division. Locally, faint laminations are developed and distinct bioturbation structures are not observed in coarse-muddy turbidites. In contrast, fine-muddy turbidites do not show any distinct grading and are better sorted than coarse- muddy turbidites. The base of fine-muddy turbidites is gradational and locally shows sharp contacts to the underlying coarse-muddy turbidites. Fine-muddy turbidites are developed only in a distal submarine-fan setting and locally contain minor bioturbation structures. These lithofacies features and distribution patterns of fine-muddy turbidites are interpreted to represent deposits from lofted turbulent fluid in a distal submarine-fan environment. Microstructures of coarse- and fine-muddy turbidites and hemipelagites, in general, are characterized by clay fabric called random structures in both cross-sections and plan-views of each sample. However, muddy turbidites also contain aggregates of clay particles with the long axis of 5–20 µm long, and any aggregate was found in hemipelagites, except for some aggregates that contain skeletal fragments and are called bioflocs. The aggregates in muddy turbidites are characterized by face-to-face contacts of clay particles, and the development of these aggregates are interpreted to reflect higher concentration of suspended sediments and more frequent collision between flocks in turbulent suspension than in hemipelalgic suspension. Thus, aggregates with higher density and strength were likely preserved after the settling of flocs in muddy turbidites. The aggregates found in muddy turbidites by the present study can provide one more important criterion to the characterization of muddy turbidites from a limited volume of fine-grained sediment samples.

Volcanogenic gigantic outburst flood from Towada caldera, northeast Japan: geomorphic and sedimentary evidences

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Volcanic eruptions supply a large volume of volcanic debris to surrounding basins by various eruptive and fluvial processes that modify the landscape and river morphology drastically (e.g., Newhall and Punongbayan, 1996). Volcaniclastic resedimentation by water process (i.e. lahar) can be induced by heavy rain (e.g., Lavigne and Thouret, 2002; Newhall and Punongbayan, 1996), snow and ice melt resulting from eruptive activities (Major and Newhall, 1989; Pierson *et al.*, 1990), direct draining of crater- or caldera-lake water by an eruption (e.g., Thouret *et al.*, 1998), dam failure of crater- or caldera-lakes (Waythomas *et al.*, 1996; Manville *et al.*, 1999) and volcanically dammed impoundments (Kataoka *et al.*, 2008; Macías *et al.*, 2004), and direct influx of debris avalanche deposits that eventually transform into debris and/or flood flows (Vallance and Scott, 1997). Amongst these, catastrophic outburst floods by a breach of volcanic dam or caldera rim tend to be larger with voluminous impounded water and loose unconsolidated pyroclastic material. Such extreme floods can travel long distance from the source volcano that ultimately affect landform and hydrology further downstream areas and eventually threaten human life and economy. Many regions in the volcanic arcs of the Pacific Rim hosting active volcanoes are susceptible for such a catastrophic flood by dam break. However, most of previous researches have considered the primary eruption processes in the subject fields of volcanology and igneous petrology and limited numbers of studies have addressed to the sedimentology, geomorphology, and hydrology in relation with sudden and voluminous input of volcanic debris to sedimentary basins. The present study shows that geomorphic and sedimentary evidences in and along the Oirase River, northeast Japan indicate a gigantic breakout flood from Towada caldera volcano after the 15 ka Towada-Hachinohe ignimbrite eruption. In the upstream bedrock fluvial system, the presence of 1) many hanging valleys and a horseshoe- shaped waterfall, 2) boulder bars, and 3) dry valley at the higher elevation does not fit for capability of the present Oirase River. The Sanbongi fan is distributed in the downstream (alluvial system) area of the Oirase River, and is composed of thick, lithic-rich hyperconcentrated flow deposits including pumice clasts derived from the 15 ka Towada-Hachinohe ignimbrite and well-round meter sized boulders derived from bedrock of welded ignimbrite as outsized clasts. The deposits are totally aggradational with no major channels that indicate absence of major hiatus during sedimentation. The depositional facies indicates that a single, sheet-like flood formed the Sanbongi fan. Furthermore, grainsize analysis for the Sanbongi fan deposits shows the dominance of dense lithic particles and positively skewed characteristics in grainsize distribution. This indicates that low-density pumiceous particles and finer fraction were swept way due to the high-energy flow, however the deposition was not en masse debris flow origin. The most probable water source for the flood is Towada caldera lake, as suggested by the geomorphology and sediments left along the outlet. Paleohydrological analysis indicates that at least 6 km3 of water mass was released from the caldera with > 10000s to 100000s m3/s of peak discharge during the breakout flood.

Fluvial and geomorphic responses to explosive volcanism: lahar sedimentation and terrace formation after the 5 ka Numazawako ignimbrite eruption, northeast Japan

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Explosive volcanic eruptions can produce large amounts of loose unconsolidated volcanic debris and cause widespread and severe volcanic hazards to surrounding areas by various eruptive and fluvial processes such as ashfall, pyroclastic density currents, and lahars. Volcanic activities also can create, degrade, and modify land-forms and river morphology drastically in a geologically short-time span. Thus, fluvial response to an eruption is sudden and unique; burial of pre-eruptive river topography by thick ignimbrite and pyroclastic fall deposits, post-eruptive volcaniclastic resedimentation by various hydrological processes (i.e., lahar), and reestablishment of river systems after the eruption can leave unusual sediments and landforms. However, there are very limited numbers of studies discussing formation processes of fluvial terraces influenced by explosive volcanism (Kataoka *et al.*, 2008; Manville, 2002; Manville *et al.*, 2005; Yokoyama, 1999; Yoshida *et al.*, 2005) as most of the studies have focused on the relationship with local tectonics, global eustatic sea-level changes, and climate changes during the middle/late Quaternary period. Numazawa volcano in northeast Japan erupted most recently at about 5 ka, forming a 2 km diameter caldera and emplacing at least 4 km3 of valley-confined ignimbrite followed by plinian/phreatoplinian eruptions. The ignimbrite dammed the Tadami River to a depth of > 100 m, temporarily impounding > 1.6 km3 of damlake water that was catastrophically released by dambreak (Kataoka *et al.*, 2008). Pyroclastic material resedimented by the flood is widely distributed along the Tadami and Agano Rivers as deposits of 10s of meters thick as far as the coastal Niigata Plain more than 150 km downstream of the volcano. Sedimentary facies analysis with geomorphic characteristics of post-Numazawako volcaniclastic deposits indicates supra- and pro- ignimbrite lahar sedimentation with a catastrophic breakout flood event during the eruption aftermath. Terraces along the Tadami River can be subdivided into four, namely, T1 terrace: ignimbrite plateau capped with plinian deposits, which in turn, overlain by thin supra-ignimbrite lahar deposits (indicating sedimentation by debris flows, hyperconcentrated flows, shallow braid stream); T2 terrace: thick supra-ignimbrite lahar sequences composed of various lahar facies (same processes as the T1 terrace) with secondary pyroclastic flow deposits and secondary hydroeruption crater-fill deposits; T3 terrace: flood terrace with boulderly facies in ignimbrite deposited area (T3a terrace) and thick aggradational pumiceous hyperconcentrated flow facies in area beyond the ignimbrite distribution (T3b terrace); and T4 terrace; recessional terrace composed of bedrock derived gravel beds (indicating a braid stream environment), in descending order of elevation. Vertical, lateral, and proximal-distal changes in volcaniclastic sedimentary facies show spatio-temporal changes in lahar and fluvial responses in the Tadami River catchment as follows: 1) burial of pre-existed river valley caused choking of river water in the initial stage and small-scale rain-triggered lahar on the T1 terrace surface occurred; 2) lahar deposition and incision concentrated in depressions accompanied with hydro-eruptive activity resulting in thick lahar depositional surface (T2 terrace); 3) voluminous flood water induced by the outburst of damlake left boulderly sediments (T3a) and thick hyperconcentrated flow deposits in downstream end (T3b); and 4) the top of the T3b terrace deposits were eroded partly when the catastrophic flood waned and further confined, and subsequently recurring of braided river system formed T4 terrace. Thus, fluvial terrace formation in the Tadami River catchment was highly controlled by 5 ka Numazawako and fluvial re-adjustment to the eruption rather than other factors.

Physico-chemical parameters of near shore coastal waters, sediments and foraminifera along the east coast Tamil Nadu, India

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The depletion of organic and/or inorganic dissolved materials in seawater may affect near shore coastal environments. The determination of physico-chemical parameters (e.g., pressure, temperature, pH, conductivity, salinity, turbidity, oxygen, density, nitrite, nitrate, ammonium, phosphate) of seawater at various depths and foraminiferal abundances in bottom sediments are important tasks to monitor coastal environments. In the present study seawater samples from 50m, 75m, 150m, 250m water depth from the coastal zone off Chennai to Nagapattinam (east coast Tamil Nadu) were analyzed for understanding coastal water geochemistry. Bottom sediment samples were collected from 12 stations during pre-monsoon and post-monsoon periods at the water depths of 50m, 75m, 150m and 200m for understanding sediment geochemistry. The geochemical profiles of nutrients such as nitrite, nitrate, ammonium, phosphate and the CTD (conductivity, temperature and depth) measurements carried out on the water column revealed a distinct change in nutrient concentrations and also exhibits a drop of nearly 5°C from the surface to 75m water depth and 7°C drop from the surface to the water depth of 100m. However no change in temperature was observed from the surface down to 50m water depth. Accordingly, density and dissolved oxygen follow the same pattern. The data collected indicate seasonal variations in nutrient concentrations. The properties of the seawater are not homogenous both horizontally and vertically and changed with depth during both sampling campaigns. The observed values of nutrients for the post- monsoon period are higher compared to that of the pre-monsoon period. Organic carbon and calcium carbonate contents of the sediment samples do not reveal significant variation between 50m and 150m water depth. Foraminiferal species such as Globigerina bulloides and Globigerinoides ruber are abundant during pre-monsoon and post- monsoon seasons. However, other species such as Brizalina striatula, Globigerinella aequilateralis are more abundant in the pre-monsoon period. Variations in temperature, salinity, light intensity and availability of nutrients in seawater highly influence the phytoplankton distribution. All these parameters are important factors of the coastal food chain. In this study the importance of distribution of foraminifera and their sensitive response to environmental physico-chemical properties are presented.

Are Human influences responsible for the existence and possible drowning of (parts of) the Ebro Delta, Spain?

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The modern Ebro Delta, Spain, has developed since the Holocene sea level stabilized around 6,000 years ago. Delta progradation rates since than have changed significantly. Historical charts dating from the Middle Ages suggest that the delta prograded from the Roman epoch until the 10th century at rates 2-3 times faster than before. The Romans deforested significant parts of the 80,093 km2 large hinterland, mainly to supply the ship industry, which induced severe erosion. In contrast, dams and reservoirs emplacements for irrigation works on the Ebro and its tributaries during the last 150 years led to the retention of almost the entire fluvial sediment normally transported to the Mediterranean, resulting in acceleration of coastal erosion. Climatic impact on the sediment load transported to the coast is less well understood but Paleohydrological reconstructions suggest that riverine sediment to the Mediterranean increased during the Middle Ages and the Little Ice Age. For this study, a numerical model, HydroTrend, is applied in a first attempt to unravel the impact of climate change and human impact of the Ebro basin over the last 2,000 years. HydroTrend is able to compute water discharge and sediment load in daily increments over centuries based on the geomorphic, geographic and geologic catchment parameters as well as human activities. For model input, a Holocene climate record is reconstructed, based on dendrochronology. Spatial and temporal human deforestation reconstructions are based on a high resolution simulations by Kaplan *et al.* (2009) who determined deforestation over time by population density, and land suitability.

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Deriving event scale discharge records from low resolution data

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Stratigraphic models need long time series or a statistical representation of high temporal riverine input data (water discharge and sediment load) to mimic event bed layers that are observed in the stratigraphy. Event beds are commonly thought to be deposited within days. We here present novel relationships, which constrain high-resolution river water and sediment flux time-series even when much lower resolution data is only available. We have derived empirical relations which downscale low temporal resolution discharge records to event scale records. A global database was generated of 100 rivers, which spans a range of scales; average discharges are at least >30 m^3/s and record length are over 10years of daily water discharge data (time span of the discharge dataset varies between 10 to 104 years of daily data). The total drainage basin area of this database represents 22% of the earth land surface. Rivers are selected such that they are spatial well distributed into 3 zones, the Arctic, Temperate and the Tropical zone, as well as representing small and larger river basins. Daily, monthly and annual standard deviations, variance and coefficient of variance are derived for each of the rivers. Analyzes indicate that daily standard deviation of water flux can be well predicted (R2 > 0. 90) based on yearly standard deviation, monthly standard deviation or long-term water discharge. Similar results (R2>0.90) are established when comparing monthly with the daily coefficient of variation of water flux. This implies that low-resolution time series can be statistically downscaled and serve to drive stratigraphic models to generate event bed layers.

Provenance and tectonic setting of Neoproterozoic-Lower Cambrian and Permian-Triassic terrigenous basins, Taimyr fold and thrust belt, northern Siberia: insights from U-Pb detrital zircon and Sm-Nd isotopic studies

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Taimyr fold and thrust belt (TFTB) frames the Siberian craton from the north. It is commonly accepted that the southern zone of the TFTB is a deformed margin of the Siberian craton, whereas central and northern zones contain accreted terranes including the Kara plate. Three orogenic events in Neoproterozoic, late Paleozoic and Mesozoic are recognized. Two major terrigenous successions of Neoproterozoic-Lower Cambrian and Permian-Triassic ages correspond to related orogenic events and have wide distribution in the eastern TFTB. To clarify terrigenous sedimentary basins evolution and their relationship with orogenic belts we carried out SHRIMP U-Pb detrital zircon and whole-rock Sm-Nd isotopic studies of 5 sandstone samples from Neoproterozoic-Lower Cambrian and 4 sandstone samples from Permian-Triassic successions. Both U-Pb and Sm-Nd studies were done at VSEGEI, St. Petersburg. Detrital zircons of 1930 Ma – 2020 Ma predominate in samples from the lowermost unit of Neoproterozoic succession. Detrital zircon age distribution in this sample is very similar to that in Mesoproterozoic sandstones on the margins of the Anabar shield pointing to Siberian basement source for several terranes from the central zone of the TFTB. Other samples from Neoproterozoic-Lower Cambrian succession contain numerous zircons with ages varying from 800 Ma to 950 Ma that is very close to the age of local Neoproterozoic granite intrusions and metamorphic rocks. Immature arkosic composition of most Neoproterozoic sandstones also supports their origin from local source. Approximately 40% of grains are Paleoproterozoic and Archean showing a mixture of local and Siberian craton sources that corresponds with Sm-Nd isotopic data as well. Permian and Triassic sandstone samples contain detrital zircon with age varying mainly from 440 Ma to 540 Ma, and from 250 Ma to 290 Ma. Only a few grains are ca. 780 Ma or older. The only possible sources for most grains are granite and metamorphic rocks from the northern zone of the TFTB, Severnaya Zemlya islands and, probably, submerged parts of the Kara plate. Sm-Nd isotopic study shows evidence of erosion of Neoproterozoic or younger oceanic-type rocks. Absence of Paleoproterozoic and Archean grains shows that neither the Siberian craton nor central zone of TFTB were significantly eroded in Permian and Triassic. Although both Neoproterozoic-Lower Cambrian and Permian-Triassic terrigenous successions have close distribution and related to orogenic events in the TFTB, paleogeography of related sedimentary basins was very different. During Neoproterozoic and Early Cambrian both local uplifts and Siberian craton basement were important sources for terrigenous rocks that is not typical for foreland basins. However, Permian-Triassic sedimentary basin contains products of erosion of only local fold and thrust belt that is typical for foreland basins. Combined results of U-Pb detrital zircon and Sm-Nd whole-rock isotopic studies show that during Permian and Triassic both southern and central zones of the TFTB were lowlands and no divide separated eroded northern Taimyr and Kara plate from sedimentary basin in the southern TFTB. It demonstrates that no late Paleozoic (Hercynian) tectonic event affected central and southern zones of the TFTB and numerous thrusts which cut Neoproterozoic and Paleozoic succession of the southern and central zones were formed during a Mesozoic tectonic event.

Permian dune fields as geomorphic traps for gas accumulation: Upper Rotliegend - Zechstein Basin, SW Poland

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In early Late Permian, deserts occupied vast territory of the European Upper Rotliegend Basin, named the South Permian Basin (SPB) [1]. Western and central parts of SPB were occupied by a large salt lake surround by sabkha plain and a broad dune belt along its southern margin [2]. The eastern part of SPB (Polish Basin) was an area of playa-lake bordered on south and south-west with vast eolian dune fields, called Eastern and Southern Erg [3]. Eeolian depositional system of SPB was expanding and shrinking several times during the period of about 8 Ma years, due to alternating arid and humid palaeoclimatic phases [4]. In result, dune and interdune deposits (stacked ergs) formed thick sedimentary cover, reaching in some cases (graben settings) near 1000 m in thickness. Desert conditions waned as a result of rapid Zechstein Sea transgression and resulting inundation of SPB. At first, marine waters filled up vast and deep depression in central part of SPB and, subsequently, flooded eolian ergs. Waves and water soaking of eolian sands caused lowering of dune tops and induced mass-flow and slips on dune slopes. Mass-flow deposits were accumulating mostly in inter-dune areas. The water-laid, reworked eolian deposits form irregular sandy cover above dune surface [5]. These deposits are called Weissliegend, due to predominating white-grey colour, characteristic of marine environment, and/or resulted from red-beds bleaching. In result of very rapid inundation and accompanying sea-level rise, most of dunes have been preserved at the sea bottom. Subsequently, thick series of halite or anhydrite have precipitated to form impermeable cover for the buried dunes. During Late Triassic and Jurassic times, gas expulsion and migration occurred. Migrating gas was trapped in the buried dunes which acted as geomorphic traps. Most of, important gas fields in the Polish Rotliegend Basin belong to this type. In turn, stratigraphic and in some cases subtle traps are found in Rotliegend deposits in UK Southern North Sea, that is at western side of the SPB, where apart of the Zechstein seal, Silverpit Fm claystones form an additional sealing horizon in the Rotliegend section [6]. Gas fields related to buried dune fields in the Polish Southern Erg area are a few to tens of square kilometers in area and from several meters to over 100 m in thickness. In many cases, the gas-bearing eolian forms are larger because in the current practice the area of gas field is calculated at the level of gas-water contact and height of trap high determined from gas column size. Estimated hights of preserved dune fields may reach over 150 m. Dune fields are composed of several types of dunes, still poorly recognized due to scarcity of core material and modern geophysical measurements as imaging tools. Shape and internal structure of dunes determine directions of better permeability and, in a lesser degree, porosity of eolian sandstones, which are significant for gas trap features and gas exploitation. In regional scale, desert formed before marine inundation is characterized by relatively low sand supply and partly reworking and remigration of older eolian sands. The location of largest dune fields (present gas fields) within the whole erg area suggests paleogeographic control. It appears that sands were accumulated in specific areas of "wind jail", forming fields of possible complex star dunes. In other cases, wandering barchanoid ridges and single barchan dunes were forming in local depressions, giving rise to large complex dunes. In some cases single barchanoid dunes were buried ("frozen") during their migration and nowadays gas fields shape well reflect their dune shape. Wind directions were defined with the use of dipmeter. Measurements of sedimentary dips for individual dune foresets together with azimuths were interpreted in relation to reconstructions of paleogeographical position of SPB in the Late Permian. [4]. During the last stages of eolian processes, the winds prevailing in Polish Rotliegend Basin area were easterly and north-easterly. This determined the position of sand source areas and pathways for dune migration. The obtained results also help to find dune fields which represent most promising gas traps.

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Characterising the Paleocene submarine fans of the UK Central North Sea: observations from seismic, petrophysical and core analysis

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The Paleocene basin floor submarine fans of the UK Central North Sea are important petroleum reservoir units recording the cyclic input of sand-rich turbidity currents into the deepwater of the failed rift structure making up the Central Graben basin. Each of these cycles (Maureen, Mey (Andrew) and Forties) have associated hydrocarbon production with the youngest Forties sands being the most prospective (for example the Nelson, Forties, Everest and Pierce fields). Thanks to this regional prospectivity, there is an extensive associated dataset of 3D seismic, well logs and core material. Analysis of these datasets has enabled a regional-scale re-evaluation of these well known deepwater deposits. Observations from seismic, core and well log analysis are used to map the reservoir quality and seismic stratigraphy of the Palaeocene Maureen and Mey (Andrew) sandstone members and advance our scientific understanding of the syn- and post-depositional dynamics within the submarine fans. The use of regional seismic data allows observations to be made about the extent, thickness, net to gross, bathymetric interaction and temporal evolution of the submarine fans. Observations from seismic data benefit greatly from correlation with core analysis and an extensive well database. Currently, core from 21 wells has been studied to evaluate the types of facies present and how these relate to bed connectivity, grain size distribution and porosity and permeability trends. Furthermore, integration of a regional well database (containing hundreds of wells) allows for large-scale mapping of formation thicknesses and reservoir quality trends. In turn, this has enabled seismically derived maps to be ground-truthed enabling a more quantitative approach to seismic attribute-based reservoir property mapping. The integration of these observations into a single database will enable powerful interpretations to be made with both academic and industrial applications. Examples are presented of potential scientific advances including clarification of our understanding of the spatial and temporal evolution of the submarine fans. Observations are made of the impact of basin geometry and salt-induced bathymetric variations on the distribution of reservoir properties as well as potential changes in the source area and the validity of previous models. Maps of sediment distribution and reservoir quality also allow industry workers to consider the remaining prospectivity of these intervals and the impact on the overlying Forties sandstone reservoir. It is hoped that this study will prove valuable to workers in both the Central North Sea and global deep water sedimentology.

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Petrographic evidence for multiple replacement and cementation events in Miocene and Pliocene dolostones from Mayaguana Island (SE Bahamas)

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Petrographic examination and new isotopic analyses of recently discovered Miocene and Pliocene dolostones from Mayaguana reveal that each of these units represents a multi-phase system comprising both replacive and cementing dolomite formed in the marine realm during distinctive time intervals. Mayaguana Island represents the emerged portion of a small, elongated carbonate bank located in the SE Bahamas. One low-elevation sea cliff along its northern coast exposes two superimposed well-lithified dolostone units. The lower one (U1) consists of dense, laminated, white, microsucrosic dolomite dating from the late Miocene, whereas the upper one (U2) is made of massive, tan, crystalline-mimetic dolomite of middle Pliocene age. We provide here more detailed petrographic observations using both polarizing and cathodoluminescence (CL) microscopy and new Sr-, O-, and C-isotope analyses on bulk-rock samples to better constrain the nature and origin of these two rock units. U1 is made of laminated microsucrosic dolomite, preserving no evidence of an earlier rock fabric. Petrographic analyses indicate that it consists of (1) tiny dolomite crystals appearing as irregular "dirty" patches under the polarizing microscope, and (2) limpid, euhedral to subhedral, finely crystalline (up to 50 μm) dolomite cement adjoining intercrystal pores or the interior margins of rare biomolds. In CL, replacive dolomite crystals are homogeneous and exhibit a dark blue colour, whereas the cement crystals are growth-zoned, with up to five zones of varying thickness showing red, yellow and dark blue colors. U2 dolostone preserves the texture of the pre-existing limestone. Allochems were mimically replaced by cryptocrystalline dolomite, whereas coarser, subhedral limpid dolomite precipitated in intra- and intergranular pores. Most samples further include a late generation of low-Mg calcite cement. In CL, the replacive dolomite exhibits bright, orange to red colours. The dolomite cement pattern is complex revealing an early generation of small brightly luminescing crystals rimming the grains, followed by a second generation of larger, growth-zoned crystals where bright hairline zones alternate with wider dark blue bands. The late phase of calcite cement is non-luminescent. Whole-rock $\delta^{18}O$ and $\delta^{13}C$ values measured from U1 average at +2.68 and +1.92 per mil, respectively, whereas U2 samples gave mean $\delta^{18}O$ and $\delta^{13}C$ values of +1.28 and -0.33 per mil, respectively. Sr-isotope analyses of U1 gave $^{87}Sr/^{86}Sr$ ratios ranging between 0.708966 and 0.709022, whereas those made on U2 rocks vary between 0.709048 and 0.709081. Comparison with the Sr-isotope evolution of global seawater for the Neogene confirms the late Miocene age for U1 with ages between 6.59 and 5.44 Ma. U2 ages range between 4.49 and 2.15 Ma spanning the entire Pliocene. Three main conclusions can be derived from the presented data. (1) The studied dolostones are multiphase systems comprising both replacive and cementing dolomite, thus confirming earlier observations made on microsucrosic dolostone only. The dolomite cement further represents a significant portion of the rock volume and precipitated in several distinct phases, as indicated by its marked zonation in CL microscopy. (2) $\delta^{18}O$ and $\delta^{13}C$ values indicate that dolomitization and dolomite cementation took place in a marine diagenetic realm, which agrees well with the geological setting of the studied area. The slightly negative $\delta^{13}C$ values measured from U2 are likely related to the low-Mg calcite in these rocks, which might have precipitated from meteoric waters long after the formation of the dolomite. (3) The scatter of Sr ages obtained from each unit suggests that part of the measured Sr derives from the parent limestone and/or that dolomitization of allochems and dolomite cementation occurred during distinctive time intervals, likely corresponding to different sea-level events.

Post-accretionary Cretaceous basins at the East Asian Continental Margin (Far East of Russia)

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The Jurassic to Early Cretaceous continental margin of East Asia represents a collage of progressively accreted plates (terranes). Accretionary complexes have been formed by the interaction of the oceanic (Izanagi) and continental (Eurasian) plates. The variety of facies in the convergent zone is dependent upon convergence rates, plate structure and a sediment input rate from the continent. The deposits in convergent zones are continuously deforming and changing position many times. Types, composition of the sediments and geological structure of the post-accretionary Late Jurassic to Cretaceous basins at the East Asian margin can be reconstructed, resulting from the comparative analysis with the recent well-studied convergent zones (the Nankai Trench, the Aleutian Trench, the Oregon-Washington Trench, the Reru-Chile Trench, and the Middle America Trench). When studying modern trenches, four main facies can be established in the convergent zone: pelagic and terrigenous oceanic plate facies, trench wedge and fan. They can combine in various ways to form many configurations or arrangements of convergence zone deposits in response to different conditions of tectonism and sedimentation. In general, twelve combinations of these four facies are possible. The first type of the post-accretionary basins was formed at the East Asian margin after termination of an oblique subduction of the Izanagi Plate beneath the Eurasian Plate during early Late Jurassic time with a very high rate – 30 cm/year. The oceanic plate cover was simple in structure, dominant was a pelagic facies (cherts) including oceanic basalt fragments. As a consequence of the oblique plate convergence, the Tan-Lu Fault System was formed. An extensive (650 km) sedimentary basin filled in with Tithonian-Middle Albian marine turbidite-dominant and shelf facies with a thickness of about 13 000 m, was generated along the main shear. The rate of sedimentation was moderate (about 300 m/Ma). The second type of the post-accretionary basins was formed after termination of a frontal subduction episode of the Kula Plate beneath the Eurasian Plate in Middle Albian time with a high rate of 13 cm/year. The structure of the oceanic plate was a rather complicated. Basalt fragments of the oceanic basement, oceanic islands covered with shallow limestone bodies are reconstructed, and also pelagic facies (cherts, clayey cherts) of the oceanic plate. As a result of frontal subduction, the East Sikhote-Alin marginal-continental volcanic belt and a series of back-arc basins began to form. A cyclic sedimentation of a typical deltaic succession, which begins with the off-shore facies, passes into delta front sandstone/siltstone interbeds, and ends with thick-bedded cross-stratified sandstones and conglomerates, took place in the back-arc basin during the Middle Albian to Cenomanian. Thus, from the characteristics of sedimentation and deformation style, the first type can be assigned to transtensional strike-slip basins developed along the sinistral strike-slip faults of the Tan-Lu System. The second type of the basins is comparable to benched and shelved fault-controlled back-arc basins.

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Sulfide oxidation generating acid-mine drainage in the Concordia abandoned mine, Salta, Argentina

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Pyrite is an essential mineral of the metallic mineral deposits and is always classified as a waste mineral because of its null economic value. Hence, during the mining process, this mineral is accumulated in waste dumps and tailings. In the Puna region of Argentina there are several Pb, Ag, Zn abandoned mines, such as La Poma, Pan de Azúcar, La Concordia. This last one is located at the western portion of Salta province, 3770 m above sea level, where the climate is arid. The mine is located 15 km from San Antonio de Los Cobres village, and it was abandoned in 1986 without any planning for its closure. Nowadays this underground mine is water-filled and the groundwater is in contact with the sulfide minerals generating acid mine drainage (AMD). The Concordia river heading is located within the mine, where the water pH is low (3-4). However, until reaching the San Antonio River, the pH of the stream during its pathway changes to neutral values when the water from the Pompeya thermal system (pH 8) flows into the stream. Then, the river crosses the San Antonio town and finally flows into the Salinas Grandes closed basin. During the mining activity and after the concentration process, the dumping material was stored in four tailings. The estimated total volume of sediment in these tailings is 42000 m^3. After the mine activity finished, the Concordia stream passed through the tailings transporting some of the sediments and metallic minerals that were deposited there. In the first tailing the pyrite concentration is between 0.9 and 2.2%. The sulfide oxidation mineral from the enriched pyrite level was investigated by means of microscopy equipped with an energy dispersive system for microanalysis.The analysis of the samples showed that the pyrite grains are limpid and some of them have a slight oxidation coating. Those grains have been exposed to weathering during the last twenty five years, thus indicating that the weathering process in arid climate produces a low oxidation level, and hence, pyrite grains represent a durable source of AMD.

Geobiochemical investigations on large-shelled clams Retrotapes and Pitar (Bivalvia, Veneridae) sampled offshore Uruguay: Analyses of growth line periodicity and shell-geochemistry as useable tools for ecological reconstructions of paleoceanic parameters

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Bivalve molluscs represent excellent biorecorders of the past. As a result of their close relationship to their ecological environment, bivalves store valuable geochemical information in carbonate secretions that can be interpreted in terms of paleoclimatic conditions. The organism's metabolic activity is a direct link to water chemistry, thereby even smallest changes of seawater composition, temperature, salinity or food supply are recorded in the shells. Thus, detailed analyses of the shell's growth periodicity can provide a wide range of information, linked with annual to sub-annual growth line accumulations, analogous to growth rings of trees. In addition, a predominantly sessile life, closely related to the ambient facies and the longest lifespan of a non-colonial animal observed on earth (up to 410 years) predestine some bivalve molluscs as important climate recorders of marine conditions. Numerous studies, achieved before on Arctica islandica (Island Cyprina) revealed a wide-ranging applicability of long-life bivalves for palecological reconstructions. Here we present two clam specimens, collected from sediment core sections taken off Uruguay (Meteor Cruise M78-3a, 1999), identified as veneroid bivalves *Pitar rostratus* (Koch, 1844) from the mid shelf and *Retrotapes exalbius* (Dillwyn, 1817) from the outer shelf environment near the shelf break. Both articulated clams were analyzed in terms of functional morphology as an adaption to the palaeoenvironment, seasonal growth cycles and geochemical analyses. The aim of the study was to establish an integrated "in-core" climate archive of high resolution (ideally seasonal to sub-seasonal), which is reliable to sedimentary information of the cores of cruise M78- 3a. Large-shelled veneroid bivalves provide a full range of attributes for being suitable for this analysis; a wide-spread occurrence and a good conservation caused by infaunal life habit. We expect to obtain important information concerning the depositional environment off northern Argentina and Uruguay and to identify key-parameters useable as biogeochemical proxies.

What is the value of deepwater analogues?

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Analogues are especially important in deepwater systems; unlike many other depositional systems, we cannot easily make direct observations in deepwater environments, since they are remote and hostile, and the events are unpredictable and often highly destructive. Modern sea floor visualisation has helped but lacks a stratigraphic dimension. Physical and numerical experiments both offer useful insights but also suffer from serious scaling issues. Use of very large outcrops can bridge the scale gap between well and seismic data, but can never be expected to be a one-for-one analogue for any subsurface case. Their principal value is in: providing analogues for elements of systems rather than complete systems; casting light on system evolution; illustrating processes and principles; forming a basis for forward modelling; generating dimensional data and formulating quantitative models based on algorithmic reductions of these quantitative data. These points will be illustrated with examples from a late Cretaceous slope channel system (the Rosario Formation), Baja California, Mexico.

A sequence stratigraphic study and reexamination of Upper Paleozoic glacigenic deposits of the Pagoda Formation at Tillite Glacier, Central Transantarctic Mountains, Antarctica

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Antarctica has long been hypothesized to have been covered by an extensive terrestrial ice sheet during the late Paleozoic Gondwanan Ice age. Reexamination of the glacigenic units in the central Transantarctic Mountains (CTM) are challenging this conclusion and are suggesting that deposition occurred primarily in a glacimarine setting with sediment derived from ice flowing out of multiple glacial centers. In particular, study of the strata in a 190-m-thick section of the Pagoda Formation at Tillite Glacier has identified the occurrence of massive and stratified diamictites, sandstones and dropstone-bearing mudrocks. Synsedimentary deformational structures in these strata are abundant and include load (small and large-scale) and dewatering structures, and slide and slump blocks. All of these features indicate subaqueous deposition in a glacimarine environment from meltwater plumes, iceberg rafting, debris flows and other mass flow processes. Also, at the Tillite Glacier site, at least one unit which shows a progressive increase in deformation suggests subglacial deposition near the grounding line of a wet-based glacier. Regional studies in CTM indicate that subglacial diamictites and proximal glacimarine sediments were deposited primarily along basin margins; whereas glacimarine sediments predominate within the basin. The findings of these studies contrast with earlier reports from CTM that identified these strata as the deposits of a terrestrial glacial system. Previous reports identified many of the diamictites as “tillites” and concluded that each “tillite” marked a separate glacial advance and retreat episode. A sequence stratigraphy and re-evaluation of glacial advance and retreat cycles for these deposits are currently being determined, and results will be presented. Preliminary research findings indicate subaqueous depositional environments associated with a temperate grounded glacier, with several possible glacier advance/retreat cycles. Re-correlation of fossil spores and pollen with Australian palynomorph zones indicate that the Antarctic glacigenic strata are restricted to the Lower Permian. The findings reported here suggest that glaciation was less widespread (temporally and spatially) in Antarctica than was previously hypothesized, and that it was unlikely that a single ice sheet covered Antarctica during the late Paleozoic.

Audru landslide – slope failure in glaciolacustrine varved clay in western Estonia

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During the last decade the frequency of landslides at river valley slopes eroding into the glaciolacustrine plain in coastal Estonia has grown. The largest landslides are associated with varved glaciolacustrine clays and one of them, Audru landslide, was chosen for detailed investigation. Landslide morphology was instrumentally measured and underlying geological setting investigated with eight boreholes penetrating the varved clay. Changes of key properties, moisture content and grain size distribution within the laminated clay complex were traced by stepwise geotechnical sampling. Shear strength properties needed by the slope stability analysis were calculated according to the empirical model. Failure zone and its influence to the landslide body were described via varve correlation. Varve-by-varve correlation of cores demonstrates that initially laminations of silt and clay were slightly tilted toward the Audru River. Cores from the lower part of the landslide show that relatively large interval of clay is absent between the marker horizons. Morphological and geological data lead to the conclusion that lower part of the landslide body liquefied and was pressed out during the slope failure. Limited equilibrium model displayed a retrogressive complex of three separate sliding events. The first stage of Audru landslide was initiated by the river undercutting and was followed by retrogressive slides that progressed upslope. Groundwater levels and water level in the Audru River were the most changeable parameters in the slope stability analysis so their influence to the slope stability was investigated in detail. In the case of the first slide phase the slope is more strongly influenced by the water level in the Audru River. Groundwater level affects more strongly the third, largest slope failure. The correlation (~0.98) between those parameters in both cases is almost linear. For the first slide phase the best fitting line can be described with the formula: factor of safety (FoS)= 0.01+ (0.44*X) there FoS is a function of X (water depth in the river) and FoS= 1.19+ (-0.3*X), where X is a piezometric level of the groundwater layer. Corresponding formulas for the third slide phase are the following: FoS= 1.07+ (0.07*X) and FoS= 1.31+ (-0.18*X). The rise of the pressurised groundwater level in average 9 meters were recorded in nearby Pärnu town during the period 1990-2000. Our analysis suggests that this process strongly conduces to more frequent and larger slope failures in the area.

Last-glacial to postglacial climate formation in the continental interior inferred from multi-proxy records of Lake Hovsgol, Mongolia

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Southwest of Lake Baikal in Mongolia lies Lake Hovsgol, the second largest and second deepest lake in the Baikal watershed. The lake's north–south axis is 136 km, varying between 15 and 35 km from east to west. The maximum water depth is 262 m. However, the temporal sequence of terrace deposits shows fluctuation of the lake level on a tens-of-meter scale in response to Late Quaternary climate changes. The Hovsgol Basin, which formed under a strike–slip tectonic regime in the Baikal Rift System, is separated from the Baikal depression by east–west-trending mountain ranges. Fedotov *et al.* (2004) proposed that the rift system became activated and a mantle plume intrusion occurred between ca. 9.5 Ma and 0.4 Ma. Since then, the rifting has slowed, and fine-grained terrigenous materials have gradually filled the basin. The water surface of Lake Hovsgol is at 1667 m above sea level; high dividing ridges surround the narrow catchment of the northern part of the basin. The modern climatic conditions, cold, dry winters and mildly wet summers specialize the water circulation in this high-altitude watershed. The runoff originates in mountainous regions of the basin, and water is apparently supplied to the lake mostly by precipitation, which, totalling as much as 350 mm annually, occurs mostly as rain in summer. Evaporation is a major cause of water loss in the basin; nearly 90 % of rainfall is lost to evaporation. The Siberian High dominates the climate in winter: cold dry air masses cover the basin and the air temperature decreases to as low as -50 °C. The extreme climate has greatly influenced the lake evolution. Paleoclimate proxy records from the lake are expected to reflect stadial–interstadial changes in the atmospheric moisture supply directly to the continental interior. Such knowledge is useful to interpret the feedback effect of terrestrial processes on the continental climate. Considering the active hydrologic budget in the watershed, it is reasonable to interpret that the lake level changed greatly during the last glacial–interglacial transition. Prokopenko *et al.* (2005) estimated that a lake-level rise extending to 100 m took place at around 15.4 cal ka BP. Large fluctuations of air mass movements have occurred in Central Asia throughout the Late Quaternary (Herzschuh, 2006), and changes in atmospheric humidity are crucial for elucidation of mechanisms triggering climatic cooling or warming. Herein, we present last-glacial to postglacial records of paleoclimate proxies from Lake Hovsgol. The summer monsoon developed because increased solar-energy absorption of the ocean surface transported moisture from oceans onto continents, thereby producing warm, wet climatic conditions in the Asian interior as orbital-scale insolation gradually increased. Associating this response with high-altitude terrestrial processes via changing atmospheric desiccation–precipitation reactions, we suggest that the enhanced solar radiation activity accelerated deglacial warming through feedback from increasing vegetation.

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Sedimentary process of the latest Pleistocene to Holocene incised-valley fills under Tokyo area, central Japan

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Sedimentary processes of narrow incised-valley fills under the lowlands spreading around Kanto Plain, central Japan, has been studied in recent decades. These valleys were incised at the last glacial maximum, and filled with marine and nonmarine sediments during the following sea-level rise from the latest Pleistocene to Holocene. We are aiming to reveal the depositional environments of the valley-fill under the Arakawa Lowland, which is one of major rivers flowing through the eastern part of Tokyo and Saitama Prefs. We examined three sediment cores, which are arranged along the axis of the Arakawa Lowland. Based on the analysis of the sedimentary facies, shell fossil assemblages, CNS chemical element contents, and radiocarbon dating, sedimentary environments of the valley-fills are reconstructed as follows in ascending order: gravelly rivers, sandy rivers (channels and floodplains), an inner-bay floor, deltas, and, finally, new sandy rivers (channels and floodplains). Additionally, radiocarbon dates within these Holocene valley-fill deposits indicate that: (1) a ravinement surface is not isochronous but diagonal to the time line, and (2) a deltaplain submerged at the maximum sea level.

Net-to-gross outcrop estimation and its application to stochastic lithologic mapping of a fluvio-lacustrine sequence: a case study of the Cretaceous Gyeongsang Basin, SE Korea

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Field-based approximation of lithologic distribution in onshore basins provides basic information about geometry of subsurface aquifer rocks prior to coring, logging and seismic analysis for projects such as petroleum exploration and carbon capture and geologic storage. Regional-scale lithologic mapping is generally conducted for sedimentary facies analysis. This traditional field technique, however, is highly dependent on experiences of investigators. Although recent stochastic characterization and modeling of sedimentary facies are being established on an outcrop scale, these attempts are yet applicable on a geologic map scale. In order to establish more accessible and quantitative technique for lithologic mapping in onshore basins, we developed a model to interpolate lithologic distribution on a regional scale with outcrop estimation of net-to-gross ratio (N/G) correlated with the result of facies analysis. The Lower Cretaceous fluvio-lacustrine sequence (the Sindong Group) of the Gyeonsang Basin, SE Korea, was examined as a case study. The Sindong Group consists of sandstone and mudstone, with minor amounts of conglomerate and marl. It is interpreted that alluvial to fluvial environments existed in the lower and middle parts of the Sindong Group, followed by lacustrine environment in the upper part. The lithology of 148 outcrop sections in three study areas was described and classified broadly into channelized sandstone, alternating sandstone-mudstone, and mudstone successions, which are interpreted as fluvial channel (FC), crevasse splay-floodplain complex (CS-FP), and floodplain-lacustrine (FP-L) facies associations, respectively. N/G was calculated by normal sandstone-mudstone ratio (N/G1) and weighting lithologic types based on grain size (N/G2). Sandstone becomes dominant when N/G1 is near to maximum, whereas coarser-grained sandstone becomes dominant when N/G2 becomes higher. The defined FC, CS-FP and FP-L facies associations are roughly correlated with high, medium, and low values of N/G, respectively. We interpolated the geologic map of the study area with N/G estimated at each columnar section to graphically demonstrate the stochastic lithologic distribution on a regional scale. The lithologic maps based on both N/G1 and N/G2 values clearly show reducing high-N/G zone and increasing low-N/G zone up sequence, representing the large distribution of channel sandstones in the lower part of the Sindong Group. This result is coincident well with a previous interpretation that fluvial plain in the lower part of the Sindong Group became to lacustrine environments in the upper part. In addition, these two lithologic maps show inhomogeneous distribution of high- and low-N/G values within the same formation, which is indicative of lithologic heterogeneity and also of kilometer-ordered channel distribution and channel migration patterns in time and space. Although both the N/G1- and N/G2-based lithologic maps apparently provide similar lithologic variation described above, it seems to be more convenient to interpolate sand-mud distribution with N/G2 rather than N/G1 because thicker, coarser-grained sandstone beds tend to develop in fluvial channel belts. In practice, as the N/G1 value does not consider sandstone grain-size differentiation, fine-grained sandstone-dominant zone can have a relatively high-N/G1 value in spite of relatively low-N/G2 value, and thus it may cause incorrect interpretation of facies type in the interpolated area.

OSL dating of the Holocene Baltic Sea sediments: a case study from the Neva estuary

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The Baltic Sea (BS) is a shallow (average depth of 55 m) European epicontinental basin, and is one of the largest brackish water bodies in the world. It has experienced several large changes in both water level and salinity during late- and post-glacial times (past 15 ka). The environmental conditions of the BS ecosystem strongly depend on meteorological forcing in the area and the adjacent North-East Atlantic. This forcing can affect e.g. regional hydrography and saline water inflow from the North Sea into the BS, and such changes are recorded in the BS sediments. By studying these sediment archives within the INFLOW project, we aim to identify the forcing mechanisms for environmental changes in the BS, and so to differentiate natural variability and changing patterns due to man-induced activities. A crucial part of this project is reliable dating of the sediments. For this purpose a set of independent dating methods (paleomagnetism, radiocarbon and luminescence) is used. As a part of the dating package, we are in the process of developing a chronology based on optically stimulated luminescence (OSL) dating. For OSL dating it is essential that any prior OSL signal is well zeroed or bleached before final deposition. This is known to be true in the Arkona Basin in the BS, to the south of our sampling location (Kortekaas *et al.*, 2007) and is likely to apply at our sampling site. Here we present preliminary results from a core from the outer Neva estuary (water depth 38 m). This location is thought to record continuous sedimentation and a relatively high accumulation rate. The 4.54 m long sediment core was recovered by piston coring during R/V Aranda cruise in August 2009. The sediment consists mainly of bioturbated silty mud with laminated intervals. Preliminary luminescence ages from 20 samples, measured using the SAR procedure and fine-grained quartz grains, are presented, and the implications of the chronology discussed.

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Intra-Holsteinian (MIS 11) climate variability reconstructed from microfacies and micropaleontological analyses of the Dethlingen core (northern Germany)

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The Holsteinian is widely considered to be equivalent to Marine Isotope Stage 11, which with regard to orbital forcing represents one of the closest analogues for the present interglacial. Hence, in order to gain further insights into the natural (i.e., non-anthropogenic) climate change during an interglacial, we have analyzed a ten-meter-long core from the Dethlingen paleolake (Lüneburger Heide, northern Germany). The interglacial sequence at Dethlingen consists predominantly of biogenic (diatomaceous) varves. A floating chronology has been established based on varve counting on thin sections of epoxy-impregnated sediment under a petrographic microscope. The varve chronology in combination with decadal-scale palynological analysis enabled to assess the duration of climate oscillations within the interglacial period as well as a biostratigraphic correlation with other Holsteinian vegetation records. The vegetation dynamics as derived from the Dethlingen core suggest increasingly milder winters and increasing precipitation towards the younger stages of the Holsteinian interglacial. However, the temperate stage of the interglacial was interrupted by two pronounced regressive phases in vegetation development that lasted for 220 and c. 300 years respectively, and has been attributed to climate forcing. The older regressive phase is characterized by an abrupt and severe decline of temperate taxa (e.g., *Corylus*, *Taxus*, *Quercus*) and increase of heliophilous trees (e.g., *Pinus* and *Betula*); these changes can be ascribed to particularly low winter temperatures. Temporal cessation of the varve formation reflects mixing in the Dethlingen paleolake during that time. Based on the established varve chronology, the decline of temperate taxa continued for 100 years, whereas their recovery lasted for another 120 years. The vegetation dynamics of this phase are comparable to the imprint of the Holocene 8.2 kyr B.P. cold event on the vegetation in central and northern Europe. The younger regressive phase is also characterized by a decline of temperate taxa; however, the presence of several winter-frost sensitive taxa (e.g., *Ilex*, *Buxus*, *Hedera*) during this interval points to a lack of summer warmth as potential forcing agent. This phase punctuates a gradual, c. 1600 year-long decline of temperate taxa. Sedimentologically, this long-term decline is associated with several clastic-detrital layers intercalated in the diatomite pointing to increased surface runoff processes. The nature and duration of the two regressive phases in vegetation development suggest that they have been caused by mechanisms within the climate system. Potential trigger mechanisms comprise a slowdown of the North Atlantic circulation and/or a decrease in solar activity for the older phase and orbital forcing for the younger phase.

Geochemistry and provenance of Upper Miocene and Pliocene sediments from the southwestern part of the Pannonian Basin System, Croatia

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The Pannonian Basin System (PBS) is a system of small basins whose development started in the Early Miocene as a result of continental collision and subduction of the European Plate beneath the Apulian Plate. During the Late Miocene and Pliocene, in the south-western part of the PBS, a several km thick sequence of sandy and pelitic sediments was deposited. Previous studies have mainly dealt with the modal composition of these sediments, while there exists very little data about their geochemical characteristics. The aim of this study was to determine the geochemical characteristics and origin of the Upper Miocene and Pliocene sands and Upper Miocene pelitic sediments from the south-western part of the PBS. According to the content of major and trace elements these sands mostly belong to the lithoatrenite group (according to Pettijohn *et al.*, 1972) or lithoarenite and greywacke group (according to Herron, 1988). The chemical composition of major elements indicates that the source rocks of sandy and pelitic detritus (Roser and Korsch, 1988) were mostly quartz-rich sedimentary rocks, felsitic rocks and neutral igneous rocks. Trace elements also show that the analysed sediments were mostly formed by weathering of acidic (Si-rich), or felsitic rocks. The major and trace element content according to Bhatia and Crook, (1986) and Roser and Korsch (1986) suggests that the source rocks geotectonically belong to continental islands arc and active continental margin settings. The obtained results are in accordance with the results of the provenance analysis of the same sediments based on their modal composition. Namely, according to Kovačić & Grizelj (2006) and Grizelj *et al.* (2007) the source rocks of clastic detritus, which filled the south-western part of the PBS in the Upper Miocene and Pliocene, were mostly older sedimentary and metamorphic rocks of a recycled orogen setting, probably the Alps and Carpathians.

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Coprolites from the Eocene of Central Patagonia, Argentina: applying the actualism for interpreting the producer

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Biogenic structures previously attributed to coprolites are studied applying an actualistic criterion for determining a possible producer. The structures were found in the Las Flores Formation (Lower Eocene), San Jorge basin, Patagonia Argentina. The coprolitic origin is supported by fusiform to sub-cylindrical shape, constrictions, striated surface texture, sub-circular to sub-elliptical transversal sections, grey- olive to white color, phosphate cryptocrystalline groundmass, radial and concentric marks, and the presence of phytoliths. Comparison with feces of extant fauna allows establishing the following relationships: (1) the morphology is similar to that of reptiles, in particular canid and felid feces; (2) surface texture would be the product of the superposition of successive layers of excrements added during the passage by the cloacae; (3) resulted from deposition of the original mass in plastic state on the substrate; (4) cracks would be formed by dehydration of the original fecal mass; (5) the color of the feces, the basal mass without inclusions, and the content of phosphates indicate carnivore producers with high digestive power. Herein, definition of reptiles as possible producers, discarding mammals, is based on the absence of inclusions. In order to test this hypothesis we have compared broad-snouted caiman feces with the coprolites. The comparison shows high similarity in shape, size, color, and elemental composition. Absence of inclusions would be the result of bone decalcification by crocodilian digestive processes. The content of phytoliths could be a consequence of secondary ingestion, common in the caiman, and other crocodilians. The assignation of a crocodilian origin for the coprolites allows inferring the presence of organisms with similar paleocological habits and needs like those of caiman. The paleontological record of the area supports this interpretation. Remains of *Eocaiman*, a genus accepted as the most basal of the alligatoridae Caimaninae are known for strata underlying and overlying strata bearing the coprolites.

Palaeosols of the Peñas Coloradas Formation: warm and humid conditions in the Late Palaeocene of Central Patagonia

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The Peñas Coloradas Formation (Upper Palaeocene) is a thin (30 m) continental unit from Central Patagonia. It consists of sandstones, mudstones and tuffs deposited into a mixed-load fluvial system. Strongly-developed palaeosols are recognized as modifying floodplain and abandoned channel deposits. Three distinctive palaeosol types are analyzed for providing new palaeoenvironmental and palaeoclimatic interpretations of the Palaeocene of Patagonia. The Colicurá pedotype is a reddish tuffaeous palaeosol characterized by a complex ichnofabric. Three horizons are present, all lacking ped structure and having gradational boundaries. Bioturbation intensity varies through the profile, sparse to absent in the upper and lower horizons, and moderate in the middle one. An undifferentiated b-fabric is recognized in all horizons, but grano-striated fabric is also present in the middle horizon. Amorphous iron oxides are frequently observed. Clay coatings are especially abundant in the middle horizon. Alumina/bases ratio ranges from ~14, in the upper horizon, to ~ 5 in the middle-lower horizons. The Ba/Sr ratio is uniform and <0.7. The CIA-K and S values range from 89 to 96 and from 0.01 to 0.07 respectively. The clay fraction is composed of kaolinite (24-77%), smectite (5-74%), chlorite (<10%) and illite (2-6%). The Keyoit pedotype is a reddish grey palaeosol developed on tuffaceous sandstones. It is characterized by the presence of meter scale slickensides. Fine material (<0.062 mm) is almost absent. Two horizons with gradational contact are recognized. The upper one displays a granular structure, and frequent reticulated to polygonal mottles. Soil slickensides are restricted to this horizon. Rhizoliths and meniscate burrows are common. Micromorphological analysis shows abundant argillans, coating planes, pores and biogenic galleries. The lowermost horizon is massive and lacks mottling and recognizable pedofeatures. Alumina/bases ratio ranges from ~3, in the upper horizon, to ~6 in the lower one. The Ba/Sr ratio is ~1. The CIA-K value is higher than 90 and the S value is ~0.02. The Yatenteh pedotype is a brown palaeosol also developed on tuffaceous sandstones. Three horizons are recognized. The upper one shows granular structure with common iron nodules and rhizoliths. Results of micromorphological study show a poro- and grano-striated b-fabric along with abundant illuviated clay. The base is wavy and sharp. The middle horizon also shows granular structure with common passive-filled and meniscate burrows and rhizoliths. The most significant pedofeature is abundant illuviated clay. The basal contact is gradational. The lower horizon is massive, with common burrows and rhizolits in the upper part. Illuviated clay is present but in less abundance. Alumina/bases ratio ranges from ~7, in the upper horizon, to ~3 in the lower horizon. The Ba/Sr ratio ranges from 0.6 to 2. The CIA-K is ~90 and the S value is~ 0.01. Geochemical and clay mineral data suggest that these palaeosols represent deeply weathered soil profiles, typical of strongly-developed Oxisols and Ultisols, probably formed under warm and humid conditions. Weathering molecular ratio, the presence of well-defined horizons, dominance of kaolinite, and abundant clay illuviation in some horizons (Bt horizon) are features characteristic of Ultisols. Other orders with argillic horizons such as Alfisols are ruled out because of the very low base cation contents. The high CIA-K value near or higher than 90 suggests intense chemical weathering. The high concentration of kaolinite in the Colicurá pedotype supports this interpretation. The CIA-K and S values provide an estimate of the range in mean palaeoprecipitation between 1200 and 1400 mm/year, and a range in mean annual palaeotemperature from 15°C to 16°C. The Peñas Coloradas palaeosols are the oldest non-biotic record of a Palaeocene warming event in Patagonia, probably related to the global Palaeocene-Eocene thermal maximum.

Dissipation processes on the Pampean Sand Sea (Late Quaternary) deduced from sedimentological data

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A large sand sea (PSS) covering the central plain of Argentina was investigated. The study comprised geomorphologic mapping, stratigraphic studies and a drilling programme complemented with grain-size and mineralogic analysis of cores. The PSS reached its maximum extent during the OIS 4, the coldest period of the last glacial in South America. The deposits of OIS 4 are characterized by longitudinal megadunes with SSW-NNE and S-N orientations covering the SW of the PSS. OIS 3 is marked by a climatic improvement, with complex responses on the PSS: 1) development of a soil at the top of the dunes, 2) a period of generalized flattening of the relief and 3) formation of a second soil. The OIS 3 sand is massive, locally dissipation structures are visible. Dissipation reflects the action of torrential rains, which saturated the superficial layer of loose sands not covered by vegetation. The final result of the dissipation is the formation of large flat areas, very long low angle hills and a few sand fields with moderate relief. An important aeolian remobilization of sand occurred in the PSS during the OIS 2, which generated extensive dune fields in the NE of the PSS. The fields are formed by small, regular dunes, 100-200 m wide and about 500 m long, with S-N orientation. A largely erosive aeolian phase occurred after the OIS 2 sand accumulation; it was characterized by Western winds that carved large deflation hollows indicating a shift of the Westerlies to the N up to 34° lat. S at the Late Pleistocene-Early Holocene. During the optimum climaticum of the Holocene a soil was developed on top of the aeolian formations. The Late Holocene was characterized by a dry climate that produced the development of parabolic dune fields. Two typical formations representing dissipated dune fields of different ages were formally described at the leeward margin of the PSS. The study comprised areal sampling of dune fields (50 samples) and the recovering of sedimentary cores (41 m drilled in five boreholes). In order to discriminate the sedimentary process occurred, particle size analysis were carried out by contrasting methods. Conventional grain-size results (by sieving) have not demonstrated to reach the necessary level of detail. Analysis by low angle laser light scattering (LALLS) resulted in 63 grain-size classes (0.05-750 µm) with intervals of 2 a 3 µm in the modal class obtained for each core. The main drilled column (Teodelina; 34°11´S and 61° 31´W) begins with the Carcarañá Fm correlated to the OIS 3 (12-15.2 m depth). It is composed of sand (50%), with abundant silt (43%) and scarce clay (7%). The grain-size distribution is unimodal (Mo: 76-89 µm) with marked positive skewness (Mz and Md: 63 µm). The deduced saltation and suspension mechanisms had a similar participation (pure saltation: 21.7%; modified saltation: 28.3%; short-term suspension: 31.2% and long-term suspension: 18.8%). The Teodelina Fm (3.5-12 m depth, OIS 2 in age) lies on erosive discordance on Carcarañá Fm. It is a sandy silt (53-70% silt, 16-38% very fine sand and 8-15% clay), with unimodal distribution (Mo: 56 - 65 µm for the lower part and Mo: 48- 56 µm for the upper section) and positive skewness (Mz>Md, in the coarse/medium silt). Aeolian suspension represents between 66 and 80% of the identified transport mechanisms, been saltation processes subordinated (mainly modified saltation). Minerals of volcaniclastic nature (Andean) dominate in the coarse silt and very fine sand fractions of these units. LALLS results from both aeolian formations are consistent with field data indicating that the incorporation of fines during the dissipation processes altered the initial composition of dunes. The mechanisms of pure and modified saltation and the short-term suspension are responsible for the sedimentological characteristics of the dunes. The dissipation would explain the predominance of the deduced suspended mechanisms of transport, mainly the long-term suspension.

Multidisciplinary analysis of the last glacial loess at the NE of the Pampean aeolian system

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Loess deposits are the main component of the Late Quaternary sequences of Pampa plain, covering the largest loessic area of Southern Hemisphere. Pampean loess region lies downwind from source areas located to the S and SW, comprising a large sand sea and alluvial systems that drain the eastern Andean piedmont. The loess unit of the last glacial maximum (LGM) at the leeward side of the Pampean aeolian system represents a primary loess, indicating the expansion of semiarid conditions to the NE. Stratigraphic, sedimentologic, mollusk and phytolith data, including OSL and 14C ages, are presented for a loessic area of 14,000 km² at the SW of Entre Ríos province, Argentina. LGM loess is a homogeneous unit, characterized by considerable spatial continuity in the North Pampa. It occurs as a mantle of 2-4 m thickness; only locally the loess has been fluvially reworked or evolved under non- permanent swamp conditions. Typical loess is a well-sorted brown (7.5YR 5/4), massive and porous silty sediment. Secondary structures are represented by burrows, fissures, CO_3Ca rhizoliths and concretions. Well-exposed LGM loess sections were investigated and sampled along the left margin of the Paraná River cliff and in other selected profiles. Particle size data reveal that the silt fraction of the loess (4-8 ϕ, 63-4 µm) is dominant (60-80%). The grain-size frequency distribution of the key section is polymodal (principal mode in 26.7 µm and secondary modes in 6.7 and 0.2 µm). Median and mean values have the highest frequency in the range 5-6 ϕ (positive asymmetry). The standard deviation is close to 2 ϕ (very poorly sorted). Two subpopulations of particles associated with transport by suspension (short-term suspension: 63-15 µm, 49% of the distribution and long-term suspension: <15 µm, 47%) and two subpopulations transported by saltation (moderated saltation: 63-125 µm, 3% and pure saltation: >125 µm, 1%) are deduced from cumulative frequency curves. The subpopulation of suspension between 4.5 and 7 ϕ is the best sorted. Ca. 50% of the particles were mobilized as dust clouds composing by grain-size fractions minor than medium silt. Mean particle size in a SE- NW transect across the loess region (170 km long) reflects a northwestward gradient in particle size from 19-23 µm (coarse silt) at the SE margin to 9-14 µm (medium silt) at the NW area. The very fine sand content of the loess decreases from 16-20% at the SE to 4-14% at the NW; the total clay increases from 4-10% (<2% colloids) at the SE to 11-24% (3-6% colloids) at the NW area. Mineralogical studies support the participation of multiple loess source areas. The modal sand fraction is predominantly composed of Andean volcaniclastic materials (mainly glass shards, plagioclases, polycrystalline quartz and lithoclasts). The secondary source of the materials is the upper reach of the Paraná River basin (heavy minerals and quartz). Illite (Pampean source) is the common clay mineral; smectites and kaolinite (respectively upper Paraná and Uruguay River basins sources) are subordinated. Luminescence ages from the loess key profile are: 32,640 ± 2120 yr. BP and 24,040 ± 1570 yr. BP on samples taken respectively at 3.5 m (swamp facies) and 2 m (loess) below the surface. Phytolith assemblages found in the loess show a homogeneous composition. With the presence of around 40 morphotypes, and according to their variability in the study area, a NW- SE differentiation was defined, in the same sense that observed in the grain-size trend. The presence of panicoid, chloridoid, pooid and stipoid elements, jointly with arecoid and cyperoid remains reference to a megathermic grassland with patches of palms trees and swamp communities with sedges. The molluscan fauna preserved exhibits considerable abundance but low diversity. It is characterized by Succinea meridionalis (^{14}C age of 27,650 ± 250 yr. BP) associated with Biomphalaria peregrina (^{14}C age of 24,390 ± 170 yr. BP), taxa living today in the same area.

Clay minerals as a tool for reconstruction of the sedimentary environments evolution in the Central Arctic Ocean (based on IODP-ACEX-302 data)

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Studies of Arctic Ocean sediments allow to reconstruct the history of its development from the initial moment of basin formation up to present day. During the evolution of the Arctic Ocean changes in temperature, salinity, water depth and water circulation occurred (Backman, Moran, 2009). The present work is based on the materials obtained from the ACEX-IODP-302 drilling on the Lomonosov Ridge, Central Arctic Ocean. Samples from Campanian up to Pleistocene sediments were taken from core depths of ~20-427 mbsf and studied with following methods: X-ray diffraction, scanning electron microscopy, infrared spectroscopy in the near and medium field, thermal analysis. Additionally, published paleontology data and age dates (Brinkhuis *et al.*, 2006; Sluijs *et al.*, 2006) were used. Clay minerals and amorphous silica of different origins with different characteristics, structure and composition characterize different conditions of weathering and transport of sediments and can be used for reconstruction of the sedimentary evolution in the Arctic Ocean. The Cretaceous sediments are differed by an increased content of chlorite and kaolinite reflecting transport of material from the nearby land under continental conditions in Campanian time. Then, in the Paleogene, a shallow and fresh water Basin was formed that, probably, periodically was flooded and drained. The warm humid conditions, especially at the Paleocene-Eocene Thermal Maximum (PETM), produce a large amount of kaolinite and smectite, which entered the basin from the nearby land. After the PETM a temporary cooling occurred. By lowering the sea level, conditions close to the mainland are formed, in which processes of desilication evolved (probably in the soil conditions), producing a large amount of abiogenic amorphous silica. Then, during the Azola phase, monomineralic smectite clay was accumulated reflecting inflow of volcanic ash and its rapid transformation in warm fresh water channels under alkaline conditions. This period may correlate to a maximum degree of weathering in the central Arctic. With the onset of colder conditions, the depth of the Basin also increased, changing from almost continental condition to a lagoon basin (with biogenic oozes) and then to marine conditions. The first seasonal ice appeared around 44.5 Ma and is recorded in the sediments by abrupt changes in the content of clay minerals. In the marine Eocene basin clay minerals were delivered in the form of suspended matter and by near- bottom flows. In periods of standing seasonal ice, the sediment transport by surface currents was hampered and smectite ceased to come in the basin, which leads to sharp fluctuations in the sediment´s smectite content. After a long break in sedimentation, likely caused by the uplift of the Lomonosov Ridge, the deep ocean basin was formed and sedimentation was influenced by sea-ice conditions. Permanent currents that carry ice and serve as the main source of terrigenous material in the central Arctic formed ~ 13-14 Ma (Krylov *et al.*, 2008). Since that time, all deposits are formed under the influence of the oscillatory movements of cooling- warming phases. During warmer periods the proportion of smectite component in the sediments is somewhat increased. This increase can be attributed to increased weathering in continental areas. On the other hand, during periods of melting ice, the main circulation of water masses has slightly changed. Additional sources of smectite material are activated, whose contribution may result in smectite content increase in the sediments and affect the overall pattern of distribution of clay minerals.

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Genesis of palygorskite in sedimentary rocks of Low Cretaceous time in Moscow and Kaluga region (Russia)

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This work is based on detailed investigation the structure and crystal chemistry composition of palygorskite from early Carboniferous palygorskite-smectite deposits of Russian platform. Samples were taken from different layers of industrial clay deposits: Dashkovskoe (Moscow region, Serpukhov) and Borschevskoe (Kaluga region, Kaluga) which are located on the south from Moscow and the distance between them is about 70 km. The following methods have been used: grain size analysis, X-Ray diffraction on bulk and clay fraction (<2 mkm), infra-red spectroscopy in mid and near region, thermal analysis, scan electron microscopy (SEM). 4 lithological units can be subdivided in Dashkovskoe clay deposit: palygorskite-smectite clays, dolomites, palygorskite clays with dolomite interlayers and mixed clays with quartz and illite. Content of palygorskite varies from 30 to 90% in different sediments. Palygorskites from all horizons are characterized as an Al-dioctahedral varieties and constant crystal chemistry composition. Palygoskite and smectite aggregates organize thin microlayers. As it seen on SEM images, fibers of palygorskite sometimes exfoliate from montmorilonite particles. Borschevskoe deposit is characterised by higher amount of quartz and feldspars and smectite and lower dolomite and calcite in the clays. Near-infrared spectroscopy allows to estimate crystal chemical composition of clay minerals (Chryssikos *et al.*, 2009). Palygorskite of Borschevskoe appears to be a mixture of Al- and Fe- palygorskites. Also, in sediments of this deposit the remains of bacterial mats were found. Genesis of palygorskites of investigated deposits can be assumed on the base of this study and paleogeographic reconstructions of Moscow and Kaluga regions in early Carboniferous time. Dashkovskoe's palygorskites were formed in-situ by chemogenic synthesis from oversaturated solutions in periods of aridization. During the humid periods cation ratios in the water have been changed, and montmorillonite was deposited. The additional source of palygorskite could be transformations of montmorillonite (Moll, 2001) due to changing of composition of pore water conditions. Borschevskoe deposit's field palygorskite originates from two sources: 1 – with water flows from the east (from the region of Dashkovskoe deposit), where it was forming in-situ (dominant source, Al-palygorskite), 2 – from the west with debris flows from weathered rocks, supposedly during microbial alteration (Fe-palygorskite). During the deposition of material from two flows clays were mixed and new layers were formed.

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Detailed analysis on the terrestrial paleoclimate based on total organic carbon proxy of lake sediment in the late Quaternary in Japan

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Detailed paleoclimate in late Quaternary has been revealed based on the analysis of total organic carbon (TOC), total nitrogen (TN) for the lake sediments from Lake Nojiri, Lake Biwa, Takano formation and Yoshino formation. These sediments are homogeneous silty clay, which suggests continuous and constant sedimentation in a deep and calm environment. Although these sediments were deposited in the isolated lakes, they can be well correlated by many marker tephra beds. TOC and TN contents show semi-periodic fluctuations in each lake sediments, and the periods of their high amounts well correspond with warm periods which are confirmed by pollen composition or other proxies, and vice versa. TOC of lake sediments may reflect biologic productivities in a lake and its surrounding area, which might be controlled by global and local climate changes. TOC and TN measurements is proper for high-time-resolution analysis such as interval of a few ten years, because of convenient instrumental analysis. The amount of TOC and TN contents itself is significantly different among the lake sediments, but fluctuation profiles during the same period are very similar each other. For example, when the measures of TOC contents are normalized using standard deviation, the fluctuation patterns of TOC in the same period are very similar each other. These TOC profiles from different localities or ages can be overlapped concordantly, and can make up a long continuous record covering the last 400 ka in Japan. The TOC profile can be well correlated with the oxygen isotope stratigraphy of LR04 in long-term change and also with that of ice-cores from Greenland and Antarctica in short-term change. This result is one of the most detailed and longest climate reconstructions of the late Quaternary in land area of Japan, and can offer a useful key to compile the late Quaternary climate in Japan.

The importance of weak layers for submarine landslides in Norwegian fjords

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The location of near-shore and submarine landslides at all scales is often controlled by weak layers in the marine stratigraphy. Except from some notable exceptions (e.g. Storegga slide), little is known about the nature and characteristics of these weak layers. This presentation addresses weak clay-rich layers detected in marine deposits and their relevance for mass-wasting processes along the shoreline of Norwegian fjords. An integrated study of cores, swath bathymetry and high resolution seismic data shows that several large near-shore landslides have developed along planes associated to such clay-rich beds. The studied decimeters to meter-thick clay-rich beds consist of clay and silt with sandy lamina (1-5 mm) and their light grey color and clear stratification distinguishes them from the surrounding, brownish, bioturbated sediments. The origin of the clay-rich beds is associated to large terrestrial landslides to have occurred in sensitive clays during the Holocene. Following such liquefaction of clays on land, thick clay–rich beds were rapidly deposited by gravity flows outside river deltas. It is considered that subsequent loading from delta progradation onto these weaker beds has been the main factor preconditioning the stability of present shoreline and submarine slopes. Results show that the main influence of the clay-rich beds on shoreline and submarine slope stability relates to their physical properties as they are more sensitive and brittle than the surrounding bioturbated deposits. In addition, the layers are barriers for groundwater flow with the potential for build-up of excess pore-pressures. Their great lateral extent makes such beds particularly important for slope stability assessment. Weak, fine-grained and laminated beds with similar origin and properties related to shoreline and submarine slope stability may well be a general trend along coasts of previously glaciated areas.

Heavy minerals placers of fluvial - lacustrine Oligocene Paleosystem of West Siberia Plain

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West-Siberian terrigeneous-mineralogical province is located predominantly lengthwise to west and south borders of West-Siberian plain. It is perspective for prospecting of heavy mineral placer (HMP) of titan and zircon minerals (TZM). Source of heavy minerals of West- Siberian terrigeneous-mineralogical province is connected with Late Mesozoic – Early Cenozoic weathered crusts that developed on magmatic and metamorphic rocks of surrounding area. Tectonic activation had been started in Oligocene resulted to erosion of the crusts and transportation of eroded material to shallow lacustrine – marine sedimentation basin located on the territory of present-day West Siberian plain. On the researched territory of West Siberia adjacent to Ural Mountain System main direction of fluvial transport had orientation from west to east. Interpretation of aerogeophysical data (electrometry and radiometry in K and Th spectra) allows determining of location of fluvial paleosystem. Research of sedimentary structures allows revealing in the region of four adjoining facial zones where transit and sedimentation of TZM took place on Oligocene. The zones have different input to HMP perspectives. From west to east these zones are: 1. Transit zone of fluvial paleovalleys and sub-aerial delta. Sands of this zone are characterized by cross bedding with east orientation of the dips. Because of imperfect separation of sand deposits, sporadical significant concentrations of TZM were revealed in this zone, but it do not form united placer body. 2. Beach and submarine delta zone that locates farther to the east from fluvial transit zone is characterized by cross beds with opposite dips of north and south orientation that reflect regular changing of alongshore sediment flow direction. This zone is perspective for HMP with relatively coarse mineral grains (mainly 0.25 – 0.1 mm) and low content of clay and detrimental impurities, but usually they have relatively small volume and lateral dimension. 3. Zone of shallow sea with moderate hydrodynamic activity. Here we often see small symmetric and asymmetric ripple marks up to 2 – 3 cm height and 10 – 15 cm long. This is zone of submarine bars and shallow banks with sea depth several meters. While facies of shallow sea are more extended in both alongshore and seaward than beach facies, placers of this area have extensions of several km width and tens km long. In spite of relatively small size of TZM (mainly less than 0.1 mm) and higher content of clay fractions, HMP of this zone are more promising for discovery placers of economic importance. 4. Farther from the paleo shoreline zone of moderate hydrodynamic activity change to zone of local depressions where wave activity had not influence to the bottom sediments. As TZM-bearing sediments were eroded and transported from zone 3 to zone 4, HMP deposits had been accumulated here. Thus, research of facial zoning is obligatory stage of prospecting of ancient buried HMP.

Laboratory experiments on erosion of consolidated soils by high-speed water flow applied to paleochannels

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Analysis of existing methods applied to estimate the onset of consolidated soil erosion caused by water flow shows that the methods now in use provide a certain knowledge of conditions under which erosion of cohesion-less (sandy, pebble gravel) and cohesive (clay, sandy loam, clay loam) consolidated soils starts under impact of a flow the speed of which does not exceed 2.5 – 3.5 m/s. The data on interaction of flows running over rock and semi-solid rock channels were used only in theoretical considerations related to the effect of both rock block sizes and conjugated fractures dissecting rock mass on the critical erosion velocity responsible for the beginning of erosion process. Experimental evidence of the obtained results turned out to be presented by fragmentary and accidental field data, usually of a roughly approximate nature, with no information on hydraulic conditions, i.e. on velocities and depths of the flows involved in erosion process. Scientific significance of the work is connected with an attempt to determine erodibility for some types of consolidated (semi-solid) rocks under impact of high-speed flow moving over their surface. Five types of the rocks were used for the experiment: (1) sandstone, glauconitic, light grey, fissured; (2) limestone, dolomitic, glauconitic, pink-grey; (3) limestone, dolomitic, glauconitic, with rare large pores, pink-grey (4) sandstone, glauconitic, weathered, brownish-brown; (5) dolomite, calcareous, fissure-free. Experimental equipment consisting of a pump and closed loop circulation hydraulic high pressure pipe system allowed an average flow speed in the working area up to 27 m/s. Erodibility of soil samples under impact of water flow was estimated visually and determined instrumentally as a difference in their masses before and after experiments. The results of all experiments show that limestone (samples 2) and dolomite (sample 5) were not scoured by water flow moving over their surface with a velocity of $V \leq 26.0$m/s. Sample 3 (limestone) shows moderate erosion. General duration of action of the flow on the sample surface facing the flow was 22.5 hours – for sample 2 in a series of experiments, 15.5 hours - for sample 5 in a series of experiments. Initial 50 hours of experiments with the sample 3 did not reveal erosion, and only the last 18 hours of experiments registered small erosion under the velocity of the flow up to 25.8 m/s. It should be noted that the fluctuations of the water discharge in these experiments accounted for ± 5 % of its average value. The maximum velocity of the flow, which did not produce any scouring of these samples (critical erosion velocity), reached V_{max} = 27.3 m/s. The research conducted on erodibility of five consolidated soil samples (each of which is a fragment of fissure-free monolith) under impact of high-speed water flow, has allowed drawing the following conclusions: 1. Calcareous and dolomitic monoliths are resistant to eroding action of water flow with velocities $V \leq 26$m/s. 2. Sandstones can have critical erosion velocities (non-eroding velocities) V_{cr} varying over a very wide range $4{,}5 \leq V_{cr} \leq 11{,}0$ m/s, depending on strength properties of rock. 3. Decisive factor of the flow channel erosion is preliminary weathering of the rocks rather than power of the water flow. 4. In real conditions of the flow, erosion occurs as the result of deleting fractured block of the rock and due to impact of transported clastic material (sand and pebbles) rather than erosive ability of pure water flow. Obtained results allow reconstruction of hydraulic condition of the paleochannel's formation.

Development of technology of micropaleofacial analysis for optimization of geological exploration on Ti-Zr Placer Deposits

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Heavy mineral placer deposits of marine origin are the main resource of world metallurgy industry for Ti and Zr. There are two main facial types of Ti-Zr placer concentrations: high-dynamic littoral and moderate dynamic shallow sea zone, that are differ in the shape of placer bodies, size of heavy minerals, content of clay component and volume of resources. These variations demands different approaches to exploration of the placers and estimation of technologic features of the placer deposits. Therefore detail research of the structure and mineralogical charecteristics of the deposits for optimizing of the processes of exploration and technological mapping of Ti-Zr placers could be of significant economic importance. Whereas facial reconstruction of shallow-lying placers could be based on structure analysis, using cross beds, ripple marks etc. But the analysis is impossible in the case of deep-lying placers explored with drilling that provides ruptured and non-orientated core samples. Classical point of view is that placers form in result of mechanical concentration of chemically inert heavy components. Recent researches revealed that the most part of ore clastogenic minerals of placers, even such resistant ones like zircon, ilmenite, and rutile, show signs of con-sedimentary and post-sedimentary changes. These evidences are represented by different-kind destructive structures of corrosion, chemical alteration, etching, surface desquamation, on one hand, and new formation of specific mineral phases on the surface of clastogenic grains on the other. These last are represented by dioxide of Ti (pseudo-rutile and pseudo-brookite) on ilmenites, and by the polycomponent crust enriched in Ca, Fe, Cu, Zn, Pb, U, etc., colomorph segregations of coffinite, quartz, Y- and REE-phosphates, dioxide of Zr, asbolane, etc. on zircon and rutile grains. Detail study of the secondary processes in heavy minerals of placers shows different features and degree changes in different facial zones of placer-bearing deposits. For example, degree of carrying-out of the iron component in the sequence titaniferous magnetite – ilmenite – leucoxene – rutile and roudness of the clasts increases during transition from alluvium deposits to deltas sediments and farther to littoral, shallow sea zone and deep sea facies. Whereas delta deposits are characterized with high dispersion of the chemical and morphological characteristics of heavy minerals, active hydrodynamic facies contain many well-sorted, well-rounded and semi-rounded (broken) clasts. Moderate hydrodynamic zones (shallow sea and especially deep sea zone without hydrodynamic activity) very often contains specific mineral phases on the surface of clastogenic grains are typical. Developing method of paleofacial analysis by typomorphic-mineralogical features of placer-forming components is proposed. It allows determining of localization and metallogenic characteristics of the most perspective placer deposits, and to make the exploration works more efficient. The possibility of determination of facial conditions of placer-bearing deposits on the basis of limited geological information is important both for understanding of genesis of placer-bearing deposits and for exploration of buried placers when ordinary texture facial analysis is impossible.

Petrology and geochemistry of Mesozoic microbialites from Campeche Sound

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The Campeche Sound, located in the southern Gulf of Mexico, is one of the most prolific petroleum provinces in history. Even though much geological attention has been paid to the nearby World Class Cantarell megafield, little academic attention has been paid to understand some of the unusual sedimentary formations with complex diagenetic history uncovered during oil exploration in these area. This paper focuses on the petrological and geochemical characteristics of some highly dolomitized rocks from assumed Cretaceous rocks recovered in two oil wells in the Eastern part of the Gulf of Mexico. Detailed petrographic studies were performed using regular, polished thin sections (polarizing microscopy, cathodoluminescense, UV microscopy) and rock slabs previously attacked using very diluted hydrochloric acid to reveal minute details under SEM-EDS. These rocks are represented by a boxwork of dolomite laminae, similar to a Rauwcken texture, composed by the accumulation of dolomite crystals that grew over fibrous nuclei and globular-like dolomitic structures. Under SEM, the fibrous structures found in the dirty cores of the first generation dolomites are considered to be cyannobacteria nanofossils, reassuring the microbial nature of the rocks. Both the original fabric and the superimposed diagenesis (with possible collapse structures) originated an unusual, highly porous and somehow chaotic structure that characterizes this rock. The diagentic study revealed the presence of, at least,three different diagenetic stages, represented by three different dolomite textures: (1) Idiotopic-S dolomite crystals, with cloudy cores, formed either by bacteria mediation or by substitution of the original microbial framework; (2) Idiotopic-C and S (planar) dolomites; and (3) Idiotopic-C to xenotopic-C (non planar, baroque/saddle) dolomites. Under cathodoluminescense the two first dolomite generations show the same response from dull to red luminescence. The last dolomite present an evolution from from a non luminescence core to bright orange outer growths. Despite a clear textural dolomite sequence, the C and O isotope composition, for the whole sequence show a narrow variation, ranging from +1.3‰ to +3.5‰ for δ13C, and from -1.1 to +2.6‰ for δ^{18}OPDB. The beginning of the saddle dolomite precipitation event seem to represent a pervasive diagenetic event that mimmicks the previous textures and somehow homogenizes the isotopic composition of the whole; while the C isotopic values are comparable to the regional unaltered cretaceous limestones, the O isotopic composition is probably indicating a low to moderate temperature diagenetic setting. The complete absence of fluid inclusions host by the diagenetic phases is noticeable. This can be due to an anomalously small precipitation rate, precluding the formation of crystal defects and the trapping of primary fluid inclusions, or a prolonged dolomite recrystallization that caused the the expulsion of any impurity off the crystals (such as brine droplets). This is the first thoroughly documented occurrence of Cretaceous microbialite formations in the Southern Gulf of Mexico. Nevertheless, microbialite formation are well known in the Upper Jurassic Smackover Fm, in northern Gulf of Mexico, as well as in all the Tethys basins since the Triassic in China up to the Cretaceous in Europe and North America.

Late-Quaternary sedimentary buildup of the Uruguayan shelf

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The shelf off Uruguay is presently characterised by strong currents and excessive sediment supply from the de la Plata River (about 130 million tons of suspended sediment load per year). However, the sedimentary framework as result of such conditions and their changes in the past remain largely unclear because previous studies were almost exclusively restricted on (1) sea-level fluctuations within the area of the outer de la Plata estuary, and (2) the surface distribution of sediments on the shelf. Here we present preliminary results of the 2009 Cruise M78/3 with the German research vessel Meteor encompassing a high-quality set of high-resolution sediment echosounder Parasound data and 18 sediment cores retrieved by vibro and gravity coring. The Parasound data reveal three major seismo-stratigraphic units which display (i) an old tilted basement, (ii) a temporal-lateral succession of various internally-stratified aggradational to progradational deposits which are often very locally defined, and (iii) a upper transparent unit covering large areas of the shelf. This information is combined with AMS radiocarbon dating to establish a robust and detailed stratigraphic framework of the Uruguayan shelf system. Sediment cores were investigated by visual core description, grain-size analysis, and microscopic component counting. The combination of Parasound data and sedimentary characteristics allows the genetic-oriented identification of eight characteristic types of sedimentary facies. These contrasting facies types display the sedimentary changes during the past sea-level cycle. Thus, an outer-shelf mud depocentre and palaeosols indicate enhanced localised deposition and subaerial exposure during glacial sea-level lowstands. Coarse-sandy to gravelly shell-fragment beds are interpreted as palaeo-coastlines and storm deposits which both have formed in association with ravinement processes during the past deglacial sea-level rise. These deposits are covered by a homogenous drape of transgressive sands due to intensive reworking of older deposits. Finally, a mud depocentre has developed in a morphological depression interpreted as the Rio de la Plata palaeovalley during the Holocene. Hence, although excessive volumes of sediment are supplied by the de la Plata River through all times, shelf sedimentation is time-dependently restricted to confined positions on the shelf. Those locations are dominantly controlled by the respective current system and local morphology in interplay with the frame-setting sea-level fluctuations.

Tracking induced-and-supported organomineralization (ISOM) in modern deep-water coral mounds

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Organomineralization refers to a mineral precipitation that involves non-living organic matter. It is considered to be induced when organic matter plays a chemical role (redox reaction, pH) leading to mineral precipitation, and supported when organic matter also serves as a substrate for mineral precipitation. Induced and supported organomineralization (thus referred to as ISOM) is one of the main processes leading to carbonate precipitation in microbial mats and biofilms and is often used to explain microcrystalline seafloor precipitation in ancient sponge-rich carbonate mounds. Our understanding of ancient sponge-rich carbonate mounds improved with the rediscovery of a modern, calcifying siliceous sponge (Spheciospongia, Bahamas), where highly reactive, freshly produced humic compounds that originate from sponge tissue degradation-exudation contribute to a permineralizing interstitial fluid as a dissolved to colloidal phase. This fluid selectively adsorbs into degrading sponge connective tissue that then serves as a non-living, organic substrate for aragonite precipitation. This kind of ISOM corroborates a number of petrographic and geochemical observations made from ancient sponge-rich carbonate mudmounds, namely sponge soft tissue calcification in association with selective entrapment of fluorescent dissolved organic matter (FDOM). Because such kind of ISOM is entirely diagenetic, it may serve as a tool to explore similarities between ancient and modern carbonate mounds that only differ in composition due to their stage in biotic evolution. Pen Duick escarpment (offshore Morocco), with its living and non-living deep-sea coral mounds, offers an excellent setting to explore whether ISOM takes place in modern deep-water coral mounds. Sediment pore water samples were taken from a gravity core and from box cores retrieved from Gamma and Beta mounds. Bottom water was sampled from ~ 0.5 m above Beta mound. Excitation-emission fluorescence was measured using a Varian fluorescence spectrophotometer. Protoporphyrin IX (Sigma-Aldrich) was used to identify low-energy emission peaks (≥ 600 nm); pyoverdine and pyocyanine (Sigma-Aldrich) were used to assess siderophore-like compounds. Pore water displays biological activity within the first metre of sediment, and below 2 m in sediment. This activity, apparent through protein-like fluorescence, correlates well with the fluorescence of porhyrin-like compounds. Bottom water displays a blue-shifted variety of protein-like fluorescence suggesting hydrolysis and diffusion from the benthic realm into the water column. A significant accumulation of refractory FDOM does not occur at less than 2 m depth. It is accompanied by a late stage of biodegradation of organic matter (peak Geol.-A; ex 224 ± 2 nm; em 385 ± 8 nm) and the occurrence of a new fluorescence peak Q that is expressed along an emission band with peak Geol.-A (peak Q; ex 295 ± 5 nm; em 385 ± 1 nm). Peak Q might represent a product of exudation from anaerobic microorganisms and/or derive from siderophore-like pigments. Reactive fluid that combines protein-like fluorescence (peak SR) with fresh, humic compounds (peak M2) is present at the surface, to a minor degree at ~ 20 cm depth, and in a distinct layer at 100 cm depth. However, no ISOM-related authigenic carbonate was observed. The absence of ISOM end-products in Pen Duick mounds is supposedly due to the loss of reactive humic FDOM by upward diffusion, the lack of suitable organic substrates (degrading connective tissues) and the sorbing property of the hemipelagic argillaceous mud plugging the cryptic interskeletal space. As documented by ROV dives, coral rubble facies at Pen Duick escarpment often offer complex tridimensional habitats prone to host a sponge-rich cryptic community. Future work should focus on tracking and sampling these specific facies as they could potentially share early diagenetic conditions and processes with the Phanerozoic sponge-rich mounds.

Landforms and chronology of aeolian activity in the Pampean Sand Sea, Argentina

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The inactive Quaternary Pampean Sand Sea spreads on near 300,000 sq km in central Argentina. We present here information on the geomorphologic characteristics and age of different generations of aeolian landforms. The geomorphologic and sedimentary record is a sequence of stacked aeolian deposits and landforms of different ages. A main characteristic is the presence of huge approximately S-N to SSW-NNE linear dunes, more than 100 km in length and 5 to 7 m high in relation to the general relief of the plain. These dissipated linear dunes are recognized in the southern-half part of the San Luis province and in the northwestern area of the Buenos Aires province. The large dunes are currently a formidable obstacle in the development of a well- organized drainage network and for that reason good part of this region is dominated by a disorganized arreic system. While in San Luis the interdune area is dry, in Buenos Aires province the interdunes are occupied by permanent and non-permanent bodies of lentic water. This is a consequence of the east-west rainfall gradient that dominates the Pampa (wetter to the east and drier on the west). We identified that the dunes lie in some areas on "Bonaerense" fine calcareous sediments with OSL ages of ~108,000±14,000 BP. OSL dates of the megadunes in Buenos Aires and San Luis provinces provided ages of 42,700±5200 BP and 41,400±5.900 BP respectively. In San Luis Lujanean fossil mammals are found in this unit. A huge field of parabolic dunes developed later on the previous linear dunes in the central part of the Buenos Aires province during the LGM. Several OSL dating in Bolívar area provided ages close to 30,000 BP. In San Luis province large sub-rounded blowouts (pans) two to three kilometers in length developed reworking older aeolian sediments. The pans follow a general S-N to SE-NW trend because of dominant southern winds. OSL dates of the pans provided ages close to 16,700 BP. Younger aeolian deposits and smaller linear dunes generated as well on the plain and one of them provided an age of ~8900 BP. In the Holocene units archeological and autochthon fauna remnants are recorded. The interior of the large pans is still active in some areas and erosion is favored by cattle grazing and trampling. Lakes and akle- barchanoid dunes develop inside the pans in the downwind face and the depressions that can reach up to near 10 meters depth. Human impact also triggered the development of several smaller active pans that rework older aeolian sediments. The Pampean Sand Sea is a very particular kind of paleo-desert with unique characteristics when compared to others aeolian non-permanent dune fields of the large South American plains that were active during the Pleistocene and partially reactivated during several moments of the Holocene. First of all, no other area developed such large linear dunes. Secondly, while the Llanos and the Chaco were characterized by younger parabolic dunes superimposed and reworking older linear dunes, the Pampean Sand Sea reacted in different ways and with different kind of landforms generation in different sectors. For example, complex large pans and smaller linear dunes to the west and parabolic field dunes partially but not totally overlapping the late Pleistocene linear dunes distribution and smaller rounded pans superimposed on older landforms to the east, in the Buenos Aires province.

Landslide damming lakes in the Matienzo basin, Mendoza province

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Along the Mendoza-Las Cuevas river valley (32ºS) in the Central Andes at least four dammed palaeo-lakes have been identified (Fauqué *et al.*, 2000). Besides, four impounded palaeo-lakes were inferred by Suarez (1983) in the upper basin of Las Cuevas river (Matienzo gully) assuming a glacial origin for damming deposits. However, recent studies reinterpreted the genesis of these deposits as landslides (Moreiras, 2007; Moreiras *et al.*, 2008). An integral research to determine the accurate role of these geodynamic processes and morphometric analyses of associated palaeo-lakes being previously ignored were encouraged in this research. The origin of Quaternary deposits was established by geomorphological studies and detailed analyses. Four rotational slides denominated respectively Goyete, Negro, Susanita and Matienzo were identified. In addition, the Lagunita rock avalanche generated in the western hillslope of the valley was recognised; as well as three relict Pleistocene lateral moraines and the Holocene moraine of Casa de Piedra. Landslides are characterized by local deposits with no continuity along the valley. They are poorly sorted deposits with angular and subangular clasts. Also they show a great variability in the volumetric relation between clasts-blocks/matrix and a homogenous lithology. They usually have low matrix content (30% - 50%) commonly rich in sand fraction (60%). Generally, they have great blocks on the top of landslide deposit. On the other hand, moraines are characterized by heterogeneous lithologies composed of Jurassic-Cretaceous trachyites, basalts, vulcanites, granites, shales and sandstones. In these deposits predominates subangular –subrounded blocks/clasts. They have higher sandy matrix content where predominate the 500 - 250 microns fraction. Accordingly to above, five of the palaeo-lakes were generated by gravitational collapses. These palaeo-lakes had a great areal distribution. The smallest one was generated by Negro landslides turning out 594 m long and covering 55226 m^2 with a volume of 0.16 hm^3, whereas the biggest lakes associated to the Susanita landslide was 1496 m long with an extension of 32,6140 m^2 and 2,83 hm^3 in volume. Concerning to stability of palaeo-lakes, they seem to have a short life as their coast lines could not been determined and lacustrine sediments are absent. Based on the blockage index (BI) (Ermini & Casagli, 2003), all paleo-lakes, except for the stable Goyete lake with a BI= 2.43, result unstable. The re-interpretation of Quaternary deposits of Matienzo gully improved the knowledge of regional palaeo-climate conditions remarking the hazard of impounded lakes associated to gravitational collapses in the mountains areas.

Magnesium isotope ratios in Paleozoic saddle dolomites of eastern Canada: a new research tool for dolomite understanding

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The processes that form high temperature dolomites are controversial, with end-members of: 1) early and tectonically-controlled processes with rapid upward migration of high temperature fluids, and 2) late and burial-dominated processes with regional slow migration of high-temperature brines. For both end-members, the formation of dolomite requires large amounts of magnesium. Magnesium stable isotope ratios in saddle dolomites, ultramafics and shales are presented and offer critical new data in the ongoing debate. Results suggest that Mg isotopes may provide a potential tool for identification of Mg source(s). In the Paleozoic of eastern Canada, hydrothermal saddle dolomites are recognized in Lower and Middle Ordovician shallow marine platform and slope (Lavoie *et al.*, 2009; Lavoie and Chi, 2010; Conliffe *et al.*, 2010), in Lower Silurian ramp (Lavoie and Chi, 2010) and Lower Devonian pinnacle reef (Lavoie *et al.*, 2010). The host successions overly diverse Precambrian and Paleozoic basements which may have acted as Mg sources. The dolomites and potential Mg sources were chemically characterized (ICP-ES) and their $\delta^{26}Mg_{DSM3}$ and $\delta^{25}Mg_{DSM3}$ ratios measured (MC-ICP-MS). Column chemistry was used to purify the Mg in the digested samples prior to isotopic analysis. The Mg isotope ratios are therefore independent of matrix effects. The Lower Silurian dolomites (Th of 150-200°C) are related to fluid flow along foreland faults. The Mg2+ was interpreted to originate from underlying Ordovician ultramafic slivers. Near the Silurian occurrences, Lower Ordovician dolomitized slope carbonates are associated with a transpressional fault. These two dolomites have yielded negative $\delta^{26}Mg_{DSM3}$ values ranging from −1.6 to −1‰. Middle Ordovician dolomites (Th of 90 to 120°C), which are associated with foreland faults that reach the Precambrian metamorphic basement, yielded $\delta^{26}Mg_{DSM3}$ ratios of −0.1 to +0.4‰. Lower Devonian reef with massive replacement dolomite of magmatic origin (Th of 300 to 350°C) occurs at the junction of two transpressional faults. Even though the reef neighbours the ultramafic slivers, the dolomite has δMgDSM3 ratios of −0.1 to +0.2‰. Linear relationships between $\delta^{26}Mg_{DSM3}$ of the dolomite and 1) $\delta^{18}O_{VSMOW}$ of the fluid and 2) $^{87}Sr/^{86}Sr$ in the dolomite suggest a link with the nature of the fluid and its source. Linear relationships between $\delta^{26}Mg_{DSM3}$ and $\delta^{26}Mg_{DSM3}$, and between $\delta^{26}Mg_{DSM3}$ and Th of fluid inclusions indicate a thermal kinetic effect on Mg2+ incorporation in the dolomite. Data from potential Mg sources are being gathered. Lower Ordovician ultramafics in northern Gaspé are serpentinized (Lavoie *et al.*, 2009); the altered material has a tight range of $^{26}Mg_{DSM3}$ values of −0.4 to −0.3‰. Lower and Upper Ordovician shales abound in the Lower Paleozoic basins (Lavoie *et al.*, 2009). The shales have Mg isotope ratios that differ with age; the Lower Ordovician has yielded $\delta^{26}Mg_{DSM3}$ values of −0.6 and +0.5‰ whereas the Upper Ordovician has given $\delta^{26}Mg_{DSM3}$ values of −1.3 and −0.9‰. More analyses are in progress.

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6,000 years sedimentary record of flood events in Lake Aydat, French Massif Central: climatic and anthropic signals

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The history of human land use *vs* climate impacts on natural environments is of direct relevance in the perspective of future climate change and increasing human pressure on ecosystems. Although these impacts were inconspicuous before agriculture and breeding development, they became critical after the industrial revolution, due to the massive anthropization of terrestrial surfaces. Natural archives such as lacustrine sediments potentially preserve information about past land uses and environmental conditions. Lake Aydat, located in the catchment the longest French river - the Loire -, might have recorded several major local and regional events, especially the major floods that sometimes dramatically affected the valley and its inhabitants.

Lake Aydat (45° 39' 40" North, 2° 58' 27" East) is the largest natural lake of the French Massif Central. Located at an elevation of 825 m a.s.l., it has a surface of 6 x 10^5 m^2 and a volume of 5.2 x 10^6 m^3, for a maximum depth of 15 m. The lake waters are provided by its major tributary - the Veyre River, draining rainfall events mainly originating from the Atlantic Ocean. The lake formed 8551 ± 400 cal BP ago by the damming of the Veyre River by a basaltic flow.

A continuous sedimentary sequence of about 20 m has been obtained from two twin sediment cores sampled in the deep lacustrine deposits, away of the Veyre delta. A multi-proxies analysis has been led on these cores: Geotek core scanner analysis (magnetic susceptibility, gamma-density, and video-captured lithologies), X-ray densitometry (dual energy X-ray absorptiometry), AMS ^{14}C dating on a dozen of terrestrial macroremains, and radionuclide dating (^{137}Cs) of the upper sediments. Coupled with historical archives of past flood events, these techniques allowed the reconstruction of the Veyre River flooding activity since the mid Holocene, through the characterization of three sedimentary units over the last 6,000 years. The upper unit (late Holocene) is constituted by a background organic rich dark sediment faintly laminated frequently interrupted by flood deposits (1-5 cm thick), identified by straight elevation in magnetic susceptibility and in density. The middle unit is interpreted as a mass wasting deposit. The lower unit (mid Holocene) is finely laminated and contains few flood deposits, and an event of potential volcanic origin.

The ongoing work aims at discriminating anthropic perturbations and climatic signal through time. Molecular studies have already been led on soil samples from the watershed for calibration, and are then applied to lacustrine sediment. These studies are intended to reconstruct the evolution of the past landuses of the catchment area, using molecular biomarkers imprints that are characteristics of different biological precursors.

Stable isotope stratigraphy and sedimentary analysis of the Permo-Carboniferous succession in the Venezuelan Andes

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Permo-Carboniferous times were important on the global scene with the formation of Pangaea which led to significant tectonic, sedimentary and stratigraphic developments, global changes in climate, and biotic evolutionary events. In the northern part of South America, specifically in Venezuela, the Upper Palaeozoic stratigraphic record is poorly documented but the succession there reveals major changes in palaeo-environments and palaeo-climate which can be related to the global-scale changes. Detailed fieldwork in the Venezuelan Andes has been supported by petrographic studies and stable isotope analyses ($\delta^{13}C$ and $\delta^{18}O$). The tropical marine succession commences with calcareous sandstone and mudstone with ostracods of tidal-flat environment; these grade upwards to dark-grey calcareous outer-ramp deposits. Upwards the succession becomes more shallow-marine with fusulinid grainstones, calcareous algal packstone, crinoidal-bryozoan wackestone and finally dolomites interbedded with bioturbated lime mudstones with sponges. The succession consists of shallowing-upward peritidal cycles in the lower part and shallow to deep subtidal cycles higher up. The nature of the high-frequency cycles was strongly influenced by climatic factors in this low latitude region, with dominant humid conditions giving way to a more arid climate in the upper part of the succession. There is a long-term stratigraphic trend in $\delta^{13}C$ showing a progressive increase towards more positive values from -3.3 to +5.3. This probably relates to oceanographic changes and increased organic-carbon burial; support for this is provided by a parallel increase in TOC up through the succession with values reaching nearly 2%. Relatively high $\delta^{13}C$ values are characteristic of the later part of the Permian generally. This pattern could be related to the long-term change from super-oligotrophic conditions which were predominant during Cambrian-Devonian times through to more sub-mesotrophic conditions during Permo-Carboniferous times. There also short term variations in δ13C which could perhaps relate to glacial-interglacial cycles which would have directly affected organic productivity. The $\delta^{18}O$ data, based on whole-rock analyses, vary significantly between -11.0 to -2.1‰. However, there is a long-term trend towards less negative values through the succession which could indicate climatic cooling or changes in oceanographic circulation. However, short-term variations are again present, which could reflect local climate change or further evidence of the global Permo-Carboniferous glaciation. Thus, the isotopic and sedimentology data, as well as the nature of the cyclicity, contribute further to our understanding of Permo-Carboniferous time in Venezuela

Cryogenian (Sturt and Elatina) glacial sediment records of South Australia

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Two Cryogenian glaciations, the Sturt and Elatina glaciations, occur within the Adelaide Fold Belt, S Australia, and are part of an ~8 km thick succession recording the break-up of Rodinia. We compare and contrast these glaciations, presenting new data, including detailed logged sections, for both glacial sequences. Facies analysis reveals a total of six facies associations, recording a range of ice-proximal through ice distal processes. These are a diamictite facies association (ice-proximal debris flows), a sheet sandstone facies association (sandur plain deposits), a flaser and rhythmically-bedded facies association (tidal flat), a hummocky cross stratified sandstone facies association (shoreface to offshore transition zone deposits) and an underflow facies association (recording offshore deposition). A sixth facies association, a ferruginous lonestone-bearing siltstone, is restricted to the top of the Elatina Formation and records rapid environmental amelioration and emergence from glaciation. In the central Flinders Ranges, the Sturt succession is cradled by a glacial erosion surface (GES) which, in agreement with previous workers, was probably enhanced by rifting. This GES is overlain, in ascending order, by the Pualco Tillite, Holowilena Ironstone and Wilyerpa Formation, with the Warcowie Dolomite Member at the base of this latter formation. A second GES is preserved within this latter unit, and is overlain by a stratigraphic motif that records delicate alternation of offshore transition zone and offshore deposits. Significant base level falls within the Wilyerpa Formation are identified by sandur plain deposits sitting disconformably upon offshore deposits. In contrast, within the Elatina Formation, a single GES is proposed, which defines the base of the formation. The Elatina Formation is split into two informal members on the basis of analysis of sediment stacking patterns and the recognition of a sharp stratigraphic surface that divides the formation. Apart from a locally preserved basal diamictite, the lower member consists of sandur deposits, whereas the upper member is dominated by a mixture of tidal flat sediments and ice-proximal debris flow deposits. The sharp stratigraphic surface that these units is therefore interpreted as a hybrid surface recording tidal ravinement in some areas and a glacial advance in others. Deglaciation left contrasting deposits: Sturt deglaciation culminated in deposition of black shale of the Tindelpina Shale Member, seemingly as a sheet-like deposit over the Adelaide Fold Belt and beyond into the Amadeus Basin of central Australia. The Elatina deglaciation, meanwhile, began first with deposition of the sixth facies association (ferruginous dropstone-bearing siltstone), then proceeded with deposition of cap dolostone of the Nuccaleena Formation. Noting the organic enrichment of the Sturt deglacial shale, it is suggested that these may represent a potential hydrocarbon source rock over the Centralian Superbasin.

Storm beds within the Sturt glacial succession of South Australia: sea-ice free conditions during an early Cryogenian Snowball Earth

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In the Neoproterozoic Snowball Earth hypothesis, the earliest shutdown of the global hydrological system has been attributed to a global ice cover during one or more global glaciations. In the central Flinders Ranges, South Australia, the up to 5000 m thick Yudnamutana Subgroup, of Sturtian age includes thick diamictite, sandstone and siltstone units of glaciomarine origin, and is succeeded by a post-glacial siltstone and shale blanket of the Tapley Hill Formation. In the central Flinders Ranges, the Yudnamutana Subgroup consists of 1) the Pualco Tillite (gravity resedimented glacial deposits, representing the glacial maximum), 2) the Holowilena Ironstone (lonestone-bearing ferruginous siltstone), 3) thick, poorly stratified pebbly dolomite of the Warcowie Dolomite Member and 4) the Wilyerpa Formation. This latter unit consists of repeated siltstone and sandstone event beds, including multiple intervals of hummocky cross-stratification (HCS) that are interpreted to record storm deposition in a shallow marine environment. The storm deposits, which occur at about 2000 m below the lowermost post- glacial shale of the Tapley Hill Formation, are succeeded by lonestone- bearing shales and siltstones that are interpreted to record resumption of ice-rafting processes and hence a re-advance of ice masses. We argue that the presence of hitherto unrecognized HCS within Sturtian glaciogenic successions militates against the presence of continuous sea ice throughout the Sturtian glaciation, as its presence would inhibit the action of oscillating waves that are probably required to produce this structure.

Neoproterozoic–Devonian stratigraphic evolution of the eastern Murzuq Basin, Libya

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The Murzuq Basin is one of the most petroliferous intracratonic basins of North Africa. Its remote eastern flank, however, remains little known and has been little studied since the last major datasets from early expeditions were published in the 1950s and 1960s. This paper presents new stratigraphic and sedimentological data on the Neoproterozoic through Devonian succession from the Mourizidie and Dor el Gussa regions. In the eastern part of the Mourizidie region, the Mourizidie and Hasawnah formations dip to the east and north-east and rest directly on late Precambrian metasediments and granitoids. These strata, which are assigned Neoproterozoic through Cambrian ages, record the initial progradation of proximal over distal braidplain systems upon a denuded Panafrican topography. Rhyolite clasts in the Hasawnah Formation indicate tectonic activity in the southern Tibesti Massif or tectonomagmatic rejuvenation to the south of this massif. In the western part of the Mourizidie region, Late Ordovician through Silurian strata (Mamuniyat and Tanezzuft–Akakus formations) directly overlie late Precambrian metasediments and granitoids, and dip at a low angle toward the west into the Murzuq Basin. Elsewhere at the eastern Murzuq Basin flank, in Dor el Gussa, Late Ordovician glaciogenic sediments rest with angular unconformity upon shallow marine sandstones of Cambrian–Ordovician age. This angular unconformity may also occur in the Mourizidie region and indicates widespread tectonism, either as a result of a Middle–Late Ordovician orogenic event or alternatively crustal depression associated with the growth of Late Ordovician ice sheets. Unconformity development was also probably associated with glacial incision. Following ice sheet retreat, isostatic rebound during deglaciation resulted in uplift of tens to hundreds of metres, locally removing all Cambrian and Ordovician formations. Rising sea levels in the Silurian led to deposition of the Tanezzuft Formation on Precambrian basement in the northwestern Mourizidie region.

New insights on dryland fluvial sedimentology from the modern Luni River, Thar Desert, Western India

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The Luni River is the largest river in the Thar desert, and hence one of the important dryland fluvial systems worldwide. Although several studies exist on the Quaternary deposits of the Luni River basin, details of the sedimentological characteristics of the modern channel are sparse. Monsoon-related peak discharges in the Luni River can reach nearly 14,000m^3s^{-1}, carrying high sediment loads, scouring the bed and leaving substantial deposits (Kale *et al.*, 2000) but yet the bed is dry most years. An exceptional opportunity for studying the sedimentology of the Luni River arose with the construction of the Barmer-Salaya CAIRN pipeline in 2009. The pipe trench exposed a 700 m long and 5 m deep section across the channel. This paper presents the results of the detailed sedimentary architecture of the Luni river that bring new insights into sedimentary processes in dryland rivers. At the pipeline crossing, the Luni River is confined by higher topography on the left-bank (the talweg also being on this side), but the right bank is low-slope and essentially defined by a change in vegetation density. The cross-section was trenched in a sand bar where the channel widens from upstream. GPS positioning and mm-resolution survey levels of marker strata allow detail recording of the cross-section stratigraphy using field observation logs and photomosaics. Nine sediment samples were taken in selected strata at various depths for OSL dating. Preliminary OSL results indicate that the whole section is 'young' < 5000 years and usually 100's of years old. These dates, if confirmed, must reflect considerable reworking to depth or rapid alluviation during recent times which is somewhat surprising given the rarity of large floods. At the study site, mostly fine sand, is abundant at all depths and quite independent of sedimentary structure types (possibly due to available material reworked from aeolian deposits). Planar lamination is more abundant than dune stratification. No clear fining-upward trend in dune set thickness is observed, as large dune sets (> 50cm thick) are not frequent and were observed in the deepest trench as well as at about 1m from the bed surface. Sand-to gravel-size, sub-rounded mud clasts are strikingly abundant; these are often found at the base of planar laminated layers, at some places near their source layer but also within stratification of plane beds or dune sets at any elevation. Gravel-sized clasts other than mud-clasts are rare. Only one 1-cm thick continuous clay-mud layer was found topping a typical decreasing-flow deposit. Preliminary results suggest that fine sand was deposited either under very high sedimentation rates at peak discharge or only during decreasing flow, in which case mud clasts, eroded from the previous muddy, dry bed were then transported at some considerable distance from their source. Future work will address spatial correlation of detailed sedimentary texture and structure in relation to deposition history related to a refined OSL dating.

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An unusual cnidarian-dominated trace and body fossil assemblage from the Lower Permian Robledo Mountains Formation, south-central New Mexico, USA

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Recent collecting from near the eastern border of the newly established Prehistoric Trackways National Monument in southern New Mexico, USA, known for its Early Permian tetrapod trackways and invertebrate traces, has yielded an unusual cnidarian-dominated trace and body fossil association. This association occurs stratigraphically high in the Lower Permian Robledo Mountains Formation in a siliclastic facies that was paralic to the Hueco seaway. The association contains examples of *Bergaueria* cf. *B. hemispherica*, several of which display associated tentacular resting impressions. These tentacular impressions may constitute a unique occurrence in the actinian trace fossil record. A single specimen of a probable actinian locomotion trail has also been found, which adds to the scant record of these traces. The association contains the first Permian record of *Selenichnites rossendalensis*. These burrowing traces, some of which show telson marks, were likely produced by a paleolimulid. Numerous porpitid ("chondrophorine") body impressions also occur over an outcrop area of tens of meters. Specimens preserved in aboral aspect display pneumatophores consisting of a raised, central boss surrounded by radiating bands, which resemble the extant genus *Porpita*. Rare specimens in oral aspect display soft-bodied, subumbrella anatomy that allows taxonomic identification to the family level (Porpitidae), and underscores that these are not sedimentary pseudofossils (scratch circles). This is the first record of porpitid fossils from the Permian and records a rare cnidarian mass stranding. This new association occurs in a marginal marine setting that differs from the nonmarine association previously reported from inland tidal flat settings of the Robledo Mountains Formation.

The Campanian Twenty-Mile Sandstone clastic wedge: source-to-sink facies architecture

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The Cretaceous Western Interior Seaway (WIS), an epicontinental seaway that connected the Arctic Ocean with the Gulf of Mexico/Atlantic Ocean though the middle of the North American continent, was part of a retroarc foreland basin on the east side of the Sevier thrust-and-fold belt. One of the final 3rd-order clastic wedges shed from Sevier Belt into the WIS contains the late Campanian, alluvial and coastal plain Canyon Creek Member of S. Wyoming that passes basinwards into a series of marine, regressive shorelines, the TwentyMile sandstone of Northwest Colorado. The transgressive limb of the clastic wedge is represented by the landward-stepping Holderness Member (N Colorado) and Almond Fm (S Wyoming), both of which contain thin shoreface units within coal-bearing coastal-plain deposits. The Twentymile Sandstone is a thick (> 40 meters) deltaic sucession that prograded some 80 km from Maybell to Steamboat Springs. It presents at least two delta lobes of contrasting process domination on US Hwy 40, a lower deltaic lobe clearly dominated by storm waves and an upper lobe of complex tide-river domination with some storm influence. The upper lobe also presents an important variability along strike varying from tide-river domination to storm domination laterally. A 300 km nonmarine to marine transect through this Twenty-Mile clastic wedge allows an examination of the signals of the regressive-transgressive shoreline cycles implanted in the fluvial feeders.

Autostratigraphic response of clinoform evolution to back-tilting subsidence – a numerical model

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When deltaic or shelf-margin clinoforms are subject to constant or steady allogenic forcing (i.e., baselevel change, sediment supply, water discharge, and subsidence rate), the evolving clinoforms display its autogenic behavior. This behavior has been well studied numerically and experimentally under these simplified allogenic controls (including spatially uniform subsidence rate)and the general framework of Autostratigraphy has been proposed (Muto *et al.*, 2007). Previous studies (e.g., Muto and Steel (2002), Kim and Muto (2007) and Petter *et al.* (2010)) show that as the clinoform progrades and both topset and foreset of the clinoforms get longer. The imbalance between this growth and the sediment supply will lead to an unavoidable transgression of the system, in what has been referred as "autoretreat". In contrast, our modeling study indicates another, distinct autostratigraphic response in the geometry of the evolving clinoform when back-tilting subsidence in the basin is imposed. In this tectonic setting (e.g. foreland basins), the clinoform progrades into shallower water through time, and therefore the length of the foreset tends to decrease. Autostratigraphic behavior of the clinoforms in this setting is controlled by the relative strength of two processes, one that forces a decrease in foreset length due to clinoform progradation over an inclined basement and another one that forces an increase in foreset length due to aggradation and progradation These clinoforms will exhibit two distinct behaviors depending on the imposed rate of back-tilting subsidence; one showing the classic autoretreat signal and another showing an accelerated regression (henceforth "autoregression" to follow the autostratigraphic nomenclature). In classic stratigraphy an autoregressive shoreline trajectory could easily be misinterpreted as either an increase in the sediment supply of the basin or a reduction or even rebound of the regional subsidence. Autoregressive segments of delta transit could be common on shallow, fault-influenced seascapes, or might explain unusually long regressive deltaic transits (long delayed autoretreat) such as is seen in the Cretaceous Western Interior Seaway at times.

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Carbonate microbialites from Rincón de Parangueo maar; an alkaline, hypersaline lake in central Mexico

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Rincón de Parangueo maar is located at the northern end of the Michoacán-Guanajuato volcanic field in central Mexico. The maar represents one of the youngest (late Pleistocene) eruptive events in a regional volcanic lineament. The crater rim has WNW- and NNE-trending axes, which are 2200 and 1700 m long. The crater's had a perennial, shallow lake that was gradually desiccated in the past several decades, as a consequence of drawdown in the regional aquifer. This decrease in water level has exposed large areas of nearshore microbialites. We sampled Parangueo microbialite ring and lake water in June 2009. A few microbialite samples were kept alive in laboratory aquaria for continuous study and DNA characterization. The water in the lake remnants is alkaline (pH >10) with a chemistry dominated by K, Mg, Ca, SO4 and Cl and CO2-3 and high concentration in B and Li. Water temperature display seasonal variations and also increase with water depth from 18-30 ºC. The chemical composition of the water is well mixed, and there is evidence of degasification such as bubbling and H2S stench which can be easily noted near the lake remnants. During the dry season evaporation notably reduces the amount of water and oversaturation of the brine allows the precipitation of trona and evaporite assemblage (halite + silvite + eitelite + …). The organogenic structures range in size from a few mm to over 30 cm in diameter, they usually form extensive biostromes near the former coast of the lake, and in places developed bioherms up to 1 m high. They have various external morphologies, which depend on the shape of rocks or wood fragments that core the individual structures. Variations in mineralogical composition were also documented. Internal fabrics range from finely laminated to massive and radial desiccation cracks are notable. Both the thickness and morphology of the biostromes and crusts vary considerably. Crust thickness on detrital boulders and coarse shoreline clastic fragments occur as encrusting domical laminated deposits, which range from mm to dm in thickness. Crusts are formed by sub-milimetric scale, monomineralic laminae. Most of these crusts have botryoidal structure. The laminated stromatolitic crusts and the botryoidal boulder coatings are composed by varying combinations and poorly to well consolidated microcrystalline hydromagnesite and aragonite mixed with remnants of organic material. The modern crust is constituted mainly by aragonite and siliceous detritic material. Most of the biostromes are centimeter-scale in thickness and can form extensive and continuous flat, featureless platform areas. Modern microbialites occur in sheltered portions of the lake and more isolated parts of the bottom of the crater. These microbialites are coated with a thick cyanobacteria mat. These mats contain both primary carbonate precipitates (hydromagnesite & aragonite) and detrital carbonates and siliclastics. The C and O stable isotopes measured in a single structure show a negative evolution line. Analysis from the internal portions a botryoidal array, 3 cm in diameter, performed from the core to the periphery show general enrichment in 16O as well as in ^{13}C, which occurred over the xx year growth period of the structure. Values range from 5,35‰ to 1,76‰ $\delta^{18}O$ and 14,75‰ to 16,68‰ $\delta^{13}C$. The Rincon de Parangueo microbialites share a lot of common features with the Alchichica maar (Puebla) microbialites.. They are all related to modern volcanism, high altitude, alkaline lakes, primary mineralogy dominated by hydromagnesite and aragonite and possibly same bacterial family. In Rincon de Parangueo, the water lake chemistry, active degassing, trona precipitation, and C-O isotopic values evolution indicate the predominance of modern volcanic control. Rincon the Parangueo is a wonderful natural laboratory of modern alkaline environments with in situ calcifying microbial mats generating biosedimentary structures such as those known from Precambrian

Modelling seabed disturbance and sediment mobility on the Canadian Atlantic shelf

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A poorly understood topic in continental shelf sediment transport and sedimentology research is what percentage of the Earth's continental shelves are subject to hydrodynamic processes strong enough to mobilize the bottom sediment, and what are the dominant processes that cause the sediment mobilization in different regions of the world's shelves. Numerical modelling approach was used in this study to obtain shelf-wide systematic predictions of the magnitude and frequency of seabed forcing and sediment mobilization for the Canadian Atlantic shelf. Bathymetry and sediment grain size data were first digitally compiled. Tidal current, waves, and ocean current were predicted from various wave and current models for the 3-year period of 2002 to 2005. The bathymetry, grain size, and model predictions of wave and current data were then coupled in a sediment transport model to quantify the magnitude and frequency of seabed shear stress and sediment mobilization for the study region. The sub-shelf regions were classified based on the seabed disturbance rate and the relative impact by tidal, wave, and ocean current processes. Strongest mean tidal current shear velocity of 5 cm/s is found in Bay of Fundy and at the entrance to Hudson Strait. Moderate mean tidal current shear velocity of 2 cm/s also occurs on Grand Banks and on the banks of Scotian Shelf. Mean wave shear velocity can reach up to 3-4 cm/s and but only occur on Grand Banks and on the banks of Scotian Shelf. Mean shear velocity of circulation current is generally less than 2 cm/s and restricted at the shelf edge and on the upper slope. Interaction between waves and currents produces enhanced bottom shear stress. The mean combined wave-current shear velocity up to 5 cm/s is found in Bay of Fundy, on the banks of Scotian Shelf, on Grand Banks, and at the entrance to Hudson Strait. Tidal currents can mobilize sediment 100% of the time over large areas in Bay of Fundy and on the shelf at the entrance to Hudson Strait. Sediment mobilization by waves is restricted on the banks of Scotian Shelf and on Grand Banks, and reaches up to 30% of the time. Sediment mobilization by circulation currents can reach >30% of the time but is restricted in small patches along the shelf edge. Analysis of relative time percentage of sediment mobilization by various processes indicates that seabed disturbance is dominated by tide in Bay of Fundy, on the Southeast Baffin Shelf, and at the entrance to Hudson Strait, while wave-dominant disturbance occurs on Grand Banks, on the inner and mid-Scotian Shelf, and on the inner Labrador Shelf. Seabed disturbance due to mixed waves and currents occurs in small areas on the central and eastern Scotian Shelf. Two new indices were proposed as universal parameters that quantify both the magnitude and frequency of seabed exposure to oceanographic processes and sediment mobility on continental shelves.

Longshore transport rates in the coast of Paraná, Brazil

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In this present work streamer traps were used to collect samples of sediment in suspension transported by longshore currents and the results were used to predict rates of the total sediment transport. The study area is represented by the shoreline of Praia de Leste coastal plain (state of Paraná, Brazil), which is 35 km long and limited by the entrances of the Paranaguá Bay at north and Guaratuba Bay at south. The shoreline is aligned NE-SW, waves approach mainly from SE and longshore current is stronger from south to north. Amplitude of spring tides is 1.5 m. Erosion problems affect urbanization in the south region (Praia Brava) while accretion processes dominate in the north (Atami) and an equilibrium state is found to the middle region (Caravelas). The streamer traps comprise a 1.8 m high steel frames that holds 6 nets arranged in an equally spaced vertical array , with the base of the first net being 10 cm above the seabed when frames are deployed. The nets are made from polyester sieve cloth with a mesh size of 63 mm and they are attached to metal frames 9 cm high and 14 cm wide in order to hold them open to the flow. In each field trip, samples were collected at two locations across the surf zone. The streamer trap remains in the water for 5 or 10 minutes and the hydrodynamic conditions are simultaneously gathered, including visual measurements of wave height, period and angle of approach and the current speed and direction, using drifters. Sediment samples from the bed were also obtained to the same points. Four fieldtrips were held at the three different sites and both winter and summer beach profiles were identified. A total of 24 vertical profiles of sediment in suspension were obtained representing different points within the beach profile, including troughs and bars, resulting in 144 sediment samples. The data revealed that beach morphology changes from a well-defined scarped and steeper profile in the south to a longer and more convex-shape profile in the north. Significant variation was observed in the medium grain sizes present in the suspended samples at the study sites. Half of the results indicate a decreasing in grain sizes with distance from the bed, which are composed by fine and very fine sand. The model developed by Bayram *et al.* (2007) was used to estimate the total longshore transport rates. It showed to be very sensitive to the specific grain size chosen to represent the suspended sediment, which has to be inputted in the equation. The greatest variation was identified when predicting longshore transport rates using the highest wave height values. The use of bigger grain sizes (i.e. from the bed samples) underestimated the transport rates in 54 % in the Atami beach, when compared to rates estimated using the actual grain size values of suspended samples. On the other hand, the use of smaller grains sizes from the bed sediment generated overestimated values to the Caravelas beach (up to 20%) and to the Praia Brava beach (up to 44%). Key words: streamer traps, sediment, rates, longshore transport, Paraná

Sedimentary facies and taphonomy of Late Cretaceous mass deaths of dinosaur, Zhucheng, Eastern Shandong, China

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The Upper Cretaceous Wangshi Group composed of, in ascender order, Linjiazhuang Fm, Xingezhuang Fm and Hongtuya Fm, is developed in Zhucheng Basin, eastern Shandong, China. Upper Cretaceous Xingezhuang Fm consists of purple fine grained clastic rocks and the rhythmic deposits of dark purple sandstone, while conglomerates make up Hongtuya Fm in which an age of 73.5 Ma (Campanian) was obtained by Ar-Ar dating from basalt in the upper horizon. Lots of bone fossils of dinosaur are present within the transition from the top Xingezhuang Fm to the lower Hongtuya Fm. More than 8000 isolated bones and few complete dinosaurs remains cover areas of 20000 m^2 in total three excavation sites. The bone- hosting stratigraphy is correlated with the horizon in which Tsintaosaurus and egg fossils were found in 1958 at Laiyang, 200 km to the south. Except for the large quantities of bones, a number of were founded 20 km to the south. Based upon detailed studies on lithofacies and sedimentology, a fluvial fan and braided-channel depositional and taphonomic model has been proposed for the preservation of dinosaurs fossils in Zhucheng, eastern Shandong. Using this model, major taphonomic modes of occurrence of vertebrate remains found within the study sequences are readily explicable in terms of the sedimentary context of their host lithofacies. The studied sequences are composed of three main sedimentary facies and corresponding taphonomic lithofacies: (1) mud flow deposits: sandy and muddy conglomerate (T-DF); (2) floodplain deposits including immature paleosols, shalestone and mud with intercalations of pebblestone (FP);(3) sandy and muddy conglomerate with inclined bedding (BRC). Fossils occur as articulated skeletons, bone beds and isolated skeletal elements. In general, thin-long column bones were parallel to the sedimentary laminations, most bone fossils, on the surface show a disordered distribution and even stacked each other. All of these three major taphonomic occurrence modes are dominantly associated with mud flow and floodplain deposits indicating a preferential preservation of vertebrate material at these microfacies. These three taphonomic occurrences are believed to represent the end products of mass deaths of herding ceratopsians of Hadrosaurus, perhaps by drowning as animals attempted to cross flooded rivers and no link to the mass extinction for dinosaurs at the terminal Cretaceous.

Terriestral Biota Evolution and Sedimentology, Palaeogeography of Late Mesozoic in Northern China

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Two well-preserved Mesozoic terrestrial Biotas as the Yanliao Biota (J2-J3,165-152 Ma) and the Jehol Biota (K1,144-110 Ma) characterized by the feathered dinosaurs, the earliest swimming and flying mammals, pterosaurs, insects and plants as the earliest angiosperm et al, widely exist in north-eastern China. Evolutionary radiation and a transition of the two biotas were not only accompanying a series of geological events such as lithospheric thinning, magmatic activities which suggest a mechanism of interaction and response in the earth surface systems, but also shown a different biotic elements including vertebrate and invertebrate animals, insects and plants and particularly geographical sedimentary extents and lateral extension through the chronological episodes from the Middle Jurassic to the Early Cretaceous between them. Palaeogeography and contemporaneous sedimentology of the earth surface system had a strong affection on them, and in order to survive, the biotas had to change themselves and to radiate to adapt the affected ecosystems or palaeogeography. The biota(fossils) are mostly preserved in lacustrine deposits bearing a number of volcanic tuffs or intercalations of lavas which provide a window for understanding the interaction and response in a perspective of sedimentology. Synthesized researches on biotic evolution, alternation and accurate chronological dating, taphonomy of vertebrate or invertebrate fossils have displayed a biotic responses to the environmental changes and palaeogeography and palaeoecologic environments in Late Mesozoic, Northern China. Sediments deposited in Late Jurassic implies a tropical, dry and hot paleoclimate be prevailing in comparision with the subtropical, humid and seasonal climate in early Middle Jurassic. The ecological environment suddenly changed from Middle to Late Jurassic, which caused the early biota massive reductions, migration or to border on exterminates even vanish. Poor ecological environment leads to a vegetation deterioration and then a evolution towards much smaller body in order to adapt the decreasing of food for a phytophagous dinosaur. Furthermore, a most than 90% genus and species of the Yanliao Biota were unfortunately died out (extinction) until the next ecological recovery in the early period of the Early Cretaceous(the initiation of the Jehol Biota). The accurate time point of the two biotas transiton is well defined as 154 Ma. The Jehol Biota provides a rare, incredibly detailed picture of an intact Early Cretaceous terrestrial ecosystem and another interaction and response between biotic radiation and evolutionary and palaeoecological, paleogeography and sedimentological evolution.

Reconstruction of depositional environments and climate along SW India from Late Quaternary coastal sediment archives

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The Trivandrum Coastal plain is an isolated plano-convex lowland covering 80 sq km extending 40 km along the coast and 2 km into hinterland, located in the southern side of the southwestern coast of Indian Peninsula. The plain abode longitudinal sand dunes separated by depressions pooled with brackish water, giving a ridge-runnel topography (Soman, 2002; Limaye *et al.*, 2007). The sediment column varies its depth averaging at 40 m, with a basin irregularly sloping towards the west. The ongoing study educes the stratigraphy of the region by quantifying the characteristics based on time, biota contents, geochemistry and morphogenesis from sediments. Lithologically three different sediment layers have been identified in the subsurface to a depth of 35 m (Longhinos & Nambiar, 2008), below which either lateritic horizons were encountered or recovery of undisturbed sediments were not possible. The sedimentological and morphoscopic character of quartz grains identifies three different environments of deposition, one succeeding the other, up to the depth studied. An upward sequence of fluvial sediments followed by a thin lacustrine and then aeolian covers almost in every part of the basin. The lacustrine sediments are highly organic rich, having thickness between 2-4 m. The pollen assemblage in this layer stores the signatures from high altitude/ temperate to semi-evergreen/moist deciduous to dry deciduous/ arid flora, exhibiting similar trend in aquatic species pollens and fungi, which is the evidence for climate change from cool, wetter to hot arid climate. In terms of major and trace element geochemistry the three-tier strata division is ratified. The OSL dates spans over a period of 23,544 years in this basin, the oldest date from 30m depth. The rate of accumulation was estimated and found inconsistent, indicating the fluctuation of energy conditions across the basin with time. The slowest accumulation was accompanied by change in sediment characters and deposition of organic sediments in middle layer between 10,500 yr B.P and 7,300 yr B.P. The geochronological constraints brought out for the basin provide valuable insight into the geological stage of evolution, especially at the time lines which brought substantial changes in the depositional regime. Streif sequence map was prepared for the basin enumerating the Holocene stratigraphy from depositional sequence after deciphering the ages. The closeness of equator emphasises the importance to the time-lines brought out in the present study. These time-lines manifest the chronological markers of d desymmetrization of Earth during the Quaternary (Cherkasov, 2010). In nut shell, the work discusses the tentative depositional history, in chronometric terms, focussing earth dynamics through Late Pleistocene to Late Holocene epochs.

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Geologic maps and derived thematic maps for coastal management

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The Norwegian coastal zone is very important for value creation based on marine resources. At the same time, knowledge of the environmental conditions is limited. Much of the planning of coastal activities is based on old and often outdated information. For example, standard nautical charts provide very limited information on bathymetry, and virtually no information on submarine landscapes, sediments, currents and other environmental parameters. In order to optimize value creation, in a sustainable way, better knowledge is required. This increased knowledge should also facilitate reduced conflict in the use and development of particular areas. In Troms County in northern Norway, a group of local municipalities have joined forces to make better plans for the management of their marine areas. The plan covers location of fish farms, fishing- and spawning areas, environmental status, and the location of infrastructure to optimize the use of their areas. As part of the project, The Geological Survey of Norway has provided swath bathymetry data for the fjords and done ground truthing by video and grab sampling. The benthic faunal assemblages and content of pollutants in the sediments have also been mapped by the project partners. The environmental status for the area is presently good, and the data provide a base line for future monitoring. This fact is used to promote sales of marine products from the area. Marine base maps including geological maps and derived thematic maps are incorporated in the area plans as a GIS. These include sea bed sediment grain size, average current velocity, anchoring conditions, and potential oxygen deficiency areas. At the same time these base maps are made into electronic charts for use on chart plotters on work vessels. The maps have given the fish farmers tools to optimize the location of the fish farms for better fish health and productivity, and to anchor their installations more safely. Through this initiative the municipalities have gained tools for knowledge based management of their marine areas, including far better knowledge on potential habitats for vulnerable species. The Troms project is a pilot project which may serve as a model for a full coverage mapping effort for the entire coastal zone of Norway, providing “geology for society” and facilitating economic growth and the maintenance of a sustainable environment.

Geochronology and sedimentology of Norwegian cold-water coral mounds in shelf- and fjord-settings

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Cold-water corals (e.g. Lophelia pertusa) thrive in the NE Atlantic in 350- 1200 m depth, in the aphotic zone, at 5.5 to 10°C, in nutrient enriched and current dominated settings. Coral frameworks and accompanying background sedimentation form carbonate mounds. These can reach 300 m in height, with up to ~2.5 Mio yrs in longevity (Irish margin). On the Norwegian shelf, which was entirely glaciated during the Last Glacial, corals do cover extensive areas today, but mounds rarely exceed 10 m height. These youngest mounds of the European margin are rooted on glacial deposits and hence ascribed to the Holocene. Gravity cores were taken (RV Poseidon, POS- 325; EU- HERMES project) on the mid-Norwegian shelf (65°N; Trænadjupet) and in Stjernsund (72°N) near the biogeographic coral limit. The key goal of this study is (1) to radiometrically date the temporal coral growth onset after the last glacial, and (2) to reconstruct oceanographic patterns from sedimentological and geochemical properties. In Stjernsund corals grow today on a terminal moraine sill (-250 m) at 400 to 270 m, constricted to the entrained North Atlantic Current (NAC) water, with a typical density of $\sigma\theta$ = ~27.5. Corals are absent in the immediately adjacent trough (- 500 m), where NAC is absent. The core transect across this Younger Dryas (YD) moraine (>11.5 ka) comprises coral deposits from the crest and flanks, glaciomarine rhythmites on the seaward flank and postglacial silty to muddy deposits in the proximal trough. An erosional hiatus constitutes the contact of the moraine and coral deposits. Computed- tomography helped to visualize 3D coral distribution and fragmentation, and to select the stratigraphically oldest corals. U-series dating unveiled an unexpectedly early coral growth onset at 10.9 ka BP - 2 ka earlier than previously reported. This Preboreal start of north-Norwegian coral growth witnesses the rapid implementation of the North Atlantic Current (NAC) following the deglaciation. The constant $\delta^{18}O$- signal in benthic foraminifera, contrasts with known insolation-triggered Holocene temperature shifts (>5°C; SST), and reflects a maintained seawater density ($\sigma\theta$ = ~27.56) – also indicating a persisting northward NAC export. The basal hiatus reflects the implementation of the prevailing strong currents, following a rapid glacier retreat. Suitable conditions for corals were established within <500 yrs after the YD. U-series ages reveal fast mound accretion rates of ~60 cm/ka, interrupted by a prominent mid- Holocene hiatus. Radiometric age pairs of corals and benthic foraminifera from the same horizon, show a temporal coincidence or subtle lag (<200 yrs) with younger foraminifera. Directly above the hiatus foraminifera ages appear ~1 ka older than the corals, consistent with time-averaging by sediment mixing in a current dominated regime at times of reduced coral growth. Further inferior hiati are currently dated, as they may hold information on sub-millenial scale NAC-variability. Siliciclastic matrix particle sizes show a broad peak (mean ~5 µm), which is equal in all cores and stable through the Holocene even across hiati. This reflects homogenous background sedimentation and a preferential fine-sediment baffling by the corals, which render current reconstructions from the siliciclastic portion not feasible. Bottom current variability was instead evident from particle-size variations of carbonate components. Further sedimentary properties like sediment weight, water content, radiographic density, carbonate concentration, XRF, magnetic susceptibility and benthic foraminifer assemblages were used to reconstruct environmental conditions during coral mound growth. Coupled U-series and ^{14}C-coral ages yielded local reservoir ages. Substantial early Holocene $\Delta^{14}C$-deviations from the surface marine curve (Marine04), highlight the need to establish local calibration curves, to increase the calibration precision for bathyal ^{14}C-ages in fjords and in open shelf settings.

Advances in harmonic analysis of tidal rhythmites in the Puncoviscana Formation (Proterozoic - Early Cambrian), northwest Argentina

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The Precambrian-Cambrian sedimentary sequences of northwest Argentina are represented by the Puncoviscana Formation and equivalent units, which are widely distributed in Cordillera Oriental. Depositional environments were recently redefined as coastal systems with tide-, wave- and storm-influenced tidal flats and estuarine facies. Tidal rhythmic sequences register variations in lamina thickness that can be analyzed as harmonic series with Fast Fourier Transforms (FFT), allowing preliminary calculation of Moon-Earth distance for the Precambrian-Cambrian boundary for the first time. This technique is applied in Argentina for the first time and permits characterization of tidal periods astronomically influenced during deposition. Lamina thickness in tidal rhythmites ranges from 0,40 to 36,50 mm. Thickness variation presents an oscillatory pattern that evidences sinusoidal curves with different symmetries. Systematic alternation of thin and thick lamina is common in modern and ancient deposits, and can represent the diurnal inequality of tides. Equal thickness of successive lamina represents equal magnitude in morning and afternoon tides that happens when Moon is directly over the Equator. This is the manifestation of the lunar tropical month. Systematic changes in laminae thicknesses can be related to neap- spring cycles in the synodic month (lunar phase), with higher tides developed when the Earth, Moon and Sun are aligned (syzygy). The harmonic analysis of raw and filtered data with FFT produces a Power Spectral vs Period (events/cycle) diagram of clear spectral density patters with a dominant peak defining two flood events per lunar day (semidiurnal cycle) also recognized in the sedimentary profile. A secondary peak would be related to the tropical month that has also a clear imprint in the sedimentary record. A third peak resemble the interaction of several periods as synodic, tropical or anomalistic (apogee and perigee lunar positions) or to seasonal variations along the year (winter/summer). The last peak represents the conjunction of synodic, tropical and anomalistic periods that occurred twice a year (semiannual period), during which tidal forces reach a maximum due to re- enforcement of each period. The Earth-Moon distance can then be calculated as follows: $(Psid/Psid°)^2 = (a/a°)^3$, were Psid°: number of solar days in the actual sideral month (27,3186 days), a°: actual Earth-Moon distance ($3{,}844 \times 10^{10}$ cm), Psid: number of solar days per sideral month in the past, a: Earth-Moon distance in the past. According to FFT analysis in Puncoviscana Formation, Ptrop°=Psid°=26,64 days, and then the Earth-Moon distance in the Precambrian-Cambrian boundary, expressed as lunar semi-major axis, is $3{,}78 \times 10^{10}$ cm. Lunar retreat along the geological time was analyzed from Earth-Moon distance obtained for Weeli Wolli (2450 Ma), Big Cottonwood (900 Ma), Elatina (620 Ma), Puncoviscana (540-520 Ma) and Brazil Formations (Carboniferous), that evolved towards the actual value of $3{,}844 \times 10^{10}$ cm. Value for the Puncoviscana Formation is coherent with the evolution curve of lunar retreat between the Paleoproterozoic and today. Data suggests a singular and exceptional astrophysical event during the Paleo-Mesoproterozoic transition (900 Ma) with a significant increase in rate of lunar retreat up to the Cambrian. Minor and discrete events are recognized in the Cambrian and Upper Paleozoic with a reduction of 50% in the lunar retreat rate. Progressive and important stabilization of the lunar retreat from the Cambrian is coincident with species development and specialization on the Earth. Relations between both phenomena have to be analyzed in new detailed studies.

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Sedimentary structures in the Puncoviscana Formation (Proterozoic - Early Cambrian), NW-Argentina: a comparison with modern shallow water analogs

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The Precambrian-Cambrian sedimentary sequences of northwest Argentina are represented by the Puncoviscana Formation and equivalents, which are widely distributed in Cordillera Oriental and Northern Pampean Ranges, Argentina. This unit represents a passive margin basin formed from the breakup of Rodinia hat changed into an active continental margin basin consecuence of collision of the Arequipa- Antofalla terrane. during the Early Cambrian. The sedimentary sequence provides an important record of trace fossils and synsedimentary volcanism. Palaeoenvironment of the Puncoviscana Formation has traditionally been interpreted as deep turbidites contemporaneous with shallow carbonate platform sequences to the east. New paleoenvironmental interpretations, presented herein, arise from multidirectional paleocurrents, trace fossil bathymetry and diverse subfacies containing a diagnostic suite of shallow water sedimentary structures. Caution should be exercised for deciphering paleoenvironments, particularly for Proterozoic rocks, where one has to depend only on physical sedimentary structures. Comparison with modern analogs helps understanding processes and flow characteristics and these resemble intertidal and subtidal storm-influenced environments. The most intensively studied modern tidal environments are tidal flats, tidal inlets, deltas and subtidal shelf banks, with attention focused on siliciclastic tidal flats of North Sea, Gulf of California, Bay of Fundy and Hudson Bay in Canada; Gironde estuary, Mont Saint-Michel Bay in France; Bohai Bay and West Yellow sea in China; Pacific coast of Japan and Bay of Bengal in India. Sedimentary structures in Puncoviscana Formation include ripples of diverse forms (linguoid, linear crested with symmetric and asymmetric surfaces, double crested ripples with mud drapes, interference ripples). Subfacies association suggests that these bedforms developed in intertidal settings by ebbing tides. Rhomboidal ripples associated with 3-D ripple migration structures are common when there is a strong effect of swash/backwash system of waves. Asymmetrical ripples in two successive levels, with different orientations to demonstrate multidirectional flows affected by tides and coastal currents possible driven by wind. Up-sequence, tidal rhythmites with mud/silts couplets, isolated ripple trains (subordinate), fining upward layers and wide variety of trace fossils indicate a tidal flat system with high suspended load and quite environmental conditions for organism development. Parallel lamination with uniform and non-uniform lamina in sandy layers and hummocky cross stratification are common in modern wave- dominated flats affected by storm episodes. Presence of tidal rhythmites, herringbone cross stratification, wrinkle and rill marks at the bottom of the profile are found in tidal flats with sub-areal exposures in the intertidal zone. Those paleoenvironmental changes are thought to be related to seasonal variation (summer/winter and storms) when processes and hydrodynamical change. Facies analysis carried out in Rancagua and Palermo Oestelocalities allows recognition of shoreface to open shelf environments, with transition from wave- to tide-dominated systems possible related to seasonal cycles occurred during basin deposition. Harmonic analysis on tidal rhythmites allow recognition of four major cycles due to its spectral power: 2.03, 26.64, 50.33 and 119 events (tidal days)/cycle. These can be interpreted as representative of ancient tidal periods including semidiurnal tides, the tropical month, seasonal episodes (possible storm episodes) and a semiannual cycle, respectively. This last could represent variation in sedimentation between winter and summer seasonality, which was manifested in the sedimentary profiles.

Chemistry of surface waters in the "salar de Surire" (Chile) saline system and relation with the origin of borate deposit

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The "salar de Surire" system is a saline water body located in the Andean region of northern Chile. This area has marked volcanic features and it suffers extremely arid climatic conditions. There exist at least 60 m of saline-detritic sediments in the salar record. Such materials were accumulated in one of several saline lakes developed in this altiplano region from the upper Tertiary (Miocene-Pliocene ages). The current hydrological balance in the salar basin does not allow a permanent surface water table, and hence salar de Surire appears as a vast, flat saline area covered by water in a maximum of 25% of his total surface. It is possible to distinguish at present three main types of solutions in this closed basin: water inputs coming from basin drainage (locally named "vertientes"), waters accumulated in a marshy rim (known here as "bofedales") and waters associated with saline body (geothermal springs and brine ponds). A close chemical relation exists between waters from vertientes (basin drainage inputs) and bofedales (surrounding marshes), and, on the other hand, thermal spring waters and brines show almost identical ionic ratios, but without apparent chemical connection between both groups of waters. In the northwest of this saline body an important borate deposit exists, placed at shallowest sedimentary levels, and mainly composed of ulexite (Na-Ca borate), with an estimated reserves of 1,500,000,000 Tm (metric tonnes). The current input of boron in the salar system is due mainly to thermal waters located at southeastern edge, since the boron content of drainage waters is extremely low (below 5 mg/l). On the other hand, the boron content measured in thermal solutions of Polloquere (the most important spring in this system) is about 39 mg/l, with a nearly steady water input of about 50 l/s. In these conditions, the current boron input due to thermal springs is about 60 Tm/year, from which 450 Tm/year of ulexite could be formed. Taking into account the borate estimated reserves and the minimum age of salar (active at least from the upper Tertiary, between 5 and 2 My), the only contribution of Polloquere spring is enough to explain the origin of boron accumulated in the salar. This element could be concentrated in the final dessiccation stage of the saline lake, giving way to a borate deposit of economic interest located at northwestern edge due to a slight tilting of surface.

Provenance of gypsum in filling sediments of "Salada de Mediana" playa-lake system

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"Salada de Mediana" is an hydrologically active playa-lake saline system located in the Central Ebro Basin (NE Spain, near Zaragoza). This lacustrine system lies within a little basin without a permanent surficial drainage system, and developed on Tertiary sedimentary materials mainly composed by gypsiferous rocks. Dilute surficial waters accumulated in the bottom of that depression evolve under evaporation to become brines in the spring season, reaching total dryness in summertime. The most recent sediments accumulated in the bottom of the basin have been studied under petrographic microscope, after obtaining thin sections of material collected from a profile in the central area. Just below the surficial saline crust formed in dessication stages (later spring and summertime) a sedimentary blackish level appear. This layer is a 5 cm thick sedimentary accumulation consisting mainly of alabastrine gypsum crystals, with minor amounts of carbonate particles, clays, and organic matter. Below this level there is a layer of light brown sediments composed almost entirely of gypsum crystals, lenticular in shape but with an alabastrine nucleus; this fact has been demonstrated by petrographic study, as the morphologic observations under scanning electron microscopy only allowed to describe the surface features of individual crystals. Such textural variations in depth indicate that an important amount of gypsum accumulated in the bottom of the basin has been transported by surficial runoff and wind. Precipitation of gypsum from the interstitial saturated brine that soaks this filling sedimentary material takes place mainly as overgrowths covering these clastic particles, belonging this process to an early diagenetic stage.

Identification of Guayatayoc Basin river patterns (northern Argentinean Puna): implications for a chronological landform history

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The endoreic-evaporitic Guayatayoc basin is located in the northwest part of the Argentinean Andes, between 65°20'W - 66°35'W and 22°24'S - 24°00'S. This region is arid and has desert weather; rainfalls are less than 300mm per year. The feeding rivers of the basin, only and episodically, flow during the summer monsoons. The waterbody of Guayatayoc Lake, the lowest drainage point of the basin, reaches an altitude of 3400 meters above the sea level and it is included within the eastern border of the Puna Geologic Province (González *et al.*, 2000). The determination of the most important spatial arrangement of the stream channels in the basin landscape has been based on several important factors like slope and structure without forgetting other factors as weather. However the adjusted and anomalous river patterns are mainly produce by slope and structure (Twidale, 2004). Some slope linked river patterns in the Guayatayoc basin, such as parallel arrangements, are well represented in the plains zones of Coranzuli ignimbrite, as well as the subparallel streams in the highest parts of the quaternary glacis located at the west side of the Sierra de Santa Victoria. Several radial patterns can be recognized in basin borders zones and also have been observed around basin waterbodies. Distributary patterns are well developed in quaternary alluvial fans like Las Burras and generally in the west slops of the Sierra de Aguilar. On the other side, there are quite a lot of examples showing structure linked straight arrangements in large areas dominated by parallel, angular, trellis and segments of other patterns which can be considered linear patterns on a local scale. Some of those straight streams, arranged on the quaternary alluvial deposits, are demonstrating a neotectonic activity. In some parts of Coranzuli ignimbrite plains, angular and trellis patterns are well represented too. Annular arrangements characterize the surrounding drainage in the vicinity of the Miocene volcanoes. Scares of relatively recent direction change of subparallel and dendritic streams were identified in the quaternary alluvia of Cangrejo subriver basin. Evidences of recent structural activity, which are controlling arrangements, are also identified by the present divergence of the distributary drainage closed to the town of Abra Pampa and throughout Pastos Chicos subriverbasin. Morever, some examples of anomalous fluvial designs, considering the stream flows as subsequent-obsequent, can be referred in several outcrops. An example of them is the Ordovician outcrop situated at the NNE of the Huancar village. Anabranching streams, which characterize aggradational plains, are often represented in the dominion of angular- trellis patterns. This arrangement association, angular-anabranching, is only verified in ignimbrite lithologies, even though such kind of plains are not present aggradational environments. The areas of the Guayatayoc basin which have possible aggradational environments are the alluvial fans mouth of Miraflores and Las Burras rivers, although Las Burras fan does not seem active. Finally, some conspicuous examples of anabranching patterns were also found in the present alluvial sediments which are filling up the southern zone of Pastos Chicos river.

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Unraveling provenance from Eocene-Oligocene sandstones of the Thrace basin, NE Greece

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This study presents data on Paleogene (middle Eocene - Oligocene) clastics of the Thrace Basin in Greece, developed synchronous to the post – Cretaceous collisional phase and the subsequent Tertiary extensional phase, by using sandstone petrology and petro- stratigraphy. Are here defined sandstone petrofacies as a tool to unravel the complex geodynamic changes occurred at the southern continental margin of the European Plate, identifying detrital signals of the accretionary processes of the Rhodope orogen, as such as the subsequent partitioning related to the extension of Rhodope area followed by Oligocene-present Aegean extension, and the contribution of a wide magmatic activity starting during the lower Oligocene. Sandstone detrital modes include three distinctive petrofacies, a quartzolithic, quartzofeldspathic and feldspatholithic. The major contributions are from the metamorphic basement units, represented mostly by low-medium grade lithic fragments for the quartzolithic petrofacies and high grade metamorphic rock fragments for the quartzofeldspathic petrofacies. Volcaniclastic sandstones testifies supplies from different volcanic areas, with composition varying from dominantly acid to subordinate intermediate products (mainly rhyolitic – acid glass, spherulites, felsitic lithic fragment textures). The detrital mode evolution testifies contributions from three key source areas corresponding with the two main crystalline tectonic units, the Variegated Complex (ultramafic complex), in the initial stage of accretion (quartzolithic petrofacies), the Gneiss-Migmatite Complex (quartzofeldspathic petrofacies) and the Circum-Rhodope Belt. The volcaniclastic petrofacies is interbedded with quartzofeldspathic petrofacies reflecting superposition of active volcanic activity. The three key petrofacies reflect a multiple provenance from different tectonic settings, from collisional orogenic terranes to local basement uplift and the volcanic activity respectively. The composition and stratigraphic relations of sandstones derived from erosion of the Rhodope orogenic belt and superimposed magmatism after extensional phase in northern Greece provide constraints for paleogeographic and paleotectonic models of the Eocene to Oligocene western portions of the Thrace Basin. Clastic detritus in the following sedimentary assemblages was derived mainly from provenance terranes of Paleozoic section within the strongly deformed Rhodope Massif of northern Greece and south-east Bulgaria, from the epimetamorphic units of the Circum-Rhodope Belt and from superimposed upper Eocene-lower Oligocene magmatism related to gravitational orogenic collapse of the Rhodope orogen. The type of sedimentary provenance of the Rhodope Palaeogene sandstones, provides an example of the changing nature of orogenic belts through time, and may contribute to the general understanding of similar geodynamic settings.

Tectonics vs. glacio-eustasy: The Upper Pennsylvanian Bursum Formation, New Mexico (USA)

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In New Mexico, the Bursum Formation represents the transition from dominantly shallow marine carbonate deposits of the Upper Pennsylvanian to the nonmarine red beds of the Lower Permian. The Bursum Formation is mostly less than 100 m thick and composed of alternating marine and nonmarine sediments that locally form well- developed cycles, although thickness and facies are characterized by strong vertical and lateral variation. The marine facies is limestone and marine shale and rare marine sandstone and conglomerate. Nonmarine facies are shale, sandstone and conglomerate, and rare pedogenic limestone. Marine limestone units are up to 8 m thick, wavy to nodular bedded. The most common microfacies are bioclastic wackestone with a diverse fossil assemblage, and mudstone with a low diversity fossil assemblage. Less common are grainstone, packstone and rudstone. Limestone was deposited in a dominantly low-energy, open marine to restricted shallow shelf environment. Most mudstone to siltstone is purple, red, gray, greenish-gray, and greenish, and locally contains a rich flora and fauna. Most was deposited in a nonmarine coastal plain environment, although marine mudstones (contain marine fossils) are present, too. Sandstone intervals are up to several m thick and commonly have an erosive lower contact. Thicker sandstone units consist of grouped sets of trough crossbedded sandstone. Thinner and finer-grained sandstone units are massive or horizontally laminated, and rarely display low-angle cross-bedding and ripple cross lamination. Sandstones have high amounts of detrital feldspars and granitic rock fragments (subarkose to arkose). Poor rounding/sorting and high amounts of detrital feldspars indicate short transport distances. Conglomerates are siliciclastic, mixed siliciclastic or carbonate. Siliciclastic and mixed siliciclastic-carbonate conglomerates commonly are trough crossbedded, and carbonate conglomerates appear massive. Sandstone and conglomerate intervals may extend laterally over more than 100 m and display a sheet-like external geometry. Sheet-like sandstones and conglomerates are deposits of broad, shallow channels of a braided stream system. Thin, massive carbonate conglomerates probably record turbulent debris flows. Thin sandstone sheets are sheet splays; thin sandstone lenses may represent crevasse channels. Locally, sandstones and conglomerates contain marine fossils indicating deposition in a nearshore, high-energy shallow marine setting. At some sections, horizons of nodular and massive pedogenic limestone are intercalated. Massive pedogenic limestone consists of inhomogenous gray, nodular mudstone, subordinately of peloidal mudstone. Typical features are abundant fissure cracks and irregular voids filled with calcite cement. Rhizoliths are rare. The Bursum Formation is dominantly nonmarine clastic sediments deposited on a coastal plain under semiarid climatic conditions. Thin fluvial and sheetflood deposits are intercalated. Nonmarine deposition was interrupted by short episodes of marine transgression that deposited thin fossiliferous limestones of an open to restricted marine shallow shelf environment. Both glacio-eustatic sea-level changes and tectonic movements of the ancestral Rocky Mountain orogeny influenced Bursum Formation sedimentation. Sea-level fluctuations produced the cyclic pattern of nonmarine and marine deposits. The sharp facies boundary at the Bursum Formation base, which rests with angular unconformity on Precambrian to Virgilian strata, resulted from a major tectonic pulse that changed dominantly shallow marine carbonate sedimentation to alternating nonmarine and marine sedimentation. Strong variation in thickness and lateral facies changes indicate that tectonic movements also influenced sedimentation of the Bursum Formation. The upper boundary of the Bursum Formation is an unconformity that records another major tectonic event of the ancestral Rocky Mountain deformation.

Tetrapod ichnology, ichnofacies, ichnostratigraphy and perceived mass extinction at the Triassic-Jurassic Boundary

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The Triassic-Jurassic boundary (TJB) has long been identified as one of the five most severe extinctions of the Phanerozoic. On land, a major extinction of tetrapod vertebrates (notably crurotarsan archosaurs) has been identified at the TJB, but the ichnological record tells a different story. Thus, four of the five archetypal tetrapod ichnofacies (*Brontopodus*, *Characichnos*, *Chelichnus* and *Grallator*) are found in both Triassic and Jurassic rocks; these are records in water-laid siliciclastic red bed and eolianite lithofacies. Only one archetypal ichnofacies, the *Batrachichnus* ichnofacies (= medium-high diversity ichnocoenoses of the tracks of quadrupedal carnivores) disappears across the TJB, and this reflects the crurotarsan extinction, as crurotarsans are the inferred trackmakers of a significant portion of the footprints of the Upper Triassic occurrences of the *Batrachichnus* ichnofacies. Precise placement of the TJB in nonmarine strata (based on integrated correlation of terrestrial biostratigraphy, radioisotopic ages and magnetostratigraphy to the marine-defined Jurassic base at the first appearance of the ammonoid *Psiloceras spelae*) indicates that the *Batrachichnus* ichnofacies (and crurotarsan footprints) disappear during the latest Triassic (Apachean/Rhaetian), not at the TJB. At several locations, this disappearance nearly coincides with the first appearance of relatively large theropod dinosaur footprints of the ichnogenus *Eubrontes*, though some *Eubrontes* records are older than the stratigraphically highest crurotarsan footprints. Tetrapod ichnology thus indicates that an evolutionary turnover of tetrapods took place during the latest Triassic, one that involves a turnover of (at most) six tetrapod footprint ichnogenera. The relative lack of change of tetrapod ichnofacies across the TJB supports the idea that the end-Triassic extinctions did not cause a major disruption of terrestrial tetrapod communities. Furthermore, the tetrapod footprint turnover predates the CAMP volcanism and marine extinctions across the TJB. We conclude that tetrapod ichnology indicates a relatively minor tetrapod extinction took place during the latest Triassic, not the mass extinction at the TJB advocated by a less precise analysis of the tetrapod fossil record.

Cretaceous evolution of the northwestern Dinarides as revealed by multiple sedimentary provenance indicators

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In orogenic settings, where evidence of past events is often obscured by strong tectonic overprinting, dismemberment and erosion, clastic sediments represent a valuable source of information pertaining to the geological history of such regions. Synorogenic clastic formations which outcrop on the mountains and hills of northwestern Croatia document the evolution of this part of the Dinaride orogen, including the Dinaride-Alpine transitional area, a region characterized by considerable geological complexity resulting from a severe and long-lasting deformational history (Haas *et al.*, 2000). By combining a range of provenance sensitive indicators (petrography, heavy minerals, wholerock geochemistry, microprobe analysis of individual heavy mineral grains, zircon fission track thermochronology) measured on the siliciclastic detritus of sandstones ranging in age from Early to latest Cretaceous, we aim to constrain the composition and dynamics of ophiolitic and continental source terrains being exhumed and eroded in the northwestern Dinarides and neighboring regions during the Mesozoic. The quantitative data allow comparisons to be drawn with neighboring Alpine, Tisza and other Dinaride regions. Major and trace element concentrations agree with the petrography and heavy mineral content of the studied sandstones, and confirm a very strong supply of detritus from ophiolites to the area of the NW Dinarides in the Early Cretaceous. These were harzburgitic mantle peridotites and associated cumulate rocks which developed in a supra-subduction zone setting of the Neotethys (Lužar-Oberiter *et al.*, 2009). Fission track data of detrital zircons indicate that continental fragments which were being exhumed during the Late Jurassic-Early Cretaceous built up the source area along with the ophiolites. These units probably represent thrusted sheets of the Adria passive margin, parts of which underwent metamorphic overprint related to subduction-obduction processes in the Late Jurassic (Schmid et al, 2008). Medium grade metapelites made up a significant portion of these units, as did metamafic rocks, while high grade metasediments and granitoid rocks occurred more sporadically. Carbonate sediments also supplied significant amounts of detritus. A significant change in the fission track data is recorded in Maastrichtian sandstones compared to older samples, in that almost all of the zircons display notably younger ages. They indicate that the continental detritus which was supplied to the basins of the NW Dinarides in the latest Cretaceous derived from the erosion of newly, rapidly exhumed basement units which had undergone Eo-Alpine metamorphism either in the neighboring Eastern Alps and/or Tisza, or possibly the Dinarides themselves.

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Stratigraphic stacking and architecture of outcropping slope channel and overbank deposits, Magallanes Basin, Chilean Andes

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The Cretaceous Tres Pasos Formation of the Magallanes foreland basin, southern Chile, consists of mudstone- and siltstone-dominated strata associated with a prograding slope system that was characterized by > 900 m of bathymetric relief. It encompasses a graded clinoform system that is associated with coarse clastic base of slope deposits, which are the focus of this study. Outcrops like those of the Tres Pasos Formation represent an important means for acquiring the deep-water facies and architectural data necessary to build realistic models of turbidite complex development, grounded at the bed scale. This study attempts to capture the stratigraphic complexity of sandstone-rich, base of slope deposits and examine how channel stacking patterns provide insight into the sedimentary processes in the vicinity of the channel-lobe transition. Architectural analysis was completed on an outcrop belt 2.5 km long and >350 m thick. Numerous gullies cross cut stratigraphy at high angles and provide excellent 2-D and 3-D exposures. The database collected consists of over 2500 m of measured stratigraphic section, numerous photomosaics, and thousands of high-resolution GPS measurements used to map stratigraphic surfaces in 3-D. Channelform bodies 8-20 m thick characterize the stratigraphy, with erosive bases frequently draped by siltstone-dominated deposits attributed to sedimentation from largely bypassing turbidity currents. Internally, these channel complexes are composed of stacked, smaller channelform elements, with axial portions consisting of amalgamated sandstone sedimentation units 0.2-3 m thick. These units are typically structureless, high-concentration turbidity current deposits with common mudstone conglomerate or very coarse sandstone to granular basal lags. Channel margins commonly preserve interbedded inner levee and drape deposits formed by periodic outsized flows bypassing the channel environment. Channel fills are characterized by a rapid transition from axial facies with 90-100% sandstone, to thinly interbedded marginal facies with < 30% sandstone. This facies transition typically takes place over < 20 m, which is a much shorter distance than is commonly expected. Understanding these complex axis to margin relationships provides insight into depositional processes that shape the modern ocean floor, near the base of the continental slope. The collected data also has important implications for exploration and development of hydrocarbons from analogous units. The overall stratigraphic architecture records punctuated periods of channel incision and subsequent sedimentary bypass followed by depositional stages where channels are in-filled by collapsing, high- concentration turbidity-currents. At least eight successive channel elements stack vertically on top of one another, recorded by 130 m of stratigraphic section. This aggradational stacking pattern is likely associated with confinement of the channel system, although the mechanism for this confinement is speculative at this time. Large-scale outer levees have not been recognized in the outcrop belt. It is plausible that structural confinement of the slope channel system was important, consistent with interpretations of the underlying Cerro Toro Formation in the area, which was impacted by limited accommodation in the Magallanes foredeep axis.

A field-based test of spatial recurrence of ichnofabrics and ichnofacies in shallow-marine successions

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In recent years, ichnofabric analysis has been presented as a high-resolution ichnological technique for effective characterization of sedimentary facies, contending that ichnofacies analysis is outdated and too generalized to permit refined facies interpretations. Ichnofacies analysts, however, argue that ichnofabrics mainly reflect bed-scale overprinting of largely contemporaneous ichnogenera and so fail to address the ethological commonality of such variations, obscuring the facies relations. In order to test the usefulness of the ichnofabric technique, 35 sections were analyzed from the Early Permian Wasp Head, Pebbley Beach and Snapper Point formations, south Sydney Basin, Australia. These stratigraphic units are exquisitely exposed along the coast, because wave washing at high tide yields near core-quality expressions. Facies successions employed in the study represent offshore to shoreface, prodelta to distal delta front, shelf to lower offshore, and estuarine-embayment settings. Measured sections were described across 10 cm widths, equivalent to that of a standard hydrocarbon exploration core. Successions were evaluated from both an ichnofabric and ichnofacies perspective. Following published ichnofabric protocols, units were evaluated using: 1) Bioturbation Index; 2) characterization of trace-fossil tiering relationships; and 3) construction of constituent diagrams. Ichnofacies analysis identified trace-fossil suites, relative proportions of ichnogenera, Bioturbation Index, uniformity of burrowing, and ethological evaluations. For each comparison, two sections between 0.5-4.3 m apart were measured across the same bedsets. For heterolithic units, sections were spaced more closely than those for homogeneous facies, in order to minimize bed-scale changes. Lithofacies correlations exceeded 90% consistency in most section pairs. In most instances, each bed intersection yielded a unique ichnofabric. Virtually no predictable recurrence of ichnofabrics could be established between section stations, *even within the same bed*. Deltaic units of the Wasp Head showed spatial recurrences of ichnofabrics that varied from 0%-14% across distances of only 0.5-1.5m. Homogeneous facies of the lower shoreface to inner shelf in the Snapper Point showed ichnofabric recurrences of 8-12% across distances of 1.0-4.3m. This lack of recurrence calls into question the utility of ichnofabric analysis in subsurface studies where wells are spaced hundreds of meters to kilometers apart. Ichnofabric description rates for heterolithic sections varied from 1.1-2.9 hours/m (average 1.8 hrs/m). Uniformly burrowed facies ranged from 1.3-3.7 hours/m (average 2.3 hrs/m). From a time-use perspective, the ichnofabric approach, as published, appears impractical for routine outcrop mapping or core evaluation, particularly given their demonstrated lack of spatial recurrence. By contrast, ichnofacies analyses yielded trace-fossil suites that not only recur between the measured sections, but extend for considerable distances along depositional strike as well. The suites permitted characterization and paleoenvironmental interpretation of the sedimentary facies. Ichnofacies assessments were also time efficient, averaging 0.3 hours/m, and could be fully integrated with the sedimentological data as the sections were logged. This combination showcases the usefulness of the ichnofacies approach for both outcrop and subsurface studies. This field-based test demonstrates that there is little basis for depositional interpretations and bed correlations founded solely upon an ichnofabric dataset. The ichnofabrics do not recur and ultimately must be grouped with one another, regardless of the relative ordering of burrows (with the exception of palimpsest relations) in order to permit bed correlation. Only by evaluating ichnofabrics ethologically in the context of the ichnofacies paradigm can they be utilized in any meaningful way to characterize the paleoenvironment

Facies analysis and depositional environments of a continental rift type basin (Curitiba Basin, Oligocene-Miocene, Brazil)

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The Curitiba Basin is located on the east of Paraná State, southern Brazil. It has a NE elongated shape, and belongs to the Southern Brazil Cenozoic Rift System. Currently it has an area of approximately 3000 km^2 and its utmost sediment thickness is of 80 m (Guabirotuba Formation). Its bedrock is composed mainly of granitic-gneissic rocks, and adjacent highlands are made of granitoid rocks (Serra do Mar mountain chain) on the east, and metamorphic rocks on the west, all of them of Proterozoic age. Throughout the beginning of the Cenozoic (Paleogene), the southern and southeastern regions of Brazil were affected by extensional tectonics, reactivating bedrock faults with normal slip. Thus, hemi-grabens bordered by marginal systems of alluvial fans have been generated. This research was an attempt to systematize the description, genetic interpretation and facies association distribution of the Curitiba Basin. Six facies associations were recognized: A, B, C and D are deposits of alluvial fan systems, with gradual transformation from the eastern border to the basin inland. The most distal C and D associations are interfingered with deposits of facies association E, whose origin is related to alluvial fan systems with western border provenance. The F facies association occurs at the northernmost limit, and its sediments are related to a low energy fluvial depositional environment. Paleocurrent data indicates an average provenance from the edges to the interior, with a slight trend towards the north-northeast. Such results combined with the current sediment position and the distribution of the sedimentary facies associations allow to suggest differences in paleodrainage direction trough time and that the original dimensions of the Curitiba Basin were greater than the observed today.

Temporal analysis of morphological summer profile of the barrier spit in Maracaípe Beach

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The barrier spits are very dynamic geomorphological features. Its formation and transformation are associated with the hydrodynamic characteristics inherent to the place where it is located and may indicate important changes in the sedimentation of a beach. The Maracaípe beach, located on the southern coast of Pernambuco State, Brazil, has been going through an erosive process, which is intensified by human action, as an example: deforestation of native vegetation and urbanization. It is also possible to identify a retreat of the coastline in this region through aerial photographs from 1979, 1998 and sensor image from 2005. This study evaluated the seasonal summer beach profile in the region of the barrier spit at Maracaípe beach through topographic survey, using a target, ruler, measuring tape and a theodolite, as well as wave parameters. The zero level of the profiles was calculated according to tide chart of the Directorate of Hydrography and Navigation - DHN. After obtaining the data, they were processed at GRAPHER software, generating graphics referring to levels with their respective distances. It were plotted the summer profiles, from December 2009 to February 2010, corresponding to dry season in the city, they were compared with the results of the study in the same area between December 1996 and February 1997, made by the Environment Pernambuco Company - CPRH. Data from CPRH indicated a partial replacement of the backshore and foreshore whereas that monitoring of the previous months tended to erosion except for the shoreface that remained almost stable at all times. The average wave height for the period was 60 cm and spilling breaker type. In the profiles measured recently, unlike the data from 1990 decade, there was a decrease in the volume of sediments in the backshore and a slight lowering in the region of the foreshore and shoreface between December and January, accentuating it in February. This identified erosion process corresponds to the beach adaptation for the new hydrodynamic conditions of that summer, which, in this case had waves with average height 65-80 cm and plunging breaker type. Though, it has been occurring a retrogradation of the coastline, this erosional condition of the beach profile may be directly linked to an event of seasonal weather influenced by upper-level cyclonic vortex that has contributed to excessive rain and storm conditions, as the historical average of the last 10 years for these months have not exceeded 100 mm of rain. The rainfall for the months of January and February 2010 peaked 240 and 130 mm, respectively. The decreasing in the volume of the sedimentary compartment of the barrier spit at Maracaípe beach may be related to storm conditions that led to the formation of waves with larger height amplitudes favoring the removal of sediments from subaerial profile. Another factor is the barrier spit location on the left margin of the estuary of Maracaípe River in which the water flow has increased removing sediment from the adjacent beach.

Provenance of sediments in a continental basin by zircon study (Curitiba Basin, Brazil)

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The Curitiba basin is located in the south of Brazil. The sedimentary pile that filled up this intracontinental rift consists of a nearly 80m-thick sucession represented by arkosic sands, muds and conglomerates (Neogene) of Guabirotuba Formation. These deposits are attributed to depositional environments ranging from marginal alluvial fans, rivers and plains interwined within. The basement of the basin is formed by metamorphic rocks of the Atuba Complex, granites of the Graciosa Province at east and southeast, and metamorphic rocks of the Group Açungui, at northwest. The effects of changes in the original signature of origin due to weathering during transport or diagenesis were partially overcome by studying a specific mineral group. The remarkable dominance of zircon in the sediments of the basin allowed the discrimination of compositional varieties for more precise definition of the source areas. The mineral zircon is highly resistant to physical and chemical natural processes, common among the detrital minerals in most sediment. Also resists the transformation of high temperature processes such as hydrothermal, metamorphic and even partial melting. The low speed diffusion of ions in the crystal zircon structure favors the preservation of its unique chemical and isotopic composition during most of geological processes. The results presented here are based on discrimination of zircon type for its optical properties and shape. The zircon concentrate were mounted on glass-slides and analyzed on with a transmitted light microscope and scanning electron microscopy (SEM). The typology of zircon grains is based on possible combinations of prisms and pyramids, as well as their relative sizes. The preliminary analysis revealed four different types of grains: 1) with euhedral faces (20%), 2) oviform (30%), 3) irregular (10%) and 4) prismatic with rounded edges (40%). Of these, for analysis of the typology were used forms 3 and 4. According to the criteria for qualitative and quantitative analysis of zircon typology , the forms were identified: the c-axis elongated prism with pyramids partially or fully defined. The predominant types T and K in the portions east, northwest and southeast of the basin, where (101) bipyramidal is the face and one additional face (301). The types of zircon identified for these samples are classified as T 13-14, appearing less frequently types K 1-2. The presence of an additional face (301), which may indicate magma relatively rich in potassium, - A parameter (an average rate Al / alkalis in plutonic rocks) between 600 and 700 and T (crystallization temperature) around 700 could characterize igneous environment of high alkalinity. Crystallization temperatures may suggest source areas related to Graciosa Province, characteristically alkaline to sub-alkaline magma series at east of the basin. The next stages of the research would provide a chemical characterization of zircons for analysis by electron microprobe mineral chemistry for major and minor elements and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) for rare earth elements. Such results are needed to define and distinguish compositional parameters of zircon populations from different origins.

Geochemical signatures of Canova and El Caloso Members of the Mural Formation of Bisbee Group, Sonora, Mexico

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The limestones of the Mural Formation well exposed in a 300 km long transect which extends from Sierra El Chanate (westernmost part of Sonora) to Cerro El Caloso Pitaycachi (northeastern most outcrops) localities. The lithostratigraphic studies of the Mural Formation show minor facies changes from west to east. The Mural Formation exposed in the western part is divided into eight members i.e. i) Fronteras ii) Rancho Buffalo, iii) Cerro La Ceja (CLC), iv) Tuape Shale (TS), v) Los Coyotes (LC), vi) Cerro La Puerta (CLP), vii) Cerro La Espina (CLE) and viii) Mesa Quemada (MQ). In the eastern part of the basin, the Mural Formation is divided into five members i.e. Canova, El Caloso, Angostura, La Aguja and Agua Prieta members. The base of the Mural Formation is not exposed in the Cerro El Caloso Pitaycachi section. This section mainly consists of Canova member and part of the El Caloso member. The Canova member is considered as a deeper, lateral facies equivalent of Los Coyotes and Cerro La Puerta members and El Caloso member is correlatable with the Cerro La Espina member in the northeastern Sonora. The petrographic and geochemical studies were undertaken on the limestones of Canova and El Caloso members of the Mural Formation. The aims of our study are to document the REE characters in the limestones from Canova and El Caloso members of the Mural Formation deposited in the distal part of the Bisbee Basin; to find out the influence of terrigenous materials on REE characteristics of carbonate rocks and also to test the usefulness of REE geochemistry for paleogeographic and paleoceanographic reconstructions. SiO_2 and Al2O$_3$ contents are low in El Caloso member (0.9 ± 0.6, n=2; 0.3 ± 0.08, n=2; respectively) than Canova member (4.2 ± 0.8, n=13; 1.02 ± 0.3, n=13; respectively). Both Canova and El Caloso members show least variations in CaO contents (50.4 to 52.5%; 52.9 to 54.8% respectively). The limesotnes from the Canova member show high concentrations of Zr, Y and Th than the El Caloso member. The limestones of Canova and El Caloso members show low contents of Co, Sc and U. ΣREE content is low in El Caloso member (3.4 ± 2.1, n=2) and relatively high in Caloso member (11 ± 3.1, n=13). The inclusions of various proportions of terrigenous particles may cause the differences in the ΣREE contents among the limestones of Canova and El Caloso members. The limestones from the Canova and El Caloso members show seawater-like REE+Y patterns with 1) LREE depletion (NdN/YbN = 0.75 ± 0.1, n=13; 0.58 ± 0.2, n=2; respectively), 2) positive La anomalies, 3) negative Ce anomalies (Ce/Ce* : 0.79 ± 0.1, n=13; 0.77 ± 0.15, n=2; respectively) and 4) higher Y/Ho ratio (34 ± 4.0, n=13; 40.4 ± 8, n=2; respectively). The observed seawater-like REE+Y patterns in these limestones suggest that calcite uptakes REE from the seawater in which it forms. The REE+Y pattern of Canova member is identical to those of Late Devonian carbonate sediments whereas the El Caloso member is more or less similar to Holocene reefal microbalite with slight LREE depletion which indicates that the limestones from Canova and El Caloso members of the Mural Formation may retain their original seawater REE patterns. The present study reveals that the REE concentrations of the limestones deposited in the distal part of the basin having little terrigenous materials and free from major diagenetic alterations are suitable to understand the REE patterns of ancient shallow seawater and also they serve as a valuable seawater proxy.

Geochemistry of Lower Cretaceous limestones of Alisitos Formation, Baja California, México

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The Alisitos Formation is a volcano-sedimentary unit which is exposed in the pacific margin of the North Baja California in a discontinuous strip (NW-SE direction) from Ensenada to El Arco Calmalli with a length of 500 km and 50 km in width. The thickness of the volcano-sedimentary sequence varies due to complex tectonic relations. The formation mainly consists of volcanic and less sedimentary (limestone, marl, sandstone and clay) rocks. Based on the fossil assemblages an Early Albian age has been assigned to the Alisitos Formation. The Alisitos Formation exposed in the Los Torotes area of Baja California has been divided into six distinct informal members, viz. member A, B, C, D, E and F. Among them, the carbonate rocks are well exposed in the member C and E. The petrographic, isotopic (carbon and oxygen) and geochemical (major, trace and rare earth elements) studies were carried out on the limestones of the Alisitos Formation in order to understand the elemental variations among the different members. The diagenetic transformation of isotopic signatures can be evaluated using Sr and Mn concentrations. The limestones of the Alisitos Formation show large variations in $\delta^{13}C$ and $\delta^{18}O$ values (+4.13 to +5.26‰; -6.87 to -13.37‰; respectively). The lack of linear correlation between Mn and Sr (r = -0.49, n=19) and $\delta^{13}C$ and $\delta^{18}O$ values (r=-0.07, n=19) indicates that diagenetic modification of primary isotopic values can be excluded. The limestones of the Alisitos Formation show large variations in SiO_2, Al_2O_3 and CaO contents (2.5 to 29.0%; 0.16 to 2.63%; 37.0 to 53.9%; respectively). All trace elements exhibit lower concentrations than Post-Archean Australian Shale (PAAS) values, except Sr. The limestones from member C show high ΣREE content (23 ± 17, n=10) than the member E (11 ± 5.5, n=9) of the Alisitos Formation. The observed variations in ΣREE content in these limestones are due to the amount of detrital material present in them. The limestones from the member E record seawater-like REE+Y patterns i.e. LREE depletion, positive La anomaly, negative Ce anomaly and superchondritic Y/Ho values, whereas the member C records non-seawater-like signatures i.e. significant enrichment of MREE. Almost all analyzed samples from the Alisitos Formation show negative Ce anomalies (Ce/Ce*: 0.48 to 0.96). The limestones show both negative and positive Eu anomalies (Eu/Eu*: 0.58 to 2.91). The variations in Ce anomalies, ΣREE contents and REE+Y patterns are mainly controlled by the amount of detrital material in the limestones of the Alisitos Formation. The elemental ratios such as La/Sc, La/Co, Cr/Th, Th/Co, Th/Cr and Th/Sc suggest that the detrital material present in the limestones were probably derived from intermediate to mafic source rocks.

Geochemical variations in Cretaceous-Paleocene carbonate rocks of Cauvery Basin, Southeastern India

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The sedimentary rocks of Cretaceous-Paleocene age are well exposed in the Ariyalur area of Cauvery Basin of southeastern India which consisting both of clastic and carbonate rocks. The Cretaceous rocks where divided into three distinct groups i.e. Uttattur, Trichinopoly and Ariyalur and the Paleocene rocks were named as Niniyur Formation. The present study mainly dealt with the carbonate rocks of Albian-Danian age (Dalmiapuram Formation: Albian age; Kulakkalnattam Formation: Turonian to Santonian age; Kallankurichchi Formation: Maastrichtian age; Niniyur Formation: Danian age) in order to understand the petrographic variations among different formations. In addition, the detailed geochemical (major, trace and rare earth elements) and isotopic studies were carried out to find out the diagenetic imprints, source of REE and paleoredox conditions. The digenetic changes of isotopic signatures can be assessed using certain elemental concentrations (Sr and Mn) and their ratio (Mn/Sr). The large variations in Mn/Sr ratios (>2) indicate that these limestones are altered in terms of trace element geochemistry. The limestones of Cauvery Basin show large variations in $\delta^{13}C$ and $\delta^{18}O$ values (-10.89 to +2.93‰; -8.89 to -0.39‰; respectively). The limestones from the Dalmiapuram, Kallankurichchi and Niniyur Formations show high content of CaO (54 ± 1.4, n=11; 51 ± 3, n=13; 52 ± 3.1, n=12; respectively) than the Kulakkalnattam Formation (49 ± 2.8, n=5). Likewise, the gray shale and marl from the Dalmiapuram Formation show large variations in CaO contents. The majority of the limestones show high values of V, Cr, Th, Sc and Zr. Large variations in ΣREE content are observed among Dalmiapuram (13 ± 12, n=11), Kulakkalnattam (86 ± 23, n=5), Kallankurichchi (64 ± 13, n=13) and Niniyur (40 ± 36, n=12) Formations. Most of the limestones from the Cauvery Basin record non-seawater- like REE patterns. The Dalmiapuram and Kulakkalnattam Formations show flat and HREE depleted patterns whereas Kallankurichchi Formation exhibit bell shaped REE patterns while Niniyur Formation record the flat REE patterns. The gray shale and marl from the Dalmiapuram Formation record flat LREE and HREE depleted REE patterns. The Ce and Eu anomalies were calculated from the PAAS-normalized values. The limestone and marl show large variations in Ce anomalies (Ce/Ce*: 0.50 to 1.18) which may be due to mixing of sediment components (biogenic and authigenic phases) and detrital input from the source region. Most of the limestones show positive Eu anomalies, but few samples show negative Eu anomalies (Eu/Eu*: 0.35 to 2.11). The large variations in the clastic percentage, elevated ΣREE contents, high LaN/YbN ratios and non-seawater-like REE patterns suggest that the variations in ΣREE contents are primarily controlled by the terrigenous sediments in the limestones of Dalmiapuram, Kulakkalnattam and Niniyur Formations. The observed bell shaped REE patterns together with high ΣREE contents and LaN/YbN ratios indicate that the variations in ΣREE contents and REE patterns are mainly controlled by the diagenetic changes as well as terrigenous input in the limestones of Kallankurichchi Formation. The La/Co, La/Sc, Th/Sc, Th/Cr, Th/Co and Cr/Th ratio suggest that the terrigenous materials present in the limestones of Dalmiapuram, Kulakkalnattam, Kallankurichchi and Niniyur Formations were derived from the intermediate to felsic igneous rocks. In addition, the elements ratios also suggest that some amount of mafic components were contributed during the deposition of the Niniyur Formation. The limestone and marl samples from the Cretaceous- Paleocene rocks of Cauvery Basin show positive values of Mn* and low Ni/Co ratios (<5.0) suggesting that these carbonate rocks have been deposited under oxic environment whereas gray shales show negative Mn* values and high Ni/Co ratios (≥ 5.0) which support that these gray shales were deposited under reducing conditions.

Supercritical flow deposits in the alluvial fan succession in the Permo-Carboniferous Talchir Formation, Talchir Gondwana basin, Orissa, India: implications in Gondwana deglaciation

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The Permo-Carboniferous Talchir Formation is the lowermost stratigraphic unit of the Gondwana lithic fills in Peninsular India. The sedimentation and basin evolution during Talchir time were largely controlled by deglaciation of the Gondwana glacier. In the initial stage of glacial recession, a collapse of a glacier and a failure of intra-montane glacial lakes frequently occurred and gave rise to generation of a highly sediment-laden debris flow and a catastrophic flood, which brought abundant coarse clastics into the lake and built an alluvial-fan−fan-delta system on the basin margin. Within the succession representing alluvial fan sedimentation, bedforms and stratification indicative of an antidune origin under a supercritical flow condition are well observed. Antidunes and antidune stratifications reported herein from the Talchir Formation vary in their scale and morphology, reflecting differences of paleohydraulic conditions for their formation. They are of either two- dimensional or three-dimensional; the later ones are common. Broadly convex-up, concordant and continuous laminae over the bedforms are significant in these structures. Some show distinct backset laminae. The paleohydraulic reconstruction for the Talchir antidunes indicates that the antidunes were formed in a wide range of flow conditions with variable flow depths of up to 140 cm and flow velocities of up to 370 cm/sec. It is notable that many of antidunes give enormously great values of flow velocity and flow depth as the consequence of their large wavelengths, commonly of the order of 10 m to more than 15 m, seldom reported from rock records. Talchir antidunes were most likely formed by highly sediment-laden sheetflood flows, of which velocity can have attained more than 300 cm/sec and depth more than 100 cm. Common occurrence of large- scale antidunes in the succession indicates that sheetfloods of unusual magnitude frequently generated on the Talchir alluvial fan and spread over the fan surface. In the context that sedimentation and basin evolution during Talchir time were highly controlled by deglaciation of Gondwana glaciers, the development of the alluvial-fan−fan-delta system following glacial sedimentation was undoubtedly related to the climatic warming and the fan was fed by ice-melt water from the receding glacier. Coarse detritus accumulated in the hinterland from a melting glacier and were supplied into the basin due to increasing volume of ice-melt water, resulting in the generation of fans along the basin margin and their growth into the lake basin. Rapidly melting glaciers give rise to generation of montane glacial lakes. The accumulation of water in the lakes rapidly increases with the recession of glaciers and eventually results in sudden discharge of huge volume of water and debris due to the burst of lakes, causing large-scale floods. During the Talchir time, glacial lake outburst floods would have frequently occurred and given rise to highly sediment-laden, flood flows. Such flows were primarily responsible for the deposition of the conglomerates and sandstones of the Talchir alluvial-fan−fan-delta system. Large-scale antidunes in the Talchir alluvial fan succession is possibly the records of powerful, super-flood flows spread over the alluvial fan surface as a result of outburst of intra-montane, glacial lakes having a great pondage.

Forced regression deposits in an oceanic island: the example of Fernando de Noronha, Brazil

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The archipelago of Fernando de Noronha as well as Atol das Rocas and São Pedro e São Paulo rocks are located along the aligned structures of several submarine volcanic hills and high funds in the ocean floor near the coast of the northeastern Brazilian state of Rio Grande do Norte. This set of mountains was originated by an active hot spot in the Miocene, between 34 million and 1.4 million years ago (Teixeira et al, 2003). The island of Fernando de Noronha displays several outcrops of rocks formed in the last two volcanic cycles that formed the island at about 10 million years ago, producing pyroclastic rocks, flows, dykes and plugs. These rocks are partly covered by Pleistocene eolian bioclastic calcarenites of Caracas Formation and modern beach sediments deposits (Almeida, 1958). Deposits of fan deltas occur in the Bay of Caieira resting on tufts and lava and placed beneath the Caracas calcarenites. The fan deltas deposits present several layers of conglomerates with external sigmoidal geometry forming high angle clinoforms, and progradation direction to Northeast. Conglomerates look massive with localized planar stratification, are disorganized and poorly sorted with grain size ranging from granules to blocks of volcanic material supported by mud rich sand matrix. The deposits were formed by subaerial gravity flows developed during the eustatic drop that occurred between 180,000 to 130,000 years ago, when sea level fell by a hundred meters in the archipelago, and are therefore interpreted as forced regression deposits. Probably the conglomerates and sandstones that occur in the small island of Pedra da Bigorna, Rata and others, resting at the base of Caracas calcarenites as recognized by Almeida (1958) are also the same type of sedimentary deposit. Forced regression deposits are formed during periods of base level fall when the coastline is forced to regress regardless of the input of sediment (Catuneanu, 2006). There are many papers about forced regression deposits but mainly related to platform margin in the continents. This paper reports the occurrence of forced regression deposit in remote oceanic island located about three hundred kilometers far from the coast.

Projected Earth analogues of tsunami on Mars

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Terrestrial tsunamis have been principal high-energy events shaping shoreline topography over the whole of Earth's history, early episodes in the Precambrian lost by plate movement. The principal factors focusing tsunami-wave energy are the character of shoreline topography and coastal water depth, which together control wave compression and shoreline friction. Shorelines possessing narrow embayments and steep offshore gradients produce high wave compression engendering increased collision of grains within the carried load vs. linear shorelines with shallow offshore gradients that dissipate energy. Steep offshore gradients produce concentrated major wave friction with the bed engendering high kinetic energy in the wave during emplacement of tsunami-generated blanket sediment, which differs from shallow offshore beds that produce lower frictional effects over a wider area and drawdown of wave energy. Thus, overprinting of transported quartz and other minerals on Earth is greatest where wave energy is highest, attenuated down to minor or nil grain overprinting where wave energy is less. Bolide impacts on Mars within the proposed ocean boundaries ("contacts 1 and 2") in the northern lowlands are expected to have generated ultra high-energy waves similar in kind to tsunamis on Earth. Impacts into putative Noachian and Hesperian seas of variable areal extents and depths would have produced high-energy inundations (transgressions), which would have left an event-imprint in the stack of deposits adjacent to the proposed shorelines. Such mineral grain overprinting in the form of energy-induced microtextures would also be observed in other grain types such as olivine and plagioclase, mineralogies expected to dominate the Martian landscape based on orbital and local field (lander and rover) perspectives. Kinetic energy variations in Martian tsunamis is controlled more by the square of velocity than mass, the resulting grain collisional effects of which are expected to produce swarms of v-shaped percussion microfeatures on quartz and other silicate mineral surfaces when velocity and compression are highest, just as on Earth. This work indicates that a valid test for the Martian ocean hypothesis is targeting "coastal" areas adjacent to narrow embayments where offshore depths are highest, as possible tsunami-emplaced sediments, especially those that have been protected from atmospheric conditions through relatively rapid burial, may reveal a high frequency of percussion cracks, features of which appear to be unique to such terrestrial environments.

Evolution of channel formation and fill in a high sediment supply, methane-influenced deep-water slope setting: Upper Miocene Urenui and Kiore formations, Taranaki Basin, New Zealand

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This study interprets depositional architectures, stratigraphic patterns, and factors influencing deposition a high sediment supply, prograding slope system where subsurface methane and mass transport deposits influence channel formation and fill. The Urenui and Kiore formations consist of upper Miocene, mid- to upper-slope, deep-water deposits which are exposed in laterally continuous coastal outcrops in northern Taranaki Basin, New Zealand. Offshore 3D seismic-reflection data record an interval that is analogous to the outcrop and includes prograding clinoforms above a large mass transport deposit. In outcrop, the Urenui and Kiore formations are a heavily bioturbated siltstone sequence with sandstone and conglomerate filled channels preserved at different stratigraphic levels. Outcrops are divided into three lithofacies based on grain size, including (A) siltstone, (B) fine and very fine grained sandstone, and (C) granule to pebble extrabasinal conglomerate. Methane-related tubular concretions found within the siltstone lithofacies are linked to stratigraphic development of the channels and mass transport deposits, but origin of the tubular concretions remains controversial. Five patterns of repeated stratigraphic units emerge from the association of these lithofacies: 1) Units of methane-related tubular concretions are truncated by discrete surfaces and occur without chemosynthetic communities. 2) Slump deposits and channel-fill consistently overlie tubular concretions, which are linked to subsurface methane and frequent mass transport events. 3) Channel bases are found within Lithofacies A, but Lithofacies B and C are restricted to channel fill deposits. 4) Lithofacies A and B deposits consistently thin and drape onto contact surfaces instead of displaying onlapping geometry. 5) Channel fill generally coarsens and then fines upwards. These patterns and outcrop observations indicate that channels have been filled by turbidity currents with little associated erosion which may be splays. Mass-transported sediments and evacuated slump scars created conduits for sediment gravity flows and may have influenced filling of channels.

The effects of sea level fluctuations and glaciation on the Ordovician-Silurian boundary of Jordan

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The Ordovician-Silurian boundary (OS) witnessed glacial conditions throughout Gondwanaland. At that time Jordan was located on northeastern Gondwana, and was affected by the glacial event. The Ordovician-Silurian boundary in southern Jordan marks a short-lived glaciation episode. The climatic change and the major shoreline retreat of the Palaeotethys Ocean that took place at the end of the Ordovician period as a result of sea level fluctuations were responsible for the land emergence, and the subsequent establishment of the glacial and glacio-fluvial conditions. The rocks of Ammar Formation which are exposed in south Jordan between Mudawwara and Batn el Ghoul are the result of this event. The glacio-fluvial deposits of Ammar Formation rests upon a basin-wide erosional surface marked with palaeovalleys, and is incised between shallow to deep marine deposits of Tubeiliyat and Batra members of the Mudawwara Formation. This distinct unconformable boundary marks the Ordovician-Silurian boundary according to present literature so far. This paper proved the existence of at least 10 m of rock strata resting above the OS boundary which is identical to those below the boundary of Tubeiliyat rocks. These missed strata are described, measured, interpreted and recognised as a new rock formation (Harad Formation).

Field evidence that submarine debris flows can transport clean sandstone for long distances into the deep ocean: examples from the Marnoso-Arenacea formation, Italian Apennines

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Submarine flows can transport huge volumes of sediment across the large submarine fans that dominate many parts of the deep ocean floor. Ancient flows of this type have deposited thick rock sequences that now hold some of the World's largest oil and gas reserves. Classic models assume relatively diluite turbulent flows as the only mechanism able to transport and deposit thick sandstone layers in distal submarine basin plains. A different mechanisms involving more dense non-turbulent sandy debris flows has been proposed to explain the presence of thick massive sandstone layers in ancient basin plain succession. The Marnoso Arenacea Formation, extensively outcropping in the Italian northern Apennines, provides a unique case study for this purpose. This Miocene Formation represents the sedimentary fill of one of the progressively north-east migrating foredeep basins of the Apennine chain. Mega-turbidites with a distinctive composition and provenance occur every 20–50 m. in parts of the older (inner) basin sequence. The Contessa Mega Bed in particular is useful as a marker bed, because of a distinctive limestone-rich composition, thickness and provenance. Thirty-five sections have been logged in a single statigraphic interval below the Contessa marker bed. Single beds have been correlated over more than 60 km, providing unusually detailed constrains on bed shape, witch can be used to deduce flow evolution and to test the validity of transport and depositional models derived from characteristics observed in outcrops with limited lateral extent. This study analyses in particular clean (mud-poor) sandstone beds showing characteristics suggestive of en-masse debris flow deposition. A quantitative estimate of the textural characteristics of the deposits, as the vertical grading pattern and the percentage of mud matrix within sandstone is provided in order to define a useful tool for distinguishing clean debrite sandstones from clean turbidite sandstone in other outcrops, and possibly in cored reservoirs. The external bed shape and the lateral variation of facies is documented for each bed through long distance correlations. It's shown that beds pinching-out abruptly laterally are more likely to be deposited en masse by relatively dense, non-turbulent debris flows. Sandstone beds showing a gradual tapering geometry are interpreted as deposit of relatively diluite turbulent flows. The origin, the transport and depositional mechanisms of non-cohesive sandy debris flows are than discussed, together with implications of this study for predicting sandstone extent in subsurface oil and gas reservoirs.

Comparative sedimentary provenance analysis of Upper Ordovician siliciclastic rocks from the San Rafael Block (Pavón Fm) and from the eastern side of the Cordillera Frontal (Las Lagunitas Fm), Mendoza-Argentina

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The San Rafael Block as a southern part of the Cuyania-Precordillera terrane is characterized by a Grenvillian-type basement overlain by Lower Paleozoic carbonate-siliciclastic rocks. During the Late Ordovician siliciclastic detritus was deposited as a marine clastic wedge within a foreland basin, after the drowning of the carbonate platform to conform the siliciclastic Pavón Fm bearing Sandbian graptolites (Manassero *et al.*, 1999; Cingolani *et al.*, 2003). On the other hand it was discovered recently (Tickyj *et al.*, 2009) in the black shales of the Las Lagunitas Formation outcropped at the eastern side of the Cordillera Frontal the same graptolite fauna. This unit is located between the Diamante and Tunuyán River. The studied section at the Cortaderas creek is a clastic sequence comprising levels of well-sorted, coarse- to medium-grained sandstones and conglomeratic sandstones; coarse- to fine-grained wackes and medium- to fine-grained sandstones, intercalated with black shales. Within this profile the sandstone petrography of the studied samples shows quartz-feldspathic arenites with abundant undulate monocrystalline quartz, policrystalline quartz, metamorphic rock fragments, albite twined plagioclase, potassium feldspars and detrital flexures muscovite as accessory mineral. It is interesting to note that the Pavón and Lagunitas Fms show coherent sedimentary provenance from a continental block and recycled orogen sources. The new findings help to suggest that the Lagunitas Fm could be a western extension of the lithofacies of the Pavón Fm, in the Cordillera Frontal (Chilenia terrane) with source areas located to the East of the study area. Geochemical, isotopic analyses and detrital zircon ages are in progress.

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Sandstone petrography and provenance of the Los Molles and Las Lajas Formations (Cuyo Group-Jurassic) in the Arroyo La Jardinera region, Neuquen Basin, Argentina

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The Cuyo Group (Pliensbachian-Early Callovian) in the Arroyo La Jardinera area (southwestern Neuquén basin) comprises about 2000m of siliciclastic strata. This area is crossed by the 46 Route and is located about 60 km from Aluminé. It offers a good example of a regressive succession characterized by slope and basin floor gravity flow strata (Upper Los Molles Fm) overlain by shelf and nearshore facies (Las Lajas Fm) and, finally, by fluvial (Challacó Fm) deposits. Seven vertical sections have been described in the area (Paim et al, 2008) and more than 120 thin sections of medium-grained sandstone have been studied under the microscope by classical point counting techniques. This information was plotted in the Dickinson provenance diagrams and analyzed together with paleocurrent and conglomerate composition data. In general terms, the Upper Los Molles Formation records transitional and dissected arc source areas while the Las Lajas Formation dissected arc and recycled orogen provenance. Taking into account the transitional relationships between both units, the following upward trends are apparent: increasing grain size, porosity and plagioclase, microcline and chert content and decreasing matrix content. The connection between source areas, stratigraphy and paleogeography is analyzed bearing in mind the presence of widespread Jurassic andesitic source areas to the west, granitoids to the south, and acid volcanic rocks to the east. The Lajas Formation has a higher maturity – quartz content – than both the Los Molles and Challacó formations. This higher quartz content was assigned to specific sedimentary processes rather than to changes of the source area, i.e., fluvial (Challacó Fm) and gravity (Los Molles Fm) flows towards the depocentre, their strata hence recording a primary source located to the WSW, whereas parallel to the coastline, alongshore drift to SSE associated with strong wave-reworking would easily explain the higher degree of textural and compositional maturity of the Lajas Fm sandstone beds.

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Fish taphonomy in lacustrine environment: Los Rastros and Cacheuta formations (Middle Triassic, Argentina)

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Two important lacustrine successions were housed in Triassic extensional basins at Center-Western Argentina. The Los Rastros Formation (Ischigualasto –Villa Unión Basin) is a lacustrine-deltaic succession that consists of several coarsening-upward cycles of black shales, siltstones and sandstones. The Cacheuta Formation (Cuyana Basin) is a lacustrine succession dominated by black shales and silstones. The fish records from these two lacustrine sequences were evaluated within environmental context and contrasted. The Los Rastros fishes are found as isolated scales and disarticulated cranial bones (fragmentary and/or complete), clumps of scales, body fragments (articulated scales), and complete specimens, occasionally without heads. The Cacheuta fishes are found as isolated scales and disarticulated cranial bones, clumps and stringer of scales, body fragments (articulated scales and/or fins) and complete specimens. The taphonomic features allow us to define three taphofacies for Los Rastros fishes (LR-A to LR-C) and four taphofacies for Cacheuta fishes (Ca-A to Ca-D). A Principal Component Analysis was performed with the taphonomic features, supporting the seven taphofacies defined. The LR-A taphofacies, characterized by scales and bones isolated and dispersed or in clumps, and well sorted, is found in open lake facies. The LR-B taphofacies, characterized by densely packed, partially articulated remains, and poorly sorted, is related to distal turbidity current facies. The LR-C taphofacies, characterized by partially to totally articulated remains, densely to loosely packed, and poorly sorted, is found in mouth-bar deltaic facies. The Ca-A taphofacies, characterized by scales and bones isolated and dispersed and well sorted, is found in open lake facies. The Ca-B taphofacies, dominated by scales and bones associated but dispersed, forming clumps and stringer, concordant to stratification, loosely-packed, and well sorted, is related to underflows facies. The Ca-C taphofacies, characterized by scales and bones associated but dispersed, forming clumps with bioclast cutting the stratification, densely-packed, loosely sorted, is found in distal turbidity current facies. The Ca-D taphofacies, dominated by articulated fish, concordant to stratification, dispersed, and poorly sorted, is related to open lake facies. Thus, the fish features reveal their taphonomic history. The isolated and dispersed remains found in open lake facies reached the bottom after suffering flotation-decay in both Los Rastros and Cacheuta lakes (LR-A and Ca-A). The articulated fish found in open lake facies of Cacheuta lake (Ca-D) reached the bottom intact without suffering flotation-decay, predation or scavenging. The scales and bones associated but dispersed found in Cacheuta underflows facies (Ca-B) reached the bottom after suffering flotation-decay and rework by laminar flow. The scales and bones associated but dispersed found in turbidity current facies reached the bottom after suffering flotation-decay and rework by turbulent flow in both Los Rastros and Cacheuta lakes (LR-B and Ca-C). Finally, the articulated remains found in Los Rastros mouth-bar deltaic facies (LR-C) reached the delta intact without suffering flotation-decay, predation or scavenging. The Cacheuta Lake preserved abundant fish remains, in contrast to Los Rastros Lake. In both cases, flotation-decay process lead mainly to fish disarticulation. Only in Cacheuta Lake articulated fish occur in open lake facies, whereas in Los Rastros Lake these occur in delta facies. The fish assemblage studied allows us to suggest that Los Rastros fish were allochthonous to the lake and probably inhabiting the affluent fluvial system, whereas the Cacheuta fish represent an abundant autochthonous lacustrine community of primarily pelagic and nektonic organisms.

Paleontologic and sedimentologic evidence of forced regression at an active rift margin - the Triassic Los Rastros Formation, Ischigualasto-Villa Unión Basin, Argentina

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The Triassic Ischigualasto-Villa Unión Basin is a rift basin located in the western margin of Gondwana; its origin is associated with the breakup of Pangea during the earliest Triassic. A lacustrine-deltaic succession exists in the Los Rastros Formation of this basin and consists of several coarsening-upward cycles of black shales, siltstones, and fine- to coarse-grained sandstones. Cycles thickness range from 10 to 180 m and are interpreted as influenced by tectonic and climatic variation. Only in the northwestern part of the basin, near the fault-bounded margin, the base of the Los Rastros succession is dominated by deltaic facies (delta front and plain facies) linked to synchronous marginal palustrine facies, both interbedded with offshore facies. Evidence of subaerial exposure is present in these three facies (Mancuso and Marsicano, 2008; Marsicano *et al.*, 2010). Delta mouth-bars (delta front facies) show the cross-cutting relationships among the ripple marks, footprints, and invertebrate traces of the Scoyenia ichnofacies that suggests a palimpset bedding surface, and some horizons with desiccation mudcracks. After this depositional gap, lake transgression is indicated by delta front and delta plain facies on the top of the delta front track-bearing beds. Laterally, these track-bearing deposits interfinger with several palustrine carbonate bodies, developed at the end of each cycle. The peloidal and intraclastic textures in these bodies define a granular wackestone that has been described in palustrine carbonates (Alonso Zarza, 2003). Mottled textures in these wackestones suggest the remobilization of iron as a consequence of changes in the Eh of fluctuating water tables (Freytet, 1973). Evidence for a relative groundwater table fall is revealed by a decrease in water content within the upper wackestone at the time of track making and the presence of desiccation cracks in the overlying wackestone. Some offshore black shales containing mudcrack are interbedded with delta front and palustrine facies, giving evidence of subaerial exposure. These exposed shales are also covered by offshore black shales without subaerial exposure features. Upsection, the development of thick offshore facies over all these deposits (delta, palustrine and offshore) indicates the onset of a transgression over the lake margin facies. Thus, the Los Rastros succession located on the western fault-bounded margin preserves subaerial exposure features in the shoreline facies (delta front and palustrine) as well as in the offshore facies as the lake level fluctuated. Therefore, these subaerial exposure features are related to a relatively rapid withdrawal of the water basinward probably due to a forced regression perhaps related to rapid pulses of tectonic subsidence during early rifting of basin evolution.

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Paleoecologic significance of trace fossils from a Burgess Shale-type deposit in the Stephen Formation, Stanley Glacier, Canadian Rocky Mountains: Implications for understanding redox and substrate conditions of Burgess Shale biotas

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A recently discovered Burgess Shale-type locality of the "thin" Stephen Formation at Stanley Glacier (British Columbia, Canadian Rocky Mountains) hosts a low-diversity soft-bodied biota and also locally abundant, extraordinarily well-preserved trace fossils. These structures are preserved at the bedding surfaces of thin calcareous claystone beds, which accumulated below storm wave base in a distal ramp setting. Two trace-fossil assemblages have been recognized based on the study of discrete trace fossils with extensive bedding-plane distribution. Biogenic structures are characterized by very small size, typically millimetric to micrometric. Assemblage I (level 29.33 and talus slabs) is characterized by moderate ichnodiversity and a bedding-plane bioturbation index of 2-3. Several morphologic groups are represented, including simple trails (*Gordia, Helminthoidichnites, Helminthopsis*), bilobate trails (*Cruziana, Diplopodichnus*), rosary-like burrows (*Hormosiroidea*-like), radial structures, and arthropod trackways. A two-level micro-tiering structure can be reconstructed. Shallow simple and bilobate trails are consistently crosscut by slightly deeper rosary-like burrows and radial structures. Assemblage II (level 29.52 and talus slabs) is characterized by its relatively low ichnodiversity, being typically paucispecific or most commonly monospecific. The bedding-plane bioturbation index is typically 2. The dominant form in this trace-fossil assemblage is "rosary-like structures", but tiny radial structures may be present also. Substrate consolidation and oxygen content are interpreted to be the two most important environmental controls. Variations in morphology, burrow sharpness, and degree of deformation of the rosary-like burrows are attributed to variable degrees of substrate consistency. Rosary structures in trace-fossil assemblage 1 tend to display perfectly circular tiny chambers (diameter of the chamber smaller or similar to the width of axial tunnel) with sharp outlines suggestive of firmground conditions. Morphologic variability of rosary-like burrows in trace-fossil assemblage II suggests formation in firmgrounds to softgrounds. In soft substrates, rosary structures tend to display almost clustered, relatively larger, globular chambers (diameter of the chamber larger than width of axial tunnel) in very close proximity. The common theme to oxygen-deficient ichnofaunas is that density of bioturbation, trace-fossil diversity, maximum penetration, and burrow size tend to decrease with decreasing dissolved oxygen content. Following these parameters, Stanley Glacier assemblage II depics a more stressfull oxygen-deficient community than assemblage I. In addition to the two trace-fossil assemblages, diminutive trails (e.g. *Helminthopsis, Helminthoidichnites, Cochlichnus*) are directly associated with the flexible carapaces of *Hurdia, Sidneyia and Tuzoia*. The most abundant structures are simple trails, straight, curved or sinuous, that do not self-overcross. The small size and particularly the shallow penetration depth of biogenic structures indicate that the discontinuity redox surface at Stanley Glacier was always relatively close to the sediment-water interface. The absence of the *Chondrites* ichnoguild in this early oxygen-controlled ichnofaunas may be of macroevolutionary significance. Although our knowledge of Cambrian oxygen-deficient ichnofaunas is still incipient, the peculiarites of Cambrian oxygen-deficient trace-fossil assemblages revealed by the study of the Stanley Glacier trace fossils sheds significant light into our understanding of oxygen-depleted early Paleozoic ichnofaunas. Further work will most likely result in a calibrated ichnologic model for Cambrian oxygen-deficient ichnocoenoses, including those present in Burgess Shale-type deposits

Carbonate deposition in a fluvial Tufa system: products and processes (Corvino Valley – Southern Italy)

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Recent tufa deposits forming in fluvial barrage systems in Northern Calabria (Italy) reveal the remarkable influence of microbial biofilm in the formation of neo-precipitate low-Mg calcite. Tufa form in a moderate-flow low-supersatured stream generating a series of dams and pools where two types of depositional facies are produced: vacuolar tufa and stromatolitic tufa. A biofilm colonizes the external surfaces of all tufa deposits, composed of heterogeneous communities comprising filamentous cyanobacteria, green algae, heterotrophic bacteria, diatoms, mosses and arthropod larvae. The microbial community develops within the active depositional zone constituted by micro-columns of neomorphic calcite with inner cavities, separated by interstitial channels. Growth processes of the carbonate have been investigated through petrographic, SEM and ESEM methodologies comparing neoformed tufa, on both natural and artificial substrates, collected at seasonal intervals. In the active depositional zone the physical deposition of mineral occurs along the external surface of micro-columns, such as in the inner cavities, with or without connection with the external surface. Further punctual sites of precipitation can occur suspended within the cyanobacterial tuft masses. Submicron-sized crystals about 10-20 nm in diameter, with a subspherical shape, are the smallest mineral units observed. They form early agglutinated rod-shaped crystal aggregates, 100-200 nm in size, which give rise to two basic types of crystal polyhedrons: pyramidal to rhombohedral and disphenoidal solids. In the first case they are formed by closed stacked minute triads (short and long) while in the second case polyhedrons are made by the aggregation of the early-formed rod-shaped crystals. All types of basic-polyhedrons, coalesce to form larger crystals of calcite (mainly tetrahedrons) that represent the mineral structure of the biofilm (micro-columns and pinnacles). Identical petrographic components and fabric are recognizable in both neoformed stromatolitic and vacuolar facies; micrite, microspar and spar occur in more or-less well-defined alternating layers. Micrite and microsparite are often associated forming several types of fabric: peloidal to aphanitc, laminar and dendrolitic. Sparite can occur in layers composed of isolated to coalescent fan-shaped crystals, forming respectively botryoids or continuous crusts. The occurrence of the petrographic components varies in abundance following seasonal variations in their nano-crystal structures, from warmer to colder periods: micrite, microspar and spar correspond with long triads, short triads and rod-shaped aggregates, respectively. On the other hand fabrics are also influenced by the micro-morphology of the organic mineralizing substrate. The microbial community is closely connected with the active depositional zone, since no precipitation takes place in the absence of the any living or non-living organic components of the biofilm, indicating that all mineral phases originate as a consequence of the biological activities of the biofilm community.

Hyperpycnal sedimentological model of the Merecure Formation, Oligocene, Northern Monagas State, Maturin Sub-basin, Venezuela

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This paper shows the results of the study carried out in the traditional northern area of Monagas State, specifically in the Merecure Formation, one of the main hydrocarbon-bearing units in the Eastern Venezuelan Basin. During this investigation was integrated the information of 57 wells which had core data with a total thickness of 24,000 feet and over area of 1,400 km^2. Facies classification was done using a genetic and predictive facies tract (Zavala *et al.* 2007) which allowed differentiating a total of 12 sedimentary facies. The recognized facies were divided in two groups, bedload and suspended load. Depositional model permitted to apply the new methodology of genetic facies analysis development by Zavala *et al.* 2007, to process huge core data; and them, to elaborate index maps of the genetic facies distribution. The indexes were calculated from of relation between bedload and suspended load facies obtaining adimensional numbers that fluctuate from 100 to 0. According to Zavala, Pt index measures how proximal the core is located respect to the hyperpycnal system as a whole. Lt index gives an indication of how lateral the core is located respect to the flow axis. Pt (Proximity) and Lt (Lateraty) indexes were calculated and mapped in the whole study area within a sequence stratigraphic framework which show three depositional sequences of third order called in this study such as M1, M2, and M3. As a result, the Merecure Formation is composed by more than 1,000 feet of marine shelf clastic deposits where each individual sandstone bodies was studied and analyzed showing up to 30' thickness. These deposits were accumulated in an elongate basin oriented Northeast - Southwest, located between an active mountain front (North) and the Guayana shield (South). The facies analysis suggests that these sediments were deposited from gravitated sediment flows directly related to river discharge of high density and long duration (hyperpycnal systems) associated to a marine platform environment. Index mapping permitted to predict source areas, facies distribution, and reservoir quality in undrilled areas. The facies identified showed mainly massive to cross-stratified pebbly sandstone grading from massive coarse fine grained to laminated fine grained sandstone toward basinward. The bedload facies group are composed for coarse grained and related to drag forces provided by the overpassing turbulent flow while the suspended load facies group are composed of fine grained sandstones and relate to the gravitational collapse of the suspended load as the long-lived flow progressively wanes basinward and also are the result of the fallout of very fine grained sands, silts, plant debris and micas from lofting plumes mainly in the flow margin areas. Based in the petrographical analysis and core description was defined that main sediment source is from cratonic areas located in the south and south-east of Venezuela basin. Also, it demonstrated that is possible to think a close relation between reservoir properties and facies group considering that bedload facies group shows the best pertrophysical properties than suspended facies group. In general, bedload facies group has good porosity caused by its original open packing; but fine grained materials deposited in pore space would affect permeability decreasing this property; however, petrographical results showed that fine grained material was dissolved by diagenetic processes. Finally, the index genetic map allowed predicting the reservoir quality in undrilled areas and thus to propose new wells in the best reservoir quality area.

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Provenance analysis through multivariate statistics in a fault-bounded basin: implications for the tectonic evolution of the Santa Bárbara Group, Camaquã Basin, Southern Brazil

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Provenance analysis in proximal deposits is a valuable tool for evaluating the tectonic evolution of fault-bounded basins. Here we present the results of multivariate statistical analysis of pebble compositional data from Ediacaran alluvial fan and braided river successions of the Santa Bárbara Group in the Western Camaquã Basin, Southern Brazil. The statistical treatment was performed through Log-Ratio transformation, which was made possible by an alternative strategy to access the problem of zero values in compositional data sets. The resulting cluster analysis of sites was used to understand the geographic and stratigraphic variation of source-areas, with implications for the evolution of basin-border highlands and the interpretation of syn- depositional basin-border fault movement. Provenance analysis were performed through the measurement of the area expression of clasts with dimensions larger than 0.5 x 0.5cm, totaling at least 300 clasts in each site. The zero values in the compositional data set were substituted using a Multiplicative Replacement Strategy, which has the advantage of preserving the covariance structure of the replaced data set. However, instead of substituting the zero values for a value equivalent to 65% of the detection limit, the zero values were replaced by the greatest value statistically indistinguishable from zero, given the sample error for each site, thus returning a replacement value that was different for each provenance site and was small enough to avoid spurious effects. Provided the nonzero compositional data, the data sets were then submitted to the Centered Log-Ratio transformation, stretching the compositional data to an unclosed data range, thus allowing further multivariate analysis. The provenance data was obtained in two alluvial fan conglomerates levels, one in the lower portion of the Santa Bárbara Group and other in its upper deposits. In order to assess the lateral similarity in provenance between different sites of analysis, one dendrogram was constructed for each area and then confronted with the local geological map for a better visualization of the spatial variation of provenance. Both dendrograms can be correlated with the nearby sources, with the main clusters organized accordingly to the local geology. The dendrogram obtained in the lower Santa Bárbara Group shows the best fitting to the local sources, since the provenance sites comprises a narrower stratigraphic interval in comparison to the dendrogram obtained in the upper Santa Bárbara Group. The mainly proximal character of the deposits found in the lower and in the upper successions of the Santa Bárbara Group, together with the strong correlation between the provenance sites and the adjacent basement rocks and the coincidence between clusters separations and contact between source-area lithologies, indicates that none or minor lateral displacement took place between the sources and their related deposits. Such evidence implies in the absence of major strike-slip movement of the basin border faults during deposition, favoring the alternative hypothesis of normal basin-border faulting as the cause of Santa Bárbara Group deposition in a rift basin. Additionally, the data indicate that during the early sedimentation of the Santa Bárbara Group the terranes located to the south and west of the basin were uplifted, while at the latter stages of basin infilling the uplifted areas were located west of the basin, in the present Caçapava do Sul Structural High, with the progressive increase in lithoclasts from this source area suggesting that the uplift took place during the basin deposition.

Geochemical characterization of Rano Aroi peatbog for the last 70 kyr cal. BP (Easter Island, Central Pacific, 27 S): environmental and climatic implications

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Many efforts have been made to provide clues of past environmental and climatic evolution of Rapa Nui, the easternmost island of the Polynesian archipelagos (Easter Island, 27 S, 109 W). Despite the island is mainly known because its civilization collapse paradigm, there are also many questions left concerning the Late Quaternary environmental evolution. A 12 meters long core was retrieved from the center of Rano Aroi peatbog during the March 2006 drilling campaign. Here we present a high resolution XRF core scanner profiles of S, Ca, Ti, Fe and Br and stable isotope composition ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) of bulk organic matter of Rano Aroi. The age model, constrained from a set of 15 AMS radiocarbon dates, indicates that the uppermost 8.5 m cover the last ca. 50 kyr cal. BP. As sedimentation rate for these 8.5 m is broadly constant, the recovered core would comprise the last 70 kyr cal. BP. The entire sequence is organic-rich, with Total Organic Carbon (TOC) concentrations that oscillate between 45 and 70% wt. Three alternating facies have been distinguished: (1) fine-sized organic mud associated to high Ti-Fe counts in XRF, (2) granulated muddy peat with lower terrigenous content, and (3) a reddish peat facies made up of coarse *Scirpus sp.* detritus. Principal Component Analyses (PCA) of the XRF dataset allowed us to define the main sedimentological processes. Variation in $\delta^{13}C$ values from -15 to -21‰ PDB between 55 to 40 kyr cal. BP indicates changes in the flora composition, both in the peatbog and catchment area. An original C_4 type plants dominance may had been replaced by a C_3 plants community, suggesting either changes on the atmospheric CO_2 concentration-temperature balance or the arrival to the island of the *Scirpus sp.* From 40 to 14 kyr cal. BP Rano Aroi sequence presents a sedimentary hiatus that, according to other paleoenvironmental reconstructions carried out in the island, could be interpreted as dry prevailing conditions during most part of Marine Isotope Stage 3 (MIS3) and the Last Glacial Maximum period. Light Holocene $\delta^{13}C$ values indicate a C_3 plants dominance up to the present. Large fluctuations of $\delta^{15}N$ values could be related to the occurrence of anoxic events that may be interpreted as consequence of large water level oscillations during the last 70 ky cal BP. First $\delta^{34}S$ data around +20 ‰ suggest a marine origin for sulfur, likely sulphate arrived as sea-splash aerosols subsequently reduced to organic sulphur compounds and sulphides (pyrite) in a closed system.

Tephras beds from Deception Island Glaciers as potential stratigraphical markers

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The last Deception Island eruptions, in 1969 and 1970, were restricted to its eastern part in a glacier-covered zone at Goddard Hill (62°55'00,7"S /60°37'40,3" W). In the summer of 2002, a Brazilian Antarctic Program glaciological expedition investigated a small (diameter <400 m) crater formed in those events. One of its walls bisected the glacier, resulting in a 60m vertical section that exposes the annual snow and ice accumulation layers intercalated by several tephras beds from former eruptions. Their geochemical identification may be a useful tool for many research themes, especially to ice stratigraphy and paleoenvironmental reconstructions using tephras horizons found in ice cores. We sampled the 15 most expressive tephras beds, which are nonconsolidated pyroclastic ejecta, well preserved and not affected by strong alteration or erosional processes. Our first aim is to characterize each tephra layer by detailed mineralogical, petrographic and geochemical studies looking for peculiarities of each eruption. In addition, specific grain composition of plagioclases, ferromagnesian assemblages (e.g., pyroxenes, olivine, magnetite, ilmenite-titanomagnetite) and glass fragments were determined by microprobe analysis to help differentiating eruptions. During its evolution, Deception volcanism is marked by a transition from oceanic basalt to calc-alkaline rocks, recent eruptions show evidences of acid rocks induced by modifications in the pyroclastic material. This work compares the tephra beds considering their petrography (color, texture, proportion and kind of fragment), associated geochemistry using major, trace and rare earth elements concentrations and individual mineral properties (composition, specimen, homogeneity). This set of information may characterize the signature of each eruption helping to fingerprint ash layers found in ice cores elsewhere in Antarctica. The association of seawater and glaciers in the Deception Island volcanic environment favor phreatomagmatic eruption events that increase largely the production and dispersal of pyroclastic material. As a sub-product of this study, we studied the weathering mechanism in tephras that lead to bentonite rocks.

The K-T boundary in the Yacoraite Formation, Salta Group, NW Argentina: stratigraphic constraints from in situ U-Pb radiometric ages on volcanic layers

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The Salta Group in NW Argentina represents the sedimentary infill related to the Salta rift structure developed between Lower Cretaceous and Middle Paleocene times (Salfity and Marquillas 1981). The sedimentary sequence of the Salta Group comprises three main units: the Pirgua, the Balbuena and the Santa Bárbara subgroups. Few geochronological and paleontological dating are available. Two K- Ar ages (128–112 Ma, Bossi and Wampler 1969; 78–76 Ma, Valencio *et al.* 1976) for the syn-rift phase represented by the Pirgua subgroup have been obtained on basanitic lava interlayered with sediments. Sediments from the top of Pirgua subgroup contain dinosaur fossils of Senonian ages (Campanian). The age of the post-rift phase represented by Balbuena and Santa Barbara subgroups has been constrained mainly by paleontological studies. The Lecho and Yacoraite Formations, belonging to the initial post-rift phase Balbuena subgroup, contain dinosaurs fossils and dinosaurs tracks of the Upper Cretaceous. The bottom of the Olmedo Fm, in the upper part of the Balbuena subgroup, contains palynomorphic indicators of the Early Paleocene (Danian). The post-rift sediments of the Santa Barbara subgroup are characterized by the presence of mammalian fossils of Middle Paleocene and Middle Eocene times. The object of this contribution is to present new radiometric ages from the Yacoraite Fm of the Balbuena Subgroup. The Yacoraite Fm. is constituted mostly by oolitic limestones, stromatolitic limestones and limestones, with minor pelites, sandstones and scarce volcanic ash. Two different volcanic ash layers from the bottom (sample A7) and the central-upper portion (TO190602) of the Yacoraite Fm, have been analyzed using in situ zircon U-Pb LA-MC-ICP-MS method. Two different concordia ages of 71±1 Ma and 68±0.7 Ma have been obtained for sample A7 and for sample TO190602, respectively. Our data suggest that the deposition of the Yacoraite Fm. occurred during the Maastrichtian and that the Cretaceous –Tertiary (K-T) boundary could be possibly registered at the top of this Formation.

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Multistep diagenesis in a stalagmite. A new way of approach to palaeoclimate studies

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Geochemical signals from speleothems are commonly used in the investigation of palaeoenvironmental changes. In most cases, however, little attention is paid to whether or not these signals are primary or have been altered by diagenesis. The speleothems from Castañar Cave (Cáceres, Spain), which were initially formed of aragonite, have undergone a sequence of meteoric diagenetic processes that modified their primary texture, mineralogy and geochemical signals. The host rock is a dolostone that has undergone partial magnesitization. Castañar Cave is a shallow subhorizontal cave with maze pattern. This study is based on a stalagmite consisting of both aragonite and calcite. Aragonite forms an outer layer, about 5 mm thick consisting in a rim of acicular crystals. By contrast calcite occurs within the inner part of the speleothem as a mosaic of crystals . The aragonite rim is physically separated from the calcite portion of the stalagmite by a micritic and porous thin layer. Petrographic observations show aragonite relics within the mosaic calcite that follow the same orientation of the aragonite crystals of the outer rim, these calcite crystals are around 5mm long. There are also areas where calcite crystals appearance is that of pore filing cement. In that case the crystals are smaller (< 1mm) and clean. The speleothem was dated using U/Th series. The oldest age is 195,000 years B.P. and dates the aragonite rim. Dating of calcite yielded an age of 75,000 years B.P for the calcite from the lowermost portion of the stalagmite and around 50,000 years B.P for the topmost crystals. Stable isotope analyses were carried out along the vertical growth axis of the stalagmite (calcite), along the rim (aragonite) and in other selected points in between. The results show values consistent with calcite, acicular aragonite and mixing of both phases. The values for $\delta^{13}C$ range from -5.97 (aragonite) to -9.57 (calcite) and the $\delta^{18}O$ values range from -3.02 (aragonite) and -5.64 (calcite). Calcite crystals formed in pores show the most negative values of $\delta^{18}O$. Aragonite relic-bearing calcites have intermediate values, but mixing of the aragonite-calcite signals does not follow a precise pattern of distribution. Overall, values of the mixed aragonite-calcite are more positive (aragonite-rich) in the middle part of the stalagmite, and more negative (calcite) toward the micrite layer. Petrography, ages and isotope data altogether allow different hypothese for the calcitization mechanism of the stalagmite. The outer aragonite was not calcitised, thus, the orange colour may indicate the presence of clay over the stalagmite that could have protected it from the calcitization front. Aragonite is unstable at surface temperature and pressure and the transformation to calcite has to be expected unless the system is closed. Diagenesis may have already started soon after deposition, creating “nuclei” for successive diagenetic alteration. It is possible that diagenetic waters infiltrated from the bottom through the host rock during a phase of intense recharge (interstadial). The lack or scarcity of organic matter within the cave or specifically in the speleothems, that may help the process of calcitization, indicates that changes in the chemistry of the cave waters were conductive to diagenetic alteration. Ages show that aragonite was formed during a glacial and calcite during short-lived interstadials. It may indicate a hydrological and climatic pattern in the formation of the different minerals in the cave. Further studies will deal with this problem.

The unusual occurrence of sepiolite in speleothems. An example from Castañar Cave in Spain

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Castañar Cave is situated in western-central Spain. It is hosted in Neoproterozoic-Lower Cambrian rocks that form the core of the Ibor Anticline. These rocks are shales and greywackes with interbedded dolostones and magnesites. Dissolution of the dolomitic beds and the extensive weathering of the shales and greywackes favor collapses which create and enlarge the cavities. This dissolution also determines the composition of the cave waters, which are rich in Mg. The cave contains a wide variety of speleothems, such as: frostwork, anthodites, helictites, stalactites, stalagmites, columns, draperies, flowstones, coralloids, crusts, gours, pool deposits, rafts and moonmilk. Calcite (LMC) and aragonite are the main minerals within the speleothems. Huntite CaMg(CO3)4, magnesite MgCO3 and dolomite, and in smaller amounts hydromagnesite Mg5(CO3)4(OH)2•4(H2O) and sepiolite (Mg4Si6O15(OH)2•6(H2O)) are also found within the cave. These magnesium-rich minerals occur in moon-milk deposits, coatings on aragonite crystals and in crusts. Sepiolite is always associated to dolomite, magnesite and huntite. Huntite is the dominant mineral in moonmilk. Under the microscope, it appears as brown-blackish micritic masses emitting bright green fluorescence under UV light. Huntite consists of randomly ordered flakes or platelets less than 5 µm in size. Magnesite also shows a micritic texture under the microscope appearing as rhombohedral crystals of 1 to 10 µm. Dolomite forms spheroids and dumb-bells 50-300 µm across in a fibrous-radial pattern with concentric band. Spheroids and dumbbells are composite crystals that consist of fibrousradial aggregates that internally are formed by individual rhombic dolomite crystals. Dolomite is closely associated with huntite flakes and sepiolite fibres. The identification of sepiolite is not easy because it occurs in small quantities and it is difficult to extract it to get a good identification under XR-Difraction. In addition, sepiolite mats and fibres can be easily misinterpreted as EPS (extrapolimeric substances or organic filaments). EDAX and Microprobe analyses have helped in identifying it. Sepiolite forms fibres a few µm wide and some µm long that together form films that intergrow with huntite, dolomite and magnesite. Sepiolite fibres form thin irregular mats coating the magnesium-rich carbonates or even aragonite and also can form a network of fibres coating the smaller (1 µm wide) dolomite crystals that form the dolomite spheroids. The unusual presence of sepiolite is linked to the characteristics of the moonmilk of the Castañar Cave. There are two remarkable features to take into account. The first is that it is composed mostly of magnesium-rich carbonates with some sepiolite. The other is that it bears few biogenic features, as generally described for calcite moonmilks, whose formation seems to be driven by microbial processes. So we interpret that formation of the magnesium-rich moonmilk, containing huntite and dolomite, in Castañar is mostly driven by magnesium-rich karstic waters (sourced from the dolostones and magnesites), and we do not have clear evidences of microbially mediated processes. Our interpretation is that huntite is a metastable mineral that may precipitate directly from solution if there are enough calcium and magnesium available. It may later transform to dolomite. In this transformation Mg is released to the residual water, favouring sepiolite precipitation, intergrowing with dolomite. Mg-rich clays seem to be present in some caves also hosted in magnesium-rich carbonates as in the study case. The fact that these clays are so unusually found in caves may be due to their difficult recognition, including its possible misinterpretation with organic substances. Very probably these clays, including sepiolite, are much more common than expected or of what has been found till recent times.

Orbital climate forcing of lacustrine offshore clays in the Lower Miocene continental Sokolov Basin, Eger Graben, Czech Republic

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This study presents preliminary sedimentologic and cyclostratigraphic results for the Lower Miocene lacustrine offshore clays of the Cypris Formation in the Sokolov Basin of the western Czech Republic. The applicability of different proxies in the interpretation of thick homogeneous, offshore lacustrine successions is tested here. Lacustrine deposits of the Cypris Formation cover approximately 20 km2 and are represented mainly by offshore clays, up to 130 – 180 m thick. This study is based on 75 m of core and well-log data from the lower part of the offshore succession. Nearshore facies are preserved very rarely. The offshore clays conformably overlie a 30 m thick coal seam with no change in flora. Lacustrine flooding is thus interpreted as due to an increase in subsidence or a change in hydrology. Lacustrine clays mostly are laminated with a high organic content (Corg up to 2 – 18 %, mostly kerogen type I and II), a low silt admixture, and very rare thin sandy interbeds. Mineral grains also include volcanogenic material from nearby volcanics and volcaniclastics. The lower part of the studied succession (unit 1) comprises laminated kaolinitic clays with siderite with quartz, illite, feldspar, analcime, and carbonate components. The clays are interpreted as deposits of a hydrologically open permanent lake. Unit 2 contains laminated montmorillonite-illite-kaolinite clays with Ca-Mg-Fe carbonates, analcime, quartz, and Mg-mica with a high proportion of algal-rich clays exhibiting sub-millimeter lamination. This unit is interpreted to be a hydrologically closed lacustrine system with lake- level fluctuations, although evidence for subaerial exposure was not found. Statistically significant cycles can be identified in the occurrences of elements (Ca, Sr, Ti, Zr, etc.), color indices, and well-log (gamma-ray) data throughout the studied succession. However, the frequency content changes from bottom to top, with a higher number of significant frequencies in upper unit 2, reflecting either a decreasing sedimentation rate or changing climate/hydrology of the lacustrine system through periodic forcing. The most prominent, meter-scale cycles are possibly in the Milankovitch band (assuming average sedimentation rates approx. 0.1 mm per year), but the ultimate interpretation of periodic signatures must await refinement of the current chronostratigraphic constraints.

Definition of flow units in the Loma Alta Sur field, Province of Mendoza, Argentina

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The Loma Alta Sur Field is located in the Neuquén Basin, in the southern part of the Province of Mendoza, Argentina. It comprises up of 162 fluvial sand beds contained in the middle Neuquén Group. Most of the sand beds are thin and discontinuous, and may stack aggradationally with limited lateral extent. The challenge when developing the geologic model was to subdivide the sand complex of 300 m thickness into meaningful flow units suitable for stochastic modeling and numerical simulation. Flow units constitute portions of reservoir rock with geological attributes (sedimentary units and facies) and petrophysical properties (porosity, permeability, capillary pressure) that are internally consistent and affect the movement of the fluids. The Stratigraphic Modified Lorenz Plot (SMLP) and the Stratigraphic Pareto plot are statistical methodologies that were applied to capture the stratigraphic and petrophysical qualities of rock volumes with similar flow capabilities, to divide the 162 layers into 11 flow units. The SMLP is a well cross plot of Cumulative Storage Capacity (Ø*h) versus Cumulative Flow Capacity (k*h) for every 0.1 m of section. The k*h (y-axis) and Ø*h (x-axis) values are graphed in stratigraphic order, beginning with the younger units at the base of the graph progressing up to older units. This graph consists of a staircase plot where flat segments represent vertical seals bounding inclined segments, which may represent flow units. The final definition of individual zones relies on graphical correlations of selected wells across key cross-sections, which in turn are extrapolated across the field by well-log correlations. The Lorenz plot analysis identifies patterns of reservoir discontinuity, characterized by breaks in the slope of the curve within a flow unit. Discontinuous layers form local obstructions or reductions in flow. The sands that form the true conduits coalesce from one well to another around local obstructions to develop into a unique flow unit. The Stratigraphic Pareto plot charts the 162 layers sorted by depth and stratigraphic order on the vertical axis vs. the number of wells that crossed them in the horizontal axis, and shows the frequency at which any layer is observed. It is based on the Pareto Principle, which states that the majority of effects come from a minority of causes. Stratigraphic Pareto plots help visualize in a simple way the most continuous layers in the field, which gives a clue about how many flow units the reservoir might have. Therefore, Stratigraphic Pareto plots cross-validate the Lorenz (SMLP) method. The difference between any given flow units, even though they belong to the same fluvial facies, are defined by their mineralogies, grain-size distributions and diagenetic prints: • Increasing percentages of lithic clasts and diagenetic effects reduce reservoir quality, resulting in different flow units from rocks of similar grain size. • Reduction in grain size does not necessarily reduce storage capacity but flow capacity instead, resulting in flow obstructions. • Lorenz plots show that reservoir quality falls with depth as worse textural and diagenetic factors diminish flow capacity.

Applying sediment budget models on rock glaciers in the arid Andes of NW Argentina

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Active rock glaciers consist of frozen rock debris bodies, including ice lenses and cores, that extent downslope due to the deformation of the contained ice. Rock glaciers can be considered as closed sediment and ice traps. The sediment budget model developed by Brenning (2005) proposes that the amount of rock material (the sediment/ice rate is considered constant) stored within rock glaciers can be used to estimate their morphodynamics. The equation applied here (pta=sDA) is a mass conservative equation that provides an approximate sediment budget, where "pta" is the sediment volume stored within a rock glacier (expression to the left in the equation) as the sediment/ice rate content of a rock glacier (p), its thickness (t), and its planimetric area (a); and "sDA" is the total volume of post-glacial vertical lowering (right-hand side in the equation) as a function of talus shed size (s), talus denudation rate (D) in the sense of a vertical lowering rate, and the rock glacier age (A). Empirical equations are used to estimates p and t. Also an advance rate (C=l/A), is estimated as the ratio of the rock glacier length (l), and the age (A). This model was applied to 25 active rock glaciers in the Palermo and Cachi ranges between 24º 27' S and 25º 05' S in NW Argentina where the lower limit of active rock glaciers is about 4500m a.s.l. These rock glaciers are interpreted to be younger than the last glaciations recorded in the area. Zech *et al.* (2009) studied the Quaternary glaciations in the Sierra de Santa Victoria, further north, and found that the glaciers retracted since ~10Ka. We take this age as the maximum age of the rock glaciers. The model outputs a denudation rate in the source area of 0.6- 0.7mm/yr, a mean age of 6.2Ka (median 3.4Ka), and a mean advance rate of 25 cm/yr (median 17 cm/yr). The denudation rate is similar to the calculated by Azocar and Brenning (2010) for the dry Andes to the side of Chile, while estimated ages are older and the advance rate is much lower than the obtained in this work. To check the model we also applied Lliboutry's (1965) equation for glacigenic rock glaciers, H = 13.73 m5/y4*(C/sin3α)1/4, where H is the maximum rock glacier thickness and α is the inclination in the ablation zone. The results are not consistent between the two models neither in the ice thickness nor in the advance rate. The discrepancy could be related with a wrong assumption of some of the parameters and/or with the rock glacier type considered in each of the models (periglacial vs ice cored). These results represent a first approach to the study of rock glaciers characteristics in this region, but more specific data are necessary to develop an appropriate model. Future research will provide new results, improving the measurement of morphodynamic and morphometric variables like rock glacier thickness, sediment/ice rate, superficial velocity and surface slope.

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Marginal-to-foreland basin stratigraphy in the Sierra de Beauvoir domain (Cretaceous-Paleocene, Fuegian Andes, Argentina)

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The Sierra de Beauvoir domain in the Fuegian Andes is a rugged mountainous area with limited access, dense forests, and a profuse Quaternary sedimentary cover of chiefly glacial and post-glacial deposits. This domain includes Sierra de Beauvoir, Sierra de Apen, and Sierra de las Pinturas. The pre-glacial geology of the area is rather hidden and fuzzy; the good exposures are sparse and remain quite restricted to the summits reaching above the timberline, or show up at some deep sitting valleys. After thorough geological field research in the Sierra de Beauvoir area, this part of the Andean fold and thrust belt happens to involve more than just a single mudstone dominated unit as originally described (Beauvoir Formation), instead comprises a Lower Cretaceous (s.l.), largely mudstone dominated, meta-sedimentary package (variably deformed and folded; host of igneous rocks), and an Upper Cretaceous-Paleocene coarsening upwards sedimentary succession. The Lower Cretaceous (s.l.) of Sierra de Beauvoir comprises: 1) Lago Fagnano Slates, clay-rich meta-sedimentary rocks (?uppermost Jurassic-lower Lower Cretaceous); 2) Beauvoir Formation, mudstone dominated meta-sedimentary unit, with Inoceramus spp. and Aucellina spp. (upper Lower Cretaceous-?lowermost upper Cretaceous, Aptian-Albian-?lowermost Cenomanian); and 3) mesosilicic and basic igneous rocks that intrude and crosscut the Lago Fagnano Slates and the Beauvoir Formation, respectively (104 ± 4 My, isotopic age of a basic dike that cuts the Beauvoir Formation). The Upper Cretaceous-Paleocene of the area includes: 1) Arroyo Castorera Beds, mudstone dominated sedimentary rocks with Inoceramus lamarcki among other inoceramids (Upper Cretaceous, ?upper Cenomanian-Turonian); 2) Río Rodríguez Beds, coarsening-, thickening-upward successions consisting of mudstone, siltstone, and very fine silty sandstone, with inoceramid remains attributable to Cremnoceramus sp. (Upper Cretaceous, Coniacian-?Campanian); 3) Cerro Fumando Beds, sedimentary unit dominated by sandy mudstone, increasingly sandier up-section, divided into a “Muddy” Member and a “Sandy” Member, with diagnostic genera of ammonites and dinocyst species, but no inoceramids (Upper Cretaceous, Maastrichtian-?Danian); and 4) Cerro Apen Beds, sandy to conglomeratic sedimentary rocks with intercalated mudstone and heterolithic packages that rest on an erosive unconformity over the Cerro Fumando Beds, have diagnostic dinocysts, and comprise a “Lower” Member (sandstone dominated; Paleocene, Danian) and an “Upper” Member (conglomerate to sandstone dominated; Paleocene, Danian-Thanetian). Both the Lower Cretaceous and the Upper Cretaceous-Paleocene packages reflect, respectively, the main phases in the evolution of the marine sedimentary basins in the southernmost tip of South America from the latest Jurassic to the early Paleogene. The Lower Cretaceous (s.l.) units were accumulated after the main extensional period and subsequent fill of the Rocas Verdes Marginal Basin until its final closure during the earliest Late Cretaceous. The Upper Cretaceous to Paleocene sedimentary rocks accumulated during the development of the Austral Foreland Basin, having an initial transitional period with deep marine sedimentation, right after the closure and tectonic inversion of the marginal basin, followed by the progressive orogenic uplift of the Fuegian Andes under a contractional regime. The ongoing forward orogenic growth generated a coarsening upward succession that begun with the deposition of mudstone dominated units and continued with increasingly coarser, sandy to conglomeratic, sedimentary units. Additionally, coarse-grained facies recorded elsewhere in the southern Andes for the Foreland Basin inception seem not to have an analogous counterpart in the Sierra de Beauvoir domain, where mudstone facies dominate the Marginal-Foreland Basin transition without coarse sand or conglomeratic sedimentation until the latest Cretaceous-earliest Paleocene.

Correlation of shallow-marine platform carbonates using subaerial exposure surfaces (Early Jurassic, Velebit Mt., Croatia)

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Shallow-marine carbonate succession formed during Early Jurassic on the Adriatic-Dinaridic carbonate platform (ADCP) contains numerous surfaces showing evidence of subaerial exposure. Most of these surfaces represent hiatuses below biostratigraphic resolution and only detailed sedimentologic and diagenetic study can distinguish these small scale discontinuities from simple bedding planes (Hillgärtner, 1998). In order to use exposure surfaces as correlation tool, their lateral extent needs to be determined (Sattler *et al.*, 2005). Two sections of Lower Jurassic carbonate succession, that belonged to the inner ramp environment of the ADCP were studied in detail on a cm scale. Both sections are situated in the Velebit Mt. area - Kubus (82 m thick) and Mali Alan (83 m thick). Today, these localities are 50 km apart. The under- and overlying rocks of each bedding plane and rocks from the bedding planes itself were studied and detailed bed-by-bed logs recording stratigraphical data, sedimentary structures and textures obtained from field and laboratory investigations are made. A correlation of the two sections is based on facies architecture, biostratigraphy, exposure surfaces and one bed marker, which enabled correlation of the two sections on a bed level. Three types of exposure surfaces containing features of diagenesis in subaerial conditions are observed and classificated sensu Hillgärtner (1998): i) paleosols showing pedogenic features (brecciated appearance, reworked lithoclasts within brownish yellow clayey calcareous matrix, rhizoturbation); ii) inter- to supra-tidal hardgrounds (HG) showing fenestral fabric, sheet cracks, birdseyes, circumgranular and desiccation cracks; and iii) diagenetic discontinuities (DS) as bedding surfaces showing meteoric influence visible in thin sections as recrystallization of skeletal and nonskeletal particles and cements. Recorded logs are of Middle Sinemurian to Early Carixian age (FADs of Lituosepta recoarensis Cati, Orbitopsella primaeva Henson and Orbitopsella praecursor Gümbel are identified). Succession of Middle to Late Sinemurian age at both localities, shows little evidence of subaerial diagenesis: rare diagenetic DSs and inter- to supra-tidal HGs of limited lateral extent are observed. These surfaces are impossible to correlate at distance over 50 km. Contrary to this, succession of Late Sinemurian age contains the most prominent features of exposure into the meteoric diagenetic realm: 10 m interval section at Mali Alan containing several paleosols is well correlated with contemporaneous 8 m interval at Kubus containing several inter- to supra-tidal HGs and paleosols. This specific interval with different types of exposure surfaces extends laterally over 50 km and shows that their recognition can be useful in correlation of shallow-marine platform strata. Repeated periods of generally shorter-lived supratidal regime may be related to a single regressive event that occured in the studied area, but to confirm this presumption, study of a wider platform area of the ADCP is required.

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Hydrothermal karst phenomena in Danian carbonates, North Patagonia, Argentina

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Hydrotermal karst caves produced by the action of hot ascending waters were formed in marine carbonate sediments from the Lower Tertiary (Danian) in the Northeast of Nordpatagonian Massif (Río Negro Province, Argentina). The area profoundly altered of this sequence appears to be the top of the Danian carbonate sequence (Roca Formation) in the Tembrao Quarry, which has a total thickness of 6-7 meters. The host sedimentary succession is mainly composed of limestones (wackestone and packstone) dominated by skeletal grains (bivalves, ostracods, foraminifers, echinoderms, bryozoans and gastropods), associated with variable contents of carbonate cements, micrite and siliciclastics grains. The features of the different types of cements are: neomorphic developments into the grains during marine cementation; fine-grained calcite crystals (Iow-Mg ferroan composition) partially or totally filling the pore space; botryoidal aragonite and microdolomite rhombs euhedral to subhedral fine crystalline texture. The limestones are laminated and characterized by tabular stratofabric, low- angle sigmoidal cross-bedding, and hummocky cross-stratification (HCS). This sequence, based on lithology, sedimentary structures and vertical facies arrangements shows an open marine beach-nearshore and partially restricted shallow marine associations. Numerous veins of milky-white, cristaline calcite are encountered in the quarry or intercepted by other smaller caves as consequence of karts action. There are numerous coalescing spherical shapes (“pop-corn”) forming swellings mainly composed of botryoidal aragonite. The botryoids are well-developed generally between 2-5 cm in diameter, locally with overlying micrite and spectacular growth-form occurring as coalescent mamelons within cavities. Millimeter concentric bands are developed of botryoids whose long axes of the crystals are oriented perpendicular to the walls of the cavities. Their fabrics are characterized by elongated crystals which have a radial-fibrous habit and have different bands (4-6 cm in thickness) separated by thin dark bands. The mamelons resulting from the fibrous growths show a fan structure ranging from acute angles to more than 180º, sometimes attaining an almost complete spherulite. Petrographic observation shows that the botryoids have undulose extinction assigned to this radial subcrystal fabric. Closer examination reveals the presence of rhombic terminations, 24 to 96 µm across and 500 to 1125 µm in large. Under cathodoluminescence, the bands show moderately bright to dull. The rhombic terminations of the botryoids crystallites suggest that the Lower Tertiary botryoids were originally calcite, as replacement calcite tipically has square-ended terminations.

Paleoclimatic interpretation from clay minerals in the early-middle Miocene of southeast Patagonia, Argentina

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The Miocene at the south coast of Santa Cruz province (Argentina) is represented by the transition between the marine sediments of Monte León Formation (late Oligocene - early Miocene) to continental deposits of Santa Cruz Formation (early - middle Miocene). During this time, global warming trends occur that peaked in the Mid-Miocene Climatic Optimum (15 -17 Ma). This period was followed by the late Miocene cooling and drying trend. The upper part of the Monte León Formation (19.3 Ma) is a sedimentary succession composed by fine sandstones, siltstones and tuffs that culminate with conspicuous coquina banks, consisting of shells of Ostrea sp. arranged in life position. This unit reflects the shallowing from a shallow marine environment with neritic and coastal conditions culminating in a paralic environment. The invertebrate fossils of Monte León Formation are related to the first influx of Antarctic waters on to the Argentinean continental shelf, but towards the upper levels an improvement in the climatic conditions is registered. The basal levels of the Santa Cruz Formation, Estancia La Costa Member (~ 16.1-16.5 Ma), is comprised of fine to coarse-size pyroclastic and volcaniclastic deposits reworked by fluvial processes. The fine materials that conforms the floodplain contain immature paleosols (rhizoliths, iron concretions) and bioturbated beds (burrows of bees and scarabeid). The coarser sediments represent sheet-floods deposits of a fluvial system. This unit bears an exceptionally rich fauna of vertebrates that was developed under relatively dry conditions with marked seasonality and open environment (grassland). Compositionally, the upper section of Monte León Formation is represented by lithic sandstones with sporadic glauconitic pellets and reworked vitric tuffs. The more frequent cements are coatings of authigenic clays and carbonate. XRD from clay fraction points to very abundant smectite with minor participation of chlorite, interstratified illite/smectite and illite. On the other hand, the Estancia La Costa Member is composed by vitric tuffs, lithic sandstones and volcaniclastic sandstones. XRD analysis show very abundant smectite with less proportion of chlorite, interstratified illite/smectite and illite. Coarse grained kaolinite is also sporadically recognized. Since the sediments have been very little affected by diagenetic processes, preliminary clay-mineral results allow interpret paleoclimatic conditions during their deposition. The interval studied is characterized by a smectite-dominated assemblage reflecting warm and seasonal conditions. However, a relative decrease in smectite couple with and increase in illite, chlorite and illite/smectite mixed layers is noticed in the transition between both units and towards the upper part of the Estancia La Costa Member. This fluctuation probably results of cool or cool and dry conditions. The kaolinite may represent local and slightly more humid conditions. The presence of illite and chlorite in the oldest rocks is related with cooling irregular stage registered during early Miocene. Nevertheless, the smectite dominance in the middle part of Estancia La Costa Member could indicate a shift to warmer and seasonal climatic conditions (Mid- Miocene Climatic Optimum). Gradual cooling and drying that followed the climatic optimum is represented by the appearance of illite and chlorite in the upper part of Estancia La Costa Member. Upon the base of results and considering the previous paleontological data, it is possible to interpret that the paleoclimate during the early- middle Miocene in southeast Patagonia was warm and seasonal with cooling stages related to global paleoclimatic conditions for Miocene.

Taphonomy of the crustacean-dominated micro-coquines in the Permian Irati Formation (Passa Dois Group), Paraná Basin, Brazil

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The Permian Irati Formation from the Paraná Basin, Brazil, is made up of a succession of black bituminous and nonbituminous shales and mudstones with interbedded carbonate layers, deposited under marine environments. This unit is worldwide known by its famous mesosaur- bearing rocks. However, in some strata of the Irati Formation dense accumulations of crustacean remains, forming micro-coquines are also recorded, along the eastern and northern borders of the Paraná Basin. The samples described in this study were collected from quarry walls located in the following counties (Saltinho, Rio Claro, Limeira, Cesário Lange, Tietê, Angatuba, Itapetininga and Pereira) of the state of São Paulo. The studied micro-coquines normally occur on the top of a 3 meters thick dolomitic bank (locally known as Bairrinho bed) or interbeded within a succession of blackshales above the dolomitic limestones. Two types of dense accumulations of pygocephalomorphan crustacean shells were recognized in the studied samples: 1- micro- coquines made of 50cm thick concentrations of millimetric layers of tiny fragments of crustacean shells, mainly parts of carapaces and abdominal somites. These fragments are normally preserved in the matrix as concave-up, nested and stacked remains, with no clear signs of abrasion. These features are indicative of short residence time in the sediment water interface prior the final burial. Coquines and micro- coquines with dense, nested and stacked remains are usually associated to storm events. 2- Thin concentration (10cm thick) made of millimetric layers of comminuted crustacean remains and, at the top, a pavement of disarticulated, but non fragmented pygocephalomorphan carapaces, in a concave-down (stable) posture. In plan view, the carapaces have bimodal orientation. These observations indicate that the crustacean remains in the pavement were reoriented by bidirectional tractional currents, prior to the final burial. Based on these preliminary observations some questions are open: Which sedimentary processes were responsible for the genesis of the studied concentrations? How small and fragile crustacean exoskeletons can originated coquina-like deposits? Which processes were responsible for the breakage of crustacean shells, since these are small and flexible structures, less susceptible to fragmentation? Finally, why the pygocephalomorphan crustaceans thrived so profusely in certain strata and which were the main agents that lead to the mass mortality of those invertebrates?

Placer-formation of the northern frame of Alpine orogen of the Middle Miocene period in the East Caucasus (Daghestan)

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In the last decade in the Middle Miocene deposits (the Chokrak-karagan quartz sandstones) terrigenous minerals of titan-zirconium raw such as zircon, ilmenite, leucoxene, rutile have been found, and their total amount comes to 70-80 % of heavy fraction. Converted into strata in the ledge bedding, heavy fraction in them is 0.5-1 %, and only in the rare occasions in thin beds (3-4m) it approaches to the industrial values (3- 3.5 %). When analyzing titan-zirconium minerals, precious metals such as gold, platinum to a lesser extent, and, rarely, single scales of silver occurred. This fact inspired to begin more detailed analysis of precious metals. We increased the bulk of samples at tossing to 10-20 kg; tossing itself was made both manually in trough and with the use of small-size washer (CVW-200). Precious metals were searched for analytically by atomic absorption spectrometry, mass-spectrometry, and test-tube-gravitational method. In comparison with the results of tossing best data were obtained with the use of the test-tube-gravitational method. The researches allowed to make following conclusions: 1. In the region, in the territory of the Daghestan Republic, in the Middle Miocene deposits (the Chokrak-Karagan sandstones) in the heavy fraction of minerals there were found terrigenous forms of such precious metals as gold, up to 1 g/m^3 (tossing gave single samples with the contents of gold from 0,6 to 4 g/m^3 ; atomic absorption method - platinum up to 1,48 g/m^3; analytical method - silver up to 2-3 g/m^3. The strike of strata with precious metals is 180 km; the dip in single cross- sections - 10 km. 2. The Chokrak-Karagan sandstones of quartz composition crop out within the chain of the advanced ridges - Narat-Tube, Karaburun, etc., throughout the territory of the Dagestan Republic. They are weakly cemented and easily crumbled under mechanical force. The sandstones containing useful ingredients such as terrigenous minerals, are considered to be littoral sediments of the Middle Miocene period - formations of the Caspian sea paleoshelf, which are commonly developed by quarrying. 3. Precious metals are represented by small and fine-grained fractions of 0.2 mm in size, commensurable with dimensions of heavy fraction minerals. Gold is weakly smoothed, but well ground. The gold standard is 850-950. 4. Within the observed orogen there are no ledge sources of precious metals, so the source of the sediment is supposed to be outside the Caucasus. Such source area of useful components can be the East European ramp - the Voronezh massif (the remote source area), the closer source area can be magmatogenic-volcanogenic complex, lying within the territory of the East Ciscaucasia, being uncovered by deep drilling wells on oil and gas probes. 5. In the East Caucasus the gold displays have not been fixed yet. The data given above confirm determination of the East Caucasian province of precious metals.

Discovery and their significance of submerged reef rocks on the shelf off Kikai-jima Island, Kagoshima Prefecture, southwestern Japan

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Coral reefs are tropical to subtropical coastal ecosystems comprising very diverse organisms. Their community structure is highly controlled by various environmental factors such as water temperature, depth, irradiance, salinity, nutrient level, terrigenous input, and substrate. The reefs at the latitudinal limits of coral-reef ecosystems (the “coral- reef front”) are more sensitive to environmental changes, associated with glacial-interglacial changes in climate and sealevel, than those in low-latitude areas where environmental conditions favorable for coral reef formation persist. It can be considered that the coral-reef front may have migrated to higher and lower latitudes, respectively, responding to Pleistocene global warmings and coolings associated with rapid and cyclic changes in climate and oceanographic conditions and with glacioeustatic sea-level rises and falls. The Ryukyu Islands (the Ryukyus) extend for 1200 km between Taiwan and Kyushu, Japan and is located on the boundary between the coral-reef and non-coral-reef regions in the present-day northwestern Pacific. The Ryukyus are, therefore, considered to be one of the best locations to depict the nature and magnitude of coral-reef front migration in response to the Quaternary climatic and oceanographic changes, and to clarify major constraints for the initiation, development and demise of coral reefs. The COREF (coral-reef front) Project is designed to clarify the response of the coral reefs and coral-reef ecosystems of the Ryukyus to Quaternary climatic and oceanographic changes. In the Project, we found submerged reef rocks on a shelf off Kikai-jima Island, northern Central Ryukyus, during the R/V “Natsushima” NT05-14 Cruise in 2005. The area is located immediately south of the present-day northern limit of coral reef formation. If the reef rocks were formed in a lowstand and glacial period, it suggests that coral reefs could thrive in glacial periods around the present-day “coral-reef front” in the Ryukyus. The purpose of the study is to examine presence/absence of coral reefs formed in glacial periods and, if they occur, to investigate their distribution on shelf to shelf slope areas off Kikai-jima Island. High-resolution seismic survey, bathymetric mapping by SeaBat, ROV submersible observations and dredge sampling were carried out in 2007 and 2009. A series of surveys revealed that reef rocks were discovered at water depth from 70 to 100 m on the outer shelf. In the seismic profiles and the bathymetric map, those are recognized as several topographic highs, up to 10 ms thick in TWT and 200 to 400 m in width, characterized by irregular mound-shaped structure, strong reflection of seafloor and internal chaotic reflections. The ROV observation also revealed that the topographic highs are a complex of mound-shaped reef rocks with irregular surfaces, surrounded by coarse-grained carbonate sediments. Each mound-shaped reef rock ranges a few to 10 m in height and from 5 to 100 m in width and consists of a variety of reef-building organisms, such as hermatypic corals, coralline algae and so on. Further, a plentiful of rhodoliths with minor amounts of fragments of fossil corals were dredged, although the rock samples derived from the reef rocks could not be dredged unfortunately. It is well known that Kikai-jima Island has been elevated at a high uplift rate of maximum 2 m/kyr since the last interglacial period. The present-day shelf edge with the reef rocks would have been, therefore, situated in a very shallow marine environment favorable for the reef formation during the last glacial period. From these results, there is a possibility that the reef rocks are remnants of coral reefs formed in the last glacial period.

Low velocity anomaly of gas hydrate bearing sediments: implications for extensive distribution of gas bubbles

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Gas hydrate, a solid compound composed of methane and water, has been attracting a growing interest of earth scientists since DSDP/ODP identified marine gas hydrate in deep-sea sediments in 1980's. Japan was one of the leading countries to launch an exploration program to investigate the resource potential of marine gas hydrate in Nankai trough. Intensive geochemical studies and intensive 2D and 3D seismic surveys followed by multiple drilling/coring and loggings by D/V Joides Resolution have revealed that gas hydrate of Nankai trough occurs as a pore-filling cement in relatively porous and coarse grained sediments to form laterally extensive strata-bound, lithologically controlled deposits. Base of gas hydrate accumulation (BSRs) is around 250- 300 mbsf. The amount of methane of highly concentrated zone has been estimated to be 40 tdf, approximately 14 times of domestic gas consumption at this moment. Recently, we identified highly concentrated accumulation of gas hydrate along the eastern margin of Japan Sea, where Japan Sea basin is about to subduct below Japan islands. Japan Sea gas hydrate is totally different from the Nankai trough gas hydrate. It usually occurs as large massive concentration in hemipelagic mud in shallow levels, 1 to 6 m, below seafloor. 2D and 3D seismic surveys have revealed a chaotic and vertical seismic facies (= gas chimneys). BSR appears at around 110 m below sea floor. Hydrate methane is observed to have derived from thermogenic with $\delta^{13}C$ of -30 to -40‰. Gas chimneys serve as effective conduits for the migration of deep thermogenic methane to shallow sediments, and also provide space for the accumulation of gas hydrate. Thus, methane-bearing fluids and solid gas hydrate characterize gas chimneys. The depth of the base of gas hydrate stability (BGHS) is estimated to be 115 m, based on the thermal gradient of 100mK/m and the temperature of bottom water of 0.2 degree C, whereas the depth of BSR is observed to be 0.20 to 0.23 seconds in two way travel time. Therefore the P-wave velocity of the sediments is calculated to be 1000 m/s, surprising low velocity compared with normal hemipelagic mud of 1500-1600m/s. The anomalously low velocity implies that gas hydrate bearing sediments contain free gas bubbles, although the sediments are well within the stability field of gas hydrate. Occurrence of free gas in gas hydrate stability zone is not readily explained. The following mechanisms should be considered to explain such an unusual co-existence of gas and gas hydrate. （i） High salinity effect of residual waters, （ii） Degassing from ascending fluids, （iii） Bound water effect and decency of free-waters, and, （iv） Micro-pore effect in porous media. Extensive development of gassy sediments seems to be essential for the formation of gas hydrate bearing sediments, in particular clayey sediments.

Lower Cretaceous phosphates in the Cerro Salado area, Neuquén Basin

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The relationship between Lower Cretaceous (Berriasian to Lower Valanginian) phosphate levels (PLs) and eustatic oscillations are analyzed in the area of Cerro Salado (38º12'07.8" S, 70º02'06.6" W), located in the central part of the Neuquén Basin. About 270 m of fine sandstones, shales and limestones, preliminary assigned to three formational units, crop out at Cerro Salado. The lower 20 m correspond to black shales tentatively assigned to the Vaca Muerta Fm., which are covered by 200 m of gray shales, limestones, fine sandstones and marls, assigned to the Quintuco Formation. The uppermost 50 m are composed of sandstones with few intercalations of gray shales typical of Mulichinco Formation. These formations are part of systems tract belonging to several depositional sequences, which developed clinoforms prograding toward the W and NW, in a shelf-basin or ramp system. The ammonite fauna in Vaca Muerta and Quintuco formations indicates that the accumulation took place during the Berriasian to lower Valanginian. The accumulation of phosphates requires specific sedimentation-early diagenetic conditions followed by the mechanical action of currents and/or waves that produce the erosion and removal of fine particles on the marine substrate, allowing the concentration of heavy phosphate particles (nodules, pellets, coprolites, fragments of bones and partially phosphatized shells) in lag deposits. Therfore, transgressive and regressive episodes favor the accumulation of phosphates. In the first case the low rate of sedimentation in the marine setting allows the formation of phosphate in hardgrounds and condensed sequences. The regressions provide optimal rework conditions in litoral environments and incised valleys. Each PL may be composed of one or several lamina or strata. Petrographically the phosphate-bearing rocks are grouped into two lithologic types: phosphatic bioclastic limestone and phosphatic sandstone. From base to top, the general characteristics of PLs are: PL1: 4 strata of slightly phosphatic wackestones, each one about 14 cm thick, interbedded with shale. Total thickness = 1 m; PL2: 4 strata of phosphatic wackestones, each one about 12 cm thick, interbedded with shales. Total thickness = 2 m; PL3: 4 strata of phosphatic wackestones, each one about 5 cm thick, interbedded with shales. Total thickness = 8 m; PL4: one stratum of clast-supported, hybrid phosphate sandstone 40 cm thick, with abundant phosphatic clasts (36% of the total volumen); PL5: one stratum of matrix supported, hybrid phosphate sandstone 20 cm thick, with abundant phosphatic clasts (35% of the total volume); PL6: 2 strata, the lower one is a 50 cm thick phosphatic wackestone. The upper is a 22 cm thick hybrid phosphatic sandstone with floating texture and abundant phosphatic clasts (35% of the total volume). Both strata are interbedded with shale. Total thickness = 4.5 m. Phosphatic particles are composed of broken and partially phosphatized bivalve shells and subespherical phosphatic clasts averaging 1 mm in diameter. PLs 1 to 4 correspond to sea level oscillation during the Berriasian. The PL5 is likely to be associated to the sea-level fall at the Berriasian-Valanginian boundary. PL6 is probably associated with a sea-level fall in the lower half of the Valanginian. In all cases, the low grades (1 to 3%, rarely 8%) of P2O5, reduced thickness, and adverse structural position preclude economical explotation.

Late quaternary responses of fluvial systems of central Argentina

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The stratigraphy, sedimentology and geochronology of late Quaternary fluvial systems located between 32° and 38° S have been the focus of numerous studies in order to shed light on the reconstruction of paleoenvironmental and paleoclimatic conditions. The purpose of this contribution is to carry out a comparative analysis of fluvial responses during the last glacial-interglacial transition. The analysis comprises fluvial systems draining different geological and structural settings, including the piedmont of Cordillera Frontal, the central area of La Pampa province and the southern area of Buenos Aires province. In the Mendoza piedmont of Cordillera Frontal aggradation was active during the late Pleistocene documented by up to 30 m thick sedimentary sequences accumulated since circa 50,000 yr BP. Fine sandy lithofacies are dominant, representing a distal alluvial fan setting with overflows and secondary channelized areas of braided streams. Loess deposits accumulated during the Last Glacial Maximum and the late glacial followed by an interval of stability (paleosol) between ca. 10,000-11,000 ^{14}C yr BP. Overbank deposition and swampy environments developed during the early Holocene. Fluvial aggradation ended sometime during the mid-Holocene when an episode of incision occurred followed by a new aggradational cycle related to sinuous streams. During this interval, sandy silt and silty facies dominated deposition with several stability intervals documented by alluvial paleosols. A second episode of degradation took place after 400-300 ^{14}C yr BP giving way to the formation of a cut and fill terrace and the formation of the present floodplain environment. Central region of La Pampa province shows a reduced Late Pleistocene-Holocene alluvial sedimentary record in comparison with those of the Cordillera Frontal piedmont. In the Quehué valley alluvial deposits exhibit a 3 m thickness, of which 1 m represent the Late Pleistocene. The succession consists of fine sandy and silty deposits representing proximal and distal- swampy environments including a paleosol developed circa 10,000- 9000 ^{14}C yr BP. The uppermost unit is composed of aeolian deposits. Incision occurred at least after the 1200 ^{14}C yr BP followed by the formation of the present active channel. In the Pampa interserrana of Buenos Aires, fine sandy facies were deposited during the late Pleistocene with a soil developed ca 10,000-9000 ^{14}C yr BP followed by the dominance of bioclastic sedimentation (swampy environments) during the early Holocene. In the mid-Holocene aggradation continued with flooding events including episodes of subaeral exposures. Incision occurred at least after 2700 ^{14}C yr BP while loess accreted on top of the surface soil which also received very recent alluvial inputs during flooding events. The alluvial successions of the three areas under analysis are characterized by the occurrence of an interval of stability at the drainage basins recorded by a paleosol developed during the 11,000-9000 14C yr BP interval, while the early Holocene is represented by swampy environments. The present floodplains and active channels are recent geomorphological features dating back to the last millennium of late Holocene, which might be related to both climatic conditions and human disturbance. The mid-Holocene degradation cycle recorded in the Mendoza piedmont is probably related to climatic fluctuations in a highly sensitive environment characterized by a high morphodynamic.

Multi-storey calcrete profiles: a proof of the interaction between sedimentation, pedogenesis and erosion in Quaternary fluvial terraces of the Ebro Basin, Spain

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Multi-storey calcrete profiles developed on Early Pleistocene strath terraces of the Alcanadre River, a Pyrenean tributary of Ebro River in the semiarid NE Spain. The upper terrace outcrops extensively forming a prominent flat landscape capped by thick calcrete profiles. In the nearby of El Tormillo village (Huesca Province) calcrete profiles comprise different horizons whose arrangement is different of the recognized in classical calcrete profiles. In addition significant lateral changes occur in the profile in less than 500 m. The aim of this work is to provide a model of formation of these complex profiles and to explain their lateral variations in relation to the geomorphic situation in which they formed. In doing so we will try to understand the minor scale formation cycles within calcretes, especially if they are the result of climately induced geomorphological changes, which involve vegetation. El Tormillo profile is 5.15 m thick and consists from base to top of: 1) Coarse fluvial gravels constitute the host-rock of the profile, 2) Mudstone with carbonate nodules forming a multicomposed horizon of 0.75 m thick, showing indurated patches of rhizoliths, 3) Chalky horizon of about 1.25 m thick and including important amounts of etched detrital grains and some thin and irregular carbonate laminae. Rhizoliths are common, 4) A thin (30 cm) laminar horizon including at the top a peloidal horizon, 5) A thick (1.75m) and multicomposed horizon formed by at least 6 minor sequences. Each individual (25 cm thick) sequence includes a lower detrital layer, a pisolithic horizon and a thin (up to 10 cm) discontinuous laminar horizon. These minor scale sequences indicate several cycles of brecciation and/or reworking are repeated in time as indicated by the different sets of discordant laminae that cut the previous ones, 6) A topmost laminar and brecciated horizon (1.10 m) includes also reworked pisoliths. Horizon 5 changes laterally to channel fill-deposits, only 500 m to the north. The channels are about 4 m wide and their infill is 0.5 m thick. In the basal contact the underlying calcrete horizons are brecciated and form angular fragments. The infill of the channels shows a fining upward sequence ranging from clasts of about 10 cm to red silts with sparse pebbles. All the clasts are sourced from the underlying calcrete horizons. Most the horizons, specially the laminar ones, present biogenic features such as: alveolar septal structures and calcified filaments, biofilms, microspores and needle-like calcite crystals. The laminar horizons indicate the stages of maximum carbonate precipitation linked to the biogenic activity within the soil profiles. In these stages erosion and sedimentation are notably reduced and a relatively more stable surface is reached. The thickness of the laminar horizons together with their interbedding with clastic sediments and pisolithic horizons indicate that the stages of stabilization were interrupted by erosion and sedimentation. These sequences are an indication of the complex processes operating at the soil surface. The alternation of these processes occurred at small-scale and has been interpreted as the result of climate-vegetation changes. These processes could occur when important storms events generated flows that move on the terrace surface that was by that time probably disconnected from the main drainage system. Summarizing, El Tormillo calcrete profiles developed on Quaternary terraces are seen as multi-storey profiles reflecting the complex sedimentation-erosion-pedogenesis relationships. The study of these calcretes points out that surface stepped terraces are not completely deactivated from a morphosedimentary point of view, even after the entrenching of the fluvial network.

Deep drilling 2008/09 at Lake El’gygytgyn, NE Siberia: Operational success and first results

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Lake El’gygytgyn is located on Chukotka, 100 km north of the Arctic Circle in a crater of 18 km diameter that was formed 3.6 Ma ago by a meteorite impact. From Oct. 2008 until Mai 2009 the Elgygytgyn Drilling Project recovered a 140 m long core from the permafrost catchment (site D3) and a 517 m long core from the center of the lake (D1). Core D1 comprises the entire, 315 m thick lake sediment succession. The sediments show no indications for hiatuses due to glaciation or desiccation. Hence, their temporal length and geologic significance is absolutely unprecedented, for the first time providing deep and widely continuous insights into the climatic and environmental evolution of the terrestrial Arctic since Pliocene times. This is particularly true for the lowermost 40 m and uppermost 100 m of the sequence, which were drilled with almost 100 % recovery and, taking the chronological information as yet available, likely reflect the initial lake stage during the Pliocene and the last ca. 2.0 Ma, respectively. In between, the quality of the record is restricted due to lower recovery in consequence of technical problems and/or sequences of coarse sand and gravel interbedded with lacustrine mud. Processing and subsampling of the lake cores will be completed in summer 2010. The chronological, geochemical, biological and geophysical results as yet available confirmed the sensitivity of the Lake Elgygytgyn sediments to regional and global climate change on a decadal to centennial scale. Paleomagnetic and palynological data indicate that the Pliocene/Pleistocene boundary occurs at about 130 m depth, thus suggesting that sedimentation rates were significantly higher during the Pliocene, particularly during the initial lake stage following the impact. The palynological results also reflect the recolonization of the area, and significant fluctuations in moisture and temperature during the Pliocene. High-resolution geophysical logging and geochemical scanning data very well reflect the Quaternary climate cycles, with significant differences in the intensities and short-term variabilities of individual glacials and interglacials. During the latest Pliocene, more coarse-grained sedimentation could possibly be traced back to a local glaciation on the mountains to the west of the crater. The presentation summarises the major results from the multi-disciplinary investigation of the lake sediment record and draws first conclusions about the climatic evolution of the Arctic during Late Pliocene and Quaternary times.

Tectonic settings and provenance of phyllosilicates from Paranoá and Bambui groups, Brazil

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In Central Brazil the meso-neoproterozoic Paranoá Group underlies the neoproterozoic Bambuí Group. Between them, there is the Jequitaí Formation, a thin and discontinuous glaciogenic unit. These groups were formerly interpreted as a superposition of sequences deposited in the same passive margin, separated by a glacial event. Then they would have been deformed during the neoproterozoic orogeny. The lower and middle parts of Paranoá Gr. are composed by continuous and homogeneous levels of sandstones and mudstones that outcrop for more than 90.000 km^2. The upper unit of the group presents variable thickness and does not occur everywhere. It consists of numerous discontinuous facies: fine to coarse grained sandstones, thin beds of glauconitic rocks, massive or laminated mudstones and carbonate with or without stromatolites. These facies are covered by the Jequitaí Fm or, in areas where it lacks, by the Sete Lagoas Fm (bottom of Bambuí Gr). The mudstone-carbonate Sete Lagoas has irregular thickness and facies distribution, similar to the top of Paranoá Gr. Overlying Sete Lagoas rocks is the terrigenous sequence of Serra de Santa Helena Fm, followed by the upper formations of Bambuí Group: Lagoa do Jacaré (carbonates), Serra da Saudade (mudstones) and Três Marias (sub-quartzose psamites). The contrast between the psamites from Paranoá and Bambuí Groups is clear, but the mudstones from each group present similar macroscopic and outcrop features. In order to understand the relationship among compositional features of Paranoá and Bambuí Groups, their depositional settings and sediments provenance, combined petrographic, mineralogical and geochemical studies were developed. The present work focus on the composition of mudstones collected in Bezerra-Cabeceiras region, Goias State. Bulk chemical analyses of major elements were performed by ICP-AES (Si, Ti, Fe, Ca, Mg) and ICP-MS (Na and K). X-ray diffraction (XRD) analyses were performed on a Rigaku D/Max diffratometer with Cu radiation, under 35 kV and 15 mA. Polished thin sections were studied by petrographic microscopy and CAMECA/Camebax electron microprobe, operating under a 15kV, beam current of 5 to 10 mA and counting time of 10-15 sec. per element. Mudstones from Paranoá Gr. contain more potassium (K_2O <4,0%) and iron (Fe_2O_3 <0,8%) than sodium (Na_2O <0,5%) and magnesium (MgO <0,5%), respectively. Illite is the exclusive phyllosilicate in most samples, while K-feldspar and quartz occur as trace constituents. In layers containing calcite, chlorite (Mg >5; Al >3 per structural formulae) is a trace constituent. Mudstones from Serra de Santa Helena Fm. (Bbambuí Gr.) contain higher sodium (Na_2O >2%) and magnesium (MgO >0,6%) than Paranoá Gr.. Very fine grained greywackes are constituted by quartz, phyllosilicates and altered feldspars, in a matrix made of a mixture of clay and opaque minerals. Illite and Fe-chlorite (Fe+2 >5; Al <3) dominate the matrix of greywackes and mudstones; quartz, albite and hematite are minor constituents. The chemical and mineralogical composition of the mudstone and the phyllosilicates imply different sources and depositional settings for each unit. In Paranoá Gr, the depletion in Na, K and Ca documents severe weathering on a stable area and the detrital K-feldspar points to a granitic source. The extensive homogeneous levels of sandstones and mudstones indicate deposition on a stable passive margin. On contrary, petrogenetic and geochemical diagrams of immature psamites from Bambuí Gr. indicate deposition on active margin basin. Beside the geochemical features, the composition of mudstones – illite, iron-rich chlorite and albite – from Serra de Santa Helena Fm. are the first register of a mafic source, probably located in the emergent orogenic belt.

The deep-sea deposits of the Cuyo Group in the Río del Cobre depocenter, Mendoza, Argentina: characteristics and paleogeographic implications

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The Cuyo Group, of Early to Middle Jurassic age, records the first transgression in the Mesozoic Neuquén basin. This transgression was strongly diachronic, with Sinemurian to Bajocian ages, a fact which reflects the interaction of rising sea level and extensional systems in the early depocenters of the basin (Gulisano, 1981). We describe the characteristics of the Cuyo Group in a depocenter located in the Andes of southern Mendoza province, the Río del Cobre depocenter. The influence of paleotopography on the depositation of the Cuyo Group is known in the study area since the pioneering work of Gerth (1925). The Río del Cobre depocenter presents a succession of ~800 m of deep- sea deposits, and was limited to the east by a basement high, the Río Tordillo High, on top of which less than 100 m of shallow-sea Cuyo Group was deposited (Gulisano y Gutiérrez Pleimling, 1995). Further east the Valenciana depocenter has over 500 m of Cuyo deposits of deeper origin than those in the basement high (Dessanti, 1978). Segmentation of the basin by the Río Tordillo High seems to be a feature inherited from an extensional event previous to deposition, since synrift deposits do not crop out in the Río del Cobre depocenter. Vertical facies variations in the Río del Cobre depocenter were initially described by Gerth (1925); our observations support his general scheme. The lower section shows an alternance of limestones, black shales and volcaniclastic sandstones. The upper section consists of greenish sandstones and black shales with minor limestones and conglomerates. The beds are predominantly tabular, with thickness between a few cm and 2 m, and commonly present flute marks on the base. Occasionally lenticular beds of the same thickness range are observed. Slumps are widespread, and show a western provenance; redeposited and deformed limestone blocks are also abundant. Volcanic material becomes more abundant in the upper section; furthermore, some lavas are interbedded with the sedimentary deposits. Plant remains suggest proximity to an emerged land. Ammonites found in the shales and carbonates have allowed Gerth (1925) to assign the succession to the upper Lias and lower Dogger (Bajocian-Bathonian). These observations are consistent with the description of the lower Nacientes del Teno Formation, of equivalent age, located immediately to the west in Chile. This unit is composed of mostly volcaniclastic material coming from the west, and was interpreted by Davidson (1988) as deposited in proximal submarine fans. We conclude that deposition of the Cuyo Group in the Río del Cobre depocenter took place in a turbiditic system in a narrow trough, with provenance from the western margin which provided mostly volcaniclastic and calciclastic material. Proximal facies are found to the west of the study area in the Nacientes del Teno Formation. The Río del Cobre outcrops represent distal facies, consisting of deep-sea carbonates, sandstones and shales which grade vertically to sandstones and shales with minor conglomerates, suggesting an evolution to more proximal environments.

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The forgotten third dimension

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Every depositional system is inherently three-dimensional, i.e. it exhibits variation at different scales of time and space. It does so without any external changes. In order to describe the system one needs to identify all these scales for both space and time. Once that done, one can consider the system dynamically stable within each of these space and time scales. Once one understands the internal behaviour of the system one can study its response to external variation. Again, each external driver will result in variation of the system. A simple system will build out under static baselevel horizontally, i.e. shoreline position will remain at same height. But there will be lateral variation due to lobe switching. Under changing baselevel the shoreline migration will have a vertical component. However, there will still be the lateral and longitudinal variation. As a result, the system can be said to be three-dimensional. If one cuts a two-dimensional section across such a three-dimensional system a break in sedimentation can be result of either baselevel change or lobe switching. Even at a passive margin thermal and/or isostatic subsidence is occurring, hence sediment starvation causes transgression. This can be caused regionally by a stop in sediment supply to the system or locally by lobe switching. Theoretically, in four dimensions, each major external driver, tectonics, eustasy, and climate can cause a change in the rate of change of baselevel. However, interestingly enough, present day methods to interpret baselevel changes from rock record commonly disgard the third spatial dimension. This should be the first factor to consider and then at all spatial and temporal scales. Next, in order to relate thickness to time one needs to understand sedimentation rates and hiati. Then one needs to understand the role and signature of external drivers. Only then can one infer baselevel changes from rock record. Then one needs to know the three-dimensional facies distribution and natural facies succession and recognise facies and beds in the data.

The interplay between sieving, sheetflow and debris flow processes in proximal alluvial settings

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Although well discussed in the last years, sieving is a natural process that occurs in alluvial settings that forces deposition by the extraction of the transport media from any flow. The type-deposit of sieving is the sieve-lobe, in which a water stream rapidly infiltrates and as a result it dumps all the sediment load forming a protruding lobe, described o modern alluvial fans as well as from flume experiments. In several live observations of sieve lobe formation in natural settings, it was observed that in certain cases a proto sieve-lobe could be reworked into a sheetflow gravel sheet. This is the simple result of a) saturation of the bed porous space by an increasing water flow, or b) progressive occlusion of that space by the progressive addition of finer grains into the bed. In both cases, permeability is the main control of sieving, and thus a series of experiment were produced in order to test how the intergradation between sieving and sheetflow occurs. The experiments, ran at the Marburg University flume were quite simple: starting from an impermeable bed, a fine sand was progressively mixed with coarse sand. Flow was kept constant all over the two runs and water used was perfectly clear and no clay or silt was added to the water-sediment mix. This setting created an experimental alluvial fan that grew progressively more permeable and steeper. The increase of slope was the simple result of the loss of transport capacity of flows due to infiltration at the fan apex. A second run was similar but in this case, starting condition was a permeable ground given by the experimental fan already built and flows started with 100% of coarse sand to increase progressively the fine sand content. As permeability does not change significantly until fine sand is lower than 35%, the initial sheetflow did not show any significant change until that point. On the first run, sieving started to produce lobes when coarse sand was 70%, until creating a pure sieve-lobe fan when coarse sand was 100%. However, in the second rune, when the entire alluvial fan was permeable, flows that started to produce sieve-lobes passed from a stage of debris-flows before turning into a sheetflow dominated system. As there was no mud in the system, most of the flume debris flows were probably non-typical mud-free flows, however they are described in literature. The adding of fine sand to the system created the possibility to close permeability of the channel, and thus, episodically the increase of discharge within a steep channel created a time- & space-limited mass-transport system that advanced beyond the channel end, and rapidly was limited by the fast extraction of water to the ground. It is interesting to note, that sieving has been already mentioned in some field studies to explain the cause of debris flow lobe formation. It is thus possible that sedimentation of many mud-poor debris flows could be forced by bed permeability, a parameter that is usually not considered important in many depositional models. Besides, this study shows how these three end-member depositional processes are interconnected and that they depend in a large extent from the sediment supplied to he alluvial depositional environment.

The age of the largest wind ripples on Earth

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While wind ripples may form in minutes, their further evolution into larger bedforms is still a matter of debate. It is well known that, megaripples can evolve from a ripple field if grains coarser than sand are present in the bed. While its initial stage may respond to a pseudo-ballistic process, evolution into a larger bedform may not. Part of the answer to this quest relies on the age of the largest megaripples found. This would also help understanding the even larger megaripples observed in Mars surface. According to the pioneer work of Bagnold (1941) large megaripples may take centuries to form, and he noted also that they tend to grow progressively slower, suggesting their size is proportional to the square root of their age. The largest megaripples found up to now on Earth are from the Puna plateau (Milana, 2009) and hence, they are well suited to investigate their age. The giant megaripple field contain bedforms reaching up to 43 m in wavelength and 2.3 m in amplitude, while average wavelength is 24 m (n=200) and amplitude is 1.8 m (n=30). We dated by optically stimulated luminescence 4 single giant megaripples, and 2 smaller megaripple complexes. We also took a second sample in one megaripple in order to learn if the bedform was formed in one pulse, or if it was continuously evolving. The age of the single giant bedforms was determined dating the layers near their base. The age obtained for megaripple initiation along profile 1 was between 1,600 and 3,300 yrs, while megaripples along the profile 2, gave ages between 800 and 1,060 yrs. One large megaripple of 2.4 m amplitude but with only 50 cm thick gravelly foreset was dated at two levels giving 1,710 ± 130 yrs and 635 ± 45 yrs at 22 cm below surface. This megaripple suggests a steady vertical growth rate of 0.22 mm/yr, although rates would change between 0.5 to 0.13 mm/yr. As the dated foreset incline c. 10º, the expected average migration rate for these bedforms would be 1 to 3 mm/yr. The difference of ages obtained between profiles 1 and 2, is probably related to their position within the field as profile 1 is central, while profile 2 is marginal. This suggests that the entire megaripple field started to evolve at about 3,000 yrs and it is still slowly evolving, suggesting they are active bedforms. Another dates obtained from smaller megaripple complexes, which are the accretion of several smaller bedforms, gave ages around 3,000 yrs. Although they do not serve to define individual megaripple age, they support the conclusion that most megaripples today visible in this area started to evolve at about 3 Ka. These findings suggest that Bagnold's interpretation of megaripples was quite certain as they may take centuries or even millennia to evolve. However, a more important conclusion is the fact these bedforms seem to be active nowadays, although their migration rate would be very slow. Thus, it is expected that a detailed study of the wind flow structure over these active bedforms could help to understand the wind dynamics required to shape these rare bedforms on Earth, although much more spread on other planets. Our findings also suggest that large megaripples are so rare on Earth because they require stable wind flow conditions and adequate sediment supply, which in this case, seems they were maintained during the last 3,000 yrs.

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A GPR 3D study of aeolian gravelly dunes of Puna and implications to the Holocene wind regimes of NW Argentina

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The wind in the Southern Puna of Argentina moves medium-sized gravels forming gravelly megaripples that can reach 2.3 m high and a spacing of up to 43 m. Also, the gravel is transported to the deflation corridors, where it forms a continuous sheet of clasts abraded by wind. However today remains under discussion if the wind can form gravel dunes. In this contribution, we show unequivocally that during the Holocene, after the deposition of the complex of Purulla ignimbrite dated in 12 Ka. BP and the deposition of an alluvial gravel blanket possible at the end of the Pleistocene, there was a major alteration of the landscape by the wind and as a result, a special type of dune was developed. It has an atypical morphology and abnormal grain size, which involves a significant amount of gravel of different densities. The dunes shown in this study were informally called "aerodynamic dunes" because its profile is opposite to that of crescentic dunes and it is composed of a windward face of steep gradient (up to 27º) respect to the lee face (2- 5º). Basically, the longitudinal profile is similar to a yardang, but in this case the landforms are partly constructive as shown in this study, and not produced by aeolian erosion. They show a crescentic plain shape, resembling the morphology of a barchan but in this case, the concavity looks windward. These inverted morphology and longitudinal profile are explained for the action of very strong winds in relation to typical sand dunes. The frontal concavity is reminiscent of that of parabolic dunes, where the concentration of erosion at the center of the dune occurs. This atypical morphology and coarseness led the investigation of the internal structure by ground-penetrating radar (GPR). As was suggested earlier, GPR study corroborated that the uppermost part of both profiled dunes is composed entirely of megaripple translatent strata. This type of aeolian stratification is not very well known as megaripples are usually bedforms whose deposition/erosion balance is negative, so their preservation potential is low and there are not fossil examples described. This stratification is represented by a radiofacies defined by layers with a high heterogeneity of reflectance, which can be: (a) laterally continuous but showing lateral changes in the intensity of the reflector or (b) showing apparent lateral continuity but in detail subtle endings are observed. Because of the low index of megaripples near dune crests, there are no foresets, but in the lower parts of the dunes it is sometimes possible to recognize a low angle crude crossbedding due to preservation of these non-avalanche foresets. Although the aggradation of megaripples is basically represented by light-weight pumice grains, layers richer in lithics may occur. Their higher density makes them more reflective, generating heterogeneous reflectivity into a pseudo-continuous laminated context. Thus, the stratification of megaripples defines a readily identifiable radiofacies that allow interpretation of how dune was constructed. The crest of the dune body is made up entirely of megaripples advancing against to the basin regional slope, since the present advancing direction coincides with a progressive downlap of these megaripple radiofacies to the west and to the flanks of the dune. Three main constructive intervals were recognized, the first one associated with much stronger winds than the present day and formed simultaneously to the main deflation stage, generating a dune higher than what is observed today. A second intervals suggest a stage of wind reversion and deposition of a thick unit over the previously winward face. The last stage indicates a return to the normal E-directed winds, although in a more moderate scale. In this stage, a minor dune accretion occurs; and some infilling on the front of the dune with materials more finer in grain-sizes also occurs, with smaller megaripples, probably corresponding to modern conditions.

AMS radiocarbon and OSL chronology of a Late Quaternary sediment core from Lake Ulaan, Mongolia

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Radiocarbon and optically stimulated luminescence (OSL) dating methods were applied to test their applicability for establishing a chronology of a 5.88m long core recovered from arid-zone lacustrine sediments in Lake Ulaan, southern Mongolia. In the depth profile of the core, most of the OSL ages define a good linear relationship with depth, suggestive of a constant depositional rate of 0.035 cm•yr-1, while radiocarbon ages deviate from a linear regression line over almost the whole core. However, radiocarbon and OSL ages appear to be almost identical for samples at the depth interval between 350 and 400cm, representing a transitional period between the Pleistocene and Holocene whose paleoclimate is known to be relatively humid. However, compared to corresponding OSL ages, radiocarbon ages are shown to be consistently older by 3300-5500 yrs in the 100-300 cm interval (early to late Holocene) and by ~2300 yrs at the 450cm horizon (late Pleistocene). Grain size analysis indicates that eolian processes (at 100-300cm and 550cm) were the dominant sediment transport mechanism. Consequently, the radiocarbon ages older than the corresponding OSL ages during the Holocene and the late Pleistocene seem to have been caused by the influx of ^{14}C-deficient carbon components derived from adjacent soils and Paleozoic carbonate rocks by prevailing westerly winds, which is also active even today. The results of this study suggest that when eolian sediment transport is strongly suspected, especially in lakes within arid environments, the OSL dating method can be a more reliable tool for dating sediments than the radiocarbon method (common 'old carbon' problem).

Reconstruction of the AD 869 Jogan tsunami in Northeast Japan

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The fore-arc region of northeast Japan is an area of extensive seismic activity and tsunami generation. An earthquake in the offshore region of northeast Japan on July 13, 869 gave rise to a large-scale tsunami that caused damage to the low-lying coastal zones of Northeast Japan. The AD 869 tsunami, named the Jõgan tsunami after the then emperor, is unusual because of its widespread flooding. A well-known document named Sandai-jitsuroku, which records the history of all of Japan in detail extending over the past 1200 years, describes the Jõgan earthquake and the subsequent tsunami as follows: "The large earthquake was attended by a luminous phenomenon, and the coastal areas were illuminated in the dark. Some time after severe seismic shocks, a gigantic tsunami reached the coast and then invaded the whole region of the Sendai plain. Rising seawater flooded an old castle town (Tagajõ), with the loss of 1000 lives." There is no historical evidence of co-seismic subsidence of the plain, and thus the prolonged period of flooding indicates that waves of the Jõgan tsunami sequentially invaded coastal areas. Structural foundations from the 8th and 9th centuries have been discovered destroyed in the ruins of Tagajõ, and are overlain by sediment layers containing relics from the middle 10th century. The administrative committee studying the remains interprets that the exposed structures of the castle town collapsed because of erosion by the Jõgan tsunami. More than 100 years have passed since the beginning of scientific observation in Northeast Japan, and in that time no tsunami has penetrated inland farther than 2 km. It is inferred from the site of Tagajõ that seawater inundation by the Jõgan tsunami reached 4 km or more inland from the coast. Does the deep penetration of seawater record the occurrence of unprecedented large-scale tsunami? The Pacific coast of Northeast Japan is notorious for the repeated invasion of tsunamis. The Sendai plain, however, has not been affected by such a large tsunami since the occurrence of the Jõgan event. Rapid urbanization has advanced to the coastal areas, so that most of the area inundated by the Jõgan tsunami is now developed. Understanding the cause and effect of regionally extensive invasion of the Jõgan tsunami is important, not only to prevent a disaster, but also to gain an understanding of fore arc tectonic processes. In this study, the Jõgan tsunami deposits were studied using sedimentological analyses and numerical hydrodynamic models in an attempt to make clear the origin of the Jõgan tsunami.

Cluster analysis as a ground-up method for testing ichnofacies models

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Ichnofacies are conceptual constructs, based on observations of recurrent associations of trace fossils and the behaviours that they represent, that are considered to be indicative of particular depositional settings and environmental conditions. To date, ichnofacies have been proposed and defined on the basis of qualitative observations and correlations of trace fossil assemblages. Following the original inception of the various ichnofacies models, many additional trace fossil assemblages have been discovered, described and apportioned. The principal objective of this study was to investigate the utility of cluster analysis as a ground-up method for objectively testing the current definitions of ichnofacies models. In addition, cluster analysis results in a hierarchically clustered dendrogram, much like a phylogenetic tree, and therefore provides the potential to move towards the delineation of a hierarchical system. It can also assist in resolving and unifying current issues within the field regarding the differing approaches of ichnofacies versus ichnofabrics workers and the utility of invertebrate versus vertebrate ichnofacies. A global database of non-marine trace fossil assemblages from the Devonian to Permian was used as a case study. Separate associations of assemblages were resolved that represented non-marine subaqueous and transitional subaqueous to subaerial depositional settings and the constituent trace fossils corresponded to the *Mermia* and *Scoyenia* ichnofacies respectively. Support was also found for an association of assemblages from non-marine depositional settings with high-energy, shifting sand substrates and the constituent trace fossils corresponded to the *Skolithos* ichnofacies. A cluster of assemblages dominated by arthropod and tetrapod trackways was also resolved, supporting previous observations that such associations are recurrent, and represented tidal flats and sandflats. This could be deemed a subdivision of the *Scoyenia* ichnofacies. Comparison of analyses where vertebrate ichnotaxa were coded individually or pooled revealed the occurrence of clusters of assemblages that were heavily influenced by the co-occurrence of time-restricted vertebrate ichnotaxa and this was to the detriment of similarities in invertebrate ichnotaxa. The analysis of trace fossil occurrences to identify environments should be holistic, incorporating both invertebrate and vertebrate ichnotaxa, but vertebrate ichnotaxa should be pooled when conducting broad-scale analyses, and then coded individually to enable finer-scale discriminations amongst depositional settings within particular time periods.

Storm deposits in transgressive sequences: An example from Eastern Kachchh, India

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The peri-cratonic Kachchh sedimentary basin is situated at the extreme west of Indian craton. The Mesozoic shallow marine sedimentary succession (ca.500m) of Eastern Kachchh (Wagad and Khadir Island) ranging in age from Bathonian to Early Kimmeridgian is composed of different cycles of transgressive and regressive units. Most of the previous studies were restricted to the documentation of transgressive – regressive cycles. Present study has been carried out taking importance of storms processes and sea level change in to consideration. Regional field study supported by laboratory investigations reveals that the storm played an important role in redistribution of sediment particles during transgression however, regressive deposits are characterized by dominance of wave / tide generated features. Present investigation relates to the recognition of storm generated features during transgression. Sedimentary features preserved due to high energy storm flows during high stand include: (i) inter bedding of storm lag unit (medium to coarse grained / gritty, graded to massive, sheet like fossiliferous calcareous sandstone) and swell lag unit (fossiliferous mudrocks); (ii) thickness of individual unit varies from 5cm - < 1m; (iii) abundance of reworked sediment particles, high proportion broken bivalve shells with convex up orientation; (iv) irregular to sharp nature of basal contacts of units together with well preserved bioclast. These features are commonly observed in sand dominated, fining and thining upward sedimentary succession exposed in Eastern part (marginal part) of Kachchh sedimentary basin. The study suggests that the transgressive units were deposited below wave base by high energy storm flows.

Process response model of Jurassic rocks of Khadir Island, Kachchh basin, Gujarat, India

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The Mesozoic sediments of Kachchh sedimentary basin are recognized as classical example of Jurassic in the world. Biswas (1977), on the basis of detailed geological mapping, proposed for the first time lithostratigraphic classification of Mesozoic rocks, wherein three main lithologic provinces have been recognized: Kachchh mainland, “Island- belt” and eastern Kachchh. The area under investigation falls in the domain Khadir Island having thickness of 400m, consisting of five members in ascending order- Cheriya Bet Conglomerate Member, Hadibhadang Shale Member, Hadibhadang Sandstone Member, Gadhada Sandstone Member, Bambhanka/ Gangta Member. The investigated strata range in age from Bathonian to Early Oxfordian dated by lateral correlation with basinal deposits. Based on outcrop data supported by laboratory investigations, four lithofacies assemblages were differentiated: (A) Mudrocks-calcareous sandstone: medium to coarse grained, thickly bedded, fossiliferous thinning upward, calcareous sandstone inter bedded with mudrocks; (B) Limestone - bioturbated mudrocks (C) Ferruginous sandstone - mudrocks: mudrocks inter bedded with moderately to thickly bedded, medium to coarse grained, thickening upward massive ferruginous sandstone (D) Calcareous sandstone – mudrocks: mudrocks inter bedded with medium to coarse grained / gritty calcareous sandstone. The assemblage- A is interpreted as transgressive deposits followed by still stand deposition (assemblage- B). Assemblage- C indicates its deposition during regression; however, high storm flows deposited assemblage- D during highest stand of sea level. Based on distribution of these lithofacies in vertical column, the whole sedimentary succession has been divided in to three depositional sequences: (I) 100m transgressive sequence-I (facies A&B); (ii) 200m regressive sequence-II (facies C); (iii) 100 transgressive sequence-III (facies D).

Provenance analysis of Paleocene-Lower Eocene sandstones in the Eastern Cordillera (Colombia): relations between source areas and the regional tectonics

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Despite the multivariable system (source area, relief and climate), source area composition and tectonics may exert a first order control in sandstones provenance. An important up section decrease of compositional maturity has been documented in Paleocene to Lower Eocene sandstones of the Eastern Cordillera, which causes are still not well understood. These strata had been interpreted either: (1) as a continuous sandstone bed across the basin bounded by two source areas, one to the west (plutonic and metamorphic rocks of the Central Cordillera) and the other to the east (basement rocks of the Guyana craton), or (2) as the record of different depocenters separated by internal uplifts presently involved in the Eastern Cordillera. A provenance analysis that integrates petrography, heavy minerals and detrital zircon geochronology, was carried out in three areas of the Eastern Cordillera of Colombia, named from West to East: Usme Syncline, axial area (Checua, Tunja and Umbita), and foothills area. A total of 40 samples of the Paleocene – Lower Eocene succession were analyzed, in order to understand their relation with regional processes of uplift and magmatism from three possible source areas: the Central Cordillera to the west, internal uplifts of the Eastern Cordillera, and cratonic areas to the East. Lower to Middle Paleocene sandstones in the Usme Syncline consist of quartzarenites to sublithoarenites, whereas the Upper Paleocene sandstones include sublithoarenites to lithoarenites with a major sedimentary source. The shift to more inmature composition is observed in Lower Eocene sandstones, marked by lithoarenites to feldspathic lithoarenites with volcanoclastic, sedimentary and metamorphic sources. Unstable heavy mineral minerals, like hornblende and biotite, are also observed in this interval. Zircons of this syn-depositional volcanic event have an age of 56.13±0.87 Ma, and dominant zircon population ca 70-300 Ma indicate provenance from the Central Cordillera. In the axial zone, Lower Paleocene sandstone composition and the heavy mineral association are more mature than Upper Paleocene and Lower Eocene sandstones; detrital zircons recovered in latter sandstones record the syn-depositional volcanic activity. All sandstones have dominantly a sedimentary source with minor metamorphic material. Zircon populations show an increase in the old zircons (ca. 900-1500 Ma) that are interpreted as reworking of the Cretaceous sedimentary cover, with a small contribution of zircon ages from the Central Cordillera. At the eastern foothills, Lower to Middle Paleocene sandstones are quartzarenites, with a major change in the Upper Paleocene-Lower Eocene sandstones that includes a mix between metamorphic and sedimentary sources. Zircons show old populations ca 900-2000 Ma, but in Upper Paleocene-lower Eocene sandstones are reported syn-depositonal ages varying from ca 51 to 61 Ma, with a depositional age calculated of 57.58±0.37 Ma for one sample. These temporal and spatial changes on the sandstone provenance suggest that both the Central Cordillera and internal uplifts of the Eastern Cordillera contributed terrigenous detritus to the easternmost and axial basins during Late Paleocene to Early Eocene time. At the foothills, metamorphic and sedimentary detritus should be derived from nearby sources, such as Paleozoic highs in the southern Llanos, and sedimentary cover of uplifted blocks. The volcanic activity associated with basin filling processes may be associated to contemporaneous Paleogene Plutonic bodies within the Central Cordillera or other plutonic bodies farther east. Intraplate faulting and magmatism are linked to the transition between Late Cretaceous – Early Paleocene Caribbean accretion to Late Paleocene – Early Eocene subduction of he Caribbean plate.

Sedimentary facies and architecture of a gigantic gravelly submarine channel system in a Cretaceous Foredeep Trough (the Magallanes Basin, southern Trough)

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The Lago Sofia conglomerate in southern Chile is deep-marine gravelly deposits, which are hundreds of meters thick and kilometers wide and extend laterally for more than 100 km, filling the foredeep trough of the Cretaceous Magallanes Basin. For understanding the depositional processes and environments of this gigantic deep-sea conglomerate, detailed analyses on sedimentary facies, architecture and paleoflow patterns were carried out, highlighting the differences between the northern (Lago Pehoe and Lago Goic areas) and southern (Lago Sofia area) parts of the study area. The conglomerate bodies in the northern part occur as relatively thin (< 100 m thick), multiple units intervened by thick mudstone-dominated sequences. They show paleoflows toward ENE and S to SW, displaying a converging drainage pattern. In the southern part, the conglomerate bodies are vertically interconnected and form a thick (> 400 m thick) conglomerate sequence with rare intervening fine-grained deposits. Paleoflows are toward southwest. The north-to-south variations are also distinct in sedimentary facies. The conglomerate bodies in the southern part are mainly composed of clast-supported conglomerate with sandy matrix, which is interpreted to be deposited from highly concentrated bedload layers under turbidity currents. Those in the northern part are dominated by matrix- to clast-supported conglomerate with muddy matrix, which is interpreted as the products of composite mass flows comprising a turbidity current, a gravelly hyperconcentrated flow and a mud-rich debris flow. All these characteristics suggest that the Lago Sofia conglomerate was formed in centripetally converging submarine channels, not in centrifugally diverging channels of submarine fans. The tributaries in the north were dominated by mass flows, probably affected by channel-bank failures or basin-marginal slope instability processes. In contrast, the trunk channel in the south was mostly filled by tractive processes, which resulted in vertical and lateral accretion of gravel bars, deposition of gravel dunes and filling of scours and channels, similar to deposits of terrestrial gravel-bed rivers. The trunk channel developed along the axis of foredeep trough and its confinement within the trough is probably responsible for the thick, interconnected channel fills. The large-scale architecture of the trunk-channel fills show an eastward offset stacking pattern, suggesting that the channel migrated eastwards most likely due to the uplift of the Andean Cordillera.

Evolution of tectono-sedimentary systems in the Nankai Forearc: A summary of results from NanTroSEIZE drilling and 3D seismic expeditions

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Sedimentary deposits in the forearc of the Nankai accretionary prism off Kii Peninsula, Japan, record complex interactions between sedimentation and deformation processes. Three-dimensional (3D) seismic data image more than 2 km of sediment in the Kumano forearc basin deposited on top of the accretionary prism. The seismic and core data show that the unconformity between the prism and the overlying basin sediments is time-transgressive. The unconformity separates 5 Ma prism rocks from 3.65 Ma basin deposits at drill Site C0002 and 5.6 Ma prism rocks from 3.8 Ma basin sediments at drill Site C0009 (~ 20 km landward of C0002). The basal basin sedimentary sequence is sub-parallel to the underlying accretionary prism and varies in thickness from 50 to 500m and is interpreted as lower trench slope deposits. Overlying the basal sequence is a basin-fill unit of landward-onlapping seismic sequences that are progressively tilted landward in response to regional uplift along a mega-splay fault at the seaward margin of the basin. As the basin's depocenter shifted landward, the basin expanded from ~10 km in width to > 30 km. The onset of turbidite deposition in the basin began when accommodation space was created by the uplift of the outer ridge along the splay fault at ~1.65 Ma. Within the upper km of the basin fill, there is one large-scale slump mass (4.5 km x 4.5 km x 135m) as well as several thinner (50-75 m) slump deposits. Horizontal depth slices and amplitude maps on individual horizons at a depth of ~1 km in the basin fill show several large channels oriented approximately perpendicular to the basin axis that start landward of our survey and extend into the middle of the basin. Seaward of the forearc basin is the frontal accretionary prism. Although the present accretion takes place at the toe of the prism, the sedimentary cover over the prism demonstrates that thrusting is active throughout the entire frontal prism. Ramp anticlines have formed in the hanging walls of thrusts that sole into a basal décollement. Young slope sediments onlap the still growing anticlines and form small trench slope basins near the toe of the prism that expand into larger basins up slope. Slumping is a dominant process on the slope, with numerous surficial slump scare evident in the seafloor topography. The basin sediments have many stacked, thin mass transport deposits (MTD), as well as at least one large MTD (> 5 km in the strike direction x 5 km in the dip direction x 150 m thick), indicating that slumping has been an important sedimentary process in the slope basins throughout their histories. Multiple small channels cut during a very short time period (~1.55-1.24 Ma), oriented perpendicular to the paleoslope were filled within the next seismically-resolvable time step. At the tip of the megasplay fault, we have documented the growth of the fault and its interaction with slope sediments. Slope sediments deposited in small basins in front of the advancing splay fault hanging wall are overridden by the hanging wall. Dating of the slope sediments at drill Sites C0002, C0004 and C0008 indicates that splay faulting began ~ 1.5 Ma with an episode of significant movement between 1.3 and 1.0 Ma that caused the main forearc basin tilting. Splay fault movement continues to be active today.

The Late Berriasian - Early Valanginian deposits of the western Tethys: record of climate change prior to the Valanginian carbon-isotope excursion

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The Cretaceous is generally considered as a period of high atmospheric pCO_2 and resulting warm climate, which led to the diversification of shallow-water organisms and to the proliferation of carbonate platforms. However, environmental conditions evolved not in a uniform way during the entire Cretaceous period. Shifts in the carbon-isotope record indicate important shorter-term changes in the global carbon cycle, which were often accompanied by episodes of platform drowning and associated changes in faunal assemblages. The first platform-drowning episode of the Cretaceous occurred during the Valanginian. The associated perturbation of the carbon cycle was global and affected both marine (deep and shallow water environments) and continental settings. The formation of the Parana-Etendekà large igneous province (LIP) has been proposed as a mechanism driving environmental change during the Valanginian. The latest stratigraphic chart, however, suggests that Parana-Etendekà LIP activity started after the onset of the $\delta^{13}C$ excursion. Several studies have shown that the $\delta^{13}C$ shift was preceded by an increase in nutrients levels in the Early Valanginian, which is indicated by a rise in phosphorus values in pelagic sediments, the distribution of nannofossils sensitive to trophic conditions, and a change in platform ecology from photozoan to heterozoan communities. This indicates that environmental change occurred prior to the positive excursion. Moreover, clay assemblages in the Tethyan and western European basins show an increase in humidity since the Late Berriasian. We studied sections at Capriolo (N Italy), Montclus (SE France) and Musfallen (E Switzerland) located in the Lombardian and Vocontian basins and on the Helvetic platform, respectively, in order to precisely characterize and date paleoenvironmental and paleoclimatic change during the latest Berriasian - Early Valanginian time interval and to establish whether these changes constitute a prelude leading to the late Early Valanginian $\delta^{13}C$ event. We perform analyses on phosphorus and stable-isotope contents, in addition to clay and bulk-rock mineralogy, and facies determinations. The three sections show similar and comparable trends: The phosphorus content (in ppm) is relatively high in Late Berriasian sediments (compared to Early Berriasian and Early Valanginian deposits) and the $\delta^{13}C$ values decrease during this period. These changes, recorded both in platform and basin sediments, are probably generated by enhanced continental weathering. This goes along with a change in clay assemblages with the appearance of kaolinite and chlorite, indicating that the climate became indeed more humid during the Late Berriasian. This climate change has already been observed at different sites in France, Switzerland, England and the Netherlands and occurred at least on the scale of the western Tethys area, and may have set the stage for the changes to come during the Early Valanginian.

Sedimentary changes on the Guadiana River mouth (Portugal-Spain) as a consequence of human modifications

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The Guadiana River Estuary is one of the most important rivers of the Iberian Peninsula. The last 60 kilometers of their fluvial course makes the natural border between Spain and Portugal and are strongly influenced by tides. In the frontal zone of the Guadiana River estuarine channel extensive intertidal sand bars are developed, constituting its deltaic front. In its natural state, these bars were continuously reworked by waves and tides activity and occupied a position of dynamic equilibrium which reflected the balance of power between both agents. The rapid growth and mobility of these sandy platforms originated continuous problems of navigation in the access to harbours located in the inner estuary and prompted the need for an artificial stabilization of the channel by means of two jetties which were built in 1980. On the other hand, an enormous dam was built at Alqueva (Portugal) in 2002, just at the last point of tidal influence. Both facts have led to an imbalance in the coastal dynamic of the frontal bars. The aim of this work is the analysis of the sandy platforms position changes in the 30 years that have elapsed since the construction of the jetties using GIS tools. A comparative analysis of the nautical chart of 1982 with the available aerial ortofophotographs has been developed using the software MapInfo 7.0. This comparative analysis has noted that a rapid migration bars towards land has taken place since the construction of the jetties, estimated in 21.60 meters per year between 1982 and 2007. In addition, coastline changes have been studied. It was observed a direct relationship between the beach erosive or cumulative behavior with the extension of the sandy shelves located just in its front. The dynamic explanation of this coastal behavior is based on the fact that the jetties originated a disconnection of the sandy bars from the Portuguese margin (Punta da Areia). So, tidal currents ceased to act on them, and they only are subjected to the wave action. The energy of waves acting on the sandy platforms causes a transport of sand landwards. This displacement of the sand signifies a wave energy dissipation on the shoals. In consequence, the emerged coast is protected by them. However, depth and extension changes of sand bars causes the presence of a complex system of wave refraction, which induces the presence of erosive areas where refraction generates sections with divergent senses of longshore transport. The construction of Alqueva dam inhibits the bypassing of fluvial sediment towards the coast. The subsequent sedimentary deficit generated at the mouth is reflected in the destruction of the deltaic frontal lobe.

Pleistocene climate proxies from landslide impounded lakes

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Dammed lakes in mountain areas are characterised by a very short life as they rarely survive more than one day. Nevertheless, long life impounded lakes such as the Negra lake dammed by the Holocene Meson Alto rock avalanche (Yeso River, Chile) and the Inca lake dammed by Portillo rock avalanche have been studied for understanding paleo-climate conditions. Despite this, climatic proxies from Pleistocene paleolakes are occasional in the literature. Herein, three palaeolake sequences were studied in the northern extreme of the Cordon del Plata, Central Andes (32º 30´ S) in order to assess the paleoclimatic history of the region. Analysed lake sequences, reaching 30 meters in thickness and extensions of 0.4 square kilometres, were impounded by huge rock avalanches with volumes in the order of one million cubic meters, called TD, PA, and PB, respectively. These diamictons resulted older than an ash level dated by tephrochronology 350±80 Ky (Ar39/Ar40 method on biotite) (Moreiras, 2006, 2010). However, new ages obtained for the lake sequences of PA and TD by thermoluminescence technique reveals 47,440±3700 ky and 43,950±3895 Ky, respectively. Thus, dental remains found in the paleo-lake related to the PB rock avalanche were identified as Hippidion devillei (Cerdeño et al, 2008). This endemic species appearing in South America around 2.5 My is restricted to the Andes mountains and associated to Early-Middle Pleistocene sediments (Ensenadense) (Alberti and Prado, 2000). Sedimentary sequence collected from the palaeo-lake related to the PB rock avalanche (22 samples) shows a very fine grain size distribution with more than 75% of silt-clay content. Scarce organic matter content and no palynological content were determined for these levels. However, abundant carbonate nodules were observed at 17 m deep from the top of the sequence. As well diatomite levels, rich in carbonate and with high volcanic glass content, were identified in the PA paleo- lake. Plant species identified in diatomites are cosmopolitan (Amphora sp., Achnantes longipes, Central, Cymbella af. cistula cymbiformis, Cymbella ventricosa, Denticula, Fragilaria brevistriata var. Trigona, Gomphonema sp., Navicula sp., Neidium sp.?, Nitzschia sp.) not being a good climate proxy. Both sections are not varved. Moreover, the PB lake sequence is disturbed by liquefaction processes. Existence of the long life paleo-lakes with calcareous layers and very low matter content could roughly implicate dry-warm climate conditions. However, $\delta^{13}C$ values range (-8.5 and -9.3 PDB) obtained from the tooth enamel carbonate of the horse remains indicate a regime diet based on C3/C4 plants, while the oxygen isotope values ranging between -4.5 and -8.3 (PDB) may indicate a similar climate to the Present as -8 %0 VSMOW has been measure in water stream at 2000 mean elevation (Hoke *et al.*, 2009). However, differences in $\delta^{18}O$ values of meteoric water are suspected according to rain source (Pacific vs Atlantic).

3D static and dynamic modeling of a carbonate reservoir: a case study from the Lower Cretaceous La Tosca Unit (Neuquén Basin, Argentina)

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This work presents the integrated 3D static and dynamic reservoir characterization and modeling of La Tosca unit (Huitrín Formation) in the southern area of Cañadón Amarillo concession block. The Lower Cretaceous Huitrín formation of the Neuquén Basin consists of mixed clastic-carbonate-evaporite sediments accumulated in shallow marine to continental settings. The unit is subdivided into three lithostratigraphic members: Chorreado, Troncoso and La Tosca. All three members in varying locations are hydrocarbon bearing. The main structure in the studied area is an East-verging basement anticline with El Pichanal, Pata Mora and Puesto Molina fields all being located on its western flank. The studied area (Pata Mora field) corresponds to a homocline gently dipping (<5°) to the West. Both, a High Resolution Sequence Stratigraphic model (HRSS) and a Discrete Fracture Network (DFN) model, were built through the integration of seismic, core, well cuttings, borehole imaging and log data, and validated by well tests and dynamic simulations. La Tosca depositional sequence consists of a third order transgressive-regressive 30 m-thick cycle accumulated on a shallow carbonate platform. Main deposits comprise low- to high-energy subtidal to intertidal facies including skeletal banks, ooid-skeletal shoals, peloidal platform interior, algal mats and sabkha deposits. The facies stacking pattern allows further subdivision of the unit into possible fourth (14 to 19 m thick) and fifth order (3 to 13 m thick) accommodation cycles. Fourth order cycles show evident facies partitioning, with overall argillaceous-carbonates dominating transgressive hemicycles and clean carbonates (ranging from skeletal and oolitic grainstones to algal-mat boundstones) dominating regressive hemicycles. Fifth order cycles also show similar facies partitioning, with transgressive hemicycles bearing argillaceous limestones and regressive cycles characterized by oomoldic and skeletal grainstones. These cycles show a clear log response enabling reliable cycle correlation of the non-cored wells. Two types of fractures, diagenetic and tectonic, were identified in core. Diagenetic fractures show preferential occurrence within the regressive portions of the interpreted 5th order cycles mainly in oomoldic grainstones due to enhanced cementation and in algal mats due to desiccation. Tectonic fractures are ubiquitous and their intensity is related to fault distance. We propose a model of dual porosity where matrix represents the hydrocarbon storage and tectonic fractures provide the production mechanism. The best matrix reservoir intervals occur within 5th order regressive hemicycles where permeability of oomoldic and algal mat facies were enhanced by a network of centimeter-scale diagenetic fractures.

First evidences of several pedo-sedimentary cycles in recent Quaternary sandy deposits in Los Llanos plains, La Rioja (Argentina)

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The eastern part of the Province of La Rioja (Argentina) integrates a large region usually known as "Los Llanos" (Callela and Cardozo, 2006) corresponding to the piedmont plains of the Northwestern Pampean Ranges. The climate is semiarid, while the vegetation is mostly characterized by xerophytic shrubs, and from a phytogeographic point of view it integrates the subregion known as the Wooded Chaco (Morello, 1968). The information about the soils of this region is rather limited, most of them being included into two soil Orders: Entisols and Aridisols (SAGyP-INTA, 1990). In this work, three soil profiles developed on a sedimentary mantle of Quaternary sandy materials of a probable Upper Pleistocene-Holocene age were studied (Carignano, 1997). The area studied is located at about 29°57'S and 65°52´W, where two geomorphological units were differentiated: gently rolling low hills and concave areas associated with the drainage pathway; two of the profiles were described in the first unit and the other in the second unit. Several physical and chemical parameters were measured in samples from soil horizons of each profile; the mineralogical composition of the clay fraction and of bulk samples of each horizon was studied by X ray diffraction, and the bulk magnetic susceptibility of samples taken every ten centimeters depth was also measured. The results obtained show that the soils are of sandy loam texture and have very little morphological development. Nevertheless, and contrary to what was established in the soil map for the area concerned, cambic horizons were found in the three soils studied; this leads to classifying them as Haplocambids, appearing differentiated at the subgroup level. The mineralogical analyses of the bulk samples indicate a predominance of quartz and feldspars, with lower proportions of muscovite, calcite and traces of other minerals. The scarce clay fraction is mainly composed of illite, intermediate contents of swelling minerals (smectite and interestratified illite/smectite) and lower proportions of kaolinite and accesory minerals. The values of bulk magnetic susceptibility (MS) (χ) oscillate around 1.70 10-6 m^3kg^{-1}; MS values increase irregularly but progressively up to the surface in the profiles of the low hills; in contrast, the profile in the lowlying sector shows a more complex SM depth function which can be related to the higher humidity and higher number of discontinuities in this soil. The small frequency-dependent MS values measured in the three profiles indicate that their magnetic fraction is basically inherited from the sedimentary material. On the basis of the morphological features and the analytical parameters evaluated, several compositional discontinuities and buried cambic horizons were identified in the three soils; discontinuities and buried horizons could be correlated spatially between the profiles, thus suggesting the existence of four pedo-sedimentary cycles in the materials under study. Consequently, these results indicate a more complex succession of environmental changes and of sedimentary and pedological processes than the single sedimentation-pedogenesis cycle should be recognised up to the present for the superficial sandy materials in this area of the Province of La Rioja.

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Depositional architecture of the Lower Cretaceous Sparky, Waseca, and McLaren Formations, West-Central Saskatchewan, Canada

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The Lower Cretaceous Sparky, Waseca, and McLaren formations of west-central Saskatchewan, Canada, consist of weakly consolidated sandstones, shales, heterolithic bedsets, and minor coals. These units were deposited in low-gradient shallow-marine to coastal-plain environments, yielding thin cycles that reflect multiple, small-scale relative sea-level changes. Cores from 100 wells in the study area were evaluated for trace fossils, bioturbation index (BI), sedimentary structures, and evidence of stratigraphic discontinuities, leading to the identification of ten recurring facies combined into 6 facies associations. The most common facies associations correspond to inclined heterolithic stratification (IHS), deltaic intervals (bay-head delta and bay-margin deltas), fluvio-estuarine valley fills, and coastal plain channels. Discrimination between these broadly similar facies requires the integration of sedimentological and ichnological data. In the lower part of the succession, IHS deposits accumulated by lateral accretion in tidally influenced channels. Facies display BI 0-3, and contain ichnological suites dominated by *Skolithos*, *Planolites*, *Gyrolithes*, *Cylindrichnus*, navichnia and fugichnia, consistent with brackish-water accumulation. Deltaic deposits are also heterolithic, with abundant, organic-rich fluid mud drapes, syneresis cracks, soft-sediment deformation features, carbonaceous detritus, normally graded beds, and structures recording oscillatory, current and combined flow processes. Facies display variable bioturbation intensities (BI 0-3), with low-diversity trace-fossil suites dominated by diminutive *Gyrolithes*, *Teichichnus*, *Planolites*, *Palaeophycus*, *Cylindrichnus*, *Skolithos*, *Thalassinoides* and *Chondrites*. Discriminating between bay-margin deltas and bay-head deltas can be challenging. Ichnological characteristics show bay-margin deposits to contain ichnogenera that reflect the activity of organisms considered intolerant of physico-chemical stress (e.g., *Asterosoma*, *Phycosiphon* and *Helminthopsis*). Stratigraphic correlation shows that bay-head deltas are confined within the valley fills. Distributary channels are associated with the deltaic deposits and are largely unburrowed (BI 0- 2). Brackish-water bay deposits, into which the deltas prograde, display reduced physico-chemical stresses, manifest by the combination of higher bioturbation intensities (up to BI 5) and greater ichnological diversities than expressed by deltaic suites. This presumably reflects the reduced influence of river discharge into the setting. Bay successions contain *Planolites*, *Cylindrichnus*, *Skolithos*, *Teichichnus*, *Palaeophycus*, *Thalassinoides*, *Chondrites*, *Asterosoma*, *Gyrolithes*, navichnia and fugichnia, as well as wave- and combined flow- generated structures locally mantled with normally graded mud drapes and soft-sediment deformation features. Valleys are incised up to 25 m into palimpsest deltaic deposits, reflecting relative sea-level falls. Incised valleys were filled with fluvial to estuarine deposits during the subsequent transgression. Ichnological evaluation of the valley fills shows them to contain low-diversity suites consisting of small numbers of diminutive ichnogenera produced by trophic generalists, consistent with the brackish-water trace fossil model. BI values within the valley fills are generally low (0-2), but can reach up to BI 5 at the seaward limits of the study area. The stratigraphic succession comprises parts of two depositional sequences. The lower sequence encompasses the Sparky and lower part of the Waseca formations, reflecting both transgressive and highstand systems tracts. During the Waseca, a lowstand disconformity was produced, with lowstand to early transgressive systems tract accumulation confined to the incised valleys. A maximum flooding surface separates the upper Waseca from the McLaren Formation. The McLaren represents a return to regional shoreline progradation, corresponding to a highstand systems tract

Anatomy of a large bioclastic sand wedge, Favignana Island (Italy); preliminary results

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Bioclastic sand-wedge complexes may form important hydrocarbon reservoirs. Unraveling flow-unit geometry and connectivity characteristics is critical to plan effective exploration and recovery. The stratigraphy, sedimentology, petrography and reservoir property distribution of the Plio-Pleistocene bioclastic wedge outcropping in the eastern part of the Island of Favignana (Sicily, Italy) is being investigated in detail. The many exposures along the coast and in numerous quarries excavated throughout the studied area, offer a unique opportunity for unraveling the anatomy of this type of complex deposits. The sediments are dominated by medium to coarse carbonate sandstone, characterized by large intra- and intergrain connected porosity. Grains are mainly skeletal carbonate detritus of foraminifera, bivalves and gastropods, shell fragments, echinoids, coralline algae and bryozoans. Sedimentary facies shows important lateral and vertical variability. Laterally extensive beds, consisting of high-angle foresets, likely associated with large dune systems, pass upwards to sets of small- scale through cross bedded strata and parallel, low-amplitude undulating bedding with 2-3 m wave length. These sequences are often cut by sub-horizontal to steeply dipping (incising up to 10 m) erosion surfaces filled by structureless bioclastic-rich, normally graded sequences and cross-laminated beds. Prograding inclined bed sets forming large clinoform complexes up to 15 m thick are also present, and form distinct downlapping sequences over the basal marine shales. Preliminary observations of the ongoing study suggest that the genesis of this bioclastic complex was characterized by aggradation phases associated with high-energy currents and high sediment supply alternating with phases of reworking and erosion, which remobilized and redistributed previously deposited sediments. The importance of factors such as the proximity of a sediment source, sediment supply, frequency and intensity of storm activity, sea-level fluctuations, variations of accommodation space and tectonic activity are currently being investigated.

Sedimentology and sequence stratigraphy of glaciogenic deposits using hig-resolution quantitative analysis of drill cuttings

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In the past decade glaciogenic deposits from Palaeozoic age in North Africa and the Middle East have been recognised as important reservoirs for hydrocarbons. However, the sedimentary system associated with glaciers and continental ice-sheets is highly complex and still poorly understood. Commonly glaciogenic deposits, often confined in deeply incised valleys, are vertically and laterally heterogeneous as the sedimentary mechanisms and depositional environments developing during the valley infill after the ice melting, can be very variable and changeable over time. The purpose of this study was to reconstruct the depositional environment, sedimentary processes and resulting sequence stratigraphic units occurring in a 400 meter deep glacial valley infill in the city of Hamburg (NW Germany) penetrated by the deep borehole Billstedt-1. This sequence is considered to be a relevant analogue for Palaeozoic reservoirs. Overall 170 samples from borehole cutting materials were analysed using QEMSCAN®, an automated mineralogical equipment based on a combination of XRD and SEM techniques. The sediment texture and textural trends as well as the mineralogical composition and sediment lithotypes were identified and calibrated with the available wireline logs. Grain-size was then compared with the reconstructed density and porosity logs and used to identify and differentiate between potential different reservoir flow units. Composition of coarser grain-size fraction were also analysed separately, providing indication on provenance at different stratigraphical intervals. Diagenetic minerals such as clay and secondary cement infills were also analysed to assess the relationships with facies and stratigraphical position and assess whether such elements could be used for correlation purposes. Overall this study highlighted the compositional heterogeneity of tunnel valley infills and confirmed the potential of this approach as a tool unravel the complex stratigraphy and quantify the associated reservoir potential. The compositional characteristics of the borehole Billstedt-1 allowed us to infer important information regarding the depositional environment, sediment provenance which ultimately served to reconstruct the sedimentary and erosional history associated with the tunnel valley. Sediment provenance: ultra-stable heavy minerals such as zircon and rutile are typically enriched in sediments that have been recycled many times. A comparison of these minerals with a less stable mineral such as quartz or feldspar can give an indication of the origin: crystalline shield gives low amounts of ultra-stable minerals and high amounts of quartz, whereas reworked Tertiary shallow marine sediments yield the opposite. Depositional environment: presence of minerals such as glauconite, pyrite and iron oxides can give indications on depositional conditions. Glauconite is formed in anoxic conditions typically in marine environments indicating, based on relative amount provenance from reworked Tertiary marine sediments or newly established marine environment. Vertical variations in calcite amount and the recognition of shell fragments have been used in this case to identify interglacial transgressive sequences. Based on our results, the tunnel valley infill of borehole Billstedt-1 could clearly be divided into five stratigraphic units. These units can subsequently be correlated regionally and describe the complex sedimentary processes occurring in between two major Middle Pleistocene glaciations (Elsterian and Saalian). Variations in mineralogical, textural and porosity data in fact reflect both large and subtle changes in depositional environment and provenance, giving insight in the sedimentary processes involved in the infill of the Hamburg tunnel valley complex.

Sedimentology and sediment dynamics of storm bedforms in a coastal bay

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The investigation of bedforms related to high-energy events has proven to be an important tool in the estimation and evaluation of the physical agents that give rise to these forms, thereby contributing to knowledge on the oceanographic, physical and sediment characteristics of such deposits. Integrating sediment analyses, hydrodynamic measurements and sonar surveys, changes in seabed morphology during storms can be used to interpret the stratigraphic pattern of coastal deposits. Among the storm-generated bedforms described thus far, there are "tabular sand patches", "hummocky megaripples" and "rippled scour depressions", which were recently reclassified as "sorted bedforms" by Murray and Thieler (2004) due to the new hypotheses put forth by the authors regarding the maintenance and positioning of these bedforms. All bedforms mentioned above have the same morphological/sedimentological characteristics: elongated bands/patches of coarse rippled sediments along with abrupt contact limits between these forms and fine sand domains. The internal structure of these deposits can be described as tempestites, showing normal graded bedding with associated hummocky cross-stratification. The main focus of the present study is to assess the morphology, composition, sediment dynamics and hydrodynamics of storm bedforms and sediment deposits in the Espírito Santo Bay, southeast Brazil, and to compare the ones found herein with storm-generated bedform models proposed in the literature. Seabed acoustic imaging has revealed two signal reflection patterns – a homogeneous low-intensity pattern (HL) and a heterogeneous high-reflection pattern associated to sand ripples (HSR).These two patterns appear as intercalated patches, with abrupt contact limits. The homogeneous low-intensity pattern is characterized by fine to very fine sands over large flat areas. The heterogeneous high-reflection pattern associated to sand ripples referred to thin stretches of considerable acoustic signal return intercalated with stretches of low return. This type of reflection was associated to the presence of coarse sand ripples. The contrast between the lines of high and low reflection is well marked, revealing high definition and a good state of conservation of the bedform in question. Sedimentary cores were taken from HL and HSR domains. Cores at HL show a typical normal grading sequence, from coarse to very fine sands, which are being interpreted as tempestites. At least two tempestites sequences were observed in a 50-60cm long core. At HSR domain, the top of the core is basically made of coarse to very coarse sands, which can be related to the bottom facies observed in a tempestite sequence in HL. Hydrodynamic and sediment transport measurements and calculations have shown that sand beds are not mobile under the action of tidal currents alone. In order to reach threshold for sand grain movement, wave action is required. During the period of measurements, 3 storm events were observed. Sand transport calculations show that under these measure conditions, coarse to gravel ripples could be formed, and up to medium sands could be resuspended. Finally, the results point out that these intercalated patches of coarse and very fine sands are definitely storm-generated bedforms, which fit better with the description of sand patches by Kenyon (1970)

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Geomorphological and sedimentological characterization of Pleistocene – Holocene alluvial fans on the west side of the Aconquija Ranges, NW Argentina

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In this abstract, tectonic and stratigraphic controls on the morphology and sedimentation of Pleistocene – Holocene alluvial fans in the Aconquija Ranges (Argentinean Pampean Ranges) are analyzed. The ranges has an igneous – metamorphic basement and present a Tertiary sedimentary filling; upon the Tertiary rocks there are 4 alluvial levels from the Pleistocene – Holocene age. The alluvial fans located on the west side of Aconquija Ranges are divided into two parts: the northern part, from Amaicha Valley in the north to Punta de Balasto in the south; and the southern part from Punta de Balasto to the southern end of the Aconquija Ranges. The subdivision is based on the structural and stratigraphic control of underlying Neogene deposits (Santa María Group) on the alluvial fans. In the northern part the control of the eastward-tilted Neogene is strong and affects the fan location. In the southern part the Neogene rocks are in the subsurface and do not have an important influence on alluvial fan location. The differences in structural and stratigraphic control results in two distinctive sedimentary environments, highlighted by the morphology and sedimentology of the alluvial fans. There are four levels of sedimentation of alluvial fans distinguished. Alluvial level 1 is the oldest deposit; the main outcrops are in the northern part and cut the Neogene sedimentary rocks. This level in general does not present the main geomorphological features related to alluvial fans, due to erosion and deformation, related to the uplift and tilting of the Neogene rocks. Alluvial level 2 is mainly located in the central part of the Santa Maria Valley, in the northern part and with minor occurrences in isolated parts in the southern part; they are joined to the basement of the ranges and are dissected by alluvial level 3. Their surfaces are pedimented and show active fluvial channels. Alluvial level 3 has its main outcrops in the southern part and constitutes alluvial fans with all the geomorphologic features; the modifying proccesses of the alluvial sediments (secondary processes) are dominant. It is possible to observe abandoned fluvial channels on its surface. Alluvial level 4 is the most modern and occurs in the northern and southern part. They are formed partly by reworked materials from ancient levels and by the supply of material from the catchment areas. The forming proccesses of the alluvial sediments (primary processes) are dominant in this level. Alluvial level 1 was uplifted together with the Neogene sedimentary rocks. They present extensive and distant outcrops, indicating an intense tectonic activity affecting the Aconquija. They formed syn- to post-tectonic deposits with the orogenic movements that uplifted and tilted the Neogene sedimentary rocks. Alluvial level 2 shows a poor development And could be related to the alluvial level 3, the difference between them is the space for the location of the sediments. Alluvial level 4 constituted the modern alluvial sedimentation related to primary proccesses.

Geomorphological, sedimentological and tectonic evolution of Pleistocene – Holocene alluvial fans located on the west side of the Cumbres Calchaquíes Ranges, NW Argentina

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In this abstract, tectonic and stratigraphic controls on the morphology and sedimentation of Pleistocene – Holocene alluvial fans in the Cumbres Calchaquíes Ranges (Argentinean Pampean Ranges) are analyzed. The ranges has an igneous – metamorphic basement and present a Tertiary sedimentary filling; upon the Tertiary rocks there are 4 alluvial levels from the Pleistocene – Holocene age. The alluvial fans on the west side of the Cumbres Calchaquíes Ranges have undergone strong structural and sedimentological control by the eastward tilting of the Neogene sedimentary rocks (Santa María Group). Four sedimentary levels could be identified of alluvial fan sedimentation: from old to young Alluvial levels 1 to 4. Alluvial level 1 has its main outcrops in the central south sections of the ranges. The alluvial fans in this level are eroded and cut by modern deposits. In Alluvial level 2 the original geomorphologic features are preserved and their surfaces are pedimented and cut by active channels related to the modern sedimentation. Alluvial level 3 is strongly pedimented but also conserves the original geomorphologic features. The modern sedimentation is related to Alluvial level 4; the alluvial fans belonging to this level are small and formed by reworking of the oldest levels and sediment supply from the catchments areas. In the south section of the range the outcrops of the Neogene sedimentary rocks are far from the foot of the range, occupying the central area of the Santa María Valley; to the north the Neogene rocks gradually approach the foot of the ranges, until they are attached to the basement in the northern portions of the ranges. This sedimentary configuration affects by different ways the Quaternary sedimentation. Sediments of Alluvial level 1 were deposited during a pre-tectonic to early syn-tectonic phase, with uplift and tilting of the Neogene sedimentary rocks, particularly in the north area of the ranges where the sedimentary accommodation is reduced by the Neogene sediments that are uplifting in that moment. Deposits of Alluvial level 2 are interpreted as syn-tectonic sedimentation during uplift of the Neogene rocks; although in the south section of the ranges Alluvial level 2 is not in contact with the Neogene rocks. In the northern part of the ranges Alluvial level 2 superimposes the Neogene rocks. Deposits of Alluvial level 3 are interpreted as late syn-tectonic in the south part of the range and in the north sections is post-tectonic with the Neogene sedimentary rocks uplifting and tilting. The primary processes are associated to the present-day fluvial channels, that flow to the Santa María River; these levels are the most distant from the foot of the ranges.

Geomorphological characterization of Pleistocene – Holocene alluvial fans located on the east side of the Quilmes Ranges, NW Argentina

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The Quilmes Ranges shows an important development of alluvial fans on its east side, whereas on the west side alluvial fans are absent. In this abstract, tectonic and stratigraphic controls on the morphology and sedimentation of Pleistocene – Holocene alluvial fans in the Quilmes Ranges (Argentinean Pampean Ranges) are analyzed. The Quilmes Ranges has an igneous – metamorphic basement; upon the basement rocks there are 2 alluvial levels from the Pleistocene – Holocene age. Some of the alluvial fans in Quilmes Ranges present more than one catchment area, or feeding channels from different catchments areas, which often join in the apex area of the alluvial fan. It is possible to observe colluvial cones descending from the adjacent slopes to the apex of the alluvial fan, forming terraces that overlap the current fluvial terraces of the main alluvial fan. The alluvial fans in the Quilmes Ranges can be classified in two alluvial levels. Alluvial level 1 is the oldest level, and it is barely represented. This level consists of small, dissected patches joined to the range basement. Alluvial level 2 constitutes the modern alluvial fan deposits and has all the geomorphologic features. In the southern alluvial fans of the ranges forming alluvial sedimentary proccesses (primary processes) were observed, but in the rest of the range the modifying proccesses of the alluvial sedimentation (secondary processes) are more important. The alluvial fans of Alluvial level 2 present incised braided channels that transport the flows from the apex to the distal zones and sometimes form active depositional lobes, and others they deposit the sediments over the Santa María River. In both levels the secondary sedimentary processes are dominant; the primary sedimentary processes are restricted to the active current fluvial channels in Alluvial level 2.

Signature of development of a prograding fan delta wedge under allogenic controls from the Proterozoic Simla Group, Lesser Himalaya, India

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Basins formed due to extensional rift tectonics are generally good receptacles for fan-delta deposition. The Proterozoic Simla Group of the western lesser Himalaya, India is a case in hand which bears signature of a fan-delta deposition with different subenvironments ranging from fandelta front, distal delta front, prodelta & alluvial-fan braid plain deposits. The coarsening-upward Simla sequence, ca.1500m thick is divisible into lower Basantpur-, middle Chhaosa- & upper Sanjauli Formations. The present work uses sedimentological facies analysis as an important tool to decipher the style of sedimentation in space through time in the Chhaosa & Sanjauli Formation. First signs of deltaic sedimentation appear in the middle of the Basantpur Formation & are well developed in the overlying Chhaosa & Sanjauli Formations. Agglomeration of nine facies, delineated from the study area of the Chhaosa Formation, characterize the fan-delta front, distal delta front & prodelta part of a fan-delta system. Extensive sheets of highly matured, coarse-grained quartzose sandstones with plane-parallel stratifications, well sorted subarkosic sandstone to pebbly sandstones with pinch & swell geometry, sigmoidal foresets, mud flasers, round-crested ripples, argillaceous sandstones-siltstones with wavy beds & ripples attests to its deposition in the different parts of delta front deposits of the fandelta. Facies attributes reveal that the distal delta front experienced high-energy foreshore beach action, tidal activity along with strong wave & storm action. Greenish yellow coloured shale-mudstones with wavy rippled beds, hummocky cross-stratifications interbedded with coarsening-upward fine-sandstones & laminated to massive muddy shale all bear signature of prodelta part of a fandelta, which was deposited in an open-marine shelf environment, where sedimentation was influenced by storm-wave action. Facies analysis of the overlying Sanjauli Formation reveals facies association, strikingly different from the underlying fandelta of the Chhaosa Formation. The Sanjauli Formation shows abundance of coarser clastics comprising disorganized, poorly sorted pebbly to conglomeratic sandstone, channelized sandstones with angular clasts, sheet-like tabular horizontally-stratified medium- to coarse sandstones with subangular to subrounded clasts in a sandy to granular matrix, couplet beds, multistoreyed bouldery sandstones, sandstones with convolute laminations, torn laminae & trough- & planar cross-stratified sandstones. Agglomeration of these facies with signature of processes viz. sheet flooding, hyperconcentrated flows, non-cohesive debris flows & other high-energy upper flow regime processes suggest their deposition in an alluvial-fan braid plain & fandelta-plain deposits. Laterally persistent erosional surfaces, tabular sandbodies with abundant trough cross-stratifications, channelized sandstone, poorly defined fining-upward beds all resemble braided fluvial deposits. Combination of the facies attributes represents a proximal part of a fan delta system, which was enriched in gravelly &pebbly sandstones with minor siltstones & mudstones. The gravelly proximal fan of the Sanjauli Formation prograded over the distal delta-plain segment of the underlying Chhaosa Formation with a marked textural discontinuity & facies change. Sedimentary facies analysis indicates that the middle to upper part of the Simla Group experienced deposition of a prograding fan delta owing to certain allogenic factors like regression of the sea, related to upliftment of the basin due to faulting/rifting. Generally fan deltas respond distinctly not only to tectonic but also to other allogenic factors like climatic & eustatic controls. The Simla fan-delta can be cited as a spectacular example of a humid fan delta, which experienced repeated oscillation of the basin & relative sea-level changes.

Bottom sediments of "Mar do Ararapira" estuary, southern Brazil

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"Mar do Ararapira" is an estuary located in the southern region of Brazil, between latitudes 25º19'20" and 25º19'12" S and longitudes 47º59'33" and 48º06'34" W. Its extent is of approximately 16 kilometres, averages depth and width of respectively 4 and 400 meters, with SSW-NNE orientation. Average currents intensity is 0,35 m/s, reaching a maximum of 1,4 m/s during ebb tides. In this region of Brazil tide is semidiurnal, with two high-tides and two low-tides, and amplitude is characterized as micro-tidal (less than two metres). There is a prediction of a new inlet to be open in the next few years, distant 6 km NE from the actual, due to a meandering erosive process in the sandspit that separates the "Mar do Ararapira" estuary from the Atlantic Ocean. If the prediction occurs and a new inlet is established, probably the actual one would shut, modifying circulation patterns inside the estuary. The main purpose of this work was to characterize the actual bottom sediments distribution on the "Mar do Ararapira" estuary aiming at future comparison after the new inlet opens. A total of 63 samples of surface sediment along the "Mar do Ararapira" were collected between August and December of 2008 and April 2009. Statistical analyses were conducted to determine average grain size, standard deviation, asymmetry and percentage of organic matter and calcium carbonate. Results indicate predominance of fine, well sorted, nearly symmetrical sand (67%). Organic matter concentrations fluctuate between 14-62% and for calcium carbonate concentrations between 1-18%. On concave margins of the estuary, fine to medium sands, very well to well sorted, nearly symmetrical with low concentrations of organic matter and calcium carbonate prevail. On convex margins, very fine sands to silt, poorly sorted, with positive asymmetry and highest concentrations of organic matter and calcium carbonate prevail. These data indicate that the variability among samples with respect to the shape of the margin is greater where the main channel occupies concave margins and mangroves or shoals occupy convex margins, than in the longitudinal variation (SW-NE) towards the interior of the estuary.

Contribution of X-ray fluorescence (XRF) to unravel a high-resolution, Lateglacial-Holocene climate record in the tropics: a case history from NW Colombia

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X-ray fluorescence (XRF) provides a rapid and efficient tool to determine the bulk mineralogy and elemental composition of sediment. It is useful to identify stratigraphical changes in the mineralogy along a cored section. In the sediments studied here, an X-ray fluorescence μ- probe has been used to measure the bulk content in various elements with a sampling interval of less than one year. The studied section is located in a high-altitude wet zone with a fairly limited drainage area. In such a setting, the main interest of XRF is to provide a simple chemical proxy for the input of materials derived from the surrounding reliefs. The aim of this research is to use both high-resolution palynological and geochemical proxies in order to reconstruct the climate evolution in this area during the Lateglacial-Holocene interval. A continuous sedimentary sequence has been cored in the wet zone of the Páramo de Frontino at an altitude of 3,460 m amsl, in the northwestern termination of the Colombian Andes. This high plateau is strategically situated close to the Pacific and Atlantic oceans and can provide a high-resolution climate record related with events like the El Niño-Southern Oscillation (ENSO) and the migration of the Intertropical Convergence Zone (ITCZ). The studied area occupies a glacial depression which is 14 m deep in its centre. The sedimentary infill consists of a 12.5 m thick organic-rich deposits containing peat, organic, organo-mineral and diatomeous muds, with intercalations of diatomites and volcanic ash. The mineral fraction increases in the lower part of this interval and displays oxidized horizons and paleosoils. This organic-rich succession spans the last 17,000 years and the age model based on ^{14}C dates demonstrates the absence of hiatuses in the sequence. At the base of the section, a still-undated varved sequence probably corresponds to the Pleniglacial. Palynology provides a high-resolution interpretation of relative temperature changes by using the concept of migration of vegetation belts. Lateglacial-Holocene global climate events are clearly recorded, like the Bølling-Allerød interstadial, the Younger Dryas, the rapid Early Holocene warming, the Holocene thermal maximum and warmer and colder phases during the Late Holocene. Palynology can also be used to derive some humidity trends. Nevertheless, the time resolution of palynological data is at best pluridecadal. XRF data provide a much better resolution and complement ideally climate reconstructions derived from palynology. Although their main contribution is to provide a measure of precipitations (using mainly Fe and Ti), it can also contribute to paleoenvironmental interpretation (e.g., using the ratio Fe/Mn as a paleo-redox indicator or the ratio Si/K as an indicator of diatom productivity). Fe and Ti contents show that the Tardiglacial in NW Colombia was very humid and was followed by an even more humid interval, time-equivalent to the Younger Dryas. A very rapid change to much drier conditions marks the time period equivalent to the Preboreal. The Holocene thermal maximum period displays an overall increase in precipitation. Rainfall decreased significantly over the last 4,000 years. During the Middle and Late Holocene, variations in Fe and Ti show strong similarities with those observed in the Cariaco Basin and can be related to the migration of the mean ITCZ position. This is a proof of global connections among regional climates and demonstrates the value of XRF data in paleoclimatic reconstructions.

Sedimentary environments in volcanic rift depocentres, Neuquén Basin, Argentina

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Active volcanism in extensional basins is a common phenomenon yet not entirely understood. The influence of volcanic activity on the sedimentary environments is dramatic. Most of the existent depositional models for rift basin depocentres were constructed for epiclastic and carbonatic non-volcanic environments. The purpose of the analysis herein presented is to address the main characteristics of these unique volcanic extensional settings. Five different depocentres from the Neuquén Basin, Argentina, were studied: Chachil, Catán Lil, Chacaico, Piedra del Águila and Sañicó. The Neuquén Basin was originated by extensional processes occurred in the Upper Triassic – Lower Jurassic. The geometry of the depocentres was controlled by normal faults which limited grabens and half-grabens where the fill was eminently of volcanic nature (Precuyano Cycle), including lava flows and pyroclastic deposits as well as alluvial, fluvial and lacustrine associated facies. Volcanic activity in a basin is a major control on fill composition and the generation of topography. While the duration of each volcanic event can be very short, the volume of material delivered is huge. High rates of lava flows or pyroclastic deposition are characteristic, generating a pattern of nearly constant aggradation. Extensional tectonics provides the necessary permeability for magma ascent and emplacement through the crust. The Precuyano Cycle dikes and other feeder systems follow the structural configuration of the depocentres. The interaction between volcanism and extensional tectonics can also be detected in the collapse of volcanic edifices and caldera formation enhanced by normal fault activity. In that manner, volcanotectonic subsidence becomes responsible for the deposition of thick piles (> 200 m) of pyroclastic density currents. The Precuyano fill is mostly composed of pyroclasts and effusive volcanic clasts deposited by alluvial processes. Complex sequences of succeeding lavas and volcaniclastic deposits are generated at the margins of the volcanic constructions. The products from the volcanic activity are widely varied in terms of their chemical composition and physical constitution. The volcanic material can be coherent (lavas in general) or fragmented (autoclasts and pyroclasts). The nature and availability of the diverse volcaniclastic size-fractions is seen to be a definite control in the dominant processes of transport and deposition (e.g. debris flow vs. hyperconcentrated flow deposition). Fluvial deposits completely constituted of pyroclasts are a proof of the chocking effects of eruptions over the sedimentary systems. The spectrum of possible compositions from basalts to rhyolites defines very particular behaviours towards physical and chemical meteorization. The same alteration and desvitrification processes observed in primary volcanic rocks also affect the clasts contained in the associated sedimentary deposits. Volcanic glass is a component very susceptible to chemical decomposition, playing a fundamental role during the diagenesis of these rocks. The study of the Precuyano Cycle successions provides clear insights into the effects of volcanism on the evolution of rift depocentres. A feedback between structural and volcanic processes is observed in the creation and fill of accommodation space, the conduction of magmatic products and the generation of topography in the depocentres. Convergence of volcanic and extensional structural processes thus results in complex stratigraphic patterns distinctive for this kind of rift basins.

Deltaic lobe deposition associated to normal fault growth, El Qaa Fault Block, Suez Rift, Egypt

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Syn-rift deltaic lobes are studied from Miocene exposures of the Abu Alaqa Group and Kareem Formation on the Suez Rift, Sinai Peninsula, Egypt. Their deposition is associated with the growth and evolution of the NNW-SSE trending normal faults defining the eastern margin of the El Qaa Fault Block half-graben. The input source of the deltaic system studied is controlled by the location of a transfer zone linking the Sidri and Alaqa fault segments. The deposits consist mainly of conglomerate-dominated successions, intercalated with sandier facies and carbonate bodies of coral and algal origin. The delta lobes tend to have a convex top and an irregular base controlled by the topography of the older lobes. They are composed of several beds 1 to 6 m thick, arranged in clinoforms, normally summing a total thickness of 10 to 30 m for each lobe. The paleoflow direction is to W to WNW and the approximate depositional dip of clinoforms ranges from 7º to 15º. Clinoforms are composed of massive concave base lenses and planar base wedges of conglomerates intercalated with bioturbated laminated tabular sandstone bodies. The coarser facies are matrix-supported cobble conglomerates with outsized boulders. The clasts consist of rounded prolate to equant limestone and chert derived from pre-rift lithologies. The matrix is invariably constituted by very well sorted coarse to very coarse sandstones. The sandstone units share the same composition as the conglomerates matrix and floating pebbles and cobbles are commonly present. Carbonatic clastic facies occur as shelly grainstones and rudstones laterally related to coral boundstones. Coral bodies constitute massive units with irregularly planar bases and convex tops, with a ribbon plan-form elongated transversally to the overall lobe progradation direction. They have dome geometry in cross section, reaching up to 50 m or more in thickness. A progressive thinning away from their crest towards their margins is characteristic, eventually disappearing into thin veneers (< 1.5 m) of grainstones and rudstones. The deposits immediately covering the corals are new conglomeratic lobes in proximal areas while thick accumulations of bioturbated sandstones and siltstones are found in their most distal zones. Different deltaic lobes are seen to be stacked in a progradational pattern forming distinctive wedges 60 to 80 m thick, bounded by angular unconformities. A combination of hangingwall back tilting and fault related monocline folding is involved in the progressive rotation of these wedges. Based on a structural and geometrical approach, a three-fold scheme is proposed implying lobe deposition following major fault displacements, accumulation into greater clastic wedges, and finally the rotation of the whole system during the next extensional phase. Several fault displacement events create accommodation space for the deposition of new deltaic lobes whilst simultaneously rotating the older ones. The whole set of wedges define a fanning geometry, built from the succeeding rotated wedges separated by progressive unconformities. Wedges become colonized by coral patches on top of the abandoned lobes during periods of relative quiescence. Thus, the evaluation of spatial and angular relations between several successive coral bodies can be a gross estimator of paleobathymetry for each of the rotated wedges. In that manner, the evolution of the deltaic system is contrasted to that of the hangingwall rotation. A next step in this research is to assess the effects of climate and autogenic processes controlling the deltaic wedges.

Normal fault-related growth synclines and their control on early syn-rift shallow marine deposition: Nezzazat Fault System, Suez Rift, Egypt

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The El Qaa Fault Block half-graben on the Sinai Peninsula, Egypt is defined by NNW-SSE trending normal faults. Early syn-rift deposits are very well preserved in a series of synclines developed in a terrace zone that constitutes the depocentre western border, Nezzazat Fault System. The early syn-rift succession is composed of shallow marine carbonates and siliciclastics of early Miocene age. They are characteristically dominated by bioclastic rudstones punctuated by conglomerate bodies and one mudstone interval. The rudstones consist of very well sorted echinoid spines, disarticulated bivalves, dendritic coral fragments, gastropods, other pieces of echinoids and shark teeth. Occasionally, limestone and chert lithoclasts derived from the pre-rift rocks are also present. Rudstones are arranged in tabular beds, 20 to 50 cm thick, with sharp planar bases and tops. The conglomerates are well sorted, made of rounded to subrounded equant and prolate coarse pebbles to cobbles with fine to medium boulders derived from the pre-rift lithologies. A small proportion of matrix and bioclasts can also be found. The conglomerates are arranged in beds 30 cm thick integrating wedges up to 5 m thick. The mud horizon is a massive grey green unit 1.5 to 6 m thick containing some millimetric silty horizons and a few floating pebbles. The deposition of these facies was concomitant with normal fault growth along the Nezzazat Fault System. These deposits are preserved in different synclines in the hangingwall of NNW-SSE trending normal faults. Fault growth promoted the sagging and deepening of fault parallel synclines but local interaction with N-S and E-W fault segments generated more complicated geometries. The earliest syn-rift deposits are conglomerate wedges that drape the highly irregular topography left by the several smaller faulted blocks, creating a smoother surface on top of which younger deposition progressively defines the overall syncline configuration. Each phase of fault activity and limb rotation is recorded by the generation of an angular unconformity. The preservation of stacked wedges bounded by progressive unconformities allows the identification of different stages of syncline growth. A cyclic stratigraphic pattern of conglomerates succeeded by rudstones can be recognized across the fault terrace area. Thickness spans from 4.5 to 7 m, however may locally reach 30 m. Each of these sequences onlaps and thins onto the syncline limbs and thickens into the syncline. In that manner, the overall geometry of the deposits in each syncline is of progressively shallowly dipping wedge-shaped units. Between the first and second sequences of conglomerates and rudstones the massive mudstone horizon is present, indicating an increase in the bathymetry of the area. The angular relationship between the packages below and above this horizon implies limb rotation occurring during mud deposition times. Thus, finer grained deposition is related to the amount of accommodation space created during extensional faulting. Rudstone facies represents the background sedimentation in the area while the presence of the conglomerates at the base is interpreted as the product of the erosion of the pre-rift lithologies from relatively uplifted areas.

Microfabric characterization of marine mudstones from Jagüel and Roca formations (Upper Cretaceous – Paleocene), Northern Patagonia, Argentina

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A description of the microfabric of marine mudstones from Jagüel (Maastrichtian – Danian) and Roca formations (Danian) has been performed by scanning electron microscopy (SEM). The mudstones were studied in four sections located near Cipolletti, Allen and Roca localities in the Río Negro province (Cerro Azul, Cerro Tres Picos, Cañadón Cholino and Este Puesto López). In these sections, the mudstone´s age was refined by calcareous nannofossils analyses as is reported in Musso *et al.*, (2009) and Del Río *et al.*, (In press). SEM observations were investigated using a LEO-EVO 40 (15 kV). Prior to SEM examination, freshly fractured surfaces of representative samples were coated with Au (SPI). The mineralogical characterization of the bulk sample and clay fraction was determined through X ray diffraction. Grain size analyses were carried out by a laser-beam particles analyzer (Cilas 1180 L). Bulk mineral compositions are mainly clay minerals (> 50%) and calcite (15%-35%). Quartz, feldspars, cristobalite and zeolites are present in smaller amounts. Clay minerals are dominated by Illite/Smectite (R0, 80% Sm), containing detectable amounts of caolinite and illite. The carbonate content is mostly biogenic (calcareous nannofossils). In Roca Formation caolinite has not been recognized and a high amount of Illite/Smectite (I/S) is detected. According to X-ray and grain size analyses, these rocks are classified as Allochemic mudstones. Considering the texture, in hand specimens, the mudstones are massive to slightly laminated. However, bioturbation can be observed in samples from Jagüel Formation. At low magnification (1000 X, 3000 X), mudstone´s microfabric of Jagüel Formation shows a looser packing of individual clay particles randomly oriented. An important amount of calcareous nannofossils is observed and they are rounded by clay flakes with an edge-to-edge arrangement. At higher magnification (8000 X), clay flakes are arranged in edge-to- face or face-to-face contacts. These individual flakes are forming domains with randomly shaped voids. The morphology of the I/S is slightly crenulated to flaky and individual particle size is around 4 µm. In Roca Formation mudstones, a preferred particle orientation can be seen in a few samples (1000 X, 3000 X). The texture is closed and is primarily represented by I/S particles arranged in face-to-face contacts forming a shingle type fabric. At higher magnification (5000 X, 7000 X), chains of clay plates formed by domains of stepped face-to-face oriented flakes are common. The morphology of the I/S is smooth, slightly crenulated, occasionally flaky and the size of the particles is around 2 µm. SEM evidences in mudstones from Jagüel and Roca formations would suggest that two main processes were involved in the origin of the microfabric: physico-chemical and bio-organic (Bennet *et al.*, 1991). In both formations, clay was deposited in waters with high electrolytes concentration and hence flocculated (electrochemical mechanism). Nevertheless, the particle orientation found in some samples from Roca Formation would indicate a more dispersed clay deposition. In Jagüel Formation, calcareous nannofossils abundance exerts a significant influence on microfabric causing particle reorientation around the cocoliths (bio-organic mechanism).

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Sediment input in the rivers and estuary of Kerala: Socio-economic and environmental impacts

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Erosion and sedimentation in rivers and the major estuary as a result of changing climate and anthropogenic activities have large economic, social and environmental impacts in the state of Kerala, India. In the Cochin (Kochi) estuary which is economically and ecologically important, two major rivers carry large quantities of sediments, mostly polluted, threatening the existence of its major port and rich biodiversity. The Cochin estuary connecting to Arabian Sea is about 90 Km in length and 250 Km^2 in area, and it is the largest of its kind that exists all along the coastal belt of Kerala. This region is economically important, highly productive and plays an important role as nursery grounds for many commercially important fishes. One of the major ports of India is situated here. The region receives more than 300 cm rainfall from monsoons and local systems. Two major rivers Periyar and Muvattupuzha and numerous canals join this estuary. Steep slopes of the Western Ghats Mountains in which the rivers originate, allow the rainwater falling in their upper reaches to flow fast to reach the estuary in few hours. Large raindrops from convective clouds enhance erosion in the mountains where encroachment and deforestation have already degraded the soil. These rivers and their tributaries carry tremendous load of sediments and release them into the estuary. Extremes in local climate associated with global anomalies and impact from the needs of rising population worsen the condition. In addition, sedimentation in rivers and reservoirs all along the Western Ghats create severe water and food crisis during pre-monsoon months. Seven once perennial rivers of Kerala have become seasonal in the last few decades. Disputes over allocation worsen with falling water availability. This paper assesses the sediment input into the estuary and rivers during normal and extreme climates and analyses the factors that influence sedimentation directly and indirectly. Trends in sediment transport points towards an irreparable damage to the estuarine and riverine environments in near future, threatening the fish population and economically important harbour area. Globalisation and associated industrialisation pose another threat. There are rules and regulations to prevent environmental degradation. But, the legal and administrative mechanisms are slow and the implementation of policies and acts often fails due to political and social reasons. The State needs an appropriate environment policy and a strong political will to implement the regulations. Guidelines for an appropriate environment policy and sustainable management of rivers and estuary have been provided.

Recognition of subaerial exposure surface in Pleistocene shallow-marine carbonates based on carbon and oxygen isotopic compositions in the southern part of Miyako Island, southwestern Japan

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The Pleistocene Ryukyu Group which consists mainly of shallow- marine carbonate sediments was deposited with high-amplitude and short-termed glacioeustatic sea-level changes in Pleistocene age. Therefore it is considered that the sediments were repeatedly exposed subaerially, and that the sediments extensively suffered meteoric diagenesis during subaerial exposure. However, it is difficult to recognize some sedimentary fabrics indicating subaerial exposure, such as paleosol, calcrete, root textures and so on, because those fabrics are not always formed and preserved by controlling factors like that duration of the exposure and later erosion. Allan and Mathews (1982) suggested that specific patterns of stable carbon and oxygen isotopic composition within shallow-carbonate succession were useful for postulating stratigraphic positions of a subaerial exposure surface (SES). The advantage of their model is to be able to detect a stratigraphic position that experienced subaerial exposure-related meteoric diagenesis, even in the case that an interval with sedimentological features indicative of a subaerial exposure has been mechanically eroded out. Hence, the Allan and Matthews's model would be considered to be useful for recognition of SES, and a frequency and amplitude of sea-level changes during the deposition of the Ryukyu Group. To recognize SES based on carbon and oxygen isotopic signature, and to make clear the precise sea-level change in middle Pleistocene age, 6 boring cores (91-S-33, 91-S37, 94-S-36, 91-S-115, 90-F-9 and 94-F- 125) in the southern part of Miyako Island, southwestern Japan, were examined. Those cores were described in detail, and XRD and isotopic analyses were carried out of 273 samples from the cores. The boring cores consist mainly of reef and shallow-shelf carbonate sediments, and are divided into 7 units (Units 1 to 7) corresponding to Marine Isotope Stage 28 to 15 based on lithofacies and coral assemblage. All analyzed samples from the boring cores consist entirely of low-Mg calcite. $\delta^{13}C$ and $\delta^{18}O$ values have a wide range of -1.8 ‰ to -8.3 ‰ and a narrow range of -3.5 ‰ to -6.8 ‰, respectively. Those data indicate that the Ryukyu Group suffered meteoric diagenesis wholly. Obvious negative shifts in $\delta^{13}C$ are recognized immediately beneath unit boundaries, and the $\delta^{13}C$ values become heavier gradually with increasing depth. The negative carbon shifts with the same character are also recognized within some units, and those often correspond to the interval with sedimentary features indicating subaerial exposure, such as massive, laminar and brecciated calcrete. Further, these horizons are traceable in the study area. Therefore it is considered that the negative carbon shifts indicates SES. On the basis of the recognition of SES, each unit can be subdivided into the following subunits: Units 1, 2 and 3; 4 SESs and 4 subunits. Unit 4; 2 SESs and 2 subunits. Unit 5; 3 SESs and 3 subunits. As mentioned before, each unit was deposited associated with about 100,000 year-cycled, fourth-ordered sea-level change. Therefore, each subunit is considered to have been formed associated with the more short-cycled, higher ordered sea-level change. The sea-level curve reconstructed from lithofacies, position of SES, present altitude and subsidence rate is well correlated with the oxygen isotope curve of Berger (1994). Hence, it is inferred that each subunit was deposited during the interstadial period, such as 5a, 5c and 5e during the Oxygen Isotope Stage 5.

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Depositional environment of dolomites hosting tetrapod footprints from the Middle Devonian of the Holy Cross Mts. (Poland) – preliminary report

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Well-preserved footprints and trackways of early tetrapods were found on dolomite bed-surfaces in the lower Eifelian Wojciechowice Fm. outcropping in the Holy Cross Mts. in south-central Poland (Niedźwiedzki et al., 2010). Whereas the age of the track-bearing strata is well constrained (Narkiewicz & Narkiewicz, 2010), their exact depositional setting is not fully understood so far. Clearly, the strata represent early stages of the transgressive succession started with the Early Devonian continental to marginal marine clastics, and culminated in a development of the Givetian coral-stromatoporoid carbonate platform and Early to Mid-Frasnian reefs. The track-bearing interval (6-7 m thick) is traced within a thicker (>13 m) complex composed of grey, thin- to medium-bedded dolomitic shales and marly dolomite mudstones. Common lamination is both of regular/planar and wavy to crinkled type, the latter variety attributable to microbial activity. There are several mud-cracked horizons testifying, together with alleged raindrop impressions, to extremely shallow-water, intermittently exposed mud-flat environments. There seems to be no apparent evidence of depositional cyclicity, in particular no peritidal shallowing-upward cycles have been identified. A single high-energy event is represented by ca. 0.5 m-thick intraformational breccia resting on a scoured surface and composed entirely of poorly sorted angular dolomite clasts of local origin. The latter level is important as it represents an indirect evidence of early consolidation of a carbonate mud that was apparently capable of supporting some several-meters long tetrapod creatures. Body-fossils, except for stromatolitic levels, seem to be completely absent. First marine fossils (conodonts and crinoids) appear only ca. 15 m above the track-bearing strata. Nevertheless, the latter contain some rare levels with tube-like burrows of millimetre diameter as well as a horizon with a network of *Thalassinoides*-like burrows. The latter findings confirm a marine depositional environment of the dolomitic Wojciechowice Fm. while other sedimentary structures are compatible with a very shallow-water, occasionally drying-up setting. On the other hand, regional correlations imply a vast low-topography area remote from any permanent, eroded land masses. Also, evidence of elevated salinity is rather scarce and consists of rare small dolomite pseudomorphs after halite, and, indirectly, of thin oolitic levels found in other sections. Ongoing studies are focused i.e. on a more detailed characterization of petrology of the track-hosting strata, in particular their isotope and organic geochemistry, and insoluble residues. More rigorous study of a possible decimeter- to meter-scale cyclicity is also underway, including i.e. application of magnetic susceptibility method. The relationship between the sediment and trackmakers will be studied both in the context of general environmental controls and is also aimed at interpreting mechanical properties of the trampled sediment.

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Isotope geochemistry of lagoonal and deltaic facies of the coast of Santa Catarina State (South Brazil): relations with changes in relative sea level and climate during the Holocene

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In the last years, chemistry and isotope relations of stable elements have been used in coastal systems for studies concerning changes in relative sea level (RSL) and climate along the Quaternary (Meyers, 1997; White, 2001; Lamb *et al.*, 2005). Related to those variables, this is achievable because the ratio between stable elements switches in response to physical, chemical, and biological changes in the environment (White, 2001). The Holocene delta of Tubarão river (Santa Catarina, Brazil) is a suitable environment for geochemical studies of stable isotopes. Its submerged basin corresponds currently to a set of lagoons, that during the Early Holocene, composed a unique waterbody continuous and semi-opened to sea (lagoonal bay) (Giannini, 2002). Thereby, the Tubarão delta and its submerged basin are depositional systems of transition that were testimonies of important environmental changes during almost the entire Holocene. The present research analysed chemical and isotopic relation of nitrogen and carbon (δN-15, δC-13, Corg/Ntotal) of 129 sediment samples of the Tubarão delta and its submerged basin (bay/lagoon). Additionally, isotopic relations of oxygen (δO-18) and carbon were performed for 25 molluskan shells, gathered mainly in basinal deposits. All the samples were obtained from 10 cores with maximum depth of 20 m and separated about 3 to 4 km from each other, collected along the delta plain of Tubarão river (area of 250 km2). The results for carbon and nitrogen were useful to indicate three different aspects: 1. faciology; 2. RSL variation; and 3. climate change. In the first aspect, δC-13 and δN-15 discriminated deltaic and basinal facies, where for δC-13, 89% of basinal samples presented values > -24‰ (V-PDB), against 17% of the deltaic facies and, for δN-15, 71% of the basinal samples caught values > +6‰ (V-ATM), against 9% of the deltaic counterparts. In the second and third aspects, δC-13 and C/N presented values that ranges, from bottom to top of the cores, starting from the intermediary field between terrestrial organic matter C4 (grasses) and marine (8-6 kyr BP), then passing through the field of downright marine (~5 kyr BP), and finishing in the field of terrestrial C3 plants (arboreal) (4-0 kyr BP). This cited variation agrees with the Holocene RSL local curve, and therefore allows to interpret a maximum marine drowning before 5 kyr BP. Also, it agreed with a important local climate transition occurred in the Middle Holocene, already verified in previous studies by isotopic analysis of stalagmites (Cruz *et al.*, 2005; Wang *et al.*, 2006), where the climate shifts from dryer (favorable to predominate grasses) to wetter (where predominate arboreal vegetation). The results for oxygen and carbon in molluskan shells presents specular behaviour between this isotopes along time (from 8 to 0 kyr BP), with values of -0.38 to -1.66‰ (V-PDB) for δO-18, and of -2.34 to +0.94‰ (V-PDB) for δC-13. This isotopic decreasing in δO-18 of the lagoonal shells during the second half of Holocene is inverse to the pattern previously measured in the same region for marine samples (Angulo *et al.*, 1999). Thus, it is indicative of the progressive reduction along time of the influence of marine waters (O-16 depleted) inside the lagoons in relation to fresh water (O-16 enriched) provided by the Tubarão river. When united with the result of δC-13 and C/N ratio of the sediments, this δO-18 decreasing in the shells reinforces the hypothesis of progressive drying out of the lagoons, both due to the growing of barriers, in the marine portion, as due to the progradation of the Tubarão delta, at the mainland.

Holocene avulsions of the Tubarão River delta plain (Brazil): insights from remote sensing, faciology, and radiocarbon datings

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Avulsion is the phenomena in which a river abandons its previous channel in favor of a new course (Allen, 1965). The recurrence of this process in distributary channels is considered the main responsible factor for the construction of deltaic systems in drowned basins, and have great influence in its external geometry and stratigraphic architecture (Stouthamer & Berendsen, 2007). When the avulsion is controlled by the intrabasinal sedimentary dynamics, it is called autocyclic or autogenic. In the other hand, when the avulsion is related to extrabasinal processes, like tectonics or relative sea level, it is called allocyclic or allogenic (Beerbower, 1964; Miall, 1996). The lagoonal Tubarão river delta is the major delta (c. 250 km^2) in activity on the centre-south coast of Santa Catarina State (Brazil). It was studied regarding to natural avulsions by means of remote sensing, faciology, and radiocarbon datings. The remote sensing was done using aerial photographies (years of 1957 and 1978) and Google EarthTM images, and involved recognition and avaliation of the relative age of distributary channels. Two premises were adopted: 1. truncated channels are older than the truncating ones; 2. truncations of channels in upstream realms are older than its counterparts in the downstream portions. Two measurements were performed: the maximum offset between the original channel and the displaced channel (acquired in the median section), and the azimuth of the displacement. By its turn, the faciology was made using ten cores with maximum depth of 20 m. In this case, the main criteria for recognition of avulsion was the abrupt overlapping of sandy and poor sorted facies, attributed to active channel, by muddy and peaty facies, attributed to abandonment. Thirty radiocarbon datings (AMS 14C) were obtained along the successions. This approach resulted in the mapping of 69 avulsions in the Tubarão river delta plain. Apparently, the majority of the avulsions have shifted its channels with offsets of about 300 to 600 m, but higher values (till 1,000 m) also occur and are predominant in upstream areas. The distribution of displacement senses of avulsion allowed to discriminate three groups of channels, with different locations on the delta plain. The most upstream group, in the apex, moved channels predominantly to SW (200-250º). The second group, in the central portion, spread its palaeodistributaries rather to ENE (50-100º). The last group, at downstream regions, prograded the delta front in resultant sense to NNE (0-50º), although with strong dispersion (67º). This dispersion occurs in a region surrounded by several topographic depressions, such as the lagoons of Garopaba do Sul, Santa Marta, and Ribeirão Grande, and therefore mainly suggests autogenic control in the avulsions. Radiocarbon ages in three cores of the distributary Guarda resulted in period of activity of c. 400 years for its westernmost palaeochannel. The subsequent avulsion towards east previously verified by truncaments in aerial photos was confirmed by the facies succession, and would have occurred in 512-324 cal yrs BP. Further datations in successions of the other distributaries showed that the delta must have started in the apex around 5 kyr BP, and that the channels in the north of the plain (Sambaqui and Carniça) were formed for as much as c.a. 2,000 years before its counterparts in the south (Madre and Mirim).

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Sedimentary facies of Plio-Pleistocene sucessions between Chira and Piura rivers (norwestern Peru)

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Sedimentary successions of Pliocene-Pleistocene age crop out in the Chira and Piura rivers, department of Piura, northwestern Peru. These deposits have been described using a standard code of lithofacies (Miall, 1978) mentioning CH, SB, GB and SG architect elements, which correspond to channel and overflow deposits; and Gmm, Gci, Gm, Gp, Sr, Sp Sh and Sl lithofacies, that represent fine and coarse facies with several sedimentary structures (Miall, 1978). In Chira river architectural elements and sedimentary facies have been described from nine sedimentary fining upward sequences. The first sequence shows architectural elements such as SG + GB + SB, composed of lithofacies Gmm, Gci, Sp, Gp, and Sh. The second presents SB + GB, constituted by Gt and Sl lithofacies. The following five sequences have GB, characterized by Gm and Gp lithofacies. The eighth sequence presents CH, composed of the lithofacies Gm and St. The ninth sequence presents SB + FFP, according to the lithofacies Sh, Sr and Fl, along with the presence of fossils from *Otaria byronia, Charchorodon carcharias, Gunnarea sp. Negaprion brevirostris and Mylobatidae ind.*, which suggest the beginning of Pliocene age. These deposits are interpreted by the architectural elements SG+GB+SB, which are gravitational deposits with lobes concave shapes, interspersed with sand bodies and gravels in tabular shape. The low ratio of channel/flood plain and the abundance of overflow units suggest the development of a mixed-load fluvial system of low sinuosity. The SB + GB + CH deposits, represent overflow bodies, with the installation of costly interspersed with channel fill bars, the geometry of these deposits suggest drainage systems with turbulent flow (Miall, 1978), characteristic of a gravelly braided system. The SB+FFP are channel deposits interbedded with tabular sandy beds that grade into sandy plains and flood plains, which is interpreted as a transitional environment between high sinuosity fluvial sand and a tide-influenced delta environment. The Piura river deposits have been recognized three fining upward sequences and one last of coarsening upward sequences. The first two have a CH, composed and Gm and Sr lithofacies. These strata have recorded fauna of *Carcharias taurus*, assigned to the Pliocene because they became extinct in the eastern Pacific after the emergence of the Isthmus of Panama (González-Barba & Martinez, 2008). The third sequence present CH+SB, containing the lithofacies Gm, St, Sr, with calcareous cement. The fourth sequence shows a coarsening upward sequences and SB+GB elements, consisting of grainstone with some mudstone, boundstone and lithofacies Sm, Gmm, wrapped in a bioclastic matrix of mollusks. These facies are interpreted as CH+SB, which are the bottom of channel deposits under high flow regime, lenticular bodies are the result of accretion of bed forms, dunes of low relief and sinuous ridges, Fauna of *Carcharias taurus* and the presence of teeth rodent such as *Proechimys cf. decumanus* (González-Barba & Martinez, 2008), suggest an estuarine environment. The SB+GB elements are calcareous bodies in tabular form interspersed with inclusions of sandy-conglomerate massive bodies without internal structure with the presence of bioclasts of mollusks, which suggest a paralic environment. We conclude that in Chira river, facies correspond to fluvial environments that evolve to tide-influenced delta environments. In Piura river, fluvial-estuarine lithofacies evolve to closed environments such as paralic lithofacies.

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The Neogene Sedimentites of the Northwest of basin of Beazley, San Luis, Argentina

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Towards the northeast of the city of San Luis, in San Isidro spot we can identify the dry stream Los Araditos; in its gullies a sedimentary continuous succesion outcrops assigned to the Neogene and whose substratum is made up of the cretacic sedimentites identified as Grupo del Gigante, a set of facies of red layers whose main area of exposition is situated in Sierra de las Quijadas. The base of the neogene succession is made up of Fm San Roque whose time allocation is doubtful and it overlies the Fm Las Mulitas that is described in this contribution and whose fossil remains of paleomammals allow to enclose it to the Late Miocene to Early Pliocene interval; the limit between both units is given by white gypsum with kidney-shaped habit or ehuedral crystalls and nodules of carbonate as post-depositional structures; thick to thin, massive and laminated sandstones inter- stratified with levels of siltstones and argillites; towards the ceiling there is a predominance of siltstones in which gravelled pelites are inserted. on the basis of their lithologic, texture and structure characteristics, twelve lithofacies were identified; they were grouped in nine associations, the basal of the last ones is of monofacial type composed of the lithofacies and (gypsums), whose environment involves transport in solution and depposition by precipitation in a low regime; the association ii involves lithofacies agm, agl, afm and afl corresponding to deposits of bars that are formed in conditions of fluvial environment with normal flow; the association iii, formed by lithofacies lm-fl, can vary with lm-fm / ll-fm /ll-fl being assigned to deposits typical of basin of flood; the association iv integrated by the lithofacial couple afm-ll that varies among afl-ll / afl-lm / afm-lm, belongs to deposits typical of bank of accretion that is situated in the limit between the bars and the flood plain; the associatin v is composed of the lithofacies afm-lm-fm interstratified with internal structure afl-ll-fl and it is situated in the deposits of the zone of levee; the association vi is monofacial integrated by lithofacies c that lithologically correspond to pyroclastic material whose process of formation is by suspension and decanting; the association vii integrated by lithofacies aflp is situated in just one stretch of the profile Los Araditos and correspond to the zone of the canal in a fluvial course; the association viii formed by the couple fm-fl placed in an anoxic environment, and finally, the association ix is given by the couple of facies lm-t, it characterizes a paleoedaphic horizon. The base of the succession (81 m) of the profile Los Araditos correspond to a paleoenvironment characterized by a fluvial system of meander-like type with moderate energy; whereas the rest of the succession (700 m) is linked to fluvial-eolian deposits of a plain that were subject to pedogenetic processes where the solutions saturated in carbonates and linked to phreatic levels generate the levels of gravels in the stratum of fine grain is common the presence of phytolites and volcanic particles.

Initial depositional processes on the distal passive margin of the peripheral foreland basin - fluvial deposits of the St.Marein-Freischling Formation (Alpine-Carpathian Foredeep, Austria)

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Analysis of fluvial systems and its paleodrainage provide crucial data for the reconstruction of ancient landscapes and paleogeography. The fluvial transport is quite important in the determination of the asymmetry of the foreland basin geometry. Fluvial deposits in the distal, cratonic margin of the peripheral foreland basin could often allow the study of paleovalleys preserved along the basal unconformity. The deposits of St.Marein-Freischling Formation (Oligocene – Early Miocene), which cover the crystalline basement of the Bohemian Massif in the area of northwestern Lower Austria, can provide a typical example of such a situation. Studied sandy and gravelly fluvial deposits of the St.Marein-Freischling Formation are reflecting a braiding fluvial style. Eleven lithofacies and four facies associations/architectural elements (gravelly channel dunes and bars, channels, sandy channel dunes and abandoned channels) were recognised. A relatively shallow network of streams with flash-flood character can be documented. Ephemeral braided streams or at least fluctuations in the discharge are supposed. The episodic character of transport, erosion and deposition could reflect changes in climatic conditions. Provenance study (pebble petrography, heavy minerals), evaluation of pebble size, shape and roundness, and paleocurrent data suggest two parts of the fluvial system. For the first and main part of the fluvial system a general transport from west to east can be supposed, which finally was diverted towards the south. Transverse tributaries both from north and south were connected to the west-east drained part of the paleovalley. As source deeply weathered crystalline rocks of the South Bohemian Batholith and the Moldanubian zone (Eisgarn granite, Rastenberg granodiorite, Wolfshof syenitic gneiss, Gföhl gneiss, granulites, marbles, eclogites, amphibolites) are supposed. However, local sources strongly influenced the provenance spectra. In a second, probably separate fluvial system in the southeast a general transport from northeast to southwest is evident, where Moravian metamorphic rocks, magmatic rocks of the Thaya Batholith, and probably reworked Mesozoic sediments are the main sources. For the position and orientation of the paleovalley the tectonic influence of the north-ward thrusting Eastern Alps is discussed, causing a back- bulge depression along the passive margin of the foreland basin. These west-east trending paleovalley was tilted to the east, where north-south trending paleovalley was developed along the fault separating different units of the crystalline basement. The tectonic activity within the Eastern Alps is supposed to be responsible for the reactivation of this tectonic contact between the Moldanubian zone and the Moravian zone. Tectonics was the principal ruling factor of the formation of a paleovalleys and paleodrainage system in that position.

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Secondary porosity and bitumen migration in Proterozoic carbonate rocks: Bambuí and Vazante Groups, São Francisco Basin, Brazil

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The carbonate rocks of Sete Lagoas and Lagoa do Jacaré formations, Bambuí Group, in the Alvorada do Norte region (Goiás State), and Morro do Calcário Formation, Vazante Group, in the Fagundes region (Minas Gerais State), are composed mainly by calcarenites, dolarenites and breccias (with stromatolite fragments), and their diagenetic history differs in several aspects. The main subject of this study is to characterize petrographic features (composition and texture), to understand diagenetic and hydrothermal alterations. Indeed, the relationship between petrographic features and exposure and burial processes were evaluated, including generation and obliteration of porosity. In the carbonate rocks of Sete Lagoas and Lagoa do Jacaré formations (Bambuí Group) it was observed a very low primary porosity. The originally porous facies were strongly cemented in the depositional environment and throughout shallow burial conditions. This eodiagenetic cements obliterated the pore space and avoided mechanical compaction, maintaining the primary grain textural arrangement. Dolomitization and karstification related to exposure processes occurred in the top of the Sete Lagoas Formation. Cavities and fenestral porosity was generated, with speleothem features. The secondary porosity related to the karstification was filled mainly with fine carbonate sediments. Two events of fracturing and one of dissolution occured after chemical compaction. Secondary porosity was generated, mostly intercrystal and vuggy, as well as along stylolites and in open fractures. Part of the secondary porosity was cemented by blocky calcite, dolomite, saddle dolomite and quartz during mesodiagenesis. After the late cementation process there was hydrocarbon migration, with some trace of bitumen preserved. The carbonate rocks of Morro do Calcário Formation (Vazante Group) were also cemented during eo/mesodiagenesis, and no primary porosity was preserved. Secondary porosity was also generated in carbonate rocks of Morro do Calcário Formation during mesodiagenesis, in this case related to stylolite surfaces, which acted as conduits to corrosive fluids. The secondary porosity, mainly vuggy, was intensively cemented by dolomite (eo/mesodiagenesis), and only locally remaining porosity is still present, but it is filled with solid bitumen. Moreover the cementation and dissolution processes, the carbonates of Morro do Calcário Formation were also subjected to hydrothermal alteration. This process caused alterations in carbonate rocks such as silicification, brecciation and cementation by silica, dolomite, pyrite, sphalerite and galena. The major difference between both regions is due the tectonic and structural aspects. The Bambuí Group in the Alvorada do Norte area, is mainly horizontal, with open folding, whereas the Vazante Group, in the Fagundes region, presents strong syn and post-deposicional deformation in a context of thrust faults. For this reason, the carbonate rocks of the Vazante Group were intensively fractured paving the way for dolomitizing and hydrothermal fluids. In both areas there was generation and migration of hydrocarbons. The carbonate rocks of Bambuí Group present open fractures, secondary porosity and bitumen traces, being potential hydrocarbon reservoir rocks. Differently, carbonates of Vazante Group are strongly fractured, but these fractures are closed or cemented, with rare secondary porosity filled by solid bitumen. The hydrothermal process resulted on intense recrystallization and cementation, besides hydrocarbon cracking, and no effective porosity was observed.

Characterization of mixed siliciclastic/carbonate systems within the Mulichinco Fm (Valanginian) in Cañadón Amarillo field, northern Neuquén Basin (Argentina). An integrated approach to build more robust exploration and production models

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An integrated study was carried out in Mulichinco Formation (Cañadon Amarillo Field, CAM) aiming at characterizing the reservoir by building a predictive model both at exploration and production scale. This study was based on the integration of high resolution sequence stratigraphy, log analysis and seismic attribute interpretation. The Mulichinco Formation developed after a second-order, tectonically-influenced Early Valanginian sea-level fall. In CAM field it consists of shallow-marine siliciclastics and carbonates deposited within an epeiric seaway. Mulichinco strata (140-110 m thick) can be divided into three stratigraphic intervals (Lower, Middle and Upper Members) characterized by different lithologies and seismic geometries. The Lower Mulichinco Member (35-20 m thick, thinning to East) comprises two to three, poorly-defined coarsening-upward successions (8 to 15 m each) with bioturbated heterolithics (or less commonly mudstones) at the base, grading upward to sandstones with hummocky cross- stratification (HCS) and ripple cross-lamination. Commonly, cross- stratified calcarenites and/or oolitic grainstones cap the successions. These cycles are interpreted as regressive parasequences, representing siliciclastic-dominated proximal offshore settings to mixed shoreface conditions. An internal reflector matching a flooding surface and pinching out toward the East defines a proximal (East) to distal (West) facies trend for this stage. Tide-influenced carbonate shoals and mixed/siliciclastic bars replaced laterally in the shallower portion of the ramp. Within the Lower Mulichinco, reservoir potential is restricted to some discontinuos sandstone bodies (< 2 m thick) with poor petrophysical properties interpreted as isolated mixed/siliciclastic bars. The Middle Mulichinco Member (25-35 m thick) consists mainly of micrite- rich, bioclastic floatstones and boundstones dominated by epibenthic macrofauna (oysters and serpulids), interbedded with less frequent micrite-poor floatstones with endobenthic fauna (mainly bivalves). The pure-carbonate interval is replaced towards the top by very fine-grained bioturbated calcarenites. Oyster-rich carbonate accumulations are interpreted as low-relief mounds within a gently dipping carbonate ramp, whose regional extension largely exceeds the study area. The top of the Middle Mulichinco is interpreted as a regionally significant maximum flooding zone. Moderate reservoir conditions are expected in this section within some micrite-poor floatstones having intramoldic and intermoldic porosity; these beds are quite tabular, thin and continuous (< 2 m thick). The Upper Mulichinco Member (60-75 m thick) shows a well- developed vertical cyclicity. Cycles thicken upwards (4 to 22m each), have a sharp base and comprise a basal carbonate-rich hemicycle overlain by a siliciclastic-dominated hemicycle. Carbonate hemicycles consist of micrite-rich, bioclastic wackestones and floatstones, locally associated with some cross-stratified grainy packstones and grainstones. Skeletal-rich facies are gradually replaced by siliclastic dark, laminated shales, passing upward to bioturbated sandy mudstones and muddy sandstones, an eventually into clean, very fine to fine- grained sandstones typically with HCS. Cycles are interpreted as genetic units reflecting high-frequency, low-amplitude relative sea-level oscillations, in which transgressive conditions inhibited terrigenous input and allowed for the development of a carbonate-dominated system, whereas normal regressive, siliciclastic-dominated conditions are marked by the transition from offshore shales to middle shoreface sandstones. Seismic geometries of the Upper Mulichinco cycles show E/NE prograding, low-relief clinoforms revealing a complex spatial distribution of facies with good reservoir potential, represented by middle shoreface sandstones and grainy packstones/grainstones in the uppermost part of the cycles.

Organization and distribution of a lacustrine sequence in the Jatobá Basin, northeastern Brazil: C and O behavior of a laminated limestone facies

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This study focus on the organization and distribution of a lacustrine sequence with emphasis on microfacies, microstructures and C- and O isotope behavior of Aptian laminated limestones of the Jatobá Basin, in northeastern Brazil, similar to the ones found in the Araripe and Tucano Norte Basins. These carbonates overlie sediments of the Marizal Formation. More than twenty thin sections of the laminated limestones have been studied under optical microscope and cathodoluminescence. The limestones are calcilutite, constituted by milimetric laminae (0.5 to 1.5 mm) with presence of framboidal pyrite in various laminae. The main structures are slumps, simple and complex loop-bedding (similar to sedimentary boudinage). The simple loop-bedding was generated by digenesis and the complex one, by microfaults. Five microfacies of laminated limestones are observed: plain parallel, undulations, simple and complex loop-beddings, and micro slumps. The main porosities in these limestones are vugs, fractures and fenestral. The laminated limestones are composed of low-magnesium calcite which corresponds to a stable mineral phase, formed from earlier carbonates that have experienced dolomitization. Despite the evidence of diagenetic phenomena such as presence of microscopic spheroidal clusters of pyrite grains commonly associated with bits of organic material and dedolomitization, diagenesis dies not seem to have led to important changes in the isotopic compositions of these carbonates. C and O isotopes were analyzed in six laminae, three of light and three of dark color $\delta^{13}C$ (-4.4 to -5.4 ‰) and $\delta^{18}O$ (-5.6 to -6.0 ‰ V-PDB) are typical of lacustrine environments. The lack of covariance between $\delta^{13}C$ and $\delta^{18}O$ suggests a hydrologically-open paleolake when the laminated limestones were deposited, but the response to water balance due to evaporation in a closed lake is not discarded.

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Shelly limestones of the Teresina and Rio do Rasto formations, Permian (Paraná Basin, Brazil): taphonomic implications for paleoenviromental reconstructions

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Bivalve mollusk fossils are common in siliciclastic and carbonatic rocks of the Teresina Formation (Pinzonella illusa and Pinzonella neotropica biozones) and Rio do Rasto Formation (Leinzia similis Zone), Permian, Paraná Basin, Southern Brazil, but no detailed published taphonomic study refers to carbonates. Thus, six typical carbonatic examples of this interval were selected for study. Features of the sedimentary matrix and the taphonomic signatures provide clues for interpretation of background processes (e.g., the day-by-day conditions) and those involved in the final deposition (e.g., episodic events). The Kungurian-Roadian (?) Teresina Formation is a typical aggradational succession of a shallow inland intracratonic sea, composed of fine siliciclastics (mainly pelites and very fine sandstones with wavy bedding) with intercalations of bioosparites, biomicrites or coquinas. The poorly diversified bivalve fauna was endemic and probably thrived in brackish to hypersaline conditions. The limestone beds selected for study are from the south-central and northeastern Paraná State and were classified as bivalve-ooid grainstone (from Prudentópolis and Santo Antônio da Platina Counties), ooid-bivalve rudstone or coquina (from Prudentópolis County) and peloid-intraclastic-bivalve grainstone/packstone with rare ooids and oncoids (from Rio Preto County). The lower part of the Rio do Rasto Formation, namely the Wordian (?) Serrinha Member, encompasses continental, probably shallow lacustrine deposits, characterized by mudstones with a higher proportion of intercalated sandstones and true freshwater fossils as conchostracans. In this succession, carbonatic rocks are rare, except biomicrites in the northeastern Paraná State, as well as coquinas. The analyzed taphonomic examples are a packstone and a wackestone with bivalves and oncoids from this area (Ribeirão Claro County). The six studied limestone beds (≤ 45cm thick) are intercalated within pelitic rocks, and the basal contact is usually sharp and erosive. A variable amount of pelitic intraclasts and quartz grains is mixed in the limestones. The shells are disarticulated, commonly fragmented, sometimes encrusted by stromatolites, and correspond to allochthonous specimens, which lived in muddy bottoms. The shells are randomly arranged (many nested/stacked), showing dense to disperse packing, and discontinuous grading. All examined bivalve-dominated concentrations were generated in shallow water settings punctuated by storms, under very low sedimentation rates, with frequent reworking and intrastratal bioturbation. Hence, the shell concentrations are complex amalgamated tempestites. The wide shallow conditions in the inland sea/lake were provided by the very low depositional-slope gradient of the intracratonic basin. This work corroborates previous evidences that Paleozoic shell beds from the epeiric seas have complex taphonomic histories and result from strong temporal/spatial mixing of bioclasts under storm influence.

Rapid diversification of zircon grains in the palaeo-Colorado River: re-establishing a 'late-incision' model for the Grand Canyon

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The age of the Grand Canyon and the Colorado Plateau has been the subject of intense debate for over a century. Uncertainty remains over the timing of uplift of the plateau, but the timing of canyon incision has become increasingly controversial in recent years. Most models agreed that incision since 6 Ma was most likely, but recently an alternative model has been proposed with uplift at 17 Ma, based mainly on speleothem age data. In this paper, we re-establish the 'late-incision' model, based on the detrital record of erosion in preserved in the Colorado River delta, now exposed in the Salton Trough in southern California. Exposed strata in this basin have been analyzed to determine the compositions of heavy mineral assemblages, garnet geochemistry and U-Pb age spectra of zircon grains, in order to understand the evolution of this river system in response to tectonic and/or climatic processes. We also explore the possible existence of a pre-Pliocene Colorado River, in the sedimentary record of the Los Angeles Basin. There is a clear transition in the mineralogy and age of detrital minerals in Colorado-derived sediments of the Salton Trough from the Pliocene to the present day. The oldest Colorado-derived samples have limited age spectra, with most grains likely to have been derived from the southern Rocky Mountains. Rapid diversification of zircon age spectra then occurs in the overlying strata, most pronounced from 5.3 to ~4.3 Ma, with peak ages in younger samples include progressively more grains derived from Grenvillian and Appalachian sources, which are common in Mesozoic sandstones in the Colorado Plateau. Supported also by evidence from stable heavy mineral suites, we interpret this as evidence for significant incision of the Grand Canyon in the Early Pliocene, with little or no incision having occurred in the Miocene. Drainage re-organisation and incision is likely to have occurred following the opening of the Gulf of California at the end of the Miocene, accompanied by the onset of the North American Monsoon.

Arc-collision and exhumation at the Izu-Bonin collision zone: quantifying deformation and resultant sediment flux to the trench

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The Nankai Trough is one of the most intensively studied subduction zones in the world, with a long history of tsunamigenic earthquakes over at least 1300 years. Continuous sedimentation and accretion since the Miocene provides us with a detailed record of accretion of exotic terranes (the Izu-Bonin Arc) and of exhumation rates in Japan, both at the collision zone of the arc with the mainland and with the southeastern margin of Japan away from the collision zone. Present models predict that the Izu-Bonin Arc collided with Japan around 1 Ma and that uplift rates are particularly high to the west of the collision zone in Honshu. However, the evidence for this event in the sedimentary record of the Nankai Trough has been largely overlooked until now and only the basic framework petrography has been considered. We use cores from IODP Expedition 316 and ODP Leg 190, along with samples from modern rivers draining Honshu, to determine the timing of the Izu-Bonin collision with Honshu and the response of the landscape to that collision. This is done using geochronological and mineralogical analyses to look at changes in sediment provenance and using thermochronological analyses to determine cooling rates and calculate uplift rates in the hinterland. LA-ICPMS U-Pb analysis of zircon grains are used to look at changes in source area, with the Izu-Bonin collision zone supplying zircons of a significantly younger age than those derived from the Shimanto Belt. Thermochronological data derived from Apatite and Zircon Fission track Analysis, combined with biostratigraphic data, provide constraints on the timing and rate of uplift of the sediment source areas, allowing reconstructions of the evolution of the landscape during the collision of the arc. This project also provides crucial information on the physical properties of the sediment input to the subduction zone, which can strongly influence mechanical and seismogenic processes in the accretionary prism.

Depositional environments, reservoir properties and source rock potential of the Lower Cretaceous Phu Quoc Formation, Phu Quoc – Kampot Som Basin, Southwest Vietnam and southern Cambodia

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The Lower Cretaceous Phu Quoc Formation forms the core of the Phu Quoc Island situated offshore Vietnam and Cambodian mainland. The island forms a triangular, 50 km long and up to 25 km wide inverted structure within the elongated Phu Quoc-Kampot Som Basin (PKSB), that strikes approx. 500 km north-south from southwest Cambodia to the central part of the Gulf of Thailand. The Cambodian and Vietnamese PKSB is a Late Jurassic to Early Cretaceous foreland basin developed in response to the build-up of a palaeo-Pacific magmatic arc. The basin and the Khorat Basin in Thailand constitute erosional remnants of a larger basin that covered greater parts of Southeast Asia in late Mesozoic time, and subsequently became segregated during earliest Palaeogene inversion and erosion. The basin history has been unravelled through interpretations of seismic data, well data and outcrop geology combined with fission track- and U/Pb-analysis. The Phu Qouc Island offers a window into the sedimentology and stratigraphy of the offshore part of the structurally complicated basin. The central part of the island is dominated by a low mountain range reaching the height of c. 550 m. The general country dip of the strata is 10-20° toward WSW-SW forming relatively gentle dip slopes, while steeper slopes typically characterise the eastward faces of the mountain hills possibly delineating faults. The Phu Quoc Formation was investigated by studying outcrops along the rocky coast, in natural river cuts and in quarries on Phu Quoc Island supplemented with field observations from the time-equivalent Bokor/Cam Pong Formation exposed in Cambodia. In addition a 500 m deep core well was drilled, which provided high quality continuous cores of poorly exposed stratigraphic levels. The investigations include analyses of sedimentary facies in outcrops and cores, sandstone petrography, clay mineralogy, well-logs, source rock potential, biostratigraphy and topography. The formation is dominated by fluvial channel successions showing erosively based, fining-upward units of cross-bedded, medium to coarse-grained, in places pebbly sandstones. Thicknesses of individual cross-beds often exceed 1 m and are occasionally up to 2 m testifying to migration of large bedforms in deep rivers. The sandstones are classified as greywacke and lithic arkose typically with 10-15 % of porosity. The petrography of the pebbles indicates a very diverse source area of various meta-sediments and volcanic rock. Between successive fluvial channel successions occur reddish and greenish mudstones mostly deposited in well oxygenated floodplains and shallow lakes. Vegetation seems to have been relatively sparse since soil- profiles, roots or coal beds are almost absent; clasts of terrestrial plant material are however fairly common. At 1-2 specific stratigraphic levels large coalified tree trunks in mudstones occur; in places remains of trunks occur in situ with roots. These so-called jetcoals have been exploited by the locals as gemstones. Source rock analyses of mudstones and the jetcoal indicate a very low hydrocarbon potential. At a few distinct stratigraphic levels occur lagoonal mudstones with marine palynomorhs interbedded with well sorted marine shoreface sandstones showing 10-20 thick cross-beds with strongly concave basis and intensive bioturbated sandstones with Skolithos, Diplocraterion and Ophiomorpha burrows. The age of the Phu Quoc Formation is poorly constrained to Late Jurassic-Early Cretaceous based on early records of macrofossils, whereas palynomorphs indicate a Hauterivian-Albian (Early Cretaceous) age. The study forms part of a long-lasting and ongoing geo-scientific programme between Vietnam and Denmark comprising a group of geoscientists, which have undertaken seismic analysis, regional structural analysis, source rock analyses, basin modelling and investigations of onshore analogues to the deeply buried basins offshore Vietnam.

Genesis, age and sedimentary architecture of the Holocene to Recent Northern Wadden Sea, Denmark

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The Danish Wadden Sea (DWS) consists of a series of barrier islands and partly submerged shoals lying in front of lagoons with sandy and muddy tidal flats intersecting by drainage networks of tidal channels. The barriers are separated by tidal inlets, up to 30 m deep and 2000 m wide terminating in the sea by ebb-deltas. Large, coarse-grained dunes up to 300 m long and with several meters of steep slip faces are present in the inlets (Bartholdy *et al.*, 2002). To the north the DWS is terminated by a spit system enclosing the lagoon and to the south, the 15 km wide and 70 km long DWS continues into the NW European Wadden Sea. The tidal range is 1.3–1.9 m, but spring tide and storm surges may increase water level to almost 5 m above msl. The fetch for the westerly winds from the North Sea is ca. 600 km. Investigations of the stratigraphic development of the DWS have been recently strengthened by applying a multidisciplinary approach including (i) drilling of fifteen ~ 25 m long cores on the barrier islands and five up to 4 m long vibrocores in the lagoons, (ii) acquisition of ~ 50 km ground penetrating radar (GPR) reflection profiles, (iii) fossil analyses and (iv) dating of ~ 150 core samples using optically stimulated luminescence (OSL) (Møller *et al.* 2008; Nielsen *et al.*, 2009). This ongoing study indicates that the initial Wadden Sea was established c. 8.000 years ago when the gently seaward dipping sand-dominated glacial outwash plain was transgressed due to a rapid Holocene sea level rise. The relief of the outwash plain seems to have influenced the development of the Wadden Sea. In the lows, peat-forming mires were drowned and transformed into lagoons, while sandy highs formed the basis for early spit system and barrier island development. In the first 3– 5000 years the overall rate of sea level rise was significant, and barrier islands were mainly narrow, vertically aggrading, with washover fans stacked upon the back-barrier salt marshes. Aeolian dunes were probably limited due to the frequent washover events. During the last c. 3.000 years the overall rate of sea level rise decreased and the barrier islands increased rapidly in size by seaward progradation and significant growth in length. The resulting barrier island succession is up to 20 m thick, comprising shoreface and foreshore sand, sandy beach ridges separated by muddy swales, aeolian dune sand and washover fans. The lagoonal succession is up to 13 m thick dominated by bioturbated heterolithic sand and mud. Detailed investigation of the upper part of the lagoonal succession indicates that tidal channel fill, mostly composed of inclined heterolithic strata formed on point bars, is the dominant facies association. This reflects intensive reworking of the extensive tidal flats by migrating channels, emphasizing that the preservation potential of the various sub-environments is highly variable (Fruergaard *et al.* submitted).

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The post-tectonic sedimentation in the Mid-Ordovician volcanic arc of Cordón de Lila, northern Chile

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The Volcanic Arc is represented by the ca. 3,000 m-thick Tremadocian to Arenigian bimodal submarine basaltic tholeiites to calc-alcaline rhyolites with minor sedimentary rocks succession of the Cordón de Lila Complex. These rocks are strongly folded and are intruded by huge masses of coeval dioritic, tonalitic to granodioritic plutons. A marine succession of ca. 1,600 m-thick composed of conglomerates, sandstones and siltstones of Upper Arenigian to Lower Llanvirnian age here referred to as the Quebrada Grande Formation overlain the Complex. A tight angular unconformity separates both formations. This study is focused on the sedimentary facies of the Quebrada Grande Formation as well as on the interpretation of its depositional environment. A detailed stratigraphic section of the Quebrada Grande Formation was measured and accordingly it may be divided in two members. The Lower Member is mainly composed of matrix- and clast- supported conglomerates with sandstone beds. Close to its base some thin limestone beds bearing fossil brachiopods occur. The Upper Member is formed by a thick succession of siltstone and sandstone beds with minor conglomerates. One of the siltstone beds bears graptolites. Three main facies associations may be recognized along the stratigraphic section: Matrix-Supported Conglomerates (MSC), Sandstones Interbeded with Siltstones (SIS) and Clast-Supported Conglomerates (CSC). The MSC facies association is the principal component of the Lower Member and is formed by the following facies: matrix supported massive-conglomerates (MSC1); reverse and normal graded matrix-supported conglomerates (MSC2); normal graded matrix- supported conglomerates (MSC3); massive clast-supported conglomerates (MSC4); massive sandstones (MSC5); undulated laminated sandstones (MSC6); clast-supported conglomerates with erosive base (MSC7) and thin limestone levels (MSC8). The SIS facies association forms the lower section of the Upper Member and is composed of three facies: sandstones interbeded with siltstones (SIS1); normal graded sandstones (SIS2) and sandstones with unorganized lenses of siltstones (SIS3). The CSC facies association is present in the upper section of the Upper Member and it is formed by two facies: imbricated clast-supported conglomerates (CSC1) and siltstones with beds of clast-supported fine-grained conglomerates (CSC2). The eigth facies of the MSC facies association represent the interaction of deposits formed by debris flows and stream fluvial flows and are typical of alluvial fans. We suggest that these proximal deposits should be assigned to a fan-delta system. The presence of fine-grained sediments and marine pelagic fossils, in addition to the waning of conglomerates towards the upper part of the succession suggest a nearshore shelf depositional environment for the SIS facies association. The facies CSC1 and CSC2 probably represent high-energy aquatic fluxes that developed in the distal part of the fan. The repetitive appearance of the MSC and CSC in the SIS facies association suggests an episodic reactivation of the alluvial system, probably related to the successive tectonic uplift of the source area that triggered the progradation of the coastal fan into the shelf. In conclusion we may state that the Quebrada Grande Formation represents a post-tectonic sedimentary record that occurred synchronically with the uplift and denudation of the arc. The latter furnished the detrital material to the foreland basin in which the sediments of the Quebrada Grande Formation where deposited.

Granular structure: Micro-scale characterization of fluid-mud deposits

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Recent studies have shown that thick muddy deposits with rapid sedimentation rates are formed in a variety of depositional systems in coastal and shallow-marine environments as a result of deposition of fine-grained sediments from high-concentration suspension called fluid mud. Thus, fluid-mud deposits likely have the potential to have developed mud-dominated stratigraphic successions in coastal and shallow-marine environments. However, fluid-mud deposits seem to have been overlooked in stratigraphic successions. A better understanding of the distinctive features of fluid-mud deposits is crucial for elucidating depositional environments and dynamic processes of mud deposition in stratigraphic records. Here, we investigated clay fabric of experimentally-formed fluid-mud deposits for exploring a new micro- scale criterion for the re-evaluation of fluid-mud deposits. On the basis of the SEM observation, we found that clay fabric of fluid-mud deposits is characterized by spherical to elliptical aggregates of face-to-face contacts of component clay particles with the long axis of up to 30 μm. The formation of this type of aggregate, herein called granular structure, is controlled mainly by the initial suspended-sediment concentration (> 10 g/L) from which fluid mud was formed regardless of salinity and agitation applied to fluid mud before the settling of fluid-mud deposits. In response to the increase in concentration of suspended clay particles, smaller flocs, which tend to be characterized by stronger bonding forces between clay particles than those formed in the lower concentration suspension, were typically formed as aggregates. These aggregates are interpreted to be preserved within random structures after settling and can be identified as granular structure in fluid-mud deposits. The granular structure was also commonly found in fluid-mud deposits formed in the turbidity maximum in a modern estuary and a modern tidal flat that was influenced by flood-water discharge. Furthermore, possible fluid-mud deposits intercalated in a storm-influenced shoreface succession formed in the Late Pleistocene paleo-Tokyo Bay also contain the similar granular structure. Thus, the granular structure is interpreted to represent one of the distinctive features of fluid-mud deposits. In conjunction with formally proposed lithofacies and ichnofacies features of fluid-mud deposits, the granular structure should be useful for the re- evaluation of fluid-mud deposits from limited volumes of muddy samples and thin- to very thin-bedded muddy deposits.

The Pipanaco Basin, northern Argentine broken foreland, and its connection with the Andean plateau rise

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The Pipanaco basin (PB) is a flat, high-elevated (~1 km a.s.l.) alluvial intermontane basins with an areal extension of >10000 km^2. It is located in the northern end of the Argentine broken foreland province -or Sierras Pampeanas- where basement-thrusting controls the topography and local basement uplift rates, basin formation and accommodation, climate and landscape. Although there are no exposures across PB, a large geological and geophysical database exists from the surrounding regions and subsurface. The aim of this contribution is to integrate a detailed stratigraphic survey with new geophysical approaches and DEM analysis to give support to some of the proposed models that explain high-elevated basins and plateau formation in the Andes. By using a gravity anomaly filter (densities <2.4 g/cm^3) we found that the sedimentary thickness signals in the PB vary from W to E from ~1 km to ~3.5 km. The stratigraphic of the surrounding ranges allows to explain this accommodation geometry by ~2000 m of Neogene + ~1000 m of Quaternary. Such a W-E arrangement can be reproduced considering an elastic flexural model with the tectonic load being equivalent to the Plio-Pleistocene uplift of the Ambato range (~5.5 km), the effective elastic thickness 40 km and a density of loads of 2700 kg/m^3. The western side of the basin was in turn, affected by the activity of a buried basement thrust detected by a gravity Euler deconvolution and analytical signal analysis. This hidden thrust drove an exhumation of ~1000 m after Neogene sedimentation, preventing Quaternary accumulation in this part of the PB. When we contrast our gravity results in the PB with available seismic sections in other surrounding intermontane depocenters (Puna boundary, Campo de Arenal Basin to the north) and in the core of the broken foreland (La Rioja Basin to the south), a remarkable increase in sediment filling is observed to the south. Records vary from 2000 m to 3500 m indicating an important accommodation difference. In addition, the top of basement elevation varies from ~2000 m a.s.l. in the N (Campo del Arenal) to -2700 m a.s.l. in the S (La Rioja Basin). A swath topographic profile along ~66ºW, between 26ºS and 29ºS, depicts southward reduction of altitudes, ~3500 m to the north and 400 m to the south. Also the PB shows a particularly high-elevated depositional surface (~1000 m a.s.l.) and sediment thicknesses larger than in the northern intermontane basins. Altogether these suggest no obvious relationships between sedimentary aggradation (including cumulative thickness), basin rim relief and the formation of high-elevated surfaces. Thus, we conclude that deep-seated geodynamic processes (e.g. delamination) are the driving mechanisms to form high-elevated basins and plateaus, supported by the clear elevation differences of top of basement from N to S and a compilation of low-temperature cooling ages along this transect indicating differential exhumation to the north. In addition, our data are consistent with a rapid uplifting of the plateau as suggested by current hypothesis.

The Jumasha Formation in the high Central Andes of Perú: sedimentology, petrography and economic Implications

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The upper cretaceous Jumasha formation is the most extensive and notorious sedimentary carbonate unit in the high Andes of central Peru. It's an important and excellent hosting rock for different kinds of deposits: skarn (Antamina) and vein mineralization (Uchucchacua) of world class. Also has a potential of source rock of petroleum in the Andes region. As well important resources of ornamental rocks (marble). The formation is defined for the appear of thick carbonate banks and became more and more thickness; the lithology is predominantly gray massive limestone and marl limestone and marl intervals are more conspicuous in the upper part; the total thickness are plus of 1000 meters. It's possible to distinguish IV map units, the first two finishes with a marly horizon; the third is a conspicuous carbonate bar, the last show a "banded" appearance with alternance or marl intervals with less carbonate. The age defined by fossils (*Lyelliceras Ulrichi* and *Coilopoceras*) is between Upper middle Albian until upper Turonian. The most abundant shallow water facies are mudstone with an occasionally variations to wackstones; to the upper part (Unit III) are packstones – grainstones with ocasionally oolitic facies and pass to bituminous limestones with high carbon organic content. The top unit show nodular white marls with mudstone levels. The vertical succession of upward sequences represents the filling of basin. Active subsiding of the basin was matched by the rate of important carbonate deposition.All the column traduit three transgressive pulsations with marly intervals more and more thickness to the upper part, its represent the big Cretaceous transgression. Petrographic studies of 16 thin sections of reactif limestones from Ayash section, Antamina and 4 from one Perforation (DDH-12), show a different and significatif abundant fauna. Most samples are limestones. Silty siliciclastic grains are scarce, except in one sample (calcareous sandstone). Dolomite replacement is scarce. Siliceous replacement is present only in one sample. Glauconite is rare. Phosphates are scarce, as gastropod or echinoid pore-filling. Some samples show lamination and/or bioturbation. Mud-supported textures are dominant: bioclastic mudstones and wackestones. Bioclastic "floatstones" are common. Grain-supported textures (bioclastic packstones and packstone/grainstones) are subordinated: only one grainstone is recognized: oolites are present in this sample. Components are almost exclusively skeletal grains. Faunal content can be grouped into: Restricted: Ostracods, green algae and foraminifers (miliolids). Mixed: ostracods, green algae and foraminifers (miliolids) associated with echinoids, large benthic foraminifers (orbitolinids or peneroplids), gastropods, pelecypods, etc. Normal marine: planktic formaminifers (globigerinids?), radiolars, calcispheres and echoniods. In the unit III (upper part) we found bioclastic packstone/grainstone with almost exclusive foraminifers: large benthic and abundant miliolids. Semirestricted environment, moderate energy. Also bioclastic wackestone/packstone (floatstone: majors components pelecipod, molusc, gasteropods and foraminifers). shaly Matrix, with mixed faune. More open environment. Show textural inhomogeneities. This samples maybe represent mecanic acumulations.

Microfacies analysis and paleobathimetric interpretations on a Barremian – Aptian (Lower Cretaceous) stratigraphic section in northern Mexico

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Northern Mexico is characterized by a sedimentary cover mainly composed of Upper Jurassic-Lower Cretaceous marine facies. Excellent outcrops of stratigraphic sequences of Barremian-Aptian age are well-exposed in this area. The classical paleogeographic reconstructions of the north portion of Mexico stands out the development of extensive shallow-water carbonate platforms during the Barremian and early Aptian times. The drowning of those platforms at the end of the early Aptian is envisaged via an exaggerated deepening of the sedimentary conditions through a global transgressive event. The Cupido Formation represents the development of one of those carbonate platforms during that time interval. The Barremian-Aptian transition in the area of study is recognized through the stratigraphic ranges of index species of benthonic foraminifera in shallow water facies that belong to the upper part of this formation. The stratigraphic and structural pattern of this platform was controlled by the paleogeographic configuration derived from the opening of the Gulf of Mexico. In outcrop, the top of the aforementioned lithostratigraphic unit is informally known as the "Cupidito" lithofacies. This facies is traditionally interpreted as indicative of a deepening sequence typical of a homoclinal ramp, supposedly developed at the first stage of the transgressive event that drowned this platform. Current research deals with a detailed microfacies analysis on a stratigraphic exposure of the Barremian-Aptian Cupido Formation in the eastern portion of the Durango State, northern Mexico. It provides additional information in regards to the paleobathymetric dynamic within the basin of this little studied area. Furthermore, our data allows the modification of previous paleogeographic interpretations of this region of Mexico for the time interval represented by the rocks of this study. The stratigraphic section studied is 118.76 meters-thick, and displays a series of medium- to very thick bedded limestones, dolomitic limestones, and pure dolostones. The basal and median portions of the measured section contain unusually thin-shale beds and chert nodules. Bedding planes (surfaces) are commonly wavy and stylolitic all throughout. Thin parallel to slightly wavy lamination is also present. Seven microfacies associations were identified from the base to the top of the section: 1) Floatstones and wackestones with abundant orbitolinids, miliolids, ostreids, and worm tubes; 2) Packstones, wackestones, and grainstones with miliolids, echinoids, intraclasts, favreinids, and pelecipods; 3) Packstones and grainstones with fecal pellets and microbial peloids, abundant echinoids, ostracods, sponges, green algae, and scarce microbial mats; 4) Grainstones and rudstones with ooids that display both, tangential and radial microfabric, filamentous algae, intraclasts, and peloids; 5) Packstones and grainstones with abundant echinoids, peloids, and miliolids; 6) Dolostones with inequigranular idiotopic mosaic; 7) Wackestones, packstones, and rudstones with echinoids, pelecipods, ostracods, sponges, and miliolids. The interpretation of these microfacies shed new light on the sedimentological regime assumed for the area of study. They are herein conceived as indicative of a partially rimmed carbonate platform, which was apparently exposed to a more complex paleobathimetric dynamic than that suggested by other authors. Thus, the facies identified in this study are assigned to a series of Standard Microfacies (SMF) typical of diverse environments of deposition, namely: a restricted lagoon, a sand bar, and a high energy fore-reef. Our results also allow for a new perception on the position of a rudistic reef trend that the Cupido Platform had during its development, which is traditionally located towards the north of the study area.

Reconstruction of Miocene siliciclastic burial history based on late diagenetic products

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Lower and Middle Miocene sedimentary rocks are exposed in Vrancea area from the southeastern corner of East Carpathians and provide a record of mixed siliciclastic-evaporite sedimentation from this tectonic regime-controlled area. Siliciclastic rocks belonging to Lower and Middle Miocene represents shallow-marine deposits, including shallow to distal shelf facies. The vertical arrangement of the facies is characterized by the presence of high-frequency transgressive cycles, themselves interrupted by strata resulting from catastrophic phenomena (storms). In this study, diagenetic constituents are used to evaluate the burial history of the sedimentary deposits from Vrancea (Subcarpathian nappe), an area for which only limited subsurface data is available. Burial diagenetic products in the Lower and Middle Miocene siliciclastic rocks comprise saddle, ferroan and zoned dolomites, together with ferroan sparry and poikilotopic calcite and chlorite minerals. Additional burial-related features include stylolites and dissolution seams. Reconstruction of the paragenetic sequence for Lower and Middle Miocene siliciclastic rocks suggests a maximum depth of about 4000 m and temperatures till 60-70°C.

Sedimentology and ichnology of the Karoo Supergroup in the Gemsbok Sub-basin of Botswana and Namibia

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The Kalahari Karoo Basin of Botswana, Namibia and South Africa preserves a laterally heterogeneous succession of Late Palaeozoic to mid Mesozoic sedimentary and volcanic rocks of the Karoo Supergroup. This succession is not as well understood as the Main Karoo Basin in South Africa as extensive cover by the Cenozoic Kalahari Group restricts detailed investigation, with most research based on borehole data. The current study focuses on the Gemsbok Sub-basin, south-westernmost part of the Kalahari Karoo Basin and is specifically intended to address questions of intrabasinal correlation, depositional environments and sediment source areas. Integrated sedimentological and ichnological analysis of 11 borehole cores of the Karoo Supergroup in the Gemsbok Sub-basin of Botswana and Namibia revealed fourteen lithofacies and two trace fossil assemblages (assigned to the *Cruziana* and *Skolithos* ichnofacies). These have been grouped into eight broadly defined facies associations (FA1 to FA8), which correspond to the lithostratigraphic subdivisions (the Dwyka, Ecca, Beaufort groups, Lebung Group [Mosolotsane and Ntane formations] and Neu Loore Formation) of the Karoo Supergroup. The eight facies associations are inferred to represent glaciomarine deposits (FA1; Dwyka Group), subaqueous turbidite deposits (FA2; Ecca Group), prodelta deposits (FA3; Ecca Group), delta front deposits (FA4; Ecca Group), delta plain deposits (FA5; Ecca Group), shallow lakes (FA6; Beaufort Group), fluvial deposits (FA7; Mosolotsane and Neu Loore formations) and aeolian deposits (FA8; Ntane Formation). Glaciomarine (FA1; Dwyka Group) deposits forms the base of the Karoo Supergroup and are mainly characterised by diamictites, turbidite sandstones, siltstones and mudrocks, and in places, slump deposits with *Planolites*, *Palaeophycus*, *Teichichnus*, and *Diplocraterion* trace fossils of the *Cruziana* ichnofacies. Overlying the Dwyka FA1 in the study area is the Ecca Group comprising FAs 2, 3, 4 and 5. Delta front deposits of the overlying Ecca Group display both wave- and fluvial-dominated deltas. This distinction can be made based on thickness of the sandstone units and trace fossil assemblage. Wave-dominated delta front deposits show an upwards transition from horizontal-laminated siltstones, sandstones and mudrocks characterised by the *Cruziana* ichnofacies (*Palaeophycus*, *Planolites* and *Diplocraterion* trace fossils) at the base, to sandstone units of up to 60 m in thickness, which may contain the *Skolithos* ichnofacies (dominated by the trace fossils *Skolithos* and *Diplocraterion*). In contrast the fluvial-dominated delta fronts show an upwards transition from ripple cross-laminated mudrocks, siltstones and sandstones with few bioturbation structures at the base, to sandstone units of up to 30 m in thickness, which in places contain pyrite nodules and mudrock clasts. A marine influence on the delta plain deposits (FA5) is recorded by the presence of tidal bedding and the marine-brackish *Cruziana* ichnofacies. Coals are present within FA5 and the thickest coals are located in the eastern Gemsbok Sub-basin where the Ecca Group deltas are fluvial-dominated. In the wave-dominated deltas of the northern and western Gemsbok Sub-basin coal horizons are relatively thin. While bioturbation was recorded, no marine ichnofacies were documented from the Beaufort Group (FA6), Lebung Group (FA7 and FA8) and Neu Loore Formation (FA7), which are all non-marine deposits. The results of this study will contribute to the enhancement of existing sedimentological and basin history models of the Kalahari Karoo Basin.

Late Miocene climatic cyclicity at the northern tip of Antarctic Peninsula reconstructed from Mendel Formation sediments

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The Mendel Formation (MF) is a sedimentary sequence appearing in northern part of James Ross Island (JRI), northernmost Antarctic Peninsula (AP). The sequence is sandwiched between volcanic rocks of James Ross Island Volcanic Group (JRIVG). Its broad depositional age is 6.16–5.23 Ma, but was very probably deposited during much shorter time in the middle of this interval, most likely between 5.9 and 5.4 Ma. This time interval is given by ages of associated volcanic rocks supported by ages of pectinids directly from MF. The formation contains a wide variety of sediments deposited in terrestrial glacigenic, glaciomarine and open marine sedimentary environments. Cyclic deposition in diverse sedimentary environments, together with thickness of >80 m differentiate MF from previously defined Neogene and Quaternary sedimentary formations from the JRI archipelago. Subglacial tills of MF were deposited by a grounded AP ice stream advancing eastwards through the Prince Gustav Channel (PGC), with most of the material carried actively at base of this warm-based glacier as revealed by clast superficial features and fabrics. These conditions differ from present cold-based local glaciers of JRI and AP. Cape Lachman (northernmost JRI) was a small volcanic island separated from JRI by ~2 km wide channel, which was crossed by advancing AP ice stream during MF deposition. The form of PGC originated before late Miocene and its present pronounced over-deepening with depths up to 1000 m resulted in multiple grounded glaciers advances during the Neogene and Quaternary. After retreat of grounded AP ice stream, sea prograded from the E and glacier margin became floating building small ice shelf, below and in front of which glaciomarine diamictites and marine laminites deposited. Marine sediments show mainly intensive post-depositional weathering of clasts' surfaces and lower proportion of crushed and abraded grains. Such material was carried from AP by small glaciers with a significant part of material transported supraglacially or englacially down to the floating ice shelf and by calving icebergs towards the open sea away from AP. The afloat ice shelf was later replaced by grounded ice stream advancing in W–E direction. No traces of volcanic synchronicity with and/or any direct volcanic influence on deposition of MF was found. We interpret depositional environmental changes found in MF by global sea level fluctuation due to Antarctic ice sheet build up and decay connected with advances and retreats of AP ice stream and associated ice shelf in PGC. This shows on the Late Miocene climatic cyclicity driven by obliquity (~41 ka period) band. MF sedimentary sequence comprises at least two "glacial" and one "interglacial" periods. The sea level rise at the northern tip of AP between "glacial" lowstand and "interglacial" highstand was >50 m during the late Miocene and was followed by a subsequent sea level fall of at least the same magnitude. The presence of well preserved, articulated pectinid bivalves testifies less extensive glaciation along AP in Miocene "interglacials" and prevailing glaciomarine deposition below or in front of floating ice shelves. The age of MF is compatible with locally relatively colder conditions in the Late Miocene with a climatic shift from a cooling period (6.9–5.6 Ma) towards warming phase at the end of the Miocene and Early Pliocene (5.6–5.0 Ma) found in circum-Antarctic waters around AP.

Geomorphological evolution of the Piura River fluvial fan, Northern Peru

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Piura River is a prominent river draining western part of Northern Peruvian Andes, which terminates in coastal lowland of the Sechura Desert. Average annual precipitation in the Piura River catchment is slightly >600 mm, but its distribution is irregular both in space and time with lower reaches having average annual precipitation typically <100 mm. Whole catchment area is also strongly affected by heavy ENSO rainfalls with annual precipitation locally >3000 mm for greatest ENSO events. Presented study focuses on lower catchment reaches, where Piura River fluvial fan is the most prominent geomorphological landform. It is a ~680 km^2 large sedimentary system that is formed in an area, where river enters its flat lower part in the Sechura Desert and overlies littoral Miocene sediments of the Sechura Basin and Late Pleistocene accumulation marine terrace Tablazo Lobitos. Last marine regression caused initial fluvial incision into the tablazo surface followed by the Piura River fluvial fan formation. This fluvial system is characterised by one principal channel and several minor channels, which are active only during high discharge. Generally, the channels are straight with low sinuosity (Pind = 1.11–1.23) and their w/d ratio is ~20. The Piura River discharge is very irregular with maximum in January–May and minimum in August–November. An average annual discharge in the Piura City was 47.9 m^3s^{-1} for 1969–1999, bankfull discharge here is ~2400 m^3s^{-1} and maximum discharge (1998 ENSO) of 4420 m^3s^{-1} was measured. The sandy material is accumulated in form of inchannel bars, lateral bars and point bars within the channels. Bifurcations and avulsions are typical processes of channel evolution. Channels are flanked by commonly vegetated natural levees with widths of ~50 m, which grow above the surrounding floodplain. In cases of levees breaching crevasse splays are formed, they have fan shape body with areal extent up to tens of km^2. Their surfaces are truncated by bifurcating system of shallow crevasse channels. Floodplains of the system are characterised by wetlands and small seasonal lakes. The Piura River fluvial fan sedimentary system is interpreted as a fluvial system with short-lived anastomosis, where avulsion channels have a form of anastomosing channel network within an avulsion belt produced by crevasse splays progradation. However, present landforms' morphology is strongly affected by intensive agricultural and construction activities that significantly limit reconstruction of ancient morphology. Evolution of the Piura River fluvial fan is controlled by a local erosional base of ephemeral lakes that form in the lowlands of the Sechura Desert. Extreme discharges characteristic for the ENSO period, aggradation of fluvial ridge and formation of crevasse splays are principal causes of the Piura River avulsions. Influence of recent tectonic tilting of the sedimentary surface is also speculated as a control of the spatial distribution of the channels. This process is documented by prominent tendency of the principal channel to move eastwards.

Paleogene conglomerate from the San Jacinto belt (Northern Colombian Caribbean region): post collisional sedimentation or continental margin reactivation?

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Due to the relative proximity to their source area, conglomerate provenance analysis can be used as a first order tool to test paleogeographic and tectonic changes on continental margins. When integrated with sandstone analysis, a more complete signature of the varied source areas and an evaluation of proximal versus distal input can be addressed. An integrated conglomerate and sandstone provenance analysis was carried out in the San Jacinto belt, northern South America Caribbean region, in order to reconstruct the source area and test various tectonic and paleogeographic scenarios from the Late Paleocene to Middle Eocene. This belt is related to the changing Caribbean-South America plate tectonic interactions. Conglomerates and sandstones show a major magmatic source, including granitoids, basalts, and porphyrictic rocks with arc related geochemical signature. Sedimentary, metamorphic and serpentinite input is relatively limited. Heavy minerals analysis from the sandstones show mixed metamorphic and magmatic suites as varieties of pyroxenes mixing with minor contribution of garnet and rutile derived source. U-Pb detrital zircon geochronology reveals bimodal Upper Cretaceous and Permo-Triassic rock sources. This result shows that the more proximal source area is mainly represented by arc remnants, where the presence of older material suggests that this arc was already near the continental margin. These conglomeratic units postdate the Early Paleocene arc-continent collisional event and were accumulated behind the colliding arc. The composition and grain size of these conglomerate units suggest that the San Jacinto belt was by then a post-collisional basin near a margin where significant topography existed with restricted drainages, most likely draining the northern Central Cordillera of Colombia. The topography needed to generate these deposits may be related to tectonic reactivation of the continental margin due to renewed oblique convergence after collision.

Sediment transport and morphodynamic state of an artificial beach in southeastern Brazil

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The intensive occupation of coastal environments and the resulting physical modification by man-made structures have encouraged researchers and environmental agencies to study the coastal sediment transport in detail. In this sense, due to their great influence in the sediment budget, the longshore currents had been determined to aid the estimation of the impacts that coastal features could cause on beaches and adjacent environments. In the present work the longshore sediment transport and the morphodynamic state of an artificial beach were assessed with the aim of contribute to the understanding of strong erosive processes and subsidizing future intervention and coastal management projects. The work was conducted over Curva da Jurema beach, Vitória, Espírito Santo state, SE Brazil. This beach is situated on a prime area and has suffered countless landfills realized through the city expansion. It has an arc form with 800 m long and is exposed to E. Winds are predominantly from NE-ENE whereas SE winds associated with cold fronts are more intense. Coastal features such as islands and promontories limit the beach arc and are responsible for wave diffraction and refraction, reducing its intensity in 97.5 %, approximately. In this environment of low wave energy we highlight the role of tidal currents. To assess the Curva da Jurena beach longshore sediment transport it was utilized the model proposed by McLaren & Bowles (1985) and for the morphodynamic state was applied the empirical model of Masselink & Short (1993). Twenty-nine cross-shore topographical profiles were measured along the beach, with a distance of 30 m between them. In each profile two superficial sediment samples were collected, one at the foreshore and other at the nearshore zones. The grain size distribution parameters were estimated using the ANASED 3.0 program. The longshore grain size distribution at the foreshore zone indicated the performance of the low hydrodynamic in the transport of the finer grains to the nearshore zone. Both at the foreshore and nearshore zones the net longshore transport subjected to low energy indicates grain size thinning, improvement of the sorting degree and asymmetry reduction along the transport direction. McLaren model was fit with the Case “B” and validated through the process of coastal erosion southward and progradation northward. Due to low energy environment, it is necessary to monitor more precisely local hydrodynamic characteristics because long-shore transport found becomes possible when there is a residual flow from southward to northward, resulting from all active forcings (waves, tides and winds). Beach morphodynamic state was classified as reflective of low-tide terrace, where there is influence of the tidal processes in the sediment transport of emerged to submerged beach due to morphodynamic adjustment as a result of the erosion process. The low hydrodynamic gradient has been responsible for persistent and gradual erosion process within the beach since nourishments and filling works, made in 1977. At the moment, Curva da Jurema beach is still in morphodynamic adaptation, thus any new intervention should be done regarding its morphodynamic state, history and geographical conditions. Also, noteworthy are the need to obtain systematic and reliable data for coastal regions with preterit and future interventions, since in the study past data are sometimes non-existent at times with different information to different sources. Investments in facilities of tide gauges and other precision instruments are needed in anthropized urban coasts.

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Understanding the way river deltas build the shelf from short to long time scales

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We describe the way river deltas form from mouth bar to delta complexes and the way in which process changes affect the system during cross-shelf transits, with examples from Holocene deltas and ancient delta deposits. River deltas dominated by different processes have an overall similar and predictive pattern in the way they disperse sediments and build the shelf in sedimentary basins. Despite the different morphologies reflected by the dominant processes (fluvial, waves, tides) all delta complexes have an overall radial growth pattern. However the details of the Holocene deltas dominated by different processes have distinct progradation patterns. Holocene river-dominated Mississippi Delta has multiple lobes prograding on the shelf through significant changes in the depocenter location (avulsion over large distances). The overall radial-irregular fluvial dominated deltas build from mouth bar at kilometer scale to mouth-bar complexes to delta lobes to delta complexes that usually extend for tens to hundreds of kilometers. Godavari Delta in Gulf of Bengal represents a typical wave-dominated delta and has multiple cuspate (strike elongated) Holocene lobes. The lobes formed an overall radial-delta complex through multiple, short- distance avulsions. The shape of the delta complex is strike elongate and extends over 100 kilometers, though it prograded only about 30 kilometers. A wave-dominated delta does not form distinct mouth bars but a delta lobe is formed from multiple shore-parallel ridges that are equivalent to the mouth bar complexes of the fluvial-dominated deltas. Holocene Mekong Delta in the South China Sea represents a typical tide- dominated delta with multiple funnel shaped distributary channels. There are no distinct delta lobes present in the Mekong delta. Is seems that depocenters of tidal dominated deltas change with activation of successive tidal distributary channels that are kept open by the tidal currents even when abandoned by the fluvial system. There are no mouth bars in tidal deltas but wave generated shore-parallel ridges could be viewed equivalent to the mouth bar complexes. Despite the well known tripartite classification of deltas there is no river delta dominated by a single process at a given time. In the same way there is no delta complex of the same river that will be dominated by the same processes during a relative sea level cycle (during regressive- transgressive cross-shelf transits). The process changes (spatially as well as temporary) in the same delta can be observed in the modern to Holocene Danube Delta. An example of delta process change in ancient deposits can be observed in the Maastrichtian Fox Hills deltas of south Wyoming where 3 kilometers lateral extensive outcrops show fluvial and tidal dominated deltas on the inner shelf while deposits of the same river delta are wave dominated on the outer shelf. The subsurface isopach maps of the Fox Hills deltas also show more elongated morphologies of the delta bodies on the inner shelf, suggesting fluvial or tide dominated deltas whereas on the outer shelf to shelf-edge areas the delta morphologies are more strike elongate suggesting wave processes. The similar overall radial pattern of different deltas and the process changes common to any delta eventually produce wide shelves with a relatively gently bulging shelf-edge. However different styles of sediment dispersion within delta lobes might affect sediment delivery to deeper water especially when the deltas are close to the shelf edge.

Quaternary Continental Carbonates of the Pantanal Basin (Matogrosso do Sul State, Brazil): semi-arid deposits in a wetland environment

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The occurrence of continental carbonates, such as calcretes, lacustrine and palustrine sediments and tufas, in the Pantanal Basin, and surrounding areas, is the most notable in Brazil, due to the variety and size of forms. This quaternary basin, knowed as the largest wetland in the World, is located in the west part of Matogrosso do Sul state and in the south west part of the Matogrosso state, west central Brazil, near Paraguay and Bolivia boundary. It is limited by the Paraguay's Mobile Belt at the west side and by the border of the Paraná Basin (Paleozoic/Mesozoic) at the east side. The sediments of the Pantanal Basin are essentially siliciclastic (Pantanal Formation) and the main structure of sedimentation is the giant alluvial fan of the Taquarí river, but some occurrences of continental carbonates (Xaraiés Formation) has been discovered in the last years in the south part of these fan, as metric lenses. The most important city in this basin is Corumbá, the entrance of Pantanal UNESCO World Natural Heritage and Biosphere Reserve. This study analyzes carbonatic sediments occurrences, in the basin and in its surrounding areas, and re-open the discussion about the climatic variation and sedimentary deposition in the basin, which in the firsts studies were considerate semi-arid and in later times wetter. The oldest facies of the Xaraiés Formation is a calcrete layer, lays directly over the Precambrian basement (Paraguay Mobile Belt) on the south, west and north border of the basin. It is characterized by a micritic matrix, with coated grains, fossil particles and quartz sand. Micrictic deposits are laid down on the calcretes. These micrítos outcrops on the borders of the Pantanal Basin, over the sands of the southern part of the Taquarí alluvial fan (Pantanal Formation). The lacustrine and palustrine environments are responsible for the micritic deposits. These deposits are characterized by micritic sediments, with fossils of gastropods and roots. The upper facies of Xaraiés Formation is composed by calcareous tufa, as active and inactive outcrops, always associated with the drainages of the borders north, west and south of the Pantanal basin, reworking older micritic and calcrete deposits. The Xaraiés Formation indicates that dry climate conditions in the past of the basin generate lacustrine micritic sediments, and the cyclic occurrence of these conditions, generate the calcretization process that outcrops as the base of the deposit. The Pantanal stratigraphic sequences from the Xaraiés Formation up to the present sands of the Pantanal Formation, attest climate changing from dry to humid, contrasting to uniform wet climate as thought before. The geographic position of the Pantanal Basin is almost the same of the semi-arid Chaco Basin. Nowadays the semi-arid climate is not present on the Pantanal Basin, because the main rivers come from equatorial area, in the water divisor with the Amazon Basin, generating a huge volume of water. But if some rain reduction must occur in the equatorial area, and less water comes to the Pantanal basin, probably the climate would turn over dry. Another important factor that is not take into consideration in the climactic definition: the sediments of the basin are composed by a very well sorted quartz sand, with aeolian origin (Paraná Basin), almost without silt and clay, causing it to be a very permeable region, capable of drying a very strong tropical rain in one or two days. In short, the conclusion of the study in the Pantanal Basin indicates that this basin is more sensible to continental climactic variations than thought, based only in the deposition of the Taquarí alluvial fan. The identification and sedimentological analysis of the continental carbonates present in the basin and in its borders lead to a different interpretation. This study still in progress, aim to set precise ages for the Xaraiés Formation.

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Ammonite facies in the Lower Campanian of Antarctica: onshore-offshore trends in stratinomy and faunal composition

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Recent biostratigraphic and sedimentologic studies in the Lower Campanian ammonite-rich shelf deposits of the James Ross Basin, Antarctica made possible a precise reconstruction of facies tracts along an onshore-offshore transect about 70 km in length. On this basis, the characterization of proximal vs. distal trends in ammonite facies and their corresponding environmental controls are analyzed. In proximal, inner-shelf settings the Lower Campanian part of the Santa Marta Formation (including the Ammonite Assemblage 6: *Karapadites* aff. *centinelaensis*-*Natalites* spp. Group 2), consists of about 150 m of coarse and thick tempestite beds, trigoniid-rich coquinas, and cross-bedded sandstones. In distal, mid- to outer-shelf settings the age-equivalent Rabot Formation consists of more than 300 m of bioturbated mudstones and interbedded tempestites that bear abundant articulated brachiopod and inoceramid shells. Each of these sedimentary facies is characterized by a very distinctive ammonite facies. In proximal settings the ammonite facies is dominated by relatively large and ornate kossmaticeratids (relative frequency c. 50%), with subordinated heteromorphs (10%), desmoceratids (12%), and gaudryceratids and tetragonitids (28%). Vertically embedded kossmaticeratids associated with abundant plant material are relatively common. Conversely, in distal settings the ammonite facies is dominated by gaudryceratids and tetragonitids (60%) and heteromorphs (20%), with subordinated small, juvenile kossmaticeratids (15%) and large pachydiscids (5%). The shell size of some gaudryceratids, particularly *Anagaudryceras subsacya* and similar morphotypes, are in excess of 100 mm. Most of the ammonite shells are horizontally embedded and concentrated by currents on the lee sides of large inoceramid shells. In both facies, preservation of the ammonite shells is similar; planispiral shells are relatively complete, with calcite-filled phragmocones and sediment-filled body chambers whereas heteromorph shells are commonly fragmented. These data are consistent with the idea that ornate ammonite morphotypes dominate inner shelf settings; however the relative abundance of juvenile, ornate kossmaticeratids in mid- to outer-shelf deposits could reflect either selective sorting during post-mortem transport or a wider and deeper life habitat than mature specimens. Similarly, the restriction in mid- to outer-shelf settings of large *Anagaudryceras* shells, with coarse ornamentation in the body chamber, seems to reflect a life habitat limited to these settings. Dominance of vertically embedded shells in shallow-water and horizontally embedded ones in deep-water settings not necessary reflects an absolute bathymetry, but results from a combination of bathymetry (water pressure), turbidity of the water mass, and sedimentation rate.

The Megafan of the Paraná River from the Pleistocene to the Present

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Downstream of the basaltic plateau located at the south of Brazil and northeastern of Argentina, the Paraná River flows in the extensive Argentine plain. In the first stretch, the river generates a large alluvial fan (or mega-fan), which covers the northwestern portion of the Corrientes Province in Argentina and the southern part of eastern Paraguay. The megafan is 260 km long and 500 km wide in the distal part, and has been stable for most of the Upper Quaternary. Inside it, the river channel built relatively stable belts occupied during some hundreds or thousands of years, eventually abandoned by the main stream and replaced by large swamps. A sequence of such intervals formed the present megafan. A few extensive deposits produced by spill outs during dry climatic phases in the Upper Quaternary are intercalated among the abandoned belts. Also during dry phases, important deflation of sand occurred in the abandoned belts, generating up to 80-km-long and 5-km-wide dune fields. Most of these fluvial deposits are named Ituzaingó Formation in Argentina, and represents the typical sedimentation of the Paraná River all along its evolution. The present river belt crosses the fan in an east–west direction; the channel design there is braided, with frequent elliptical islands and sand bars. The youngest abandoned belt in the megafan is Holocene in age and runs along the eastern limit of the system and includes some present lakes of the Iberá wetland. Paleocurrent directions measured in the Ituzaingó Formation at Corrientes Province suggest alternative expansion and downstream migration of the Paraná River. A comparison between these old and present fluvial deposits revealed that both are homologous, but the first ones seems to be smaller than those belong to the main channel of the present river, and would be related with the sedimentation of lateral and central channel-bars. In change, the present deposits showed sedimentological features linked with higher energy conditions compared with the paleodeposits.

Sediment transport of Pilcomayo River: qualitative and quantitative variations at Misión La Paz (Salta, Argentina)

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Among the large Argentinean Rivers, the Pilcomayo River presents one of the largest sediment transport rates, generating important changes in its fluvial morphology and sedimentology. This fact needs to be attended at an appropriate scale to understand the dynamics of this vast fluvial system. Towards this aim, the sediment transport at the cross section located between Misión La Paz (Argentina) and Pozo Hondo (Paraguay) (22º 22' 35" S - 62º 31' 18" O) were analyzed. During the measurement period, the local hydrometric level varied between 2.3 and 6.6 m (approximately between 8 m^3s^{-1} and 300 m^3s^{-1} in terms of discharge) from December 2006 to December 2007. The obtained results showed clear differences of the considered variables related with the hydrometric level. Local levels higher than 3 m were related with electric conductivity values around 600 µS cm-1, total salt concentration around 370 mg L^{-1} (in average); pH equal to 7.7 and water temperature higher than 30°C. Under conditions less than 3 m, the electric conductivity and total salt concentration were approximately double; pH was significantly higher approaching values of 8.2 and the water temperature diminished around 10°C. In average terms, the wash load of the whole section varied between 1357 mg L^{-1} and 7749 mg L^{-1} maintaining a direct relation with the discharge. As with other parameters, these values can be empirically associated in two conditions related with the water level. With more than 3 m of water level, the suspended sediment concentration was approximately equal to 7000 mg L^{-1}, whilst in conditions less than 3 m the concentration was around 1500 mg L-1. Vertical sediment distribution showed a typical stratification with highest values near the river bed during all the studied period. The size distribution of the wash load revealed the presence of sand, silt and clay. The silt fraction was more abundant in suspension (around 50% of the total sediment frequency) showing a nearly homogeneous distribution in flux. Suspended sand concentration maintained a direct relation with the discharge but the clay fraction revealed the opposite trend. Suspended sediment transport varied between 1200 tons day-1 during the low water period and 155000 tons day-1 during the flood showing a direct relation with the discharge. Bed material was basically sandy (sand fraction frequency ranged from 88% to 99%) with less proportion of silt (between 2% and 6 %). The clay abundance at the bottom was always less than 1%. The granulometric composition of wash load and bed material load was practically the same during the complete period of analysis. The textural homogeneity of the sediment input in the plain stretch of Pilcomayo River explains the regularity of the particle size despite the discharge variation.

Sedimentological and geochemical study of riverine travertines

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The riverine travertines studied are located in the Aksaz stream valley established through the Neogene fluvio-lacustrine succession along a NW-trended fault line, SW of Ulubey town (Uşak, western Turkey). The Neogene succession is unconformably underlain by Palaeozoic marbles and schists of the Menderes massif. Present thermal waters discharge mainly from three springs and mix with stream water at the valley bottom. In summer season the stream dries up. Temperature, EC, pH and HCO_3 of the Na–HCO_3–SO_4 type thermal spring waters of the Aksaz bath were measured providing 35.1°C, 3860 (µmho/cm), 6.38 and 1326 (mg/l) values, respectively. Travertine deposits occurred as cliffs at elevations between 450 and 500 m (asl) on both sides of the stream valley. The horizontally bedded travertines are the most common type associated subsequently with vertical and subvertical layers. The subvertical layers are composed of alternation of the microbially mediated porous and nonporous compact layers, with scarce reed casts. Horizontally bedded travertines principally comprise shrub and micritic layers and subsequently crystalline crust (up to 20 cm in thickness), paper-thin raft, pisolith and coated gas bubble intercalations. In some cases, the travertine succession is interrupted by the horizons of fluvial conglomerate, sandstone, mudstone, palaeosol, erosion surface, and subaerial desiccation. The studied spring carbonates were precipitated from warm springs, mainly in shallow and extensive pools, bounded terrace margin, slope and cascade environments, and connected to each other in down stream direction under the influence of fluvial activity. Based on XRD analyses the travertine samples are composed of almost pure calcite. Element content is 346247 to 400775 ppm for Ca, <279 to 15458 ppm for Fe, 77 to 620 ppm for Mn, 844 to 6392 ppm for Mg and 319 to 3432 ppm for Sr. The Sr ratio is higher in the crystalline crust travertine layers. Stable isotope analyses performed at the Institute for Geochemical Research (Hungary) resulted $\delta^{13}C$ values ranging between +4.3 and +6.3 ‰ (V-PDB) and δ18O values varying between +17.9 and +23.5 ‰ (V-SMOW). The significantly positive $\delta^{13}C$ values and associated geochemical data are evidence for the thermogene origin of the travertine deposits and deeply circulated thermal waters.

Deciphering the role of organic nanometer-scale spheroids in the biomineralization processes: new insights into microbial carbonate preservation

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Nanometer-scale spheroids (20-200 nm) have been widely found in the geological record and are closely associated with carbonate precipitations in the geological record. Different hypotheses have been proposed for their possible origin and role in mineralization processes, such as inorganic precipitates or organic components (Kirkland *et al.*, 1999; Benzerara *et al.*, 2006). Experiments showing degradation of organic tissues involving phages and enzymes highlighted possible proteins (Schieber & Arnott, 2003) or other compounds such as bacterial fragments, expulsed cytoplasm or extracellular polymeric substances (EPS) or proteins (Kirkland *et al.*, 1999; 2008). These authors used experimental conditions comparable to those found in Earth surface sediments, and diagenetic mineralization of these spheroids may be a common process for their preservation observed in the rock record. More recently, experiments on bacterial cultures showed the precipitation of dolomite from nanoglobules containing EPS (Bontognali *et al.*, 2008; Sanchez-Roman *et al.*, 2008). The research presented here focuses on the occurrence of nanometer- scale spheroids within organic matter (OM) in relation to carbonate precipitation enhancing their preservation in the geological record. Different recent and fossil samples have been selected according to the variable occurrence of nanometer-scale spheroids with respect to microbial input, e.g., microbial mats. Diagenetic processes have been simulated on microbial mats using a tailored laboratory strategy in order to evaluate the effects of oxygen- and light-depleted conditions occurring naturally at the water-sediment interface. Characterization of nanometer-scale spheroids has been made using microscopic and spectroscopic approaches, which include scanning and transmission electron microscopy, atomic force microscopy and micro-Raman spectroscopy. Special interest has been focused on biomineralization *s.l.* processes in recent microbial mats. Preliminary results indicate a close association between the occurrence of nanometer-scale spheroids and the degree of microbial activity. They have been found as mineralized amorphous Mg-Si in the recent microbial mats, which is associated with carbonate precipitation. Their complex organic composition would suggest a more critical role in mineralization than simple bacterial debris.

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Mudbank formations off southwest Indian coast – Influence of ground water flux across coastal sedimentary strips

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Coastal waters of Arabian Sea have a special coastal phenomenon - mud banks along southwest India in southwest monsoon. The mudbanks exerts calming effect on the sea that the area is without waves. Their formation occurs within a week or so after the onset of the southwest monsoon. The occurrence is episodic and erratic and it varies from year to year, in extent and duration. The quiescence offered is due to increase in viscosity of the sea water as the mud being in colloidal suspension over a very loose and non-rigid clay bottom. The Pamba group of rivers formerly discharged direct into the sea somewhere in mudbank area. A favorable combination of factors (rainfall intensity and duration, temperature, salinity and some other unknown factors) leads to mudbank formation, extent and duration. The activated trending faults in the regions of submerged porous lime shell beds are probably coupling the adjacent watershed and the sea. Subterranean flows from Cochin Backwaters to mudbank regions were evidenced in recent studies. The high nutrients enriched particulate organic carbon and chlorophyll a soon after the monsoon months at localized coastal regions were indications of 'external sources' of nitrogenous compounds to the coastal water. The forcing for ground water flow is gained with difference in water level in lake and the sea attains a critical value. Such conditions prevail during the peak southwest monsoon months due to heavy river discharges to the lake. Significance of this study is that subterranean flows could redefine the very concept of formation of mudbanks, which is presently recognized only as an oceanographic process. It is argued that mudbank formation is not entirely forced by coastal oceanographic processes; instead a remote forcing from the land involving a subterranean flow through the submerged lime shell beds appears to be an initiative mechanism.

Climate change as controlling factor in sediment supply: The Pliocene-Pleistocene Nile system

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This work is focused on cones associated with large rivers which represent important sources of sediment and water. The total sediment loads relative to the total discharge of water, sediment grain size, and the nature and magnitudes of the marine forcing, determine modes and distances of sediment dispersal (Wright, 1989). The principal aim of this project is to develop a model for the depositional history of the Nile Submarine Cone by comparing with models of the external controls on sediment supply and sediment delivery to continental margins, and from previous studies from a range of deep-water sediment accumulations associated with large rivers. Such controls include climate, sea level, quantity and provenance of sediment, hinterland tectonics and how those rivers merge into the oceans. The rivers used for comparison in this study were selected on the basis of drainage area, water discharge and sediment discharge based on data from Syvitski and Milliman, 2007; Hovius, 1998; Schumm and Winkley, 1994) This study involves 2D and 3D seismic interpretation (covering the majority of Nile Submarine Cone) in order to locate stratigraphic horizons and subsequent mapping. These horizons were obtained through comparison with biostratigraphy and well data, and based on cycles at 3rd order scale. Dispersion of sediments was analyzed comparing the geometry of the sequences against sea level. Despite the complexity of the Nile Drainage Basin and its effect on sediment supply, it is possible to link the amount of sediment to climate change. By relating climate fluctuations occurring during the Pliocene (arid and humid stages) and seismic response for the same period it is possible to identify parallel reflections associated with rises in sea level (Early Pliocene) and consequent humid conditions that enhance Nile River sediment supply. For the Middle Pliocene the presence of parallel seismic reflections and channels eroding previous surfaces indicate change in sea level. In spite of a growth in ice sheets, due to the complexity of the basin drainage area, more tropical areas continued supplying water and sediment from denudation areas. Finally, by Late Pliocene the increase in the growth of ice sheets and the resulting sea level fall is associated with more arid conditions and additional denudations areas, as well as chaotic seismic successions, mass transport deposits and greater presence of channels.

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The structure of flow over interacting barchan dunes

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Barchans are crescent-shaped dunes, found in both aeolian and subaqueous environments, which are formed in unidirectional flows with a limited sediment supply. While the morphology of barchans is well documented, less is known concerning the flow structure over barchans, and specifically the fluid dynamic interactions between barchans. Yet, without understanding the influence of dune interactions upon the flow, and vice versa, the mechanisms responsible for dune migration and interaction remain elusive. This paper uses physical modeling to detail the flow fields of interacting barchan dunes, and examines the implications of these interactions for the kinematic behavior of barchans that has been described in past work (Endo *et al.*, 2004). Four idealized, fixed, barchan dune models were investigated, the shape and dimensions of which were based upon previous empirical studies of dune morphology. The dune sizes were chosen to cover the range of size interactions documented by Endo *et al.* (2004), and covered volumetric size ratios (upstream: downstream dune) of 0.025, 0.056, 0.175, as well as investigating the interaction of identical size dunes. These models were placed in an Eiffel-type, open-circuit wind tunnel with a working test-section 6090 mm long by 914 mm wide by 457 mm high and a free-stream turbulence intensity of 0.16%. Flow quantification was achieved using particle imaging velocimetry (PIV) that used an 11 megapixel camera operating at 0.5Hz. PIV measurements of the mean and turbulent flow field were made in the streamwise–wall-normal plane, along the centerline of the barchans(s), at a Reynolds number of 59,000. Flow fields over the lee and stoss sides of the downstream barchan were quantified at various distances between the two dunes, ranging from where the two dunes touched to where the upstream dune was six dune wavelengths upflow. This paper will present results of the interaction between these barchan dunes and a comparison between these flow fields and that over the isolated barchan dune. Sheltering of the stoss side of the downstream barchan is seen to increase at both smaller dune separations and at larger volumetric size ratios, simply reflecting the influence of the wake region from the upstream barchan on the flow field. Additionally, the paper will present realizations of the instantaneous flow fields that illustrate the large-scale vorticity associated with the wake region and its downstream advection. The interaction between the upstream wake region and downstream dune separation zone will be examined in terms of the changing turbulence intensity and modification of turbulent kinetic energy in the leeside of the downstream dune. These fixed-bed model results will be used to discuss how such flow-field interactions may control the observed kinematic behavior of dunes under mobile bed conditions. Such bedform interactions, although idealized in these simple barchan experiments, may have general applicability for a wide range of superimposed bedforms in many aqueous and aeolian boundary layers.

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New lithostratigraphic approach and regional correlation significance of the Piedras de Afilar Formation, Neoproterozoic of Uruguay

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The Piedras de Afilar Formation is part of the Tandilia Terrane, Precambrian of Uruguay. It is a Neoproterozoic sedimentary sequence, overlying with erosional unconformity the Soca granite (2054 ± 11Ma) and the Montevideo Formation (ca. 2200 Ma). Three new members are defined from base to top: (1) Cuchilla Alta Member, which comprises whitish conglomerates, quartzitic sandstones and limestones, with fining- and thinning-upward cycles, asymmetric ripples, interference ripples, hummocky cross-stratification (HCS), trough cross stratification (TCS), as main sedimentary structures. Type area is located in the Cerros Piedras de Afilar; (2) Arroyo Junquito Member, which is made up of dark shales with plane-parallel and wavy bedding; and type area is at Imhoff Quarry (6143602.90 N, 64190.14 E UTM); and (3) Arroyo de la Tuna Member, which is composed by marls, limestones and shale/limestone rithmites with shales interbeded; its type area is at Heide Quarry (6142063.90 N, 63784.38 E UTM). The depositional environment of the Piedras de Afilar Formation is a shallow marine platform. Whereas the lower siliciclastic member is related to the backshore, the pelitic member is associated to a marine transgression and the calcareous member is related to a shallow carbonatic ramp. In respect to the age of the Piedras de Afilar Formation, the available data suggest a late Neoproterozoic age. U-Pb LA ICPMS data for detritic zircons of the Cuchilla Alta Member yielded ages of 990 Ma for the youngest zircon, constraining the maximum age of the sedimentary sequence. C isotopic results suggest that the Arroyo de la Tuna Member is Cryogenian – Ediacaran in age, according with encountered values ranging between +5.05 ‰ and +5.80 ‰; $\delta^{13}C$(PDB). These also suggests that this unit is probably correlative of the $\delta^{13}C$ results reported for lower Polanco Formation (+2.6 to +5.3 ‰); (PDB); and for Loma Negra Formation (+2.7 to +4.5‰). $^{87}Sr/^{86}Sr$ values around 0.7146, recently obtained for these limestones are too radiogenic and not suitable for age interpretation. The presence of a dolerite sill overlying the carbonates and the consequent fluids migration might possibly have affected the original contents of Sr in the limestones. Non carbonatic units of the Piedras de Afilar Formation are probably correlative of Yerbal Formation (lower Arroyo del Soldado Group).

Springhill Formation, Lower Cretaceous of the Austral Basin, Argentina. An integrated analysis from cores to seismic and its impact on regional stratigraphic models

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The Austral/Magallanes Basin in southern Argentina and Chile was affected from Berriasian to Valanginian by a strong transgression leading to the deposition of a series of diachronus coastal sediments known as Springhill Fm. (Arbe 2002); subsurface analysis allowed the recognition of third order sequences bearing a progressively younger age towards the east that are characterized by a vertical transition from coastal plain to shore face and offshore deposits (Robbiano *et al.* 1997). Later studies in the north-eastern platform allowed the mapping and characterization of these environments via 3D seismic - geomorphologic analysis (Köhler *et al.* 2008) leading to a better comprehension of the palaeo-environments and sediment dispersion processes. A careful well log analysis was carried out over an area exceeding 20.000 Sq Km to build the stratigraphic framework of the Springhill Fm. in an appropriated scale to aid the hydrocarbon exploration process. Integration with both 2D and 3D seismic, core and cuttings descriptions and comparison with other Cretaceous as well as present day analogues, led to a solid facies prediction model which served as an input to the petroleum system analysis. Even though the interpreted facies models share most of their characteristics and palaeo-environments with pre-existing ones, its integration in a regional scale and iteration with detailed 3D seismic facies interpretation led to the realization of the main variables controlling the reservoir distribution at various scales. At a regional scale, palaeo environment maps were elaborated for three third order sequences among which a regressive-transgressive sheet like sandstone was mapped over an area exceeding 30.000 Sq Km and its possible impact on hydrocarbon migration paths was stated. At a semi-regional scale facies interpretation allowed the identification of a strong topographic control on the early transgressive deposits probably due to tide current velocity enhancement that, with subsequent progradation, gave way to a more wave dominated tidal environment as topography was levelled by sedimentation. This process took place in individual third order sequences and in different areas of the basin. Locally a sequence analysis of fourth and fifth order cycles integrated with 3D seismic geomorphologic interpretation allowed a detailed reservoir distribution prediction. The stratigraphic models constructed for the Springhill Fm., which is far from being a geographically continuous and time transgressive sandy unit, were integrated with structure maps and the hydrocarbon kitchen spatial distribution to asses the controls on hydrocarbon occurrences. Calibration with existing oil fields and exploratory wells results proved that the input of detailed stratigraphic models into the exploration process is of great importance in mature basins, in which bigger structures are already drilled, and exploration tends to focus on smaller ones and stratigraphic traps.

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Hydrodynamic controls on sand dispersal in a channel – lobe transition: insights from numerical simulations

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The dispersion of sand transported by a turbulent density flow entering an unconfined region is controlled by mechanisms such as: flow hydrodynamics, degree of confinement, slope, grain sizes of suspended sediments, etc. This paper focuses on the computational simulation of the current hydrodynamic effect on sediment dispersal. The dispersal is calculated as the percentage of sediment deposited laterally to the main direction of the flow. We also investigate the influence of hydrodynamic parameters on the basinward distance of the deposits. The present study is performed using a full 3D numerical model, in which we solve the Navier – Stokes equations coupled with the advection – diffusion transport of a concentration of sand particles. We use a Large Eddy Simulation scheme, in which the turbulence is explicitly considered only in the scale of the mesh, and the sub-mesh scale is rendered numerically. Stabilized finite elements are employed to discretize the equations for both the flow and concentration equations. We defined a very simple configuration, in which a channel opens up to an unconfined region, and we ran around 30 cases varying the Reynolds and Froude numbers. The results suggest that a significant control on the dispersal can be related to the Reynolds number of the current, a very intuitive response. But we also observe, however, that the height of the current provides a better explanation of the behavior of sand dispersion than the Reynolds number alone. We explore some of these results, trying to understand what type of currents, in hydrodynamical terms, are able to transfer sand more efficiently to the deep water.

Alluvial architecture of distal volcaniclastic successions in peri-volcanic basins: the Castillo Formation (Albian) of the Golfo San Jorge basin, Patagonia Argentina

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The Castillo Formation (Albian) of the Golfo San Jorge basin represents the reworking of fine-ash mainly in a fluvial basin, with depositional areas covering up to 180,000 km^2 and thickness variations from tens of meters to up to 2,200 m. The Castillo Formation and correlatable units produce about 10-15% of the hydrocarbons of the basin, where thin and discontinuous fluvial sandbodies are the main reservoirs. The unit is mainly outcropped in the N-S striking San Bernardo Fold Belt, a group of ranges located ~200 km eastward of the Andean Volcanic Chain, the source of pyroclastic detritus. The study analyzes exposures of the Castillo Formation from the northern basin-boundary at Tronador Canyon, where the unit is ~31m thick, through 5 study locations that show increasing subsidence, to the most complete section at Codo del Senguerr anticline (964 m thick) in the southern end of the San Bernardo Fold Belt, covering roughly a N-S transect of ~150 kilometers. The dataset consist in 19 sedimentary logs, characterization of 284 fluvial channels and up to 2,500 palaeoflow measurements obtained from channel-fill and bar deposits. The unit can be divided in fifteen lithofacies, grouped in six main lithofacies associations: (LA1) subaerial floodplains and ponds; (LA2) proximal floodplain deposits; (LA3) low-sinuosity and braided fluvial channels; (LA4) subaerial mudflow deposits; (LA5) sheetflood deposits; (LA6) reworked ash-fall beds. The most widely distributed lithofacies association is LA1, which represents up to 70% in all the study locations. LA2 account only for 5% of the section, and lithofacies association LA6, although occurs in all the study locations, only represent 1% of the preserved deposits. The remainder lithofacies associations (LA3, LA4 and LA5) are mainly constituted by tuffaceous conglomerates and tuffaceous sandstones preserved in channels or as unconfined sheets. Four main depositional Regions (Region 1 to 4) owing to the differential subsidence of the basin can be defined, according to the preserved thickness of the unit, spatial variation in the proportion of coarse-grained lithofacies associations (fluvial styles), and thickness of sandbodies. At the northern basin-margin (Region 1) the 31-m thick section consists of an aggradational succession of fine, ash-fall beds with presence of core-type accretionary lapilli, variable pedogenesis and lack of coarse-grained deposits, reflecting extreme condensation of the sedimentary record. In areas proximal to the northern basin-margin (Region 2) the succession is less than 300 m of thickness and consists mainly of small-scale, subaerial mudflow deposits (LA4) and sheetfloods (LA5), evidencing a poorly integrated network of channels and large variation in discharge. In southern areas (Region 3) the unit is 300-500m thick and it is characterized by thicker fluvial sandbodies, where alternation of subaerial mudflow deposits (LA4), sheetflood deposits (LA5) and low-sinuosity fluvial channels (LA3) reflect a highly variable fluvial dynamics. In areas of high-subsidence at southern San Bernardo Fold Belt (Region 4) the unit is up to 800 m of thickness and fluvial sandbodies are of low-sinuosity (LA3), mainly single or multi-storey, as part of a well integrated drainage network, in which large variations in discharge are evidenced by sheetfloods (LA5). Braided channels were only identified in the Region 4 as a subordinate style (1%). Although up to 70% of the unit is composed by fine ash-fall strata preserved in wide floodplains, the pyroclastic supply seems to play a subordinate role on the evolution of the unit. The complex alluvial organization and their changes between study locations suggest that the main changes in the alluvial architecture are mainly related to seasonal or episodic delivery of water and volcaniclastic particles in local or regional drainage networks, linked to changes in the contemporary subsidence across the study area.

Alluvial architecture of a major oil-bearing fluvial succession of Argentina: integration of outcrop and subsurface data of the Bajo Barreal Formation (Upper Cretaceous, Golfo San Jorge basin), with implications for oil exploration and reservoir economy

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The Bajo Barreal Formation (Upper Cretaceous of the Golfo San Jorge basin) produces 85-90% of the hydrocarbons of the basin, and its deposits cover areas up to 150,000 Km^2. The unit ranges in thickness from 200 m at basin margins to up to 2,000 m in the subsurface. Two Members has been defined: the Lower Member is characterized by a pyroclastic floodplain and has upward increasing sandstone content; the Upper Member is composed by grey mudstones with isolated channel sandbodies. The most common reservoir rocks are thin, isolated, mainly single or multistorey fluvial channels. The field study consisted in the analysis of the fluvial architecture and channel dimensions of the Bajo Barreal Formation in the eastern limb of the Codo del Senguerr anticline, which is the nearest exposure to the oilfields. The 450-650 m thick succession (top is eroded) of the Bajo Barreal Formation was analyzed along a 4.5 km width exposure. The database consists of 18 detailed sedimentary logs separated each other ~ 250-300 m, and description and interpretation of up to 300 fluvial channels. True width and maximum thickness of channels, width/thickness ratio and channel proportion were obtained along the sections. Up to 4,000 palaeoflow measurements were obtained from sedimentary structures preserved in channel and bar deposits. The outcrop database was correlated with subsurface data of the El Huetel oilfield, which is 25 km apart from the outcrops in a downstream direction. A comparative study of the styles of fluvial deposition, major sedimentary cycles, thickness of sandstone reservoirs and changes in scale and geometry of sandbodies was carried out based in the analysis of 329 well logs and 3-D seismic surveys. The Lower Member (also known as Sección Tobacea) at outcrops consists mainly of fluvial channels (mean W/Th ~ 45, n=111) and ash-fall deposits preserved in floodplain areas. Up to 91% of the fluvial channels are of low-sinuosity, sometimes with preservation of alternate bars, braided sandbodies are scarce (8%) and sheetflood deposits are uncommon (1%). The mean thicknesses of fluvial sandbodies is 2,99 m and mean true width is mainly below 200 m, with thicker and wider sandbodies in upper levels of the Member. The Upper Member at outcrops consists of grey mudstones and thin ash-fall beds preserved in the distal floodplain, sandstone lobes and minor channels are common in the proximal floodplain, and large-scale fluvial channels. Fluvial channels are narrow sheets mainly of low-sinuosity (mean W/Th ~ 63, n=179), with no evidence of braided pattern and rare occurrence of either meandering channels (1%) or sheetflood deposits (1%). No major changes in the mean thickness of the channels were recognized (mean 3,30 m, n=196) but there are several multistory channels that are up to 600 m wide. Moreover, changes in the source area or stream piracy occurred during the deposition on the Upper Member, due to the occurrence of wider and thicker channels filled with rounded clasts of acid volcanic rocks up to 20 cm in diameter, not identified in older successions of the unit. Once correlated, equivalent oil-bearing sandstone reservoirs of the El Huetel oilfield have shown comparable dimensions. The averaged thickness of exploited reservoirs of the Lower Member is 4,5 m and the widest channels are around 200-300 m, whereas for the Upper Member values are 3 m and 300-800 m, respectively. However, the mapping of individual reservoirs suggests a more sinuous fluvial pattern for several of the sandbodies. Outcrop data support the early suggestion that two distinctive fluvial systems of different geometry can be found in the subsurface. Dimension of channels and changes in the external shape of fluvial sandbodies from outcrops have improved well log correlations, and also allowed more accurate prediction of efficient well spacing in both Members of the Bajo Barreal Formation, improving capital investment projections and field economy.

Deltaic morphodynamics and bifurcation stability: Wax Lake Delta, LA, USA

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Fine-grained deltaic distributary networks build significant volumes of sedimentary deposits and their position at the land-sea interface makes them especially vulnerable to perturbations in external forcing. It is predicted that changes in global climate could change discharge in river basins by as much as fifty percent in the near future, but we know little concerning the dynamic interactions within these systems and our ability to predict instability and system responses remains poor. We have collected integrated morphological, flow, and sediment transport data from a total of 7 bifurcations on the Wax Lake Delta, LA, during July 2009 and April 2010. Theory and numerical modelling predicts that over a range of channel aspect ratios, friction factors, and Shields numbers, three functions exist that relate the discharge ratio of the bifurcate arms in a deltaic system at equilibrium conditions to the Shields number. One function predicts symmetrical discharge configurations, while the other two predict asymmetrical discharges. To test these theoretical predictions, we employed high-resolution multibeam echo sounding (MBES) and acoustic Doppler velocity profiling to map the bifurcations in detail. In most cases the arms of the bifurcations are asymmetric in planform, depth, discharge, and bedload transport. The bed within the system consists of both fine sand sculpted into dunes and zones of erosion into the underlying muds. We will investigate how these bifurcations fit with theory and highlight how this data can be used to constrain new modelling approaches of deltaic systems to environmental change.

Determining the geometric and kinematic properties of coherent flow structures over a gravel bed: a new approach using combined pLIF-PIV

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In gravel bed rivers, the microtopography of the bed exerts a significant effect on the generation of turbulent flow structures, with subsequent implications for sediment transport the bed morphology. It is well known that this turbulence is not a simple random field: visualisation and multipoint measurements show it is possible to decompose complex, multi-scaled, quasi-random flow fields into elementary organized structures that possess both spatial and temporal coherence. Although both field and laboratory measurements have indicated that flows over gravel beds contain coherent turbulent flow structures, we currently have little understanding of the kinematic (size, scaling, shape, vorticity and energy) and dynamic (origin, stability, growth, evolution) properties of these coherent turbulent flow structures, which are central to improving our understanding of turbulent flow, the contribution of coherent turbulent flow structures to fluid mixing, bed shear stress and hence sediment transport. This lack of process understanding of turbulence in gravel bed rivers stems from two fundamental shortcomings: i) previous studies have used Eulerian time series to quantitatively determine processes, which may be interpolated to examine the whole flow field, rather than studying the complete instantaneous holistic flow field; and ii) whole flow field visualization provides a qualitative Lagrangian viewpoint but very little quantitative information. Here, we detail a new experimental methodology to quantify simultaneously both the kinematic and dynamic characteristics of coherent flow structures based upon combined planar Laser Induced Fluorescence and Particle Imaging Velocimetry (pLIF-PIV) to allow a combined Lagrangian-Eulerian approach to understand both the kinematic and dynamic properties coherent flow structures over a gravel bed in a flume. Results from this technique clearly show that the primary generative mechanism of coherent flow structures over gravels is at the bed, where merging hairpin vortices form around the bed clasts, and generate large ‘roller-type’ structures. The kinematic and dynamic characteristics of these structures elucidated using pLIF-PIV will be detailed.

Gravity driven flows in a submarine channel bend: direct field evidence of helical flow reversal

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Submarine meandering channels are the conduits that transport gravity driven flows and sediments into the deep-sea. Such channel systems form distributive networks across submarine fans, ultimately forming the largest sedimentary deposits on Earth. Despite this, our understanding of flow processes and the sedimentary evolution of sinuous submarine channel systems remains poor, primarily due to a lack of, thus far elusive, direct field observation and measurements of flows within submarine channel bends. In the absence of direct field measurements, our understanding of these systems has necessarily been speculative, relying until very recently on bend flow theory derived from research in subaerial river channel bends. Although recent measurements and results from scaled laboratory experiments and numerical modelling of submarine channel bends have advanced our understanding of some of the relations between flows, forms and the implications for sedimentary deposits, key results from this recent research have been contradictory. Notably, several studies have indicated that the helical flow structure within submarine bend flows closely match those found ubiquitously in subarial river channels, whilst conflicting research has reported a reversal of this helical flow structure, with associated far-reaching implications for deep-sea sedimentology. This paper presents the first direct three-dimensional measurements of the flow field in a natural submarine channel bend. The results, from a submarine channel bend on the Black Sea shelf, demonstrate for the first time that a reversed helical flow structure can occur in sea-floor channel bends. Such findings have major implications for process sedimentology in these environments, as the direction and strength of helical flow fields are known to impart a significant influence on cross-stream sediment sorting in bends and thus the stratigraphy of the deposits produced by these channel systems.

Beach features during MIS 5 and today: examples from Sardinia (Italy)

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Climate change and sea level fluctuations are nowadays one of the crucial points on which most of the studies on coastal evolution are addressed. However, it is not clear if we are at the max of an interglacial HS or if we are moving toward higher sea levels. A reconstruction of similar events occurred during the last interglacial yield the potential to model future sea-level change. We have reconstructed the morpho-dynamics of several MIS5 (Late Pleistocene) beaches present along the W coast of Sardinia, and to compare their features with those forming nowadays at the same place and where no human constructions are present. The selected areas have similar geological settings with a rocky coast formed by Late Quaternary deposits lying on Oligo-Miocene bedrock. OSL age data, have allowed us to group the last interglacial MIS5 deposits in MIS5e (125 ky) and MIS5c (100 ky) substages. During MIS5e sea level was about 4 m apsl, while during MIS5c it was about 1m apsl. S Giovanni di Sinis is located in the central part of the W coast of Sardinia. It is characterized by a promontory linked to the mainland by a ridge made of Late Quaternary aeolian deposits with sandy beaches and back shore dunes on both flanks. Med-fine grained rippled sandy shoreface develops down to -7 m. The beach is fed by grains derived from Late Quaternary sandy deposits and offshore Posidonia oceanica meadows. The MIS5e beach unit is composed of med-coarse grained, carbonate- rich sand with low-angle, seaward-dipping cross stratification. At the top, high-angle cross-stratified landward-dipping beds may be found. The unit represents pocket beaches with relatively small dune ridges. The MIS5c beach unit is composed of sandy plane-bedded deposits. Sands are medium grained and composed of up to 95% of offshore source carbonate grains. Bosa is located 50 km N from S.Giovanni di Sinis. Its N coast is characterized by a suite of pocket sandy beaches in between volcanic bedrock promontories. Beaches are mainly quartz-rich and sandy and fed by local ephemeral rivers. At the mouth of an ephemeral rivers, gravel beaches with well developed berm and outerframe zones occur. A pocket sandy beaches are composed of medium sand of carbonate and volcanic grains. Offshore the sediments are composed of medium to fine sands with well-developed ripples. MIS5 deposits are formed by sands lying unconformable on gravels. Gravel strata are about 1 m apsl and composed of volcanic pebbles and cobbles dipping toward the sea. They are interpreted as MIS5e beach deposits. Sand deposits, up to 2 m apsl; are medium grained and cross bedded. They have been interpreted as MIS5c shoreface and dune deposits. Cala Burantino bay is 30 km N of Bosa. It is a sandy, well-developed beach in an embayment open westward and backed by bedrock cliffs. The beach is composed of medium to coarse grained offshore derived bioclasts (95%). Shoreface has depths up to 7 m and is composed of medium to fine rippled sand. MIS5 deposits are formed by gravel and sand overlying bedrock. Gravel, at 2.5m apsl, is composed of boulder to cobble massive strata encrusted by calcareous algae. It has been referred to MIS5e and interpreted as a gravel beach system. Sandy strata, up to 2 m asl, rest unconformable on gravel layers and are medium to coarse grained and composed of m- thick low angle cross-bedded strata dipping seaward. They have been dated at MIS5c and interpreted as sandy beach deposits. The studied modern beaches are composed of bioclastic sand mostly derived from a sea source. They appear to be very similar to those developed during the MIS5c HS. Data relative to MIS5e, however, indicate that coarse gravel beaches were the most common features during this substage. This would imply that a 4 m increase of sea level could trigger strong coastal erosion and deeply modify the coastal landscape of the area. Wide sandy beaches were transformed into small gravel pocket beach directly overlying erosional terraces.

Interpreting sediment provenance by integrating geochronology of muscovite, monazite and zircon with bulk geochemistry and varietal detrital mineralogy: application to the Cretaceous of the Scotian Basin, eastern Canada

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In the Early Cretaceous of the passive margin Scotian Basin, more than 45 million years after the onset of sea-floor spreading, sandy deltas prograded tens of kilometres seawards. Sand supply was 3–4 times higher than in the early history of the passive margin. Multiple sedimentary petrology methods show that the dominant source of the sand was from the local Appalachians, supplied by at least three different rivers. Geochronology of detrital minerals provides a first-order assessment of the source of detrital sediment. The detrital minerals muscovite, monazite and zircon have been dated from different parts of the basin. Almost all detrital muscovite grains are Late Paleozoic in age. Mass-balance calculations require a few hundreds of metres of exhumation of the inner continental shelf during the Early Cretaceous. The paucity of older ages results from abrasion during transport from older, more inboard Appalachian terranes. Most detrital monazite grains are Devonian, but Lower Paleozoic, latest Neoproterozoic, Mesoproterozoic and Paleoproterozoic grains each make up about 10% of the total assemblage. Although monazite is relatively resistant to mechanical abrasion, it is readily broken down chemically under acid conditions. Monazites were classified according to whether they were euhedral, subhedral, rounded or irregular. There is no systematic variation of morphology with age, except that euhedral grains are over-represented in middle Paleozoic ages, characteristic of the outboard Appalachians, and involving short transport distances. This variation indicates that most monazite is of first cycle origin. Most detrital zircon grains are of Precambrian age, with peaks at 1.0 Ga and 1.7 Ga that are characteristic of reworked zircons in inboard Appalachian rocks of Laurentian provenance. A few samples show peaks at 0.6 and 2.0 Ga, characteristic of outboard Appalachian rocks of Gondwanan provenance. All samples have a few 300–550 Ma zircons, representing Appalachian crystalline basement. Comparing abundance of monazite and zircon grains of different ages in the same sample provides estimates of the importance of polycyclic reworking. Samples with similar distribution of monazite and zircon ages suggest that most zircons are first cycle, and only a few zircons are rounded or broken. Samples with many zircons older than the monazites have many rounded and broken zircon grains. In such samples, bulk chemical analyses show a good correlation of Zr and Cr. These elements are principally in zircon and chromite, derived from quite different rock types, but resistant minerals concentrated by polycyclic reworking. In contrast, Zr correlates with Ti only at low concentrations, above which the abundance of Ti is largely constant as Zr abundance increases. Ti is transported principally in ilmenite, an abundant first-cycle mineral in proximal fluvial sediments, but very susceptible to chemical weathering. Ce, which is principally present in monazite, shows no correlation with Zr but correlates well with Ti, suggesting that mostly first cycle monazite and ilmenite are concentrated together by sedimentary sorting. Understanding in this way the role of polycyclic reworking of heavy minerals, we were then able to better interpret spatial variation in varietal minerals in the basin. Polycyclic heavy minerals such as chrome spinel showed little geographic variation in relative varietal abundance. In contrast, some garnet and tourmaline varieties could be use to pin- point particular first-cycle sources.

Using grain morphology in detrital monazite and zircon geochronology to estimate polycyclic reworking, Lower Cretaceous, Scotian Basin, eastern Canada

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The sources of sediment to the Lower Cretaceous deltaic sandstones of the Scotian Basin, offshore eastern Canada, have been investigated by single grain geochronology of the minerals monazite and zircon. The geochronological data represents the time of crystallisation of monazite or zircon in crystalline basement rocks, either igneous or metamorphic, but many of the grains may have been reworked out of older sedimentary rocks. In this study, the texture and morphology of dated zircon and monazite grains was determined from backscattered electron (BSE) and cathodoluminescent (CL) images. For each grain, the zoning, inclusions, size and external morphology were classified. These data were compared with the available age estimates and different types of detrital monazite and zircon were identified. In general, there are insufficient data from outcrops on land to precisely match these types, but they provide a challenge for future petrological work on outcrops. The composition of inclusions in monazite was used to interpret some specific source rocks and some detrital zircons could be compared with zircons from dated source rocks. For both monazite and zircon, older ages tended to have a higher proportion of more rounded grains. Monazite has a hardness of 5–5.5 compared with 7.5 for zircon. Monazite has been observed to be susceptible to chemical leaching in permeable facies of the coeval fluvial Chaswood Formation outcropping on land, suggesting that prolonged chemical weathering in the source area will also destroy monazite. Monazite is thus well suited to identification of first-cycle supply of detritus to the sedimentary basin, although a few monazite grains may be polycyclic in origin. Most grains of monazite were of latest Neoproterozoic to Devonian age, indicating source rocks in the Appalachians. For western parts of the basin, detrital monazite and muscovite indicate a supply principally from the Meguma terrane of the Appalachians. The Lower Paleozoic–Neoproterozoic zircons are predominantly euhedral or subhedral; Meso- and Paleoproterozoic zircons tend to be rounded and are reworked mostly out of metasedimentary rocks. In the central part of the basin, the majority of the Late Paleozoic to Neoproterozoic zircons are euhedral or subhedral, whereas 70% of the older zircons are rounded. Some of the Precambrian zircons are interpreted as first cycle: 12% are euhedral and 19% subhedral. The presence of a few rounded monazites with subhedral features, with ages of 0.9–1.9 Ga, also suggests that there was an actively eroding Precambrian basement source. However, euhedral zircons are principally of late Neoproterozoic to Devonian age, indicating crystalline basement sources in the Appalachians. Most of the more rounded zircons are probably derived from reworking of Lower Paleozoic and Carboniferous sandstones, which likely supplied more than 50% of the zircons to this part of the basin. This interpretation is confirmed by monazite data. In the eastern part of the basin, both monazite and zircon show a preponderance of first cycle Precambrian ages, with fewer first cycle grains from the Lower Paleozoic of the Appalachians. There is evidence for a substantial source of polycyclic zircons, but not as dominant as in the central part of the basin. This study illustrates how quantitative estimates of the proportion of polycyclic zircons can be made from morphological data and from comparison with monazite data.

Cenomanian paleo-valley of Central Kyzyl-Kum: peculiarities of the lithology and mineralization

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The studied area is located in the Central Kyzyl-Kum to the southwest of the Bukantau raising, composed by rocks of folded Paleozoic foundation. The overlapping cover is presented by the sedimentary sequences of Cretaceous, Palaeogene and Neogene-Quaternary periods with total thickness to 600 m, of marine and continental origin. The study of area by boring made it possible to isolate the Cenomanian stage as the potential horizon. The Cenomanian sequence transgressively lies on the formations of the folded foundation with the angular stratigraphic disagreement, which surface is characterized by the presence of the crust of weathering almost everywhere. The two units are distinguished on the basis of lithologic, geochemical and facies features of the Cenomanian sequence. The lower unit is characterized by predominance of red-colored proluvial sediments – conglomerations, coarse-grained sand and sandstone with pebbles and gravel, pattums and lumpy siltstones. The upper unit is mainly composed by gray alluvial sands with the insignificant admixture of gravel and layers of conglomerations, gravel and horizontally layered siltstones. The cross-section of the Cenomanian period is composed by thin alluvial and proluvial sedimentary sequences, which are the unsorted sands with the admixture of pebbles and gravel. The study of the paleo-relief of Cenomanian period showed that the incline of paleo-valleys was 25-30 m/1 km, what is the optimum condition for placer development. Unrounded gold of branchy shape predominates, size of gold dust varies from 0.1 to 1.5 mm, and native ores are not discovered. Furthermore, the increased concentration of tin and tungsten are determined. The unsorted hetero-grained sands with the admixture of pebbles and gravel are gold-hosts, which lie in the base of the Cenomanian cross-section. Besides the old placers of gold in the continental Cenomanian sequence there are discovered the accumulations of zinc, silver, copper and other metals, which gravitate towards to the black layers of sand and gravel siltstones, connected to the development of swampy areas. Existence of swamp in the limits of dry valleys is due, apparently, to unloading waters from the folded foundation. Gold is localized predominantly in the limits of mountain slope belt, reaching maximum concentrations in the anastomosed river subzone of the alluvial fan zone. Scandium gravitates towards clayey varieties; therefore its greatest concentrations are located in the pluvial plain zone of mountain slope belt, and also in the overflow and lacustrine-paludal zones of fluvial belt. Yttrium creates concentration in the wider lithofacies limits. Its highest accumulations are established in the clay rocks of all facies zones. Smaller concentrations are revealed in the sandstones of the upper-channel zone. Arsenic gravitates only towards clay rocks. Moreover in the pluvial plain zone it is by an order more than in all other zones. Copper and zinc are concentrated predominantly in coarse-grained sediment varieties. The facies dependence is most distinctly observed in the distribution of copper, which quantity is gradually decreased with removal from the run-off area. The content of other elements does not change so sharply. During the Cenomanian stage the paleo-valleys served as the unique drainage system of ground water. The oxidation processes of the phyllite-shaped schists of plicated base enriched by sulfides contributed to the formation of the very aggressive solutions, which, obviously, caused the extension of the number of elements with their subsequent concentration. The most mobile under these conditions were the following elements: Mn, V, Cu, Zn, Co and Mo. It is necessary to emphasize that the erosional-tectonic structures in the rocks of plicated foundation, executed by the sedimentary Cretaceous sequence, are widely represented in the Central Kyzyl-Kum and are favorable for localization of the old auriferous placers.

Sedimentology, stratigraphy and geochemistry of Ediacaran banded iron formations (Uruguay)

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Multiple lines of evidence suggest that the Earth's atmosphere underwent a significant rise of O_2 somewhat 2.45 (Ga) billion-years ago (i.e. the 'Great Oxidation Event') but persistent oxygenation of the oceans likely developed much later, perhaps around 580 Ma. These changes in environmental redox invariably affected the abundance of bioessential elements and ultimately, the evolution of life. Owing to their distinctive mineral composition, banded iron formations (BIF) can provide insights into our understanding of the early Earth system in that they preserve a history of Precambrian oceanic elemental abundance. BIF are widespread in the Archean and largely absent after ca. 2.45 Ga (with significant exceptions at ca. 1.8 Ga and ca. 0.75 Ga) and their presence is generally interpreted as evidence for anoxic waters; however, the mechanism of oxidation remains disputed. Previous studies have suggested that the rise in oxygen during the late- Neoproterozoic created an environment permissive for animal evolution. They indicate that the ocean became increasingly oxygenated following the Marinoan glaciation, which led to the oxidation of the deep ocean and the rise of animal life after the Gaskiers glaciation. Most recently, it has been proposed that even during the beginning of the Ediacaran period, and up to the end of the Gaskiers glaciation (635-580 Ma), anoxia remained widespread beneath the mixed layer of the oceans. The deeper waters were sporadically sulfidic, but for the most part, they appeared to be Fe(II)-enriched, much like the oceans before 1.84 Ga. Although these conditions should have favored the widespread deposition of iron-rich sediments, no iron formations associated with the Ediacaran have yet been described. This study considers the sedimentology, stratigraphy and various geochemical aspects of Ediacaran BIF from the Yerbal Formation -the youngest iron formation yet reported- and associated strata deposited after a period of severe glaciations and concurrent with the emergence of complex life. Additionally, radiometric dating provides precise age constraints on the timing of deposition and therefore, the oxidation of deep oceans.

Sedimentation in a Precambrian foreland basin: Salobro Formation, Rio Pardo Basin, East Brazil

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The Salobro Formation is a meta-sedimentary pile composed by conglomerates, graywackes, quartzites, sandstones, argillites and slates, deposited in a moat formed in the frontal part of a passive margin sedimentary basin (Rio Pardo Basin), in the southeastern sector of the São Francisco Craton. The formation is unconformable on the basin and its southwestern limit is a NW-SE reverse fault, with NE tectonic transport. Provenance studies of the sedimentary rocks of the Salobro Formation, indicate their source as uplifted basement and paleocurrent data determinate sources N, NE and SW of the foreland basin. The basement rocks north of the foreland basin are Paleoproterozoic enderbitic-trondhjemitic orthogneiss and Archean enderbite and granulitic trondhjemite, in terranes of the São Francisco Craton; to the south of the foreland basin, away from the sedimentary rocks of the passive margin basin, the basement rocks are Archean horblende-biotite migmatitic orthogneisses and anorogenic granites. These rocks were folded during the Brasiliano/PanAfrican tectonic cycle together with the Araçuaí Fold Belt, southeast of the São Francisco Craton. The rocks of the Salobro Formation were deposited by three depositional cycles, each one beginning by conglomerates. The lowest one (Salobro conglomerate) is composed by gneiss, granite, quartzite, volcanic rock and granulite pebbles; its source is in the granulitic rocks north of the basin. The intermediate one (Lapão conglomerate), entirely composed by carbonate pebbles, is sourced in the carbonatic Serra do Paraíso Formation, one of the formations of the Rio Pardo Basin, to the south of the foreland basin. The uppermost beds (Mascote conglomerate) are composed by rounded, flattened, and imbricated gneiss and migmatite pebbles, that indicate its source in the Archean basement to the south. The sedimentation of the Salobro Formation in the foreland basin began with sediments with provenance in the forebulge north of the basin (Salobro conglomerate); the erosion of the folded and uplifted passive margin basin furnished pebbles of the carbonatic Serra do Paraíso Formation to the Lapão conglomerate; then, the erosion reached basement level south of the basin, from where came the pebbles of the Mascote conglomerate.

The *Teichichnus* Ichnofacies: a recurring ethological grouping for salinity-stressed ichnological suites

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Salinity-stressed trace-fossil suites depart markedly from the archetypal Seilacherian ichnofacies; so much so that they are widely described as "impoverished marine assemblages". In the past, identification of ichnological suites as brackish-water in origin necessitated direct comparison to the "fully marine" signal preserved in contemporaneous shallow marine successions. Recognizing these depauperate trace-fossil suites as indicators of salinity reduction, however, is not always readily accomplished. Physico-chemical stresses such as rapid clay flocculation, elevated deposition rates, and reduced oxygenation near the bed are commonly associated with settings prone to salinity reduction; yet these are also independent factors that can hamper the recognition of the brackish-water signal. Additionally, the preponderance of heterolithic units in many salinity-reduced settings (particularly estuaries and bays) favours the occurrence of composite trace-fossil suites manifest by marked variations in their component ichnogenera. Brackish water itself runs the broad spectrum of salinities greater than 2‰ and less than 32‰, leading to salinity-reduced suites that effectively "grade" into fully marine assemblages. Salinities may vary daily, monthly and/or seasonally, such that pronounced spatial and temporal changes in the resulting suites can be expected. Finally, the progressive evolutionary invasion of reduced-salinity settings through time exacerbates the situation, such that precisely *which* ichnological characteristics can be taken to indicate salinity reduction is not held uniform throughout Earth history. Previous studies questioned whether an ichnofacies could be defined that would effectively capture the complexities of the brackish-water realm. Careful neoichnological analysis from a number of marginal marine settings, however, has highlighted a recurring ethological grouping characteristic of the dominant infauna inhabiting these realms, and constitutes the fundamental basis for proposing a new ichnofacies. Brackish-water endobenthos overwhelmingly construct semi-permanent dwelling structures designed for: 1) interface deposit feeding or sediment ingesting; 2) protection from desiccation and predation; and 3) buffering salinity changes that occur routinely and more pronouncedly at the sediment-water interface. Persistent animal-sediment interactions record: 1) head-up deposit-feeding behaviours; 2) dwellings wherein the tracemaker leaves to search for food; 3) passive predation; 4) minor filter-feeding, ostensibly *via* pumping of water through the burrow; and 5) the rapid response of highly opportunistic trophic generalists to localized accumulations of high-quality and abundant food, which leads to sporadically distributed biogenically mottled sedimentary fabrics. Such biogenic structures are typically ascribed to the more strongly facies-crossing elements that occur as components of more marine suites (e.g., *Teichichnus, Planolites, Cylindrichnus, Gyrolithes, Skolithos, Palaeophycus*, and *Thalassinoides*). Many progenitors of these ichnogenera in brackish-water regimes are likely to be omnivores. Ancillary characteristics of the different suites include diversity impoverishment, morphologically simple structures, general size reduction (both to facilitate osmotic regulation and because of elevated mortality rates) compared to fully marine counterparts, and bed-scale juxtaposition of vertical and horizontal elements. Nearly three decades of paleoichnological analysis of brackish-water deposits throughout the Phanerozoic has led to the recognition of suites that support empirically these neoichnological observations. On the strength of establishing both spatial and temporal recurrence of these characteristics, underpinned by an ethological grouping validated by neoichnological observation, we propose a new ichnofacies archetype for salinity-reduced environments: the *Teichichnus* Ichnofacies.

Sedimentological studies in the vicinity of the Gaibu Beach and Suape Port, Pernambuco coast, Brazil

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Sedimentological studies were developed on the continental shelf of the State of Pernambuco, Northeastern Brazil, looking forward into mapping a siliclastic deposit for use in beach recovery. For the sedimentological characterization of such deposits two research areas were chosen: one (area A) adjacent to the Gaibu Beach, localized among the UTM coordinates 286200E to 291200E and 9888250N to 9074125N, and another (area B) near the Port Industrial Complex Suape, among the UTM coordinates 284000E to 290000E and 9070000N to 9068000N. Respectively 92 and 21 samples were collected using a Van Veen-type sampler in georeferenced points within a regular quadratic grid with equidistance of 1km. Granulometric analyses were performed to determine statistical parameters (mean, standard deviation, skewness and kurtosis) according to Folk and Ward (1957), processing data with the software SYSGRAN 3.0. The textural facies have also been identified using Shepard classification. The results obtained in area A show for the average diameter the predominance of the fractions medium and coarse sand. The trend of the population distribution of grains of different fractions is to occur parallel to the coastline and feature fining upward towards the middle platform. This indicates that the modern rivers in the area provide the platform with sediments of the fine fraction, and the palimpseptic, relic sediments of coarser fractions were reworked by the flows, being therefore concentrated in the most distal portions. The observed values show up very platykurtic to platykurtic in rounded concentrations (likely groupings of calcareous algae or coral) characterizing areas of moderate power and low grade of selection. Mesokurtic values are distributed as elongated strips that contour low energy areas. The leptokurtic and very leptokurtic values occur laterally to these sites. There is a predominance of moderately selected grains indicating that the energy surrounding this area is insufficient to finely select them - a fact seen in the kurtosis map. Skewness results point to a trend in fine particles enrichment shown by the positive skewness and a fine-and-coarse grain mixture pointed by the proximately symmetric values. Small portions taken from isolated points record the occurrence of well-selected grains. The prevalence of textural sand facies has been identified and quantified in 68.4%. Although the Pernambuco coast has predominance of carbonate sedimentation, in this area most of the samples of sand facies are composed of siliciclastic sediments. In area B, the average diameter map records the presence of sediments of the fractions very coarse, coarse and medium sand, distributed parallel to the coast. The absence of the fine sand fraction is attributed to the lack of river mouths near the studied area. The stretches with very platykurtic and platikurtic samples occur with elongated shapes and may also be considered concentrations of corals and coralline algae. Mesokurtic and leptokurtic samples occur and exhibit a contour gradient. It has been noted that the power grade also increases with the receding from the calcareous algae or coral. Moderately selected grains are in profusion and the more frequent textural facies are sandy gravel, gravely sand and sand indicating the strong presence of bioclastic sediments mixed with siliciclastic sediments. According to the obtained data, the studied areas have potential to serve as sources of siliciclastic sediments for the purpose of recovering adjacent eroded beaches.

Islands and sand bars in the Middle Paraná River

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Having a mean annual discharge of ~17,000 m^3/s, the Paraná River is the ninth largest river of the world in water discharge. In terms of drainage area, with ~2.4M sq km, the Paraná is the second largest basin of South America. The Parana River is an anabranching system with large islands, sand bars and a sinuous thalweg. Islands more than sand bars are the dominant morphologies of the main channel of the Paraná River from Corrientes to Rosario cities. Through aerial photographs, navigation charts, satellite images of different sensors and periods of time, and intense field work on hydraulic, geomorphologic and hydrologic dynamics, we have been identifying the mechanisms acting in bars and islands formation in the Middle Parana River. We have distinguished the islands in simple, compound and complex according to the diversity of geomorphologic and depositional environments. Sand bars are only emerging in medium-low and especially low water stages. They represent an earlier stage of evolution of the islands, so understanding their genesis is of such importance. In the case of the Middle Paraná River the origin of the sand bars is little known, except for the mechanisms that are directly linked to the thalweg shifting of the river. Ramonell and others identified "embryonic bars" (submerged), to up to 7 m depth in the bathymetric charts. Recently, we could determine the specific geometry of the submerged bars. The bars show a linguoid shape with the higher zones located in the advancing front and the flanks. They can occur as individual landforms or as a coalescent group in the center of the main channel or near the channel and island banks. The knowledge of the three-dimensional shape of the embryonic or linguoids bars allowed determining the influence on the emergence of complex bars as their growth triggering the formation of different types of islands. The emerged bars of the Middle Paraná river show a variety of planform geometry (triangle, diamond, elliptical, elongated hook-shaped or wing, etc.). All these are explained by the 3D shape, migration, and eventually coalescence or juxtaposition of the linguoids submerged bars. The varieties of shapes of emerged bars are those that will shape and control the development of the islands that become stable by vegetation colonization. The islands can continue to grow in different directions depending on both, the interaction with the submerged bars as the free space available in the channel which is a function of the shifting of the river thalweg. For example, a single island can originate from a triangular bar with the frontal progressing edge that act as an obstacle for the dune trends that overlap and climb the triangular bar frontal ramp. The upstream growing of these bars can be in some areas until 100 m/y. Islands are intricate landforms sustained by a variety of a geomorphologic sub-environments and sediment architecture. We have identified until more than 12 geomorphologic elements. A main factor in islands evolution is the advancement of linguoids bars on both sides of the island that growth in width and eventually towards downstream. The growth rates of islands in these directions have been measured in dozens m/year and hundred m/year respectively. Sub-sedimentary environments are easily recognized in two main groups: channel facies that constitutes the major volume of the islands, are formed by medium to fine sand, coarse sand (and exceptionally fine pebbles). On this unit are lying until 3meters of fine flood sediments and fine and very fine sand deposited from the suspended sandy load of the channels. We estimated that the rates of deposition of fine sediments are highly variable, and in some cases can exceed some dozens of cm/year.

Sedimentological studies on carbonate sediments of the Rocas Atoll, South Atlantic

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Atoll environments have been the target of several sedimentological studies worldwide. Most of them try to explain a model of sediment distribution according to their properties and composition. Both biology and geology have important roles on the study of reef complexes, which have directly influenced on the sedimentary processes that take place on this environment. Rocas is the only atoll of the South Atlantic, located about 266 km off the Brazilian coast, and one of the smallest of the world (3.35 x 2.49 km), with an internal area of 6.56 km². Sediment samples were obtained from some parts of the reef complex of Rocas atoll in January and July of 2009. Cumulative frequency curves were constructed from the sieving data, and mean size and sorting values computed. The results showed that carbonate sediments of the Rocas atoll were classified according to Shepard (1954) in four texture facies: sand; gravelly sand; sandy gravel and gravel. Sand facies was the dominant texture with 78% of all samples, followed by gravelly sand (15%), gravel (5%) and sandy gravel (2%). It is remarkable the concentration of the coarser sand next to the reef flat and the islets. What we can infer from this is that the reef flat contributes to the generation of sediments, where the coarser sand is deposited next to the reef, whereas, finer particles are carried to the middle of the atoll. Viewed as a whole, with all the samples, the mean size range from fine sand to granule (2.34 to -1.23ø, average of 0.69ø), with 59% of the samples fall in the range of -1 to 1ø. It is also noteworthy the low percentage of mud (≤ 4ø) at Rocas samples. Indeed, no sample presented more than 4% of mud, which could be interpreted as a high energy environment. Sorting range from very well sorted to poorly sorted (0.23 to 1.72 ø). The average sorting value is about 0.97 ø (moderately sorted). Carbonate sediments are rarely well sorted, except in extremely high energy environment or where there is just one organismal source. Carbonate sediments of the Rocas reef are composed, entirely, by biogenic particles, where 12 organisms sources were described. Coralline algae were the most abundant source. Other biogenic particles were described, as group level, by Halimeda, mollusks, foraminifera, gastropods, sponges, bryozoans, brachiopods, corals, echinoderms, crustaceans and vertebrates. The geological meaning of the size parameters is better visualized when compared with sorting values. At Rocas atoll it is remarkable that the coarser particles have better sorting, even though many studies have showed a relationship between finer grain with better sorting. High percentages of coarser sand suggests that there is a high hydrodynamic energy that takes place at Rocas atoll, and the great variation of sorting seems to be related to the different sources of biogenic particles.

On the coastal evolution of NW Iberia (Galicia) during the Late Pleistocene

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The main characteristic of the NW Iberian coast is the presence of the "Rias". Its origin is tectonic, fluvial and marine. The high regional relief is the result of a long crustal uplift since the middle Eocene which controlled the morpho-structural characteristics of the coastline. However, the substratum lithology and the regional landscape evolution are responsible for the more detailed geomorphic features. This study presents the first sedimentological and OSL dating results of a coastal reach located in the right margin of the Pontevedra Ria mouth. More specifically, the site is located at a small embayment near Sanxenxo (Pontevedra, Spain). The rocky substratum is dominated by intensively fractured Precambrian-Silurian mica schists. Along the coast, a wave-cut platform, about 500 m long and 100 m wide, is subdivided into an eastern and western sector by a rocky headland. One can distinguish a modern wave-cut platform (only exposed at low tide) from an older wave-cut platform (rocky terrace) which has a slope of 4º and is exposed at an altitude of 1.8m to 4.5-5m above sea level. In the western sector the old wave-cut platform is overlain by a 2 m- thick reddish gravelly beach deposit having its base cemented by iron oxides. This beach deposit is erosively covered by a 4 m-thick colluvium, comprising debris flow deposits alternating with gravel pavements that are parallel to the slope. In the eastern sector, the 5 m-thick coastal terrace consists of a sandy-gravelly beach deposit grading upwards into aeolian yellowish medium sands. Locally, a lenticular bed of a greyish green silt was found interbedded in the aeolian sands. At the top, the aeolian sand unit is disconformably capped by a heterometric gravel containing angular clasts of quartz and mica schists inbedded in a sandy matrix. This coastal sedimentary succession is interpreted to represent a time interval of high sea-level, more elevated than the present one, during which the littoral platform was cut and later covered by gravelly beach sands (MIS5). Later, during MIS4, the climatic conditions and the progressive sea-level lowering lead to the accumulation of aeolian sands in the eastern sector. The rocky headland (40 m high) prevented sand deposition in the western sector indicating a prevalence of southwestern winds. Finally, the colluvium unit that disconformably covers the aeolian sands in the eastern sector and the beach deposits in the western sector, points to a cold and humid environment (MIS3 to MIS2) as suggested by the debris flow deposits and associated slumping features. The altitude of the MIS5 wave-cut platform is an indication for regional tectonic stability. Preliminary quartz OSL dating results seem to confirm our interpretation of the different sedimentary units; the final ages will be presented at the conference.

Stratigraphy of the Norean Formation (Northern Region of the Middle Magdalena Valley) and its tectono-sedimentary implications

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The Norean Formation represents a volcaniclastic sequence located in the northeastern part of the Median Valley East Magdalena (Colombia). The name of this unit comes from Noreán township, north of Aguachica, in the southern sector of the department of Cesar. Based on their lithological composition and style of emplacement, the Noreán Formation can be divided into four groups: clastic - pyroclastic (Jncp), pyroclastic - epiclastic (Jnpe), dacitic effusive (Jned) and andesitic hipoabisal (Jnha). The Norean sequence developed during a major early and mid-Jurassic volcanic event, which was predominatly explosive and that generated huge amounts of pyroclastic and effusive material. The studied unit was deposited in a graben basin type, partly inundated by a shallow sea, drained by rivers and lakes in the Upper Jurassic, in what presently is the Middle Magdalena River Valley.

Mineralogical analysis in bones of Cretaceous reptiles: geochemical attack during fossil diagenesis or depositational nucleus of Fe and Mn oxides-hydroxides?

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Presence of Fe and Mn oxide-hydroxides on bones of fossil vertebrates is frequent in sedimentary deposits such as concretions lying in mottled beds and directly associated to the fossil-diagenetic process of the remains. These concretions are a consequence of precipitation of minerals present in gels formed within aqueous solutions. Bone pieces may be unaltered or modified – at least superficially – and are usually found within the same bed. Such a taphonomic attribute elicits questions on the driving process that concentrates these minerals on the bone nuclei. To understand this pattern, the chromatic variation of the bones of Kaikaifilusaurus avelasi (Apesteguía and Novas, 2003) [MPCA-365] was analyzed. The specimens were collected from the Candeleros Formation (Cenomanian–Turonian) exposed at "Huene" quarry (S39º36.831´/W68º40.254´), La Buitrera locality, Rio Negro Province. Analyses included X-ray diffraction [XRD], infra-red spectroscopy [IR-FT] and scanning electron microscope [SEM]. Following the Cailleux soil color chart, they were classified into 5 categories from A to E: very pale chestnut-brown (10 YR 8/3); weak red (10 R 5/3); reddish chestnut-brown (5 YR 4/3); dark reddish chestnut-brown (5 YR 3/2) and very dark gray (2.5 Y 3/0). Finally, following the "Bone Weathering Stages" proposed by Behrensmeyer (1978), they were grouped into stages 1 (A-B) and 2 (C-D-E). From the XRD analysis it was determined that all the pieces contained varieties of Apatite [Francolite, Carbonatehydroxyapatite and Carbonatefluoroapatite] in different proportions. In addition, A presents traces of Analcime; C contains a higher Hematite concentration than B; D is richer in this oxide than in phosphate, with subordinate Pyrolusite. Finally, E has subordinate Hematite to Pyrolusite and Manganite, with scarce Apatite. The IR spectrum indicates that A is composed of 65% Apatite and 35% Carbonatehydroxyapatite; and that in D and E there is a relative decrease of the phosphate bands. Macroscopically, A and B show fractures parallel to the bone fibres and SEM of A shows unaltered periosteal bone. On the other hand, damaged and mosaic-patterned cracking and flaking bone surfaces are clear in C, D and E. This is more clearly noticeable in C because of the thinner coating, while in D and E it is obscured by the almost complete absence of bone material. This study suggests a differential preservation of fossil remains from the same strata. Such a difference appears early in the biostratinomic process with the weathering of the carcass altering the surfaces of the bones. The extended exposure of the remains would cause the pre-burial damage observed in the periosteal bone. This renders the formation of oxide and hydroxide coatings over the material easier. During fossil-diagenesis the bones act as crystallization nuclei, and the formation of concretions over them is enhanced by circulation of fluids loaded with oxides and hydroxides within the fossil-bearing layer. This differential precipitation produces anomalous concentrations (mottles) of Hematite, Pyrolusite and Manganite over the most heavily weathered bones. A remarkable direct correlation exists between the weathering stage and the increasing (from C to E) clouding of boundaries between bone and oxide-hydroxides resulting from phosphate/Fe - Mn reactions (Staley *et al.*, 1992; Cornell & Schwertmann, 2003).

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Paleoenvironments of the Paraná Formation (Neogene), in the province of Entre Ríos, Argentina

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The Paraná Formation (Tortonian - Late Miocene) includes marine rocks deposited as a consequence of the "Entrerriense" flooding event. This event is outcropping in central Argentina, western Paraguay and southern Bolivia. An epicontinental sea connection between the South Atlantic Ocean and the Caribbean Sea was originally proposed by von Ihering (1927); later this hypothesis was supported by new record of invertebrate fossils found at different outcrops along the eastern bank of the Paraná River between La Paz and Nogoyá, in the province of Entre Ríos, Argentina. The earliest localities with fossils were described by Alcide d'Orbigny and Charles Darwin. During the early years of the twentieth century, Frenguelli, provided the stratigraphic framework. Recent studies postulate the possible presence of a large barrier reef that runs from north to south along the right margin of the Paraná River. Different sedimentology and paleoenviromental interpretations were caused primarily by the incomplete fossil and stratigraphic record, and geographic distribution of the taxa involved. In this work, nine localities exposed near the Paraná river were studied: El Cerrito (EC); La Toma Vieja (TV); Crespo Soler (CS); La Juanita (LJ); Cantera Cristamine (CC); Punta Gorda Norte (PGN); Punta Gorda Sur (PGS); Molino Doll (MD) and Cerro La Matanza (CLM). The sedimentation in these localities is characterized by alternations of white to yellowish, fine to medium-grained sandstones and green siltsones. Some of these levels are very bioturbated (among others, *Ophiomorpha* and *Skolithos*) and towards the top it is common to find bioclastic sandstones strongly cemented by calcite carbonate, product of the precipitation and recrystallization of calcium carbonate from the buried shells, this feature is clearly observable in the field and in thin-sections. On the other hand, these cemented levels contain a rich associated fauna of benthonic invertebrates and pelagic vertebrates. The taxa found shows a good quality of preservation of the shells and in some quarries, preserved microfossils can be found in the conglomerates together whith mega invertebrates. Fossils bivalves are typically marine genera such as *Portlandia, Placunanomia, Amusium, Aequipecten, Anadara* and *Chionopsis*. Also associated with marine forms, there are taxa whose current representatives live in brackish waters such as *Mytilopsis, Mactra, Polymesoda* and *Erodona*, which inhabit areas of estuaries and river mouths. In all cases, molluscs correspond to shallow infaunal superficial shapes, both free living and cementing life styles forms. Echinoderms (sand dollars) and bryozoans are found complete, the latter attached to shells. Finally, the study indicates the existence of a sea with different conditions from those postulated in the literature so far. The exposure levels of Paraná Formation correspond to the culmination point of the marine ingression and sea level fall; evidenced by slightly reworked fossiliferous strata, and in some cases, by interdigitation with the upper sedimentary unit. The reef limestones could not be identified in the field; detailed sedimentological and taphonomical observations allowed to reinterpret the hard bioclastic sandstones levels as storm deposits. The fossils association indicates a marine coastline environment, with a possible connection with brackish water bodies, typical of an estuarine environment.

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Preservation of Holocene pyroclastic deposits in Andean peatlands: the Condorhuasi Valley case (Salta, NW Argentina)

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The Condorhuasi Valley is located 12 kilometers southeast of San Antonio de Los Cobres (Salta, NW Argentina), at the north of Nevado de Acay (5716 m a.s.l.). A typical Puna sloping peatland, locally known as bofedal, has been dissected by the Patos River showing exceptional sections of the sediments filling this 2.9 km^2 basin. Elongated in shape, with a length of 5410 m and about 500 m width in the peatland area, this valley has a difference of only 90 m elevation (between 4015 and 3925 m a.s.l.) and a slope of 1.6%. Hydrological setting favored the cyclic development of peatlands with intercalations of siliciclastic, carbonatic and pyroclastic deposits. This area is in the Eastern border of the Puna plateau, at the north of the Negra Muerta Caldera on the Olacapato-El Toro fault zone. The most complete reconstructed sequence consists of three levels of peat that have been dated in 9810 ± 50, 8880 ± 50 and 7730 ± 50 years BP. The lower level is the thickest, reaching up to 1.5 m in the central area of the basin. However, the thickness of the intermediate and upper levels only reaches about 25 cm. The sequence intercalations between these levels consist of siliciclastic sediments, conglomerates and sandstones with lenticular morphologies and extensive presence of sedimentary structures. In the central zone, where the lower peat deposit is thicker, there are also carbonate deposits with abundant fauna of bivalves and gastropods. Also, in some detrital levels there are vertebrate fossils covered by peat. In addition, there are also intercalated deposits of volcanic ash, most of them showing different types of laminations. These feature associates more this deposits with pyroclastic flows than with fall processes. Sedimentary structures of both, detritic and pyroclastic deposits, indicate flow directions towards the N-NNW, suggesting that the source area must be in the area of the Nevado de Acay. The XRD mineralogical analysis of ash samples revealed some differences among levels. Ash layers intercalated between the lower and middle peat deposits are made up of abundant presence of glass, quartz and albite, with sporadic biotite. But upper ash layers Intercalated between middle and upper peat deposits evidence the absence of biotite and the occurrence of abundant illite together with the glass, quartz and albite association. Finally, in the more distal sequences, without peatland influences, the ash deposits show volcanoclastic features and the mineral composition is a mixture of the previously described levels. In conclusion, the studied basin reveals, as preliminary results, a repeated Holocene eruptive activity in the area of Nevado de Acay, with deposition of pyroclastic levels in an area of Puna sloping peatland formation. This eruptive activity disrupts the normal depositional environment and the peatland needs a period of about 1000 years to return to recover the physical and chemical conditions favorable for its development.

Delta geomorphology: is it in equilibrium with present day dynamic conditions?

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Deltas are common features at river mouths where continental sediment input is significantly greater than sediment redistribution by waves and tides. Most delta classifications are based on the relationship among these variables. However, we propose the hypothesis that even the most active deltas have general shapes that are not in equilibrium with present dynamic conditions but represent the conditions when they were formed in the past. A comparison of the typical triangular morphologic classifications with present day data shows that the location of the deltas in the triangles does not match the qualitative classifications that are commonly used. Therefore, we propose that present day deltas conserve the general characteristics of the original dynamic conditions, for instance, when mean sea level was below present, or fluvial sediment input was much higher than present.

A new bedform phase diagram for combined flows

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One central objective for sedimentologists studying bedforms is to develop empirical or theoretical bedform stability fields or phase diagrams. Despite the importance of such diagrams for the case of combined flows, where unidirectional and wave-induced oscillatory flows are superimposed, there remains a broad range of unknown conditions for the stability and existence of combined flow bedforms: this is especially apparent for strong unidirectional flows (greater than 0.30 m s-1) and intermediate oscillatory periods (between 2 and 8 seconds). To address this gap in our knowledge of these bedforms, experiments were conducted using the Large Oscillatory Water- Sediment Tunnel (LOWST) at the University of Illinois. Half of the tunnel height was filled with uniform 250µm diameter sand and the oscillatory flow velocity was fixed at 0.25 m s-1, whilst the superimposed unidirectional velocities, Uu, were varied between 0 and 0.40 m s-1. Longitudinal, one-beam, sonar data was obtained every 30 sec to measure the bed morphology and its spatio-temporal development. Under these flow conditions, five distinctive bedform types were observed: 2D ripples, 3D symmetric small ripples (SSR), 3D asymmetric small ripples (ASR), 3D asymmetric large ripples (ALR) and symmetric large ripples (SLR). From these results, we recognize three boundaries in the combined flow phase diagram: a) 2D to 3D between Uu= 0.05 and 0.10 m s-1 for 6 s and Uu= 0.1 and 0.2 m s-1 for 4 s, b) symmetrical to asymmetrical ripples at Uu= 0.1 to 0.2 m s-1 for both 6 s and 4 s, and c) a bedform size boundary, between small and large ripples, at Uu = 0.2 and 0.3 m s-1 for both 6 & 4 s. This paper will illustrate the nature of these bedforms and their development, and show how, when compared with previous studies, the present experiments appear to show an effect of oscillation period on the stability boundaries of the bedform phase-diagram.

Bedform morphology and stratification under combined flows: descriptions and implications for paleoreconstructions

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Bedforms generated by the combination of unidirectional and wave- induced oscillatory flow are ubiquitous in coastal and lacustrine environments. Despite the extensive progress made in past studies, there are still a wide range of unexplored flow conditions where the bedform geometry, and hence consequent stratigraphy, have not been explored. To address this issue, this study generates and uses *synthetic stratification* produced using data from the morphological experiments presented in Perillo et al (2010), with the addition of new results for stronger unidirectional flows (up to 0.50 m s^{-1}). Longitudinal one-beam sonar data was obtained every 30 sec to measure the bed morphology and its spatio-temporal development. The 'synthetic stratification' was achieved by superimposing the successive longitudinal profiles of the bedforms with a vertical spacing given by an average aggradation rate. This *synthetic stratification* methodology was implemented by Corea (1978) and continues to be employed by many researchers. We detail the stratification produced by a range of combined flow bedforms, and show the influence of aggradation rate on the strata produced. These results are used to test if, and when, the influence of a unidirectional component on the combined flow bedforms, can be seen within the cross-strata produced. Furthermore, preliminary studies suggest that without lee side preservation it is nearly impossible to distinguish the cross-strata created by pure unidirectional flows and current dominated combined flows. This case of climbing ripples is normally called subcritical climbing ripples and its produced when the climbing angle is smaller than stoss side angle. On the other hand, if the lee side is preserved the detail analysis of crest and the ripple index might expose the true nature of the flow. In addition, from the stratigraphy generated by individual bedforms, an experimental attempt is made to test the theoretical model proposed by Myrow and Southard (1991).

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Glacial sedimentary facies at the base of the Itararé Group (Westiphalian of the Paraná Basin), São Paulo State, southern Brazil (1)

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The region of Jundiaí (60 km NW far from São Paulo capital city, southeastern Brazil) records the easternmost occurrence of the Itararé Group. This lithostratigraphic unit has not been divided in Formations in São Paulo State yet and in that region occurs in small and narrow NE/SW - NW/SE sedimentary belts preserved in fault limited blocks between Precambrian basement rocks. Sedimentological and stratigraphic studies carried out in that region recognized nine different glacial-related sedimentary facies: Dmm (massive matrix-supported diamictite = debris/mudflow); Dms (stratified matrix-supported diamictite = lodgment till); Dms(sl) (stratified matrix- supported diamictite with sandy lenses = outwash debris flow); Sm (massive sandstone); Sm(df) (deformed massive sandstone); St (trough cross-bedding sandstone = outwash channels); Fm (massive mudstone and siltstone); Fr(s/f) (rhythmite of very fine sandstone and mud/siltstone); Fl(ds) (laminated mud/siltstone with dropstone). The genetic association of facies in several columnar profiles, after correlations among them, allowed to interpret the vertical facies arrangement as a deglaciation cycle in a costal marine environment (supported by microplanktonic species, such as Navifusa spp.) during the Late Carboniferous time (Crucisaccites monoletus Interval Zone). Therefore it corresponds to the second major marine transgression episode in the Itararé Group, above Roncador Shale (an important marine transgressive marker in southern Brazil). This facies analysis is an important contribution to understand the broad paleographic Carboniferous glacial sceneries and the stratigraphy of the Carboniferous and Permian successions in Paraná Basin.

Microbial dolomite formation in agglutinated Permian stromatolites (Zechstein, NE England)

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The "Crinkly Bed" (CB) is part of a thick stromatolitic-oolitic deposit belonging to the second Zechstein cycle (Z2, Roker Formation) of Northeast England. In County Durham the CB is around 1 metre in thickness and rests with a sharp stratigraphic break on the Boulder Conglomerate (Z1). The latter is composed of clast-supported, angular to rounded clasts of Z1 back-reef and reef facies. The clasts have contiguous coatings of laminated carbonate, and Z1 fossils occur in the matrix between clasts. The well-laminated Crinkly Bed gradually irons out the topography on the top of the conglomerate. A very broad, gentle doming on a metre-scale is locally present in the CB. In plan view, domes and ridges are seen on the bedding surface and these often appear as multi-directed ripple-marks, 5-10 cm in wavelength with a few centimetres of relief. Some stromatolitic-type domal-columnar, even conical, structures are present, and these may have a preferred growth direction. There is also a larger scale ripple-like pattern, with a 20-30cm crest wavelength and preferred N-S orientation. In cross-section the lamination of the CB bed is mostly continuous with an undulating almost chevron pattern.The CB lamination essentially consists of an alternation of micritic dolomitic layers (0.1-0.5 mm thick) with fine-grained detrital thicker layers (0.3-0.9 mm). Grains were probably derived from ooids and peloids, empty calcispheres, intraclasts and possibly extraclasts from older carbonates, as well as lens-shaped pseudomorphs of evaporitic crystals. Within the micritic CB laminae there occur remains of problematic filamentous microbial fossil forms, 8-20 µm in diameter; in granular laminae some show a fan-like subvertical pattern. There are also subspherical empty moulds within dolomite crystals, 3-5 µm in diameter, possibly after coccoid bacterial forms. Larger empty tubes, 150-200 µm in diameter, cross-cut several laminae indicating the existence of some boring organisms. The CB is mainly composed of dolomite and calcite (95-97%) with traces of clay minerals, iron oxides, quartz and gypsum. Despite the intense and multiphase diagenesis that affected Zechstein carbonates, CB dolomite mainly has a micritic fabric, irrespective of the sedimentary facies replaced (grains or micritic laminae), and consists of Ca-rich fabric-preserving light-grey/yellow anhedral to subhedral micron-sized crystals. Larger, clear subhedral sparry dolomite crystals (Mg-rich) tend to fill primary pore spaces. Relicts of micron-sized elongate swallow-tail crystals of gypsum locally fill interstitial pores within some micritic and granular laminae in the lower part of the CB. Late diagenetic sparry calcite (dedolomite) is absent in the lower layers, but gradually increases towards the top of the formation, to reach 45-50 % of the rock volume. The Crinkly Bed and succeeding microbial carbonates were deposited during a major transgression following lowstand evaporite precipitation (Hartlepool Anhydrite). The progression of the stromatolite structures indicates the gradual development of relatively lower energy conditions from intertidal to shallow subtidal conditions. Bacterial forms which lived in the micritic and sandy laminae of the Crinkly Bed are very similar to those that characterize modern microbial mat communities, indicating that bacteria had a significant role in trapping grains and precipitating microcrystalline (probably dolomitic) laminae through processes of bacterial-influenced biomineralization. However, a low degree of synsedimentary cementation would have been necessary to generate the CB-type biolaminites, since the lamination displays diffuse ripple-type structures, which must have been generated by water or wind-wave currents at the time of deposition, or shortly thereafter, while the sediments were still unconsolidated.

Ultra-structure of Holocene fine-grained stromatolites (Marion Lake, south Australia)

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Sub-fossil stromatolites, formed between 5000 and 3000 years ago, occur on a regressive marginal flat surrounding Marion Lake (Yorke Peninsula, South Australia), where they formed hemispheroids stacked or laterally linked, which encrust a variety of substrate irregularities. The relative abundance of grains or fossils distinguishes, respectively, agglutinated from skeletal stromatolite end-members; a micrite/microsparite crystal fabric characterizes the laminae of these "fine-grained" stromatolites. Marion Lake stromatolite internal lamination is characterized by an extremely fine sub-millimetric alternation of porous and dense laminae, respectively light- and dark- grey. Cavities in the porous laminae are very small (tens of microns) and empty. Trapped grains are absent. The microfabric of the laminae is composed of a widespread peloidal texture, although in many finer and darker laminae peloids coalesce to form uniform aphanitic layers. Aggregates of very fine anhedral to subhedral mini-micrite (crystal size < 1 micron constitute the peloids, which are 10-20 microns) in size, and surrounded by fringes of acicular fine microspar aragonite; the latter creates the general spherulitic organization of these mineral phases. SEM observations reveal that mini-micrite crystals in the spherulite nuclei and the aphanitic layers, are formed of coalescing nanoglobules, which can pass to small polyhedrons, probably composed of low-Mg calcite. Acicular crystals showing a prismatic elongate shape, broadly hexagonal in transverse section, are composed of high Sr-Na-S-aragonite. Mineralized bacteria-like fossil remains were found closely associated with crystal phases, consisting of empty moulds and mineralized bodies of sub-spherical coccoid forms varying in dimension from 0.5 to 11 µm. Where visible, a granular-nanoglobular texture characterizes these mineralized bacterial cells. The dark micrite that constitutes the fossils and peloids shows a strong autofluorescence, due to organic matter relics, in comparison with the acicular crystals that show very low autofluorescence. Under SEM, organic remains appear as planar or sheet-like structures with features indicating an original viscous mucus-like behaviour. Remains of degraded or mineralized EPS and fossilized bacteria, closely associated with the nanoglobular crystal aggregate, imply that the complex processes that induce mineral precipitation in living microbial mats are well recorded in these lithified stromatolites. The bacterial metabolism promoted the precipitation of micron-scale carbonate aggregates resulting from the agglutination of nanometer-scale nano-globules. Carbonate precipitation processes progressively substitute, eventually replacing, the degraded organic structure (EPS and microorganisms). The continuation of this aggregation process forms larger sub-hedral crystals (small polyhedrons), which subsequently merge to form isolated or connected peloids. The subsequent gradual formation of the aragonitic acicular crystals, which do not exhibit a nanoglobular texture, around the primary micrite aggregates may develop as ideal conditions for purely inorganic precipitation take over. This process results in the formation of a structure that has an intimate mixture of micrite and microspar and that is very comparable to the microstructures of many ancient fine-grained stromatolites.

Carbon isotope stratigraphy of the basal Zechstein (Upper Permian) strata in northern Poland

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Global C-isotope profiles proved to be effective in Permian chemostratigraphic correlations particularly in the sedimentary sequences that lack reliable biostratigraphic resolution. Recently, Tierney *et al.* (2009) reported the gradual increase in δ^{13}C values from about +2‰ at 260 Ma to +4‰ at 258 Ma, and subsequently δ^{13}C values remained steady around a relatively high value of 4–5‰ for several Ma until a consistent, gradual and progressive decline in δ^{13}Ccarb through late Changhsingian strata occurred. Regional stratigraphic correlation within the Upper Permian Zechstein of Central and North-West Europe is relatively straightforward since sedimentation throughout the area follows the classical model of cyclic chemical precipitation in a giant saline basin, but correlation of Zechstein sequences with global standard stages by means of faunal evidence is difficult because of the lack of index fossils. At its base, the Zechstein contains one of the prime correlation markers in NW European stratigraphy, the Kupferschiefer (T1). This unit records a period of basin-wide euxinic conditions, and can thus be considered an excellent time-marker. The T1 is followed by the Zechstein Limestone (Ca1) and this in turn by Werra evaporites. We have studied a section of basal Zechstein deposits in the Zdrada IG8 drill hole located in northern Poland. In this area, sedimentation of the T1 and Ca1 took place within a relatively shallow part of the shelf, comprising marginal areas of the basin. The T1 deposition lasted at most some tens of thousands of years. The T1 shows large variation in δ^{13}C values, from +0.7‰ at its base to +5.4‰ in its middle part. The average δ^{13}C value is +3.3‰ ±1.4‰, and in the topmost part of the T1 the δ^{13}C values rapidly increase, from +1.7‰ through +3.5‰ in the T1 to +5.1‰ at the lowest Ca1. Similar marked transition in the isotopic composition in the English Zechstein took place in less than 5,000 yr (Turner and Magaritz, 1986). The Ca1 shows a moderate variation; the range is +3.6‰ to +6.4‰, and the average δ^{13}C value is +5.1‰± 0.6‰. Similar trend from lower δ^{13}C values of the T1 to higher δ^{13}C values of the Ca1 was previously recognized elsewhere in the Zechstein basin, and it was supposed to be of stratigraphic significance. However, as already pointed out by Scholle (1995), it is not surprising that isotope shifts coincide with formational boundaries. In addition, the concept relating the lower boundary of the Zechstein with the Guadalupian/Lopingian boundary (e.g. Słowakiewicz *et al.*, 2009) ignores the fact that rapid changes of δ^{13}C values in basal Zechstein are not compatible with the gradual changes of δ^{13}C values recorded at the Guadalupian/Lopingian boundary (Tierney *et al.*, 2009). Consequently, the lower boundary of the Zechstein should be placed within the Lopingian, and it is definitely not older than 258 Ma.

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Strontium isotopic composition of the Middle Miocene Badenian gypsum of the Carpathian Foredeep (southern Poland and West Ukraine)

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Many ancient evaporite deposits interpreted as marine in origin in fact have a more complex origin. The earlier geochemical studies and models suggested recharge proportions during Badenian (Middle Miocene) halite precipitation of the Polish Carpathian Foredeep (CF) of between 20-30% seawater and 65-70% continental water, with 5- 10% of the continental waters recycling previously precipitated halite (Cendón *et al.*, 2004). Kasprzyk *et al.* (2007) reported two 87Sr/86Sr ratios (0.708915 and 0.709157) from the Badenian primary gypsum of the Polish CF and concluded that it was formed from marine brines that were subject to an important inflow of continental waters. We have studied the strontium isotope compositions in two sections of primary gypsum in the CF (Borków in southern Poland and Mamalyha in West Ukraine) which were previously subject both to the study of minor and trace elements including strontium content, and to the study of sulphur and oxygen isotopes. The $^{87}Sr/^{86}Sr$ ratios in Borków have values ranging from 0.708873 to 0.708944 (n=15), with a mean of 0.708913±23, and are thus invariably higher than that of their contemporary seawater. They show a clear time-related pattern, with an upsection increase of the $^{87}Sr/^{86}Sr$ ratios. Primary gypsum carries and generally retains the strontium isotope ratio of the water from which it precipitated, and thus it records the nature of water body. Postdepositional alteration of the strontium isotope ratio is very unlikely in the Badenian primary gypsum as it would need the passage of the large amounts of water containing foreign strontium to change the ratio. However, the Borków gypsum section shows consistently higher $^{87}Sr/^{86}Sr$ compared to values expected for formation in a Middle Miocene open ocean. This would suggest a local source of Sr enriched in 87Sr, but one would expect a dominant influence of Sr from Mesozoic carbonates which formed the bulk of the foreland, i.e. the Sr-isotope ratios should be lower than those for contemporary Miocene. The $^{87}Sr/^{86}Sr$ ratios of Mamalyha gypsum vary from 0.709154 to 0.709838 (n=6) and are strongly divergent from coeval oceanic values. The gypsum from the lower part of the section shows much higher ratios than the gypsum from the upper part. The higher strontium isotope ratios are accompanied by both $\delta^{18}O$ and $\delta^{34}S$ divergent from coeval oceanic values. The $^{87}Sr/^{86}Sr$ ratios of minerals in marine, bedded evaporite deposits are commonly higher than that of contemporaneous sea water what is often explained in terms of secondary origin or recrystallization of these minerals in presence of radiogenic 87Sr-bearing fluids, mostly from a detrital source, but the Mamalyha primary gypsum is very pure and clay intercalations are very thin and rare. High radiogenic $^{87}Sr/^{86}Sr$ ratios in primary gypsum of the Mamalyha quarry thus indicate important radiogenic strontium non-marine contribution to the Badenian basin, and the possible source are Lower Proterozoic and Lower Archean crystalline rocks occurring at the East European Platform some 100 km to the east.

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Dynamic controls on accretion and lithification of modern gypsum-dominated microbialites: insights from stable isotopes, trace element composition and fine scale petrography

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Subaqueous gypsum-dominated microbialites are unusual in modern hypersaline environments. However, detailed petrographic analysis of key Precambrian stromatolitic sequences suggests that gypsum may have been the primary mineral phase in some early microbialites (Hardie, 2003). Accordingly, a more complete understanding of the mechanisms by which gypsum-dominated microbialites form today is critical for understanding the significance of these features in late Archean carbonate-evaporite facies transitions. Here we report decimetre-sized, subaqueous gypsum-dominated microbialites coated by photosynthetic microbial mats and growing in the shallow waters (<1 m depth) of a restricted lagoon on the Archipelago Los Roques, Venezuela. The surface waters in this hypersaline perennial pond are characterized by temperatures in excess of 30ºC, elevated alkalinity (164 meq/L as $CaCO_3$), pH (~9.1), and Mg/Ca ratio (6.1). The morphology of Los Roques, microbialites, consisting on crudely laminated to clotted internal fabrics, resembles the thrombolitic fabric of Aitken (1967). Detailed petrographic analyses of these thrombolites show that the mineralogy consist primarily of gypsum and calcite pseudomorphs after gypsum; the former likely formed through a biologically-mediated process of HS-oxidation, while the latter was controlled by the heterotrophic respiration of the organic matter trapped during accretion. The geochemistry and stable isotopes of the carbonate phases further reflect a very active transport of reactants within the porous structure and the interplay of organic and inorganic carbon reservoirs during precipitation of early-diagenetic carbonate cements, respectively. Early attempts at distinguishing the mineral paragenesis in Archean to Proterozic stromatolites have not typically considered the extent in which microbially mediated early diagenetic processes obliterated the primary gypsum textures influencing the chemical signatures of the resulting carbonate replacement phases. In this contribution, by examining the textural and chemical signatures of early diagenetic calcite pseudomorphs after gypsum on these unusual actively growing subaqueous thrombolites we demonstrate how the complex interplay between bacterial activity and environmental conditions promotes the calcification of gypsum.

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Dilute PDC´s interacting with a body of water: the Copahue surges

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Known examples of pyroclastic density currents (PDC´s) blowing on water includes the Krakatoa 1883, Mt. Peleé (1902), Santorini 1628 B.C. and the recent examples of Montserrat 1996; 2003. Krakatoa 1883, was particularly elucidating because the surge, traveled 80 km over the sea until the Sumatra coast. In this case, distal facies decrease in sorting coefficient, median grain size and thickness. Here we present preliminary studies of facies changing in a dilute PDC because it blow on a lake and deposit inland of the shore line. The flow initiates at the present active crater of the Copahue volcano, descend by the canyon of Agrio river (12 km), cross over the Agrio lake (2 km) and deposit inland (1.8 km). Preliminary results of distal facies did not reveal significant changes in particle concentration or sorting or size. Notwithstanding, a conspicuous alternation of ductile and dry bed sets indicates both steam-enriched and normal pulses of the surge. Our study is significative to better understand the flow dynamics of dilute PDC´s before and after the interaction with a body of water, in particular, the role of steam and particle segregation in the regime of transport and deposit of dilute PDC´s flowing over water.

The Caviahue Caldera revisited - Preliminary results

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The depression of Caviahue has been previously studied by several authors and two competing hypothesis have been proposed to explain its origin and related deposits. On one side, it has been suggested an origin as a collapse caldera, while on the other side, it has been interpreted as a tectonic depression with associated volcanism. One of the main problems concerning the origin of this depression, which remains still unresolved is the apparent lack of correspondence between the intra-caldera and extra-caldera deposits (> 160 km^3 and 7 km^3, respectively). In this contribution, we present an alternative explanation of the origin of the Caviahue depression based on a revision of previous data and detailed field work, which regards it as a passive collapse caldera developed under a strong structural control in the framework of a pull-apart local tectonic setting. The origin we propose allows to satisfactorily explain the volume correspondence between caldera deposits and depression and to interpret the subsidence history in a simpler manner. Our results indicate that both intracaldera and outflow facies correspond to different pyroclastic flow deposits which may be interpreted as correspond to a caldera-forming sequence. Following a pre-caldera eruptive episode with localized strombolian activity represented by scoria-cones and low-volume lavas, a catastrophic opening of major conduits along the main fault borders of a pull-apart structure fed large volume pyroclastic density currents that generated proximal and distal facies. Interbedded volcaniclastic deposits indicate short time gaps between explosive events or the existence of syn-depositional reworking. No plinian fall deposits preceded the emplacement of pyroclastic flows, thus suggesting that the caldera-forming eruption immediately developed into massive proportions, as it occurs in many other large collapse calderas with a similar strong tectonic control. The caldera eruption continued with the emplacement of high degree and low aspect ratio ignimbrites inside and outside the caldera, forming the top of the caldera-forming sequence. After this caldera-forming episode subsidence in the Caviahue depression continued at a much slower rate controlled by the opening of the pull-apart structure and allowing the deposition of continental sediments. Post-caldera volcanism has continued till present concentrated at the western border of the caldera giving rise to the construction of the Copahue stratovolcano.

Understanding the growth of continents using a simple method for estimating sediment flux from ancient shelf-margin successions

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Rates and patterns of continental growth are a consequence of the magnitude and distribution of sediment flux across continental margins. Estimation of sediment flux for ancient siliciclastic successions has been problematic despite its importance in stratigraphic models, and has most often been expressed qualitatively, or with a proxy such as depositional rate. Recent work has utilized shelf-margin accretion rates as proxies for sediment flux. Accretion rates are useful for comparing relative sediment flux between different shelf margins but do not give actual sediment fluxes values which would (1) allow interpretation of paleoenvironmental conditions in the source area, (2) allow comparison with modern analog systems, and (3) provide values to constrain boundary conditions of stratigraphic models. A simple inversion scheme for estimating sediment flux from ancient shelf-margin successions is presented here by treating shelf-margin clinoforms as similar repetitive forms created by migration at a rate equal to the shelf-margin progradation rate. Assuming sediment conservation, deposition can be broken into components of (1) response to subsidence and sea-level changes, and (2) basinward migration of the clinoform profile. By combining the wave equation (depositional rate equal to the product of progradation rate and depositional slope) with the Exner equation (depositional rate equal to the spatial change in sediment flux) and a source/sink term (accounting for subsidence and sea-level changes), we integrate for sediment flux and find that at any point along the clinoform profile, the sediment flux is a function of progradation rate, subsidence/sea-level change rate, and elevation of the clinoform profile. An advantage of this methodology is that it requires only two- dimensional data (i.e. dip-oriented cross-sections) rather than three- dimensional volumes, making it ideal for use with sparse subsurface datasets, as well as with outcrops. This methodology is also useful for analyzing aerially limited datasets because it can predict the flux of sediment transported beyond the area of data coverage. This approach is able to accurately reproduce the sediment-flux estimates of previous workers from several margins (the Fox Hills-Lewis, Zambezi, New Jersey, and North Slope margins) using both volumetric and forward- modeling methods. Furthermore, the distribution of sediment flux across ancient shelf-margin deposits is shown to be analogous to the distribution predicted by theoretical models while the magnitude of flux is comparable to modern river loads. The methodology is also used to derive input parameters for geometric modeling of the Ebro margin. Transformation of flux estimates into a mass-balance framework indicates that approximately two-thirds of continental sediment is exported off of the shelf into deeper water at geologic timescales. These observations suggest that repetitive delivery of sediment to margins by shelf-edge deltas is fundamental to the long-term process of continental accretion. An understanding of the transfer of material from continents to continental margins is also crucial to unraveling global biogeochemical cycles (e.g. the carbon cycle). Our findings allow us to make an estimate for the flux of terrestrial-derived particulate organic carbon (POC) to the deep ocean where it is buried for geologic time intervals.

The stratal signature of backwater hydraulic conditions in Campanian Lower Castlegate Sandstone paleo-rivers, Book Cliffs, USA

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The Campanian Lower Castlegate Sandstone of Utah provides an exceptional record of downstream transitions in fluvial deposition. The Lower Castlegate changes basinward from amalgamated channel sandstones to heterolithic channel lenses within overbank deposits and finally to heterolithic channel fills incised into underlying marine shoreface deposits. These transitions are interpreted as downstream changes in river morphology from braided streams to sinuous channels which are entrenched in the distal reaches. The most distal exposures of Lower Castlegate fluvial deposits are isolated mud-filled channels with thin overbank deposits that are interpreted to result from near-complete deposition of sand within the river system which created an apparent disconnect between the distal pinchout of the fluvial sandstone and coeval shoreline deposits. Paleo-hydraulic analyses along a downstream-oriented outcrop transect in concert with observations of facies and architectures indicate that the stratal signature of the Lower Castlegate Sandstone is influenced by backwater hydraulic conditions in the distal reaches of the paleo-rivers. A transition from normal-flow conditions to backwater-influenced hydraulics arise where the channel bed elevation falls below mean sea level. The changing hydraulic conditions promoted downstream fining and sorting of bed material (sand) which resulted in a significant change in the morphodynamics of the Lower Castlegate rivers. Progressive downstream increase in flow depth indicates divergence of the channel-bed slope from the water-surface slope, and is characteristic of the backwater reach. A basinward transition from a zone of uniform paleo-flow depths to a zone of downstream increasing paleo-flow depths is recognized as the transition from normal flow to backwater influence within the Lower Castlegate paleo-river system. Associated with this transition is the downstream limit of dominant bedload transport, as shown by grain-size distributions of bar-material sediment within the Lower Castlegate. Coinciding with decreased bedload transport and volumes of bed material, the paleo-river morphology transitioned downstream from a highly mobile and avulsive braided stream to single-thread channel with lower local avulsion frequencies and rates of lateral channel migration. Diminished bedload transport also resulted in the incomplete coverage of the channel bed by alluvium, which promoted local erosion and incision. Though the basal surface of the Lower Castlegate is erosive, it does not reflect a significant unconformity or sequence boundary. It is instead interpreted as a composite scour surface created by erosion at the base of an avulsing and laterally-migrating river system. Comparison of the Lower Castlegate Sandstone with the modern Mississippi River reveals striking similarities in sediment distribution, sorting, and patterns of deposition and erosion when scaled by the length of the backwater reach and median grain size at the upstream limit to the backwater reach. The demonstrated similarity to a modern system with known hydraulic conditions confirms the interpretation that the main factor controlling the spatial variability of Lower Castlegate fluvial strata was downstream loss of perennial bedload which was influenced by the presence of backwater hydraulic conditions. This study marks the first recognition of the effects of backwater conditions on the rock record.

Stratigraphy and sedimentology of deposits of slope in the south of the Parana State (Brazil)

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This research was carried out in alluvial and alluvial-colluvial deposits has as objective to identify the characteristics of the sediments and the deposit stratigraphy of the low and middle slope in the south of Parana state - south of Brazil. In the outcrop distinct stratified layers are pointed out alternated with rich layers in palaeosoil. Cut-and-fill structure with internal sedimentary structures is also in evidence. Construction of the geological profile, grain size analysis, micromorphology and dating were the techniques used. The grain size analysis showed tree large texture groups. The first group related to the alluvial-colluvial deposits is mostly sand-loam. The second group is related to the alluvial deposition of the sandy grains which alternate with colluvial materials. The third constitutes of deposits of cut-and-fill structure and typical alluvial fill. In profile the bottom sedimentary structure is planar-bedding formed by loam and sandy grain, whereas the top is formed by cross-bedding structure and very poorly sorted sediments. Lens show layers of several size grains representing the episodic flux conduction of each layer, inserted in a broaden climate conditions that deposited the group of lenses. Analyses of a thin section of alluvial-colluvial and alluvial beds showed that the sediments have been submitted to moderate to very pedogenetical processes. The thin section of the palaeosoil presents pedologic features such as typical cutans and cutans of fill, hydrated iron oxide nodules, mud cracks and papules indicating physical alteration or disturbance. As a conclusion, this palaeosoil developed in bushy vegetation, more likely grass, since none of the biotubules have been bigger than 2 cm of diameter. Desiccation features without encapsulating the allochthonous skeleton denote a long period of dry climate. The thin section of the alluvial beds showed sindepositional structures well preserved or little disrupted. The normal and inverse gradation suggest that the deposition occurred due to variable intensity flux. The good preservation of the sedimentary structures shows physically undisrupted features like pedogentic features. The thin sections are often bimodal, very well selected, mainly with quartz skeleton. Thin section of the top of the cut- and-fill structures or palaeochannel presents mostly well-preserved stratification, with uncommon disrupt of the isotulos. The skeleton of these structures is constituted by quartz, shale, sandstone and soil relict. The deposits show that in periods of environmental stability, when palaeosoil evolved, the set of events were alternated between more viscous or less viscous fluxes. The palaeosoils were very important for the interpretation of the slope stratigraphy. However, the cut-and-fill structures show stoppage in this alternating sequence; in other words, in different periods there were deposition and dissection in the channel. The periods of deposition were dated 26.830 years BP (+/- 2.600 years) and 22.100 years BP (+/- 2.700 years). The shape of the palaeochannel and of the sediments overlying indicate a third period of deposition subsequent to the latter. We conclude that the deposition in the bottom of the valley is due to environmental instability which incorporates processes of fast linear erosion in the heads and deposition in the valley.

Climate reconstruction based on high-resolution palynological analyses of Lake Pannon sediments (Late Miocene, Central Europe)

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Environmental changes within lake systems are quick processes, which are not easily detected within paleontological studies. Best results are achieved by high-resolution analysis of cores, which allow describing even small scale changes on decadal to millennial time spans. Rhythmic patterns in these records may be related to Milankovitch and even sub- Milankovitch cycles, which are rarely resolved in pre-Pliocene lakes. The clay pit Mataschen in the Styrian Basin of SE Austria provides ideal conditions for such high-resolution palynological analysis. Within our projects two subsequently 50-cm-long cores are studied with a sample density of 10 mm and analysed for pollen and dinoflagellate assemblages. In addition, the ostracod assemblages are analysed in 5 mm intervals. First results suggest a stable lake level during deposition of the first core. This assumption is based on the absence of significant variations in the abundance of the dinoflagellate *Impagidinium* sp. and the stable amount of Pinaceae. Fluctuations observed in the pollen spectra of other taxa are thus supposed to represent changes in the surrounding vegetation. Most striking is the coincident shift of *Spiniferites* sp. and heterotrophic dinoflagellate cysts with changes in the composition of the pollen assemblage. While the differences in the dinoflagellate assemblages are most likely based on the nutrient content of the surface waters, the pollen reflect variations of the vegetation zones. The dominance of mesothermic trees is replaced by a high amount of grasses such as Poaceae, Cyperaceae and *Sparganium* sp. Soon after, forests start to spread again with a rising number of *Abies* sp., *Pinus* sp. and *Cathaya* sp. This distribution seems to be triggered by climatic conditions, especially by a decrease of precipitation. Geophysical data (magnetic susceptibility and gamma ray) reveal several highly significant cyclicities and point to astronomical forcing throughout the section. Based on estimations of sedimentation rates, the described high frequency vegetation shifts seem to have happened within only few tens or hundreds of years during the earliest Late Miocene.

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REE+Y distribution in dolostones of the Gandarela Formation, Iron Quadrangle (eastern Brazil): a record of paleoproterozoic seawater

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The distribution of the REE+Y in marine chemical sediments and rocks have long been recognized to be of major importance in recording the conditions of contemporaneous seawater, due to the homogeneity of the partition coefficients between carbonates and seawater. Even though dolostones mostly represent limestone replacement, much research has shown that dolomitization does not affect the primary REE+Y pattern, especially if dolostones are early diagenetic in origin. Thus, the trace element pattern obtained from the early dolostones of the Gandarela Formation may record the general seawater composition during deposition and early diagenesis of a Paleoproterozoic carbonate platform. The Iron Quadrangle comprises Archean greenstone terranes of the Rio das Velhas Supergroup and Paleoproterozoic and platform metasediments of the Minas Supergroup (MSG). The Itabira Group (MSG: Cauê Formation, that hosts giant iron-ore deposits, overlain by the Gandarela Formation) and the underlying phyllites of the Batatal Formation represent the lower marine transgressive sequence over the fluviodeltaic sandstones of the Moeda Formation. The Gandarela Formation (200m thick) starts with finely laminated dolomitic marl (80 m) overlain by siliceous itabirite which grade into calcitic itabirite (25 m) and into grey dolostones (55m), which is siliceous at its base. This unit is unconformably covered by black phyllite (7m). Heterogeneous pink dolostones (66m) represents the end of the carbonate platform development by sub aerial exposure. It is cut on its uppermost part by an erosional surface. Twenty seven samples representative for all units were selected for geochemical analysis. Major elements were analyzed by XRF while minor and trace elements were analyzed by ICPMS. The rare earth elements and yttrium were normalized to those of Post Archean Australian Shale(PAAS). The basal marl unit is depleted in REE+Y and displays a sub horizontal trend parallel to the normalizing shale, with extremely low values (<0.1 ppm). The overlying itabirite unit is depleted in REE+Y, with a distinct positive anomaly of Y and a Ce negative anomaly. The total REE+Y increases upsection, and may record some facies changes. The pure carbonate units (grey and pink dolostones, at the top of the section) have a very similar pattern with depletion in LREE and enrichment in HREE. In this carbonate sequence, the positive Y and Gd anomalies as well as the negative Ce anomaly represent the compositional trend of the paleoproterozoic seawater, quite similar to the modern oceans. Overall, the REE concentration in the pure carbonate units is on the order of 0.500 ppm and very similar to other paleoproterozoic and younger sequences elsewhere. On the other hand the distribution presented by the marl unit is anomalous and might results from silicification. The PAAS-normalized REE+Y pattern from the itabirite layer does not differ considerably from the dolostones where a positive Eu anomaly is absent, while Y, Gd and Ce anomalies are present. Petrographical and geochemical evidences indicate that the carbonate units of the Gandarela Formation have not undergone hydrothermal or detrital (shale) contamination during deposition or early diagenetic evolution; anomalous results are related to replacement of dolomite by silica, observed only in the lowermost marl unit. Therefore, results obtained from carbonate rocks as well as from itabirites may be considered as representing a reliable proxy for a hypotetic Paleoproterozoic seawater REE pattern and record the atmospheric evolution at that time.

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Lacustrine evidence of anti-phase distribution of moisture in Southern South America during the Neoglacial period

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An increasing number of lacustrine records is now available for southern South America east of the Andes. As a result a network of well-studied sites is emerging allowing to track hydrological changes throughout time at a regional scale. New limnogeological results spanning the Holocene across the subtropical Pampean plains of Southern South America are compared with lacustrine records covering both Andean and extra Andean sectors of eastern Patagonia. The development of contrasting hydrological patterns can be observed between the Pampas (Laguna Mar Chiquita, 30°S; Laguna Melincué, 34°S; Lagunas Encadenadas del Oeste de Buenos Aires, 37°S) and eastern Patagonia (Lago Frías, 41°S; Lago Cardiel, 49°S; and Laguna Potrok Aike, 52°S) at both sides of the South American Arid Diagonal (AD) during prevailing warm or cold climatic phases, respectively. Paleohydrological reconstructions suggest wet conditions in regions located west and south of the AD, like Patagonia or even the Central Andes, during cold climatic phases such as those occurred during neoglaciations including the Little Ice Age (LIA). These phases are characterized by a dominant Pacific source of moisture. Conversely, dry conditions can be proposed for the same climatic interval across the subtropical low-lands east of the AD. These areas are mostly under the influence of an Atlantic summer rain regime. Conversely, extensive dryness across Patagonia and wet conditions in the Pampas can be inferred during warm climatic phases such as the Medieval Climatic Anomaly or the last part of the 20th century. This new paleohydrological data from Patagonia and the Pampean plains further indicate that the development of this anti-phase hydrological pattern was active only after the middle Holocene. Thus, it appears as contemporaneous to an intensification of the Southern Westerlies in concert with a weakened Monsoonal circulation. The anti-phasing cold/wet vs. cold/dry hydrological conditions at different latitudes reveal that increased rainfall triggered by intensified Westerlies in Patagonia are synchronous with a diminished advection of humidity from the tropics to the subtropics.

Mass-transport deposits on the glaciated eastern Canadian margin: variation with ice distribution, regional margin morphology and progradation

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This paper synthesises the factors that influence the distribution of different styles of Quaternary MTD in time and space on the eastern Canadian margin. Different types of progradational and erosional margin each has a different assemblages of mass-transport deposits. Widespread Heinrich layers, with a strong acoustic signature, and the differences between glacial and interglacial sedimentation provide good stratigraphic control on the age and frequency of mass-transport deposits. Our general model appears applicable to other margins. Progradational margin segments occur (1) on low gradients seaward of ice streams, where glacigenic debris flows predominate, and (2) on smooth slope segments seaward of shallow shelf banks where sediment falls out from meltwater plumes. Erosional margins are either (3) deeply dissected by submarine canyons, extending to a continental rise dominated by turbidites, or (4) have shallow canyons to ~1500 m water depth, cutting a steep slope, with a base-of-slope ramp with abundant MTDs. (5) Composite margins resemble the erosional types in the distribution of canyons and depositional facies, but have prograded overall through the Quaternary by deposition of shelf-edge till. Each setting has a distinctive assemblage of MTDs. (1) Glacigenic debris flows are restricted to ice maxima seaward of ice streams; at steep outlets, they transform to turbidity currents. (2) Progradational smooth slopes and sediment drifts are characterized by thin-skinned failures initiated on local steep gradients and retrogressing to the till limit where present on the upper slope, producing thin debris-flow deposits and turbidites. Such failures leave numerous step-like unconformities in the overall progradational slope. They occur in multiple drainage systems and are interpreted to be seismically triggered. Their magnitude- frequency relationship is similar to that for earthquakes, with large failures extending more than 100 km along the slope with a recurrence interval of about 10,000 years. Erosional margin segments (3) and (4) have major blocky failures originating from the steep upper slope or canyon walls, involving a variety of failure and transport mechanisms. Retrogressive slumps occur in surficial material on intervalley ridges, similar to those in margin type (2). Type (3) segments, with deeply incised canyons, form by erosion from hyperpycnal meltwater flows at the ice margin. Many of the MTDs are trapped within canyon floors, but larger flows spread out on the rise. In some cases, such blocky MTDs are recognised in multiple canyons, suggesting a seismic trigger. Type (4) segments are also characterized by large blocky failures, which are less frequent than the retrogressive failures on type (2) margin segments, but some correlate chronologically with nearby earthquake-triggered retrogressive failures. In some cases, failure is associated with shallow incision of submarine canyons and involves slope sediments; in other cases, the outer shelf appears to have collapsed. Such major bank edge failures may correlate with maximum ice advance. Composite margin type (5) commonly shows characteristics intermediate between types (3) and (4). The role of MTDs in overall deposition on the margin is thus dependant on the tectonically controlled regional gradient, the type of ice margin and its proximity to the shelf edge, and whether mass-transport flows break up and accelerate as turbidity currents or remain blocky. Distribution of failures in time and space suggests most are triggered by rare earthquakes. The distribution does not support an important role for gas hydrates. Outer shelf ice loading may trigger some large failures and shelf-crossing ice streams form glacigenic debris flows. Bottom current intensification during glaciations and lower sea levels may contribute to slope undercutting. The contribution of MTDs to progradation of the margin and aggradation of the basin floor is thus complex, but predictable.

Late Cretaceous change in fluvial style in the Neuquén Basin of Argentina: Sedimentologic and ichnologic evidence

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During the Mesozoic Era, the Neuquén Basin was a wide depositional area located at the central-west of Argentina. In particular, an extensive fluvial system developed all along the north area of the basin during the Late Cretaceous. Fluvial deposits of the Anacleto Formation (Late Santonian – Early Campanian) at the anticline of Ranquil-Có (southern Mendoza Province) are analyzed and compared with outcrops from other areas of the basin, highlighting differences in their dynamic and possible controls on sedimentation. This study was based on the analysis of several sections along a 3km outcrop belt. Lithofacies and architectural elements were characterized in order to interpret depositional processes and sedimentary environments. Three gravel lithofacies (Gm, Gt and Gp), four sandy lithofacies (Sp, Sr and Sh), and two mudstone lithofacies (Fm and Fl) were defined. Associations of these lithofacies and analysis of the geometry of sedimentary bodies allows differentiating various fluvial architectural elements. The intrachannel elements identified gravel channels (CH I) and sandy channels (CH II). These latter forms consist of multi-storey fills. Channel ichnofaunas are characterized by moderate to high density and very low ichnodiversity of vertical trace fossils probably produced by suspension feeders and emplaced at the top of the channel-fill deposits between sedimentary events. The assemblage consists of *Skolithos* isp. and *Diplocraterion* isp., representing a non-marine occurrence of the *Skolithos* ichnofacies. This ichnofacies is typical of moderate-to high-energy environments. Presence of escape structures at the base of channel-fills is consistent with rapid deposition. Transverse bars spread across gravel and sandy channels (GB and SB) aggrading and migrating in a downstream direction. Lateral accretion elements (LA), such as point bars with low angle accretional surface, are recognized also. Point bar deposits are also intensely bioturbated by elements of the *Skolithos* ichnofacies (*Skolithos* isp. and *Diplocraterion* isp.). These deposits are characterized by high density of trace fossils and very low ichnodiversity. Trace fossils are visibly at the top of each surface on positive relief and due to differential erosion and filling. Presence of vertical burrows of suspension feeders is related to high oxygen levels and organic particles in the water column in a moderate-to high-energy environment. Opportunistic producers colonized point-bar deposits during times of reduced sedimentation rates followed by pulses of erosion and rapid sedimentation. Floodplain architectural elements (OF), such as crevasse channels (CS I) and crevasse splay (CS II) have been identified. These elements are interpreted as evidence of strong climatic seasonality in the area. Two different fluvial systems have been interpreted: a high sinuosity meandering system (SF II), and a braided system (SF II). The lower interval of the Anacleto Formation is represented by the Fluvial System I characterized by sandy channels (CH I) with transversal sandy bars (SB) and lateral accretion elements, all of them distinctive of high sinuosity meandering rivers. Floodplain deposits (OF) are thick and interbedded with crevasse channel deposits (CS I and CS II). The upper interval is represented by the Fluvial System II, which is interpreted as a braided river due to the presence of coarsening-upward packages, gravel channels (CH I) with gravel transversal bars (GB), absence of lateral accretion surfaces and paucity of floodplain deposits. The uppermost interval of the studied succession consists of thick floodplain deposits. Changes in the sedimentation styles are due to allocyclic controls, such us tectonic and climatic events, which affected the northern edge of the Neuquén Basin, during the Upper Cretaceous. These factors were responsible for base-level changes that markedly affected fluvial sedimentation in the area.

Ichnolithological associations from the Huamampampa Formation: a methodological approach to understand open shelf and estuarine sedimentation during the Devonian of the Sub Andean Foothill, Bolivia

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The Huamampampa Formation has been classically interpreted as the product of shallow open-marine sedimentation in a Devonian shelf. However, recent ichnological and sedimentological studies conducted on six cores and some outcrops have allowed the recognition of the occurrence of brackish water sedimentation during the deposition of the Huamampampa Formation.Trace fossils identified in cores and outcrops include *Arenicolites, Asterosoma, Bergaueria, Chondrites, Cylindrichnus, Diplocraterion, Helminthopsis, Macaronichnus, Neonereites, Palaeophycus, Phycodes, Planolites, Rhizocorallium, Rosselia, Skolithos, Teichichnus,* and *Zoophycos.*These ichnogenera are grouped in the *Cruziana*, *Skolithos* and an impoverished ichnofacies from sections of the Huamampampa Formation analysed along the Sub-Andean foothills in east-southern Bolivia. The aim of this contribution is to show the methodology applied to carry out this study, which includes the measurement every 5 cm of Numerical Facies (NF), Bioturbation Index (BI), Ichnodiversity Index (IdI), Ichnogenus Size Ordering (ISO), and the geostatistic analysis of their obtained curves. Then, ichnofacies and ichnolithological associations have been used to recognise different subenvironments in a tide-dominated delta (or estuarine)-shallow marine environment. Nine ichnolithological associations were identified.
i) Sandy facies with *Cruziana* ichnofacies (S-Cr), high bioturbation and ichnodiversity (assigned to shallow marine, upper shoreface). ii) Sandy facies with Impoverished ichnofacies (S-Imp), low bioturbation and ichnodiversity, general size reductions of ichnogenera (tide-dominated delta or estuarine, longitudinal bars, brackish water). iii) Sandy facies with Impoverished-*Skolithos* ichnofacies (S-Imp-Sk), low bioturbation and ichnodiversity, isolated *Skolithos* (top of longitudinal bars, high-energy pulses). iv) Sandy facies with belts of *Arenicolites* (S-bAr), horizontal levels of just *Arenicolites* up to 5 cm thick (high energy pulses crossing different facies, in the delta front or in the shoreface). v) Sand-rich heterolithic facies with *Cruziana* ichnofacies (Hts-Cr), moderate bioturbation and ichnodiversity (shallow marine, upper to middle shoreface). vi) Sand-rich heterolithic facies with *Cylindrichnus* and *Rosselia* (Hts-Cyl-Ros), moderate bioturbation and low ichnodiversity (shallow marine, upper shoreface).vii) Heterolithic facies with *Cruziana* ichnofacies (Ht-Cr), high bioturbation and ichnodiversity (shallow marine, transition zone between lower shoreface and offshore, open shelf). viii) Heterolithic facies with Impoverished ichnofacies (Ht-Imp), low bioturbation and ichnodiversity, reduced size of trace fossils (tide-dominated delta or estuarine, delta front, brackish water).ix) Sandy facies with no bioturbation (S-Not Biot), interpreted as fluvial channels.

Modern microbial mats from hypersaline lakes in the Puna, Andean Range, Argentina

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High-altitude lakes found in the Puna and Andean regions at the northwest of Argentina are considered extreme aquatic habitats. Microbial mat ecosystems found in these lakes are of potential biotechnological interest because of the organomineralization compounds that they produce. We describe microbial mats collected from three locations in the Argentinean Puna (Socompa Lake, Tolar Grande and Diamante Lake) and discuss why similar microbial mat communities produce different microbialite structures with varied mineral composition. The Puna region represents a large basin that is fragmented into a system of minor interrelated basins demarcated by mountains. Its climate is arid, with annual precipitation less then 350 mm, and daily temperatures range from -10 to 20ºC in summer and -15 to 10ºC in winter. Due to its high altitude and low latitude geographical position, the Puna region is exposed to high solar irradiance (~165% of the value at the sea level), especially in the UV-B region, where the instantaneous flux can reach up to 17 W/m^2 (approximately half the amount on equatorial Mars). At the bottom of the Puna basins, large lakes rich in minerals have formed. Due to irregular inter-annual precipitation, the lake limits are variable and, occasionally, the lakes become totally dry and are transformed into large salars. The lakes harbour microbial mats associated with mineral precipitation. Due to the extreme environmental conditions, such as residual volcanic activity associated with sulphur availability, hypersalinity, high UV irradiation, low O2 pressure and low nutrient availability, these modern stromatolite-like ecosystems constitute excellent models to study geochemical cycles and biogeochemical interactions during the early Earth. Chemical analyses revealed significant differences amongst the studied lakes. The Socompa Lake (pH 8.5) contains more nutrients (e.g., P=232 mg/L) and organic matter (19%), as well as large quantities of silicium (450 mg/L) and chlorophyll a (70 µg/L) due to diatoms. The Tolar Grande Lake (pH 7.2) contains large quantities of Mg (86 mg/L) and Ca (206 mg/L) but low concentrations of organic mater (1%), silicium (16 mg/L) and chlorophyll a (0.2 µg/L) due to diatoms. In the same way, Diamante Lake (pH 10) is also formed by abundant inorganic material but shows very abundant arsenic (As 234 mg/L) and phpsphorous (225 mg P/l, 700 mg PO4/L). Minerals associated with or precipitated within the studied microbial mats also differ. The mats from the Socompa Lake are composed mainly from aragonite, and can thus be considered as typical stromatolites. On the other hand, the mineral composition of the Tolar Grande (gypsum and halite) and Diamante mats (gaylussite and calcite) differ from those largely proposed for stromatolite biogenesis. These lakes are good laboratories to try to comprobe the hypothesis that similar microbial mat communities produce different organosedimentary structures with different mineral composition depending of the physico-chemical environmental conditions.

Late Holocene estuarine mud drapes: a record of human activities and/or climate changes?

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Shallow marine environments and particularly estuaries and deltas act as sediment sinks. As they experience high sedimentation rates, they provide good opportunities for high resolution studies of Holocene environmental changes. Focusing on the late Holocene period, high frequency climate changes and human activities are major forcing parameters of coastal sedimentation compared to global sea level variations. Recent rapidly deposited mud drapes found in estuaries and in the inner continental shelf of western France record increasing mud deposition and exportation of suspended matter mainly originating from the major rivers (i.e. Loire, Garonne and Dordogne Rivers). A detailed study of one of those mud drapes located in the Marennes-Oléron Bay was performed using a multi-proxy analysis (multi-sensor core logging, grain-size analysis, XRF, spectrocolorimetry, X-Ray imaging, Rock- Eval, foraminifer and mollusc assemblages, radiocarbon dating). Six radiocarbon datings allow building a detailed age model for the last centuries and shows a more than 6 fold increase in mud sedimentation rate from 350 to 150 cal yr BP. This mud is composed of terrigenous material originating from the watersheds as evidenced by Rock-Eval analysis of organic matter. The sudden deposition of mud started around 200 BP and coincides with the end of the Little Ice Age, which is a period of intense climate instability and growth of human activities. Seasonal precipitation reconstructions for the study area covering the period 1500–2000 AD (Pauling *et al.*, 2006) show contrasted trends. During the period of observed mud sedimentation increase, mean annual precipitation rates were low. But a few decades before this period, mean winter precipitation reached a maximum, which could trigger soil erosion. This period is also characterized by major land use changes, including deforestation, agriculture and land reclamation. Both deforestation and agriculture could lead to intense soil erosion and to consequent increase in river sediment load. Land reclamation and related shoreline migration could lead to a decrease in tidal prism resulting, in turn, to positive feedback and sedimentation increase and suspended matter expulsion. As those climate and land use changes are concomitant and lead to similar sedimentation changes, it remains difficult to unravel their respective contributions from this case study. From a thorough literature survey, it appears that a rapid siltation and/or an increase in sedimentation rate were recorded in many coastal environments, concomitantly to major migrations of human population throughout the world, both in time and space. Looking back to other periods of intense deforestation which were not synchronous to the Little Ice Age, such as the Bronze Age in Asia Minor and the 18th and 19th centuries in North America and Southwest Pacific, it has been shown that deforestation has led to similar increase in sediment supply to coastal environments. Comparing those sediment records at a worldwide scale supports the hypothesis that human activities might overcome climate changes to explain the observed mud sedimentation increase in estuaries and inner shelf of western France.

Pauling, A., Luterbacher, J., Casty, C. and Wanner, H. (2006) Five hundred years of gridded high-resolution precipitation reconstructions over Europe and the connection to large-scale circulation. Climate Dynamics, 26, 387–405.

Sedimentology of till deposits in the Lago Fagnano ice lobe, Tierra del Fuego, Argentina

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The grain-size characteristics of different till deposits in the Lago Fagnano valley (54°26′–54°37′S, 66°42′–68°35′W), Tierra del Fuego, Argentina, are herein presented and discussed. These glacigenic deposits were generated by the Fagnano Paleoglacier when it occupied a region of approximately 4000 km², flowing from W to E, as an outlet glacier of the Cordillera Darwin mountain ice-sheet, 130 km westwards from its maximum LGM extension. A Late Pleistocene age (ca. 26 cal. ka B.P.) is estimated. The glacial flow took place along the Fuegian Andes, a mountainous environment of varied lithology: plutonic rocks in the main accumulation area, a sedimentary-volcanic complex in the southern side of the valley and metamorphic and sedimentary rocks in the northern slopes. From a textural point of view, the following till types were analyzed: (a) subglacial till beds, corresponding to the ground moraine of the Arroyo Café, and (b) slope basal till at Cerro Jeujepén and Cerro Michi. The sediment sampling was performed randomly both in exposed outcrops and by means of excavations. The grain-size distribution of the till matrix, between the Φ -3 to 4 fractions, was analyzed at the Centro de Investigaciones Geológicas (CIG, Universidad Nacional de La Plata, La Plata, Argentina). The composition of the clay minerals was also studied using whole rock and clay fraction analyses in oriented samples by means of X-ray diffractometry. At the Arroyo Café site, a stratigraphic section was described, composed by the following units, from base to top: (1) a bluish-grey, lower till bed, with non-exposed base; (2) fine to medium sandy gravels, with interbedded sandy, silty and sabulitic beds, showing intense cross-bedding; (3) a level of clast-supported fine to medium gravels; (4) a second till bed, with medium to coarse, rounded to subrounded clasts; (5) another level of fine to medium grain-sized gravels; finally, (6) a third basal till bed, with fine to medium grain-sized larger clasts. This uppermost basal till is composed by coarse silt (31%) to coarse sand (13%) matrix, with fine gravels (38%), whereas the underlying till bed (4) is dominated by the clayey-silty fractions (90%). Both strata show high variability in the accumulation conditions within ice-contact environments. The grain-size analyses of the till samples obtained along the slopes of Cerro Jeujepén and Cerro Michi show high similarity with those of the upper basal till of the Arroyo Café outcrop. The matrix is mainly composed of coarse silt (30-36%) and coarse sand (16-20%). The content of fine gravels is close to 30 % of the bulk mass. The distribution of the fractions according to total weight shows slope curves very similar between them. At Arroyo Café, the upper till level presents an accumulation grain-size curve similar to the slope till, whereas in the second till bed the total weight curve starts to develop from the Φ 2.5 fractions. No difference between the lithological content of the gravel fraction of the various analyzed groups has been observed. The presence of allochtonous granite and granodiorite clasts in all till types is remarkable, which confirms the glacial origin of these sedimentary beds, indicating that the main feeding of the Fagnano Paleoglacier sedimentary load came from Cordillera Darwin, where these plutonic rock types are outcropping.

Paleo-environmental interpretation and organic geochemistry of the Agua de la Mula Member (Agrio Formation) in the Pampa Tril area, Neuquén Basin, Argentina

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The scope of this work is to broaden the existing paleo-environmental and stratigraphic knowledge of the Agrio Formation using sedimentology and organic geochemistry in a sequence-stratigraphy framework. Eleven facies (F1 to F11) were recognized in the 264 m thick Late Hauterivian limestones of the Agua de la Mula Member (Agrio Fm.), in the Pampa Tril area (Neuquén Province). Outcrop facies analysis enabled the interpretation of specific paleo- environments of deposition within a mixed carbonate-siliciclastic marine ramp. Basal facies (F1) belong to a low-energy marine environment with limited siliciclastic input evidenced by wackstones and mudstones with collapsed ammonites. In F4, the abundance of organic matter (~2% TOC) and bivalves (Neocomiceramus Curacoensis), which lived on substrates under restricted oxygen levels, suggests oxygen-stratified water conditions during sedimentation. F6 is composed by low-organic matter content shales with alternating levels of calcareous concretions interpreted as a low-energy anoxic environment with high siliciclastic input. In contrast, the upper facies (F9 to F11), which occupy higher stratigraphic positions and have lower organic matter content, show evidence of higher energy, likely associated to a wave-dominated and well oxygenated marine environment close to the shoreline. The organic matter analysis performed along the stratigraphic column, revealed a total organic carbon (TOC) content ranging from 0.54% to 3.07%. The Hydrogen Index (HI) values permitted the discrimination of three sample groups that plot in the trends of kerogens types I, II, and III. The microscope study of each kerogen trend reinforced the former division and allowed the recognition of specific organic matter components (amorphous, liptinite, woody, and coaly). The abundance of amorphous organic matter in group 1 samples, corresponding to F4, demonstrates oxygen-stratified water conditions. The samples of the second group, belonging to F6, show a significant content of woody and coaly organic matter components, which represents an important terrestrial input. The thermal maturity estimation derived from measured vitrinite reflectance (%Ro) and Thermal Alteration Index (TAI) places the studied interval in the early oil-generation window. These results correlate to similar values obtained in nearby study areas. The entire succession shows three cycles: two complete transgressive-regressive cycles overlying a third incomplete cycle at the base of the local stratigraphic column, within a succesion deposited in an external mixed marine ramp setting. Each cycle comprises an initial set of retrogradational parasequences, followed by a maximum flooding surface (MFS) and a subsequent progradational parasequence sets. The MFS was recognized on the basis of parasequence stacking patterns and the abundance of amorphous organic matter components, which indicates oxygen-stratified marine conditions and limited sediment input. The uppermost cycle is truncated by an erosive surface, which defines a sequence boundary, below the fluvial facies of the Lower Troncoso Member (Huitrín Formation).

Depositional elements and stratigraphic hierarchy of a basin floor fan system: Unit A, Laingsburg Karoo depocentre, South Africa: a core and outcrop investigation

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Unit A, exposed in the Laingsburg Karoo depocentre, provides an opportunity to assess the evolution of a large basin-floor fan system across multiple physical stratigraphic scales of observation. Unit A is the first and thickest sandstone-dominated unit of the Permian Laingsburg Formation with an average thickness of ~ 350 m in the field area. Unit A is interpreted as a composite sequence set and consists of a stack of numerous smaller depositional elements. From large to small-scale components, the hierarchy of depositional elements of Unit A consists of composite sequence set, composite sequence, sequence set, sequence, system tract, lobe complex set, lobe complex, lobe, lobe element and bed. The hierarchy of depositional components used to describe Unit A is based on the correct description and identification of different types of fine-grained packages and their bounding surfaces. Two main types of fine-grained packages are observed within Unit A: 1) laterally persistent fine-grained packages dominated by claystone with thin-bedded (<2 cm) normally graded fine siltstones that maintain similar sedimentary characteristics for tens of kilometres; and 2) laterally variable fine-grained packages that are siltstone-dominated and are characterised by sedimentary characteristics that may change over short distances (kms). Lateral variations in fine-grained packages include changes in overall thickness, dominant lithofacies, average grain size, and nature of bounding surfaces. The recognition and description of the different fine-grained packages is supported by the detailed study of a 550 m long behind-outcrop research borehole. The core samples the entire succession of Unit A and provides a better insight into the establishment of a hierarchy base on a 1D dataset. Large-scale components, i.e. from sequence to composite sequence set, consist of a lower sandstone-dominated package overlain by a laterally persistent fine-grained package. The lower sandstone-dominated package is interpreted as a Lowstand System Tract and the overlying fine-grained package as the associated Highstand and Transgressive System Tracts. Depositional components of the Lowstand System Tract, i.e. from bed to lobe complex set, tend to thin and fine away from their centroid. Compensational stacking patterns exist between successive components, and allow the sandstone-dominated central part of a component to be overlain by the distal (in a strike or dip sense) fringe deposits of the following component.

Reconstruction of provenances for pyroclastic material in the Permian-Early Triassic basin in the South Verkhoyansk region (Northeast Asia)

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Lithochemical and petrographic studies revealed that the Permian-Triassic rocks of the Verkhoyansk complex include volcanics of various granulometric and chemical composition. It is established that pyroclastic material supplied into the sedimentary basin is a derivative of various magmas. The Permian rocks are represented by volcanics of andesite, andesite-dacite and dacite compositions. The clastic material is fresh. It did not suffer weathering and was not transported over long distances. The Induan deposits in the lower part include tuffaceous sandstones and tuffites of basaltic composition grading up section into andesite-basalt and dacite tuffs and tuffites. The results obtained permit establishing the provenances that supplied pyroclastic material into the Permian-Early Triassic South Verkhoyansk basin of the Verkhoyansk passive continental margin, and suggest the following scenario for the evolutionary events. The Early Permian was the time of deep-water alluvial fan sedimentary environments, while in the Late Permian deltaic environments were widespread. In the early Early Triassic, a marine transgression occurred that covered the whole of the South Verkhoyansk sedimentary basin. Beginning in the second part of the Induan, mainly shallow-water terrigenous rocks accumulated filling the deep-water basin. Progradation of paleodeltas occurred mainly from south to north (hereafter in present-day coordinates), which was due to the development of a major river system oriented in that same direction. The main source areas for the clastic material in the South Verkhoyansk basin were, most likely, the Aldan shield, the Okhotsk terrane and adjacent areas of the North Asian craton. In the Permian and Triassic, to the east of the South Verkhoyansk basin there was an active continental margin represented by the Uda-Murgal volcanic arc that could possibly supply pyroclastics of andesite-basalt, andesite, andesite-dacite and dacite composition throughout the time. In the early Induan, a large proportion of pyroclastics of basic composition began to be supplied from a new source located at a great distance from the sedimentary basin. This is evidenced by considerable changes in the chemical composition of clastic material. We believe that formation of the Induan tuffites and tuffaceous sandstones of basaltic composition was related to the eruption of Siberian traps, a major terrestrial volcanic event in the Earth's Phanerozoic history. The eruption occurred over a short period of time (according to some estimates from one to several million years) in an area to the west of the South Verkhoyansk basin in the central part of the North Asian craton. Insignificant manifestations of basaltic volcanism are also reported from the Lower Triassic strata in the proximal areas of the Verkhoyansk passive margin, at the boundary with the Siberian platform. Thus, in early Induan time there were two sources for pyroclastic material in the South Verkhoyansk basin – the western largely basaltic source and the eastern mainly andesitic one. The former source was more intense, which resulted in that only basaltic component is confidently established in the volcanogenic-sedimentary rocks of that age. In the second part of the Induan, the intensity of volcanic activity connected with the Siberian traps was greatly diminished or it ceased at all, as evidenced by the presence, in the deposits of the upper part of the Nekuchan Formation, of only the products of andesite-basalt and dacite volcanism associated with the western source, i.e. the Uda-Murgal arc.

Global sea-level change and the architecture of passive margin sediments: preliminary results from the New Jersey IODP Expedition 313

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In May-July 2009, IODP Expedition 313 used an ECORD "mission- specific" jack-up platform 45-67 km off the coast of New Jersey, in 35 m of water, to core and log Upper Paleogene and Neogene sequences. The goal was to estimate the amplitudes, rates and mechanisms of sea- level change and to evaluate sequence stratigraphic facies models that predict depositional environments, sediment compositions, and stratal geometries in response to sea-level change. Despite the difficulties of coring the sandy material of the shallow NJ shelf, we collected 612 cores at three sites (M0027, M0028 and M0029) with 80% recovery totaling 1311 m in length. The deepest hole (M0029A) reached 757 mbsf; the oldest sediment (uppermost Eocene) was recovered in Hole M0027A. These three holes drilled through the mid-shelf clinoforms and complement the coastal plain (ODP Legs 150X, 174AX) and slope (Leg 150) core datasets, building up a large “New Jersey transect” across the US Atlantic passive margin. Besides the cores, we collected wireline logs at the three sites – gamma ray, resistivity, magnetic susceptibility, sonic, acoustic televiewer and vertical seismic profiles – which, together with multisensor core logs on unsplit cores, provide very precise ties between core-logs and seismic profiles. More than 16 surfaces and/or seismic sequence bounding unconformities mapped around the regional seismic grid are now confidently tied to the cores. The lithostratigraphic description of split cores shows silt-rich supply systems that reveal a notable depletion in clays and a marked difference between the top and the toe of the clinoform bodies. The topset facies succession shows well sorted silts and sands deposited in offshore to shoreface, mixed wave to river-dominated shelf environments giving rise to the toe of slope silts and silty clays deposited below wave base. These sediments are typically interbedded with poorly-sorted silts and sands deposited by continuous down-slope gravity transport processes such as sandy debris flows and turbidity currents during periods of clinoform slope/rollover degradation. The open shelf experienced frequent cycles of dysoxia. In situ and reworked glauconite is a common component of top-set and toe-set strata that also show sharp changes in pore water salinity. The latter reveals a complex pattern of fresh and salt water lenses that track abrupt changes in lithofacies as deep as 400m below the sea floor. Sr-isotopic ages measured on molluscs and forams, reliable biostratigraphic zonation of multiple fossil groups (foraminifers, dinocysts and nannofossils), magnetic reversal chronology and a full range of specific pollen and foram markers verify a nearly continuous record of c.1 myr sea-level cycles and reveal large, unexpected climate variations that may explain facies changes along the slopes of the clinoforms. We found no evidence of sea-level drop below the clinoform inflection point – i.e. depositional shelf break – but the occurrence of shoreface deposits along the slope of the clinoforms and of deep water facies on their topsets suggest large changes in amplitude of relative sea level in the range of 60 m. Stratigraphic backstripping, including calculation of sediment compaction and crustal loading, must be made to derive a more precise estimate of the magnitude of eustatic sea-level change and its role in changes of passive margin sediment architecture.

Storm deposition in temperate carbonate ramps: same causal agent, different deposits

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Depositional models of Neogene shallow-water temperate carbonates in the western Mediterranean are among the best established and characterised within the temperate-carbonate depositional realm. These models display a great variety of sediment types and composition and usually include: 1) an inner coastal belt (beaches, rocky shores, rocky submarine cliffs and spits); 2) a submarine dunes system formed seawards from the coastal environments, 3) an open mid platform where different types of carbonate factories developed and 4) outer platform-slope and basin dominated by finer-grained sediments. In these models, sediment from the factory zones is thought to be transported offshore most commonly by storm currents although seawards migrating sandwaves and high energy events (tsunamites) as well as funnelling of sediment through submarine canyons and channels can be locally significant. Three main types of storm-related deposits are found: 1) tempestites; 2) sediment gravity flow deposits and 3) hummocky and swaley cross-stratified deposits. Tempestites are coarse bioclastic deposits (floatstones and rudstones) intercalated with background facies in the outer ramp, usually dominated by nodular and branching bryozoans, calcitic bivalves and coralline algae. Tempestite beds are decimetre-scale thick, laterally discontinuous with erosive bases, locally amalgamated. Rough fining-upward grading of clasts is observed in some tempestites. Sediment gravity flows occur seawards from factory zone and include debrites and turbidites. Debrites form centimetre to decimetre thick layers consisting of poorly sorted, coarse-grained floatstones. These deposits are intercalated and grade laterally into the turbidites, which consists of grainstones/packstosnes with parallel lamination. Deposits with hummocky and swaley cross-stratification developed seawards from a carbonate factory with coralline algae, bryozoans and bivalves. They comprise calcarenites and calcirudites with components similar to those in the factory area. Hummocks typically are 1 to 2 m wide and a few decimetres in height, and show a crude internal lamination. All three deposit types are interpreted as generated by storm action affecting the temperate carbonate ramps and transporting sediment seawards from the carbonate factories. A combination of local controlling factors (palaeotopography and palaeogeographic configuration) is proposed to explain that storms caused these markedly different facies types. Tempestites are common in low-energy ramps, either in narrow distally-steepened or larger, low-gradient homoclinal ones. Debrites and turbidites developed in moderate-energy, narrow and relatively steep homoclinal ramps. Finally, beds with hummocky and swaley cross-stratification occur in larger homoclinal ramps with steep profiles, affected by high-energy storms. Sediment availability and the presence of an appropriate grain size are critical for the formation of the latter deposits.

Geomorphology of a slope system in a mixed carbonate/siliciclastic setting: submarine canyons in the Great Barrier Reef margin, north-eastern Australia

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The north-eastern Australian continental margin is the largest modern tropical mixed carbonate/siliciclastic depositional system. Three different facies belts occur in this margin: 1) a fluvial-dominated siliciclastic inner-shelf; 2) a large coral reef system - the Great Barrier Reef (GBR) - in the middle- and outer-shelf; and 3) mixed carbonate/siliciclastic sediments accumulated on slope to basin environments. Previous studies carried out on sediment cores from the slope and basin confirm the presence of deposits, including sediment gravity flow deposits, made up of mixed carbonate/siliciclastic sediment in different proportions. However, the sediment pathways from the shelf to deep-water settings and the transport processes operating here remain poorly constrained. Multibeam and seismic data collected by the expedition on the R/V Southern Surveyor (SS07/2007) revealed that the GBR margin is shaped by a large network of incised submarine canyons of different sizes and morphologies that funnel mixed carbonates/siliciclastic sediment from the shelf across the slope into the basin. Here, we present the first geomorphologic characterisation of these canyon systems as a first step to understanding the sedimentary processes and the resulting deposits in the deep-water environments of the GBR margin. The submarine canyons show a latitudinal variation in size and morphology. In the northern study area (Ribbon), submarine canyons are mainly shelf-incised, either connected with shelf channels between the ribbon reefs and/or excavated into the fore-reef slopes. These canyons are 10-20 km in length, slightly sinuous and are deeply excavated into the slope. Canyon heads are well developed, with an amphitheatre shape and fed by several small gullies. Many submarine canyons coalesce in the middle to lower slope into a single canyon valley forming large-scale, multi-sourced canyons. Small blocks and landslides are observed in canyon valleys as well as migrating submarine sandwaves in some canyon floors. Headless, gully-like submarine canyons and deeper slope canyons also occur in this region. In the southern study area (Noggin), submarine canyons are generally slope incised, only locally shelf-indented. These canyons are overall smaller than in the Ribbon region, straighter and incised into the slope to varying degrees. Canyon heads are mostly linear and amphitheatre-shaped to a lesser extent. In general, these submarine canyons have a single source, fed by gullies of different sizes and have a narrow canyon valley in the lower slope. Some canyons pass downwards into small, straight submarine channels excavated into the basin floor. These submarine canyon systems have contributed to shaping the GBR margin and provide unique insights into understanding the fundamental processes operating along a latitudinal transect. These processes have generated different slope morphologies that may have conditioned the depositional style of the mixed carbonate/siliciclastic sediments in the slope and basin. Headward erosion by retrogressive mass failures and downward erosion by sediment gravity flows are the processes involved in the canyon initiation and evolution in the study areas. The different morphology of the canyons in these two areas may result from the interplay of the various triggering factors with local characteristics of the GBR margin, such as the slope gradient, sediment supply and underlying substrate. These different canyon styles may control the morphology of coral reefs growing on the shelf edge as the change in the reef morphology coincides with the change in the submarine canyon type.

Drowned carbonate platforms on a rapidly subsiding margin: morphology, facies and sea-level changes, Hilo, NE Hawaii

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Drowned carbonate (reefs) platforms on rapidly subsiding margins contain a unique and largely unexploited archive of sea level and climate changes. In the Hawaiian Islands, subsidence results from the isostatic response to volcanic loading over the Hawaiian hotspot. Linked to this long-term uniform subsidence (2.5-2.7 m/ka), a series of coral reefs have grown and drowned episodically around Hawaii over the last 500 ky. In the eastern part of the island, offshore Hilo, we observed and sampled six submerged terraces (H1, H2a-H2d and H8, following terminology applied to terraces around the Hawaii Island) between -100 and -1200 m depth using the Hawaiian Undersea Research Laboratory's (HURL) Pisces IV submersible. We describe these drowned terraces, their facies, chronologic data and depositional models; and discuss their evolution in response to variations in sea level, subsidence and volcanic substrate. The terraces are low sinuosity, continuous structures with steep edges, generally following the bathymetric contours and parallel to the modern coastline. Pinnacle barriers and elevated rims are present in the terrace front. Six main sedimentary lithofacies are recognised: 1) Shallow water (0-20 m) coral reef limestones comprising framestones and bindstones built by massive, branching and encrusting corals and shallow-water coralline algal crusts; 2) Intermediate (–20-60 m) coralgal nodules and crusts formed by coralline algal bindstones and floatstones and subordinate corals; 3) Deep-water (~ 60-120 m) coralline algal- foraminiferal crusts and nodules that include bindstones and nodular floatstones of thin encrusting coralline algae intergrown with encrusting foraminifera.; 4) Microbial carbonate encrusting the previous facies and developed at greater depths than the coralline algal-foraminiferal facies; 5) Hemipelagic/pelagic limestones consisting of microbioclastic mudstones, wackestones and packstones, which occur as sediment caps over other facies types and/or filling bioeroded cavities in other lithologies. This facies accumulates in significant amounts in settings too deep for the coralline algal-foraminiferal facies and microbialites to develop; 6) Redeposited limestones include rudstones, grainstones, floatstones and packstones interpreted as sediment gravity flow deposits. Facies in the submerged terraces off Hilo exhibit a backstepped distribution resulting from the uniform subsidence of the area and superimposed sea level changes. As a consequence, a consistent drowning sequence, from shallow to deep water facies, is observed in each terrace. New and existing radiometric (calibrated C14-AMS and U/Th) ages and depth distribution of terraces indicates that terraces resulted from episodic reef growth during the last ~345 ky. Terrace H8 developed ~345 ka ago based on data from the western side; the terrace H2d formed during the penultimate deglaciation; terraces H2c and H2b grew ~80-125 ka ago; the terrace H2a drowned about 50 ka ago. Ages of 8-13 ka for deep-water coralline algal facies on terrace H1 and their upslope equivalent shallow-water facies are consistent with a progressive drowning of terrace H1 during the last deglaciation. In conclusion, under the high subsidence rate of Hawaii, the coral reef terraces drowned during major deglaciations and progressive sea level rise associated with interstadial events. In each episode the shallow- water carbonate factory was rapidly switched-off by rapid relative sea- level rise, backstepping upslope as deeper water carbonates continued to accumulate. Age-depth relationships suggest that the generation of shallow-water production in each terrace was coeval with the deep- water production of previously drowned shallow-water carbonate factories. In contrast to the western side of Hawaii only H1, H2a-H2d, and H8 terraces formed near Hilo. The lack of terraces H3-H7 is likely due to the continuous and prolonged growth of the Mauna Kea volcano in the eastern side of the Ha

Evaluation of mixing processes in turbidity currents using a novel experimental approach

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This study is focused on the modeling and evaluation of mixing processes in turbidity currents with the aid of physical modeling using a novel approach. The objective is to validate and to characterize prediction models, therewith improving numerical modeling as well as natural reservoir prediction. Since the relevance of turbidity currents as agents of transporting coarse sediment was first recognized many authors have contributed to its comprehension and understanding. Yet, because of its complexity many aspects of the process still lack a complete understanding. Despite the bod of work investigating mixing processes (e.g. entrainment, front mixing and erosion/deposition), a better comprehension of the phenomena is necessary as the maintenance of buoyancy has a key role in the flow dynamics. Several entrainment relations have been published on which different parameters of the flow have been related to the mixing rate. However, comparison between those relations showed a great dispersion of the data collected; also, not a good agreement with field data. These evidences suggest that other parameters need to be investigated as well as scale effects. In addition, despite several evidences suggesting that conservative and non-conservative flows present different flow dynamics, not many studies focused on mixing processes on sediment- laden flows. In order to investigate the mixing processes in turbidity currents an Odell-Kovazsnay race-track flume was used to create a density-stratified boundary-layer flow induced with the use of salt and/or sediment. The dense bottom-layer was mechanically driven by a disk pump of variable height and speed; flume was level. The total length of the flume was approximately 6 m with a working straight section of 2 m long, 0.6 m high and 0.15 m in width. While the resulting flow resembles the body of a density current, this flume differs from previous inclined channel experiments in that the flow is not buoyancy-driven but the velocity profile and turbulence are set by the disk pump. Advantages of this setup is that longitudinal uniform flow conditions can be achieved, without requiring an extremely long channel and most importantly, velocity and concentration can be manipulated independently without changing the experimental setup, while in the incline channel experiments such modification of the velocity and concentration relationship requires variations of slope or friction coefficients. Bi- dimensional velocity profiles were measured with an Ultrasonic Velocity Profiler (UVP); also, concentration profiles were obtained through an attenuation-based optical method using a uniform-light board and a CCD Camera. Several experiments had been conducted in which the rate of entrainment was observed for different values of buoyancy excess and momentum, given by the pump frequency. The initial depths of the dense and fresh layers were about 0.14m and 0.42m, respectively. All flows resulted in subcritical regimes and by assuming that the spatial variability is negligible, the continuity equation relates the mixing rate to the temporal variation of the height of the dense layer. The mixing rates showed a good agreement with some prior data acquired by experiments and theoretical analysis. The flow dynamic could be evaluated through analysis of numerous parameters as: bulk Richardson number, local gradient Richardson number, Reynolds number, interface shear-stress, wall shear-stress and Keulegan number. In addition to the acquisition of new experimental data to improve mixing processes prediction, these experiments could contribute to characterization and distinction between conservative and non-conservative flows.

Sedimentation in the littoral zone of lake Verevi, South Estonia

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Studies of sediment cores from the littoral zone of a small lake Verevi (S Estonia, N 58°13´59´´, E 26°24´22´´, area 12.6 ha, maximum depth of 11 m) were conducted in order to reconstruct the sedimentation environment. Main aim was to link the changes in sediment lithology and geochemistry with the changes in the well-established history of lake hydrochemistry and hydrobiology. The study area in the narrow northern part of the lake is shallow (up to 2 m) with flat bottom morphology and protected from the wave action as well as inputs from the catchments by a dense macrophyte cover. The ecological status of the lake was close to natural (moderately eutrophic) from the 1920s until the end of the 1950s. In the 1970s–1990s, the lake became hypertrophic. In the summer of 1998, the water table was lowered to 0.7 m. Water level was restored in the summer of 1999. Macrophytes occupied 35–50% of the lake's area between 1957 and 2003. During the last few decades significant changes have occurred in the composition of the submerged species; for example, the dominating charophytes were replaced by Ceratophyllum demersum in the 1980s. Four sediment cores (up to 60 cm) were collected from the northern part of the lake with the maximum distance of 20 m between sampling points. Lithological, macrofossil, grain-size, elemental (C, H, N) and 210Pb analyses of the samples were performed. The obtained data shows that in the studied sheltered littoral area, the sedimentation rates differ up to two times over a 20 m site in a relatively flat bottom area. The changes in the input of suspended siliciclastic matter correlate extremely well with the input of total organic matter. Although according to the monitoring data the aquatic vegetation cover in the studied area was rather dense, most of the total organic matter (75–85%) in the sediments consist of decomposition products of algae (low TOC/N values), indicating that the degradation of macrophytes in the shallow well-oxygenated littoral is quick and complete. High correlations between organic and mineral matter refer that the planktic material in the water column reaches the sediment fast enough before it is decomposed mainly with settling mineral matter. Rapid variations in the input of siliciclastic matter, sequestration of organic matter and increase in the content of authigenic carbonate during 1930s to 1980s coincide well with the changes in the aquatic vegetation. The changes in the dominating species and abundance of aquatic vegetation may have a significant impact on the accumulation of mineral and organic matter in the littoral area, as two times more mineral and organic matter precipitates in the northern and more sheltered part of the lake. Further studies are needed to test this hypothesis. Also the appearance of carbonates is in good temporal correlation with the changes in the vegetation. The share of planktonic matter in TOM increases during the same period. Those changes can be explained by the increase in trophicity, which caused higher productivity and algal blooms and therefore a rise in pH and consequently precipitation of carbonates and changes in vegetation.

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Depositional environment of Permian cherts of the Denaro and Duque de York Complexes, Patagonia, XII Region, Chile

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The Denaro Complex (CD) and the Duque de York Complex (DYC) crop out along the southwestern South American margin. Both complexes contain radiolarian chert samples which show differences in color, deformation, radiolarian content, the recristallization level, and in their contact relationships. The samples could be red, green, black or grey, be more or less intensely folded, have a greater or lesser radiolarian content, or be made of criptocristalline to microcristalline silica. There are cherts in contact with pillow lavas, other cherts, limestones, or intercalated with turbiditic successions of the DYC. The age of some samples has been established from the radiolarians, which indicates deposition during the Early Permian (Takemura, written communication, 2010). Major and trace element geochemical analyses have been carried out, with the objective of characterizing the depositional environments of 12 samples belonging to these units. The results were plotted on binary diagrams proposed by Murray (1994), in which it is possible to distinguish three depositional environments: ridge, pelagic and continental margin. The results show that Fe_2O_3 is not a good environmental indicator for these samples, possibly because of remobilisation. More reliable data are derived from trace elements, specifically the Lan/Cen ratio, which indicate that there are samples from all three depositional environments. This confirms the hypothesis of Mpodozis and Forsythe (1983), that these cherts had been accreted to an active continental margin.

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Provenance studies using geochemical discriminant diagrams and Artificial Neural Networks on Permian metasedimentary rocks from Desolation Island, Patagonia, XII Region, Chile

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Rocks cropping out on Desolation Island (DI) have been assigned to the Duque de York Complex (DYC), based in their textural and lithological characteristics, age (late Early Permian; Hervé *et al.*, 2007) and metamorphic grade. These rocks form part of a folded turbidite succession with some radiolarian chert lenses. We analized the petrological and geochemical characteristics of these rocks in order to establish the provenance and tectonic setting of the depositional basin and to compare the results with similar studies in the DYC outcrops in the northern part of the DI (i.e. Madre de Dios, Duque de York, Contreras and Ramírez Islands), as well as with rocks of the Trinity Peninsula Group (TPG) of the Antarctic Peninsula (AP). The geochemical results were plotted on binary and ternary discriminant diagrams and also used in Artificial Neural Network analysis (Lacassie *et al.*, 2004). From the petrographic characteristics of the the sandstones and mudstones from the DI we could establish that they are associated with a provenance composed of sediments generated from the erosion of the plutonic roots of a magmatic arc. The geochemistry indicates a common source of sediments, with an intermediate to acidic composition and deposition in a basin within an active continental margin. Comparisons with previous provenance studies on the DYC outcrops and in the AP (e.g. Lacassie *et al.*, 2006; Faúndez *et al.* 2002; Castillo 2008) suggest similarities in the source and depositional basin tectonic setting.

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Ichnology and sedimentology of the Late Miocene Urumaco Formation, Falcon Basin, Northwestern Venezuela: Sediment-organism interactions in tropical deltas

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The Falcon Basin is an east-west trending depression developed in Northwestern Venezuela, related to the interaction of the Caribbean and South American plates. During the Miocene, a thick (up to 8000m) deltaic and shallow-marine succession was deposited in western Falcon, controlled tectonically by pull-apart northwest-trending depressions. The Urumaco Formation represents the last deltaic succession in the basin, prior to the establishment of the fluvial regime of the overlying Codore Formation. The unit is 1700m thick and consists of a complex intercalation of medium- to fine-grained sandstone, organic-rich mudstone, coal, shale, and thick-bedded coquinoid limestone. The integration of ichnology and sedimentology allows identification of different subenvironments including offshore, prodelta, interdistributary-bay, delta-front, shoreface, foreshore, and delta-plain deposits. Offshore deposits are very scarce, and are characterized by burrow mottlings overprinted by *Thalassinoides*, *Asterosoma*, *Planolites* and *Chondrites*. Prodelta deposits are characterized by low degrees of bioturbation and low-abundance assemblages of trace fossils, including monospecific associations of *Planolites* or locally, more diverse suites with *Thalassinoides*, *Teichichnus*, *Asterosoma* and *Sinusichnus*. Delta-front deposits contain variable degrees of bioturbation and locally high abundances of trace fossils, including *Ophiomorpha*, *Thalassinoides*, *Palaeophycus*, *Planolites* and locally *Skolithos* and *Bergaueria*. Shoreface and foreshore complexes are characterized by variable degrees of bioturbation and locally high abundance of trace fossils, namely *Ophiomorpha*, *Thalassinoides*, *Macaronichnus*, *Skolithos*, *Diplocraterion*, *Palaeophycus*, *Gyrolithes* and root traces. The interdistributary bay is characterized by suspension fall-out mudstone with very low degrees of bioturbation, containing *Planolites* and deep-tier *Ophiomorpha* and *Thalassinoides*, commonly overlain by crevasse-splay sandstone with *Ophiomorpha* and root traces. Distributary-channel deposits are burrowed by *Ophiomorpha* and more rarely by *Skolithos*, while the trunk-channel deposits are unbioturbated. Both types of channel deposits contain mud drapes in the foresets of cross-bedded sandstone that may indicate tidal influence. Associated crevasse-splay deposits are unburrowed, or contain root traces at the top. Fine-grained delta-plain deposits are characterized by very low degrees of bioturbation and low abundance of trace fossils, consisting of unburrowed mudstone or heterolithic intervals with small *Planolites*, and immature paleosols with crustacean burrows and root traces. These deposits contain a rich and diverse vertebrate fauna typical of a wetland environment. Thick-bedded coquinoid limestones are interbedded throughout the succession, and are characterized by erosive bases containing firmground *Thalassinoides* of the *Glossifungites* ichnofacies. They commonly lie on top of delta-plain deposits, and are overlain by prodelta or distal-bay deposits, representing ravinement surfaces produced during transgressions. The facies succession of the Urumaco Formation represents a prograding delta-strandplain complex and the development of a wetland delta plain. The ichnofauna shows low diversity and high abundance. A seaward increase in ichnodiversity and degree of bioturbation is evident. This study has implications for current paleogeographic models of northern South America, and allows the evaluation of the depositional and biotic dynamics in low-latitude marginal-marine systems.

Mesozoic lateritic weathering crust relics and their redeposited products in Dobrogea (south-eastern Romania)

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The weathering crust relics identified in Dobrogea were produced in two of the four main kaolinization periods identified within the Central Europe: Late Triassic – Early Jurassic, and Cretaceous – Miocene. The older relics are located in Central Dobrogea, on the Late Proterozoic basement rocks of Histria Formation, and was preserved beneath the Jurassic (Bathonian-Kimmeridgian) carbonatic platform sediments of the Casimcea syncline. The main profile of weathering includes three main units, represented by saprolitic, fanglomerate and resedimented deposits. Diminishing or absence of chlorite, predominance of illite, and the upward increase of kaolinite content (9-53%) and smectite (3-8%) characterize the saprolite. Within the upper argillic zone and in the matrix of the "fanglomerate" unit, chlorite is absent, illite diminishes, and the kaolinite and smectite contents increase to 17-59% and 7-24% respectively. The resedimented sands include a more simple clay fraction, composed of abundant kaolinite (45-81%), subordinate illite (19- 52%), and sporadic vermiculite (8%). Climatic conditions favorable to intense chemical and biochemical weathering have been recorded during the Aalenian, Toarcian, Hettangian and Late Triassic. An active source-area could be represented by an uplifted landmass, appeared in the eastern part of the Moesian Platform during the Donetz phase (Toarcian/Aalenian) of the Alpine orogeny. Accordingly, the Aalenian- Bajocian subcontinental sequences of quartzose sandstones, sands, clays and coal, pierced by boreholes in the eastern part of the Moesian Platform, might represent the secondary products of the lateritic facies existing at least on the area of present Central Dobrogea. In North Dobrogea, kaolinitic crust relics are scattered all over the western, Măcin zone, where the Precambrian metamorphic rocks and the Paleozoic formations preserve in places signs of a deep weathering. The most obvious are the pre-Cenomanian weathering crust relic recorded in Mircea Vodă village, formed on gneisses and amphibolites of the Megina Group and preserved beneath the fossiliferous Cenomanian calcareous sandstones. This crust consists of a saprolite unit, covered in places by a resedimented unit consisting of thin sandstones, sands and red clays. In the saprolitic zone, the clay mineralogy is dominated by well crystallized smectite (46-100%); kaolinite becomes dominant (70- 100%) in the upper levels of the lateritic section and in the resedimented sands and clays; illite is subordinate (0-47%), while chlorite occurs eventually (0-5%). In a larger framework, the presence of an Early Cretaceous and Aptian continental formation in the adjacent areas suggests an Early Cretaceous age for the pre-Cenomanian crust from North Dobrogea, to cover the time-span necessary for transport and resedimentation of these deposits. This assumption is supported also, by the subtropical, warm and humid climate, which characterized the whole Cretaceous period. The pre-Cenomanian crust, belonging to the last kaolinization period identified in Central Europe, has formed in close connection with the development of the Early Cretaceous peneplane in Europe. Moreover, the deposition of the pre-Aptian carbonate sequence in South Dobrogea suggests the absence of intense erosion in the neighbouring emergent areas, typical for times of tectonic quiescence, which permitted the accumulation of a significant lateritic cover.

Sedimentology of Fuegian drumlins, Tierra del Fuego, Argentina

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Drumlins are subglacial landforms, aligned with the general movement direction of the ice, developed due to deformation of the sedimentary bed load under an actively moving temperate glacier. Drumlins have an ovoidal shape in surface, with (a) a long axis in coincidence with the direction of movement, usually several hundred meters long, and (b) a much shorter transversal axis, of only a few hundred metres, and even only several tens of meters wide. Slopes are asymmetrical along the main axis and greater in the up-ice direction. Drumlins occur always grouped in drumlin fields. In these fields, drumlins are frequently associated with flutes and megaflutes, i.e. very elongated subglacial features, with very large a/b axis relationships. Some of these landforms are as long as several kilometres, following the general direction of ice paleomovement. Drumlins are very rare in the Southern Hemisphere, because here alpine-type glacierization has been dominant and drumlins are generally related to continental glaciation instead. In South America, drumlin fields of varied size and nature have been described so far but only in the southernmost part of the continent, Southern Patagonia and Tierra del Fuego, of both early and late Pleistocene age. The drumlin formation in this region has been possible due to a combination of several conditions: temperate-based glaciers, sufficient ice thickness, relatively fast flowing ice, relatively low lying ice bodies, changes in flow velocity due to obstacles at the glacier, merging ice bodies and the availability of a large amount of basal sediment with dominant proportions of fine and very fine sediments, silt and clay, due to regional bedrock composition. These conditions were unavailable in Northern Patagonia and this may be the reason why no drumlins may have been formed there. The large amount of fine grained sedimentary bed load allowed for the deformation of the basal load in these glaciers as ice movement proceeded. This movement forced the spatial organization and deformation of the sediments and the later re- sedimentation in the form of basal till, on top of bedrock, proglacial sediments and/or other tills of the same or a previous ice advance. Frequent deformational and glaciotectonic structures are also observed in these sections due to ice overthrusting of its own deposits. The dominant sedimentary sequence in the studied drumlins of the region is characterized by (from bottom to top): (a) a lower basal till, usually dark grey, several meters thick, with scarce or no boulders, a very few pebble size clasts and fine-grained matrix; (b) a thick sequence of proximal outwash deposits, glaciofluvial gravels and sands and glaciolacustrine silts and clays, both usually showing intense deformation due to glaciotectonics; (c) an upper basal till, darker grey, with more frequent boulders, usually strongly striated and oriented in the direction of ice movement, abundant pebble and cobble sized clasts, and a very large amount of fine-grained matrix. Layer (a) was formed under subglacial conditions, indicating a first advance of the ice, during a first cold period, probably a stadial or perhaps a Heinrich event or similar climatic fluctuation. Layer (b) was deposited when the ice front had receded to an inner position, during a milder climate episode, perhaps an interstadial or an inter-Heinrich event, allowing for rapid and intense deposition of ice contact, generally superglacially transported sediments in proximal outwash plains, ice-contact lakes and/or intramorainic kames, due to fast melting of the ice margins during warmer periods. Layer (c) is a basal till formed during the readvance of the ice, incorporating outwash materials to the glacier sedimentary load, during a younger stadial period or Heinrich event. This upper basal till is the one that it has been effectively deformed by the overriding ice and which is directly responsible for the drumlinization of the proglacial landscape.

Comparative diagenesis and fluid flow evolution in contrasting structural settings, Jurassic, Atlas Mountains, Morocco

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The Atlas Mountains (Morocco) superbly expose the sedimentary and diagenetic history of two Jurassic intracontinental rift basins. Both rift basins contain a rift-type and a platform-type petroleum system. In addition, both basins combine a very high source potential index with an entire spectrum of potential reservoir rocks such as deep-water sponge mounds, off-platform slope deposits and rhythmic successions of carbonate platforms. This study intends to compare diagenesis and fluid flow evolution in its structural context, from basinal source rocks (Ait Moussa, Middle Atlas) via tectonically-controlled platform margins to the interior settings of carbonate platforms (Tunnel de la Légion and Ait Athmane, central High Atlas). The case of Ait Moussa (Pliensbachian, Middle Atlas) represents an alternation of dark silty marls and argillaceous, radiolarian-bearing limestones with up to 6.5 % TOC. The succession is within the oil window (Tmax ≈ 430 to 444 °C; HI ≈ 448 to 584 mgHC/gTOC, kerogen type II). Paragenetic analysis puts the onset of bitumen migration in a context with a second stage of dolomitization (fluorescent inclusions). Dolomite-2 replaces calcite and Fe-calcite cements, its mean carbon and oxygen stable isotopic composition is around -5.2 ‰ for $\delta^{18}O$ and 2.5 ‰ for $\delta^{13}C$. Dolomite-2 precedes replacive barite, replacive dolomite-3 (ferroan saddle dolomite), and replacive ankerite. The bitumen remained geopressured until the establishment of inclined stylolites (middle to late Eocene in age) that then were used as a migration pathway. The case of Tunnel de la Légion (central High Atlas) represents the northern site of the footwall scarp of the Tizi N'Firest synsedimentary fault. This normal fault became inverted during Eocene compression. At Tunnel de la Légion, the Sinemurian to Pliensbachian succession contains bioclastic and oolithic limestones that grade into fine-grained argillaceous limestones with sponge spicules and radiolaria. In the upper (Pliensbachian) part of the succession, there is an intercalation of fine- grained, bioturbated limestones, graded oobioclastic beds of calciturbidites and some sheets of lithoclastic debrites. TOC contents reach a maximum at about 2 %. The succession is overmature (Tmax ≈ 470 to 500 °C; HI ≈ 22 to 33 mgHC/gTOC). Paragenetic analysis indicates enhanced fracturing and fracture cementation during burial diagenesis. Two Fe-calcite cemented veins display fluorescent inclusions. These Fe-calcite cements are partially replaced by two generations of dolomites (dol-2 and dol-3). Dol-3 is a ferroan saddle dolomite that is cross-cutted by inclined stylolites some of which are relatively rich in bitumen. Compared to Ait Moussa and although the petrogenetic sequence of both cases displays important similarities our preliminary set of data of carbon and oxygen stable isotopic composition is consistent with a much higher maximum burial depth at Tunnel de la Légion.

Short-term variability of cold-water coral growth in the Late Pliocene North Atlantic

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The understanding of the paleoenvironment during initiation and early development of deep-water carbonate mounds in the NE Atlantic is currently focus of international research. The Integrated Ocean Drilling Program (IODP) Expedition 307 drilled the 155 m high Challenger Mound in the Porcupine Seabight in order to investigate for the first time sediments from the base of a giant carbonate mound. The initiation and start-up phase of this carbonate mound coincides with the beginning of Intensified Northern Hemisphere Glaciation (INHG) at around 2.7 Ma. Further carbonate mound development seems to be strongly dependent on rapid changes in paleoceanographic and climatic conditions at the Pliocene-Pleistocene boundary, especially characterized and caused by intermediate water masses. The investigation of this specific time interval at around 2.7 Ma uses established proxies such as $\delta^{18}O$ and $\delta^{13}C$ of planktonic (*Globigerina bulloides*) and of benthic foraminifera (*Fontbotia wuellerstorfi, Discanomalina coronata, Lobatula lobatula, Lobatula antarctica, and Planulina ariminensis*) as well as grain size parameters to determine the paleoenvironmental and paleoecological setting favourable for the initial coral colonization. Stable oxygen and carbon isotope records of the benthic foraminiferal assemblages indicate that L. lobatula provides a reliable isotopic signature for paleoenvironmental reconstructions. $\delta^{13}C$ values of *D. coronata* are significantly offset compared to other epibenthic species. This might be related to vital effects. $\delta^{18}O$ values of *L. lobatula* indicate initial mound growth started in a moderate glacial-like mode. However, temperature calculated from benthic $\delta^{18}O$ fit with values of 7–11°C well in the range of the known temperature tolerance of 4–12 °C for the reef forming cold-water coral *Lophelia pertusa*. Furthermore bottom currents of intermediate water masses of southern origin (Mediterranean, Bay of Biscay) enhanced at 2.6 Ma in times of INHG supporting first coral settlements. At this time $\delta^{13}C$ values and sortable silt analyses display a short-term variability, which in turn is characterized by vertical movements and decreased current intensities of the Mediterranean Outflow Water at intermediate depth. These gradual movements in turn favored an introduction of Southern Component Water. Therefore carbonate mound development was probably hindered by a short-term variability of water masses from southern origin.

Sedimentary environment of the Peñas Coloradas Formation in Patagonia, Argentina, during the Paleogene global warming period

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This work focuses on the distribution of sedimentological features of the Peñas Coloradas Formation (Upper Paleocene) in the San Jorge basin. This is a continental unit composed of conglomerates, sandstones, mudstones and tuffs deposited in a fluvial system. Paleoclimatic inferences from clay mineralogy, fossil logs and paleoedafic studies support a climatic scenery of humid and warm conditions during its deposition, related to the Early Paleogene Global Warming. The studied deposits have been grouped in four facies associations (FA). The FA-1 consists of tabular (W/T > 100) sandy or tuffaceous bodies, non-graded or normally graded, with planar or erosive basal surfaces. Several sandy beds are occasionally bioturbated and weakly pedogenized. This association is related to sheet-flood deposits. The FA-2 consists of lenticular and tabular, sandstone-gravel, fining-upward bodies, slightly erosive-based, 1-5 m thick and tens to hundreds meters width. Lateral accretion surfaces are frequently present. In some cases oriented fossil logs and mammal bones became visible in the coarsest facies. In sandy pyroclastic levels well-developed paleosols were recognized. Tabular bodies of this association are interpreted as the fill of laterally migrating sinuous channels, while lenticular bodies are related to confined channels. The FA-3 is composed of tabular sandy bodies, up to 2 m thick, with lateral extension of several kilometers. Burrows are commonly present in weakly developed paleosols. Coarsening or fining upward trends are presents. This FA is interpreted as fine to medium deposits of a proximal floodplain. The FA-4 is dominated by the finest siliciclastic and pyroclastic, massive facies where bioturbation and pedogenic features are common. It is interpreted as distal floodplain deposits. The distribution of these FA along a west-east transect show that in the eastern localities the Peñas Coloradas Formations is represented mainly by siliciclastic facies of the FA-2 and FA-4, with subordinate participation of the FA-3. Paleosols show weak developing. In the western area facies present a major participation of pyroclastic deposits. The FA-1 is exclusively represented in this area. The FA-2 has more abundance of basal coarse-grain conglomerates respect to the eastern localities and present some confined channels in floodplain deposits. Well developed paleosols are only evidenced here. The FA-3 and FA-4 have a greater participation than the east area. According to this, the deposits of Peñas Coloradas Formation represent a mixed-load fluvial system with sinuous single and perennial channels, surrounded by broad sandy and muddy floodplains in the east. At west, similar facies are present, although are beds related to a higher energy, with mainly bed load. The absence of desiccation cracks, carbonate concretions and pedogenic carbonates along to the unit indicates relatively humid climatic conditions. Differences in the body geometry, the channel/floodplain ratio and the siliciclastic/volcaniclastic ratios suggest control factors such as paleorelief and availability of pyroclastic material. These were higher at west and favored more energetic systems (sheet-floods and lenticular bodies with coarse material at its base). Both degree of development and frequency of paleosols may be related to differences in the sedimentation rate which was lower at west.

The occurrence and significance of beekite in Proterozoics of Central India

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Beekite, an unusual and rare structure, has been recorded from the Tirohan Limestone of Lower Vindhyan (Semri Group) of Chitrakut area, M.P. It is a concretionary form of calcite or silica that occurs in small rings and commonly found on silicified fossils or along joint surfaces as a replacement of carbonate/organic matter. Named after Dr. Beek, the then Dean of Bristol, (U.K), originally spelled-'Beckite' and described from Devon, England, UK. Beekite rings are reported from Precambrian sediments and common on the surface of invertebrate fossils of Phanerozoic sequences of the world. The 'Tirohan Limestone' is a moderately to thickly bedded dolomite and contains algal layers, stromatolites and occasionally beekite rings. The stromatolite assemblage suggests Lower Riphean age. Three beekite-encrusted zones having average thickness of about 30 cm have been developed, especially in Muradpur and Sangrampur hills. Beekite is found as thin (1–5 mm) concretionary white, opaque silica that occurs in small rings, sub spherical, discoid shaped accretion, generally intervolved as bands or layers on the surface of thin bed/lamina. The Proterozoic sequence in the area is very thin (10 -170 m) and represent a condensed horizon under conditions of exceptionally low rate of deposition and limited subsidence of the basin, where about 20 m thick sediments have been laid down over a period of ca.400 m. yrs. The sediments unconformably overlie the Precambrian granitic basement and constitute pisolitic limestone at the base, followed by glauconitic sandstone and overlain by Tirohan Limestone at the top. They are deposits of a very shallow tidal sea, mainly in tidal flats under extremely stable conditions. Tirohan Limestone is considered to be a product of penecontemporaneous dolomitisation of the lime mud in a supratidal environment. The formation of beekite requires a relatively long time, with non-deposition and fluctuating arid/semiarid conditions. The structure is a product of diagenetic replacement by chalcedony/ cryptocrystalline silica in the form of beekite rings formed by replacement and encrustation of carbonate. The participation of microbes in the process is yet to be ascertained. The presence of beekite encrustation in the upper part of the Lower Vindhyan succession indicates considerable breaks in sedimentation, and this inference is supported by the condensed thickness of the lower Vindhyan sediments in the north-central part of the Vindhyan basin.

Phosphorus fractionations in the sediments of a mangrove ecosystem in India

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Phosphorus fractionation studies were carried out in surface and core sediments to get an insight into nutrient cycling and bioavailability of phosphorus in the Pichavaram mangroves of India. Total P in surface and core sediments ranged between 451–552 and 459–736 $\mu g\ g^{-1}$ respectively and Fe bound P was the dominant fraction. Low levels of Fe bound P in the mangrove zone than the two estuarine zones is due to flocculation due to high salinity inhibition of phosphate onto the Fe- oxides/hydroxides. Post-depositional reorganization of P was observed in surface sediments, converting organic P and Fe bound P into the authigenic P. High levels of organic P in the mangrove zone is primarily due to intensive cycling and degradation of organic matter and adsorption of phosphate on the organic molecules. The burial rates and regeneration efficiency of P in the intertidal mangrove ecosystem were also studied. High burial efficiency of P was observed indicating the limiting nature of P for the biological productivity. Further, bioavailable P constituted a considerable proportion of sedimentary P pool of which an average accounted for 55 and 50% in surface and core sediments respectively.

Behaviour of trace metals in the mangroves and beach placers after tsunami - case study from Tamilnadu, India

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Surface and core sediments were collected after tsunami in the east coast of India in the Cuddalore -Nagapattinam region of Taamilnadu. They were analyzed for texture, mineralogy and trace metals. There is a significant variation in texture and grain sizes varies from medium to coarse grained and are enriched in heavy minerals after the tsunami. The enrichment is more visible in the Mangrove regions. The trace metals indicate the abnormally high concentration of heavy metals particularly of Cr, Fe, Mn and Co and their concentration was enriched especially after tsunami. Core sediments show the clear trends of heavy metals enrichments in recent years and there is a clear flotation in trends after tsunami. The study indicates that tsunami has altered the sediment composition of the region and it will have a long term impact on mangrove productivity and quality of coastal ground waters.

Late Quaternary sedimentary record and morphodynamics of the middle Paraná River

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The middle reach of the Paraná River extends along 800 km in Argentina from Corrientes to Rosario City. In the Middle Paraná region fluvial deposits of Late Tertiary-Quaternary age spread on an area ca. 100,000 sq km and 20 % of the total are related to the Holocene floodplain. The maximum and minimum widths of the floodplain are 50 km and 10 km, that means, 30 to 6 times wider than the Paraná River main channel that is in average 1,500 m in width. The present floodplain was built from the Upper Pleistocene to present times, dominantly with sandy sediments. Coarse sands with gravelly sand lenses (some of them including fossils of Lujanense Mammal Age, Late Pleistocene) are dominant in the sedimentary subsurface record, ~10-15 m below the floodplain surface. Fine sediments cover the coarse sandy strata in the western part of the floodplain. Medium and fine sands overlie the coarse sand strata and sandy sediments are covered generally by 4 to 10 m of silty and clayey sediments. Old fine sediments with disseminated calcareous and gypsum concretions were deposited in lacustrine and swampy areas of the floodplain. Remains of a dissipated aeolian longitudinal dune field cover the old fine sediments near Santa Fe City. A paleosol exists in the top of the aeolian sands (Ea. Los Cuervos paleosol, Middle Holocene?) and it was buried by more recent flood deposits. The active floodplain is since the sedimentological point of view middle Holocene-to present day feature. The main hydrographic elements that accounts for the current floodplain morphodynamics are four sub- environments coexisting in complex anabranching channel pattern: the Paraná River main channel, the major branches (ca. 200 to 500 m- width), sinuous meandering floodplain branches and the flood-born deltaic splay channels, maintained by streams of diverse sizes. The present day floodplain is mainly a water saturated floodplain that behaves like an elongated N-S floodbasin. This complex huge area of pounded water is the sink of sediments derived from the main channel through two main mechanisms: lateral delta systems and meandering belts from floodplain tributaries laterally shifting on the floodplain. The lateral delta lobes deposit near 2-4 meters in thickness covering the different older units described above while the meandering belts are characterized by lateral accretion deposits and the generation of a scroll plain. Some deltas are very actives and progradation on the pounded area can be as fast as hundreds of meters per year. The pattern of the main channel has tendency to braiding but contains a meandering thalweg. The thickness average of the sandy deposits is near 10 m. The main channel remained shifting on a relatively narrow belt during the last 100 years reworking an area equivalent to the width of the main channel system with mean shift rates up to dozens or hundreds m/year.

The mixed meandering-braided river channels of Argentina

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Extending over more than 2,700,000 sq km between 22º lat. S and 55º lat. S, Argentina is the seventh largest country in the world. Twelve major physiographic realms with a distinctive association of climate, relief and geology can be recognized in the country, including hundreds of rivers. Sandy or gravelly meandering and mixed meandering-braided channels (wandering channels, sensu lato) prevail in the country. Mixed-pattern channels are different for rivers of different physiographic regions. Here we show results on a variety of wandering rivers located over the huge plains of the Chaco-Pampa, Paraná River system, and the Central Andean Piedmont (CEP) and Extra-Andean Patagonia (EAP). Chaco Plain: the most mobile rivers of Argentina are placed in the western Chaco. Shifting is favored by easily erodible banks, huge fine sediment supply and high seasonal discharge variability. Mean discharges of Chaco rivers varies from 460 m^3/sec to 3 m^3/sec (e.g., Bermejo and Itiyuro rivers) and liquid/solid annual discharge relationships range between 400 and 40. The rivers have been building minor and mega alluvial fans. Incised braided channels prevail in the fan apexes and non-incised meandering and narrower channels occurs at middle zones of the fans. Mixed meandering-braided channels occur in the transitional reaches between those river segments, suggesting an additional control on the pattern arrangement by the dissection and regional slope decreases. The wandering pattern results from the extreme seasonal (liquid and solid) discharges: some of the sediments carried during floods would not arrive to the non-incised zones of the fans and remain as stored river bars. The stored sediments increase locally the riverbed slope promoting the development of meanders during low water stages. Pampa Plain: incised meandering-braided rivers are found in the eastern piedmont of the Pampean Ranges, at the Argentinean middle-east. Major rivers of this region are names with numbers, from Primero (“First”) to Quinto (“Fifth”) rivers. Their mean discharges range from 32 m^3/sec to 5 m^3/sec. Bed sediments are sandy gravels to gravelly coarse sands. These rivers look as meandering streams from air views, but elongate, linguoid or lozenge-shaped bars cover the riverbeds fully, and asymmetrical cross sections are absents in the “meander” bends. The present-day main dynamics of these rivers is braiding and the meandering geometry seems to be a past heritage. Present-day river channels flow incising into alluvial terrace belts of soft sediments that are meandering in planform. Paraná River: from Corrientes City to downstream, the Paraná River is anabranching, but its main channel (mean discharge: 17,110 m^3/sec) is braided with a meandering thalweg transporting coarse-to-medium sands as bedload. The tendency of the thalweg to develop true subaqueous meanders and cutoffs was well documented by bathimetric charts of the last 100 years. The shift of the thalweg belt promotes the development of channel bars and islands behind it, in the shallow parts of the bed channel. CEP – EAP: river channels have gravelly armored beds in the proximal piedmonts zones. The Quaternary history in both regions is different: large alluvial fans were developed by CEP rivers and Patagonian streams were strongly affected by vulcanism, tectonism and glaciations. The Negro River (mean discharge: 970 m^3/sec) synthesizes the wandering streams of both major regions, in the confluence area of the Neuquén (from CEP) and Limay (from EAP) rivers. As other perennial Patagonian rivers, the channel pattern of the Negro River is anastomosing but single channels are high sinuosity meandering streams with bars and islands formed by cutoffs or in-channel sedimentation resembling a mixed meandering-braided pattern in some reaches. The meander development of the channel could be related to the river capacity to remove the fine sediments of the bank in opposite to the coarse gravelly bed sediments.

Tectono-sedimentary development of a rift-initiation half-graben using LIDAR-based digital outcrop modelling: The Nukhul half-graben, Suez rift, Egypt

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Stratal development during the initial stages of rifting is highly complex. Conventional tectono-stratigraphic models are typically conceptual, lack numerical quantitative information and are often based on late stage rift basin configurations. As a result they do not accurately represent the complex sequences developed during rift initiation. These shortcomings are attributed to a lack of combined quantitative structural and stratigraphic analysis of detailed field examples. This study utilizes a LIDAR-based digital outcrop dataset to examine the stratigraphic architecture and tectono-sedimentary development of the Oligo-Miocene rift initiation Nukhul half-graben, situated within the Hammam Faraun fault block, Gulf of Suez, Egypt. The combined tectono-sedimentary and digital approach has facilitated a quantitative understanding of facies, palaeocurrent and thickness patterns of early syn-rift strata developed in the hangingwall of the intra-block Nukhul fault. The integrated approach provides key quantitative information on fault propagation and linkage histories, sediment response and reservoir architecture and the tectono-sedimentary development of the half-graben. The Nukhul half-graben succession is divided into three rift initiation units (RU1, RU2 & RU3). At the base of the succession the fluvio-lacustrine Oligo-Miocene aged Abu Zenima Formation (RU1) lies unconformably on underlying Upper Eocene aged pre-rift units. The mixed continental facies are overlain by the tidally influenced to shallow marine (RU2) and shoreface to offshore (RU3) Miocene aged Nukhul Formation in an overall transgressive succession. At the initial onset of rifting (early RU1 times) the sedimentary deposits represent the fill of deeply incised palaeovalleys oriented highly oblique to the present day trace of the Nukhul fault. At this time regional sea-level and climate were the main factors driving accommodation and sediment supply to generate key stratal surfaces and packages across the rift. By mid to late RU1, palaeocurrent and thickness patterns within mixed continental facies indicate sediment transport and deposition was dominated by both antecedent drainage as well as the presence of a monoclinal fold above the blind tip of the Nukhul fault and the presence of relay zones between precursor fault segments. RU2 is marked by a major change in basin configuration delineated by progressive truncation of RU1 and onlap of RU2 towards sites of low displacement on the Nukhul fault. This structural reorganisation of the basin was followed by a marine transgression marking the onset of tidally influenced deposition within an elongate shallow marine fault bounded embayment. Sediment transport and deposition at this time was influenced by the presence of an active fault scarp along the Nukhul fault, and the structural template of fault-parallel and fault-perpendicular folds imposed by the history of propagation and linkage of the fault system. Continued transgression led to flooding of the embayment possibly creating a shallow marine seaway before regional drowning of topography and development of a tidally influenced shelf by RU3 times. Continued fault growth may have driven the overall deepening trend by increased subsidence rates due to strain localisation.

Partitioning of sand on delta platform and slope on a wave-dominated delta complex in the Miocene of Denmark

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The distribution of sand in deltas is dependent on the type of delta complex: wave-, fluvial- or tidal-dominated delta. During the Early Miocene, three delta complexes built out from the Fennoscandian Shield into the eastern North Sea Basin. The first delta complex is informally named the Billund delta and is of Aquitanian age. This delta complex was dominantly a wave-dominated delta. It has been demonstrated in recent wave-dominated delta environments major sand accumulation occurs on the updrift portion of the delta and alternating mud and sand, i.e. barrier- lagoonal complexes occupy the downdrift flank of the delta system. This study shows that the distribution of sand in the submarine part of the Miocene wave-dominated Billund delta (mainly lower shoreface and delta slope) was deposited downdrift of the delta front and thus differs from the foreshore and uppermost shoreface accumulation found in recent delta complexes. The delta formed during the Early Miocene in the eastern North Sea Basin. Due to predominantly westerly winds, long shore currents were predominately SE-wards. The long fetch across the North Sea resulted in effective wave action at the coast and hence comprehensive sediment reworking and sorting at the delta mouth. This resulted in sand being preferentially transported in a southeast-ward direction. The Billund delta prograded into a basin with relatively deep water (*ca*. 100 m) and thus had a relatively steep delta front, *ca.* 7 – 100. The fluvially sourced sand at the delta mouth was transported southeast-wards to form spit and barrier complexes in the downdrift portion of the delta complex. During major storms, sand accumulation was directed towards the outer delta platform either from reworking of the delta mouth bar or from coastal erosion. Some of this sediment might have been shed beyond the slope break and laid down as mass-flow deposits on the prodelta slope. During major floods, sands from migrating fluvial dunes were deposited on the delta platform and mouth bar resulting in an increase in slope. Due to either oversteeped slopes or changes in pore pressure due to wave action, destabilisation of the delta slope resulted in gravity sliding. The flood was also at times so strong that direct input of fluvial sediments onto the delta slope took place. The distribution of submarine sand in the downdrift setting is important, because foreshore and uppermost shoreface sediments are rarely preserved in the geological record. Therefore, in deltaic systems are comparable to the Billund delta, i.e. steeply dipping clinoforms, clinoform heights of 50–100 m and asymmetric morphology, the reservoir sand is most likely to be found in the downdrift portion of the delta complex. This type of delta is best developed in a ramp setting or rift system that has undergone a tectonic phase that resulted in a sudden increase in accommodation space and characterised by a high sediment supply. The fluvial system is here typically dominated by bedload transport, and migration of dunes to the delta front is a common phenomenon. The composition of the river-borne sediment (sand/mud ratio) is also important, although longshore currents and wave processes may remove the fine-grained fraction downdrift and offshore and thereby permit concentration of the sand on the main delta platform.

A 20 ka multi-proxy record of climate-driven change in depositional processes and sediment sources at the continental slope off SE South America

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We present high-resolution environmental magnetic, geochemical and sedimentological records for core GeoB6211 (32.5° S, 50.24° W) recovered on the South Brazilian upper continental slope. We aim at unmixing different sedimentary source regions using magnetic and geochemical fingerprinting, as well as identifying transport- and sea-level related effects reflected mainly in grain-size variability. According to a C-14 chronology, the examined 7.74 m long sedimentary sequence obtained by gravity coring at 657 m water depth covers the past ~20 kyr without recognizable gaps. A sharp decrease in sedimentation rates from 80 to 8 cm/kyr occurred at ~14 cal kyr BP. Natural remanent magnetization was normalized by anhysteretic remanent magnetization, acquired in an alternating field of 100 mT. Isothermal remanent magnetization acquisition curves up to 2.6 T were obtained for end-member analysis by non-negative matrix factorization. Our set of records is complemented by total organic carbon, $CaCO_3$ and major element contents. Grain-size distributions of the terrigenous fraction were determined with a laser particle sizer. The results show fining grain sizes from ~20 to 6 µm between ~20 and 9 cal kyr BP. The grain-size distribution correlates with a concentration decrease of magnetic minerals and with a decreasing content of coarse-grained magnetite until ~14 cal kyr BP. However, the concentration of fine-grained magnetite stays generally constant. These trends are caused by sea-level rise since the LGM. A marked change took place after ~9 cal kyr BP, culminating in a peak of magnetic parameters at ~8 cal kyr BP and indicating a strong concentration increase of fine-grained magnetite as well as coarsening of magnetic grains. The magnetic parameters remain abnormally high until ~4 cal kyr BP. This Mid Holocene sequence shows a dominant grain-size peak of 100 µm and an increased bulk density, despite of an over four times higher $CaCO_3$ content than in the remaining core. The deposition of such distinctly coarse and enhanced magnetic sediment can neither be explained by enhanced erosion on land nor by stronger transport during the arid Mid Holocene. The observations rather indicate a change in the depositional processes at the upper continental slope or the change to a more proximal sediment source. In the Late Holocene, fluvial sediments with grain-size peaks between 6 and 10 µm as well as lower hematite and magnetite contents reflect more humid conditions in South American southern tropics and subtropics. The climatic conditions are related to a southward shift of the intertropical convergence zone. The forthcoming integration of rock magnetic and sedimentological proxies is expected to considerably sharpen these still tentative interpretations and to enable a decoupling of source and transport signatures.

Diatoms response to Late Pleistocene environmental changes in southernmost Patagonia (Argentina)

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A series of sedimentary cores were retrieved from Laguna Potrok Aike within the framework of PASADO (Potrok Aike Maar Lake Sediment Archive Drilling Program), an ICDP-sponsored lake drilling operation in Southern Patagonia. Previous multi-proxy studies in the area have characterized the environmental history of the drylands in the Patagonian Steppe for the last 16000 cal yr BP. The new cores from this maar lake provide the oldest continuous record of climatic history in Southeastern Patagonia. The ongoing multi-proxy study of these sedimentary cores includes the analyses of diatoms, since these siliceous algae are efficiently used to characterize and often quantify the impact of past environmental changes in aquatic systems. A low resolution diatomological study has been performed on PTA-1D, a 97.3 m long sedimentary core recovered from the central part of the lake covering at least the last 50,000 years. Variations in diatom concentration and in their floristic assemblages are used to track changes in lake conditions and tackle the most interesting sections where higher resolution analyses will be carried out. Diatom concentrations fluctuate between 0 and 4.6x108 valves/gr along the core and so far more than 200 different taxa have been identified, including some probably endemic species from Patagonia. The semi- quantitative analysis of the diatom assemblages is consistent in the first meters of the core with previously published results from a shorter core. This allows us to approximately locate an age of 15,560 cal yr BP in our record, with the appearance of *Cyclostephanos patagonicus* between 12 and 15 m depth and an age of approximately 8600 cal yr BP, corresponding to a peak in *Thalassiosira patagonica* at about 8-10 m depth. The species *Cyclotella agassizensis* dominates in the top part of the core along with *Thalassiosira patagonica*, although these indicators of more brackish conditions become rare or disappear in older sediments. Fluctuations in the planktonic/non-planktonic species ratio along the record could possibly be indicating relative lower lake-levels and/or periods of ice- cover development. Nevertheless, a combination of these results with other proxies is necessary to further develop these hypotheses. The multi-proxy approach of the PASADO project, combined with the first modern training set for Patagonia that is presently produced within the framework of the ongoing PIPA (Proyecto Interdisciplinario Paragonia Austral) Argentine project, will provide unique paleoecological information for the Southern Hemisphere.

Provenance and depositional setting of northeast Mexican Cretaceous-Paleogene-boundary sandstones

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The provenance and depositional setting of the well-known ejecta- and sandstone-bearing Cretaceous-Paleogene (K-Pg) boundary sequence at El Peñón in northeast Mexico is compared to near-by late Maastrichtian sandstone beds. Both siliciclastic successions represent mass flow deposits of the deep-marine Burgos basin and our provenance analysis reveals common source areas. However, the sedimentological characteristics, along with the heavy mineral data, suggest that the depositional scenarios are different for both deposits. At El Peñón, sandstones contain evidence for high-energy deposition (parting lineation, alternating current directions, water-escape structures) and burrows in the topmost part. Thus, our analysis support an extra- ordinary depositional event at the K-Pg boundary recorded in the El Peñón section, which was possibly triggered by the Chicxulub impact event. In contrast, no evidence for ejecta, high-energy deposition or alternating current directions was observed for the late Maastrichtian sandstone beds. In both sections, petrographic and heavy mineral compositions reveals that quartz (> 85%) and plagioclase (< 15%) dominate in a framework bounded by calcite cement (<3 0%) and matrix (≤ 50%). Most quartz grains were ultimately of magmatic origin as revealed by their blue cathodoluminescence colour. Most of the detritus was recycled as indicated by a dominance of zircon among the heavy minerals and by low Ca and high Mg concentrations in most detrital tourmalines. We propose transport of recycled orogenic components from southwestern United States. The river system partly also was fed by magmatic arc material from western Mexico. Longshore currents transported the siliciclastic detritus towards the southeast, sorted and mixed it with limestone clasts from the near-by emerging Sierra Madre Oriental. Instability of temporarily stored sediment forced sand packages into deep-marine areas. The fluvial system must have been long-lived to permit for similar provenance for both late Maastrichtian and K-Pg sandstones. Therefore, the change from marl to sandstone deposition at the K-Pg boundary in northeastern Mexico does not represent changes in the alluvial transport systems, but rather mass transport of sediment that was stored along the coast into deep-water areas.

Inner shelf fluvial, deltaic, estuarine, and marine depositional systems, Gulf of Thailand I: high-resolution seismic stratigraphy, seismic facies, and seismic geomorphology

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Pleistocene fluvial, estuarine, marine, and deltaic depositional systems were identified in the uppermost 80 m of the central Gulf of Thailand modern continental shelf, situated at ~70 meters below sea level. Integration of offshore 3D seismic reflection data, high-resolution shallow-penetration 2D seismic reflection sparker and boomer profiles, and 1D shallow geotechnical borehole measurements enabled the identification of seven depositional sequences. 3D plan-view images at successive time slices exhibit single-channel meandering systems that range from less than 50 m to as much as 600 m wide, deposited in the shelf during times of subaerial exposure. The high-resolution 2D profiles with a tuning thickness of ~25 cm, enabled the discrimination of high frequency stratigraphic discontinuities (sequence boundaries) and allowed a detailed bed-scale seismic facies characterization of fluvial (point bars), deltaic (clinoforms), estuarine, and marine deposits within a sequence stratigraphic context. Seven seismic facies were defined based on 2D seismic reflection terminations and reflection character: 1) convex-up high-amplitude reflections associated with lateral accretion surfaces (dip view), 2) convex-up bidirectionally downlapping moderate to high-amplitude reflections associated with lateral accretion surfaces (strike view), 3) chaotic low-amplitude reflections, 4) discontinuous reflections associated with channel lag deposits, 5) concave-up low-amplitude continuous seismic reflections associated with deltaic clinoforms, 6) high-amplitude laterally continuous reflections commonly confined within valleys and associated with estuarine fill, and 7) low-amplitude to transparent laterally-continuous reflections commonly associated with widespread marine sediments. The seismic facies and the stratigraphic discontinuities discriminated in high-resolution 2D profiles allowed dividing the succession into discrete depositional sequences. The complete succession shows that most fluvial systems lie within incised valleys in the lower portions of each depositional sequence cutting down into older strata. Fluvial facies are consistently confined within the valley walls, never overcome the interfluve level, and there is no evidence of multi-storey fluvial aggradation; overall aggradation is limited to hemipelagic sedimentation during marine incursions. A shallow (< 35 m) single-storey incised valley was described in detail, placing particular emphasis on the recognition criteria, and the controls on valley formation and preservation potential of different systems tracts in an inner shelf location. Evidence of tidal influence in the downstream portion of this valley suggests the presence of a nearby paleo-shoreline.

Inner shelf fluvial and estuarine depositional systems, Gulf of Thailand II: seismic geomorphology and reservoir compartmentalization

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Plan-view fluvial and estuarine depositional elements were identified in the uppermost 80 m of the central Gulf of Thailand modern continental shelf, situated at ~70 meters below sea level. Although marine and deltaic depositional systems also exist in this interval, they are not seismically visible in plan-view (time slices) due to their low acoustic impedance and their distinctive lack of sharp or ridged geomorphic elements that are critical for seismic-reflection geomorphic imaging. Integration of high-resolution shallow-penetration 2D seismic reflection sparker and boomer profiles, with offshore 3D seismic reflection data, allowed unraveling that most fluvial events imaged in time slices are in fact separated in vertical space by deltaic clinoforms and/or marine laterally continuous reflectors. 3D seismic time slices show single meandering channels (up to 600 m wide) and channel belts (up to 10 km wide) deposited in the shelf during times of subaerial exposure. Additional geomorphic features imaged include incised valleys, interfluves, oxbow lakes, neck and chute cut-offs, and point-bar meander scrolls showing evidence of expansion and translation. Incised valleys with subordinate entrenched tributary valleys are present at different depths of the data set. However, a few fluvial systems have no clear evidence of incision and they seem to have flowed across unconfined floodplains. Incised valleys show basal truncation with subsequent sand-prone fluvial deposition and followed by mud-prone estuarine seismic facies that onlap the valley walls. The fluvial seismic architecture and seismic amplitude character of these 2 facies are distinctly different both in plan-view and cross-section, what implies an acoustic impedance contrast between them, most likely due to a change in lithology. The 3D characterization of a shallow (< 35 m) single-storey incised valley allowed differentiation of sand-prone point-bar deposits and mud-prone abandonment channel facies (mud-plugs). The sinuous but continuous mud-filled channel may act as a lateral fluid barrier or baffle that can potentially subdivide a reservoir system (point bars) into discrete compartments. Understanding fluvial architecture and its processes helps predicting sandstone distribution and reservoir compartmentalization, which are critical components for reservoir modeling. This fluvial system is a good practical reservoir analog for deeper fluvial exploration targets where geomorphic imaging is poor.

Geodynamic evolution of the early Paleozoic Western Gondwana margin 14°-17°S: U-Pb and Lu-Hf isotope evidence of detrital zircons

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In an attempt to trace the provenance of sedimentary detritus and to gain information on the crustal evolution of the Early Paleozoic western Gondwana margin (14°-17°S) we applied a combined in situ U-Pb and Lu-Hf LA-ICP-MS isotope analysis on detrital zircon from 12 Ordovician and Devonian sandstones in southern Peru and northern Bolivia. The sandstones are exposed in the Eastern Cordillera, the Altiplano and the Coastal Cordillera. The sedimentary basins are part of the Peru- Bolivia trough. Few intrusive and extrusive Early Paleozoic rocks indicate that the Ordovician basins developed in a back-arc position, with the arc on the Arequipa Massif in the west and the Amazon craton in the east. This plate-tectonic setting appears to have changed into a passive margin in the Early Devonian. We present zircon U-Pb and Hf isotope data from the coeval or younger siliciclastic strata in order to verify this hypothesis. The U-Pb zircon age distribution of the Ordovician sandstones from the Eastern Cordillera has the most distinctive peak between 0.5 and 0.7 Ga (Brazilian orogeny). Contrastingly, the most prominent U-Pb zircon age peak of the Ordovician sandstone from the Altiplano is at 0.9-1.2 Ga (Grenvillian orogeny) with a smaller peak at 1.7-1.85 Ga (late Transamazonian orogeny?). The Devonian sandstones from the same locality contain zircons with a major age peak at 0.4-0.5 Ga (Famatinian orogeny). Smaller U-Pb age peaks can be connected to the Brazilian, Grenvillian and Transamazonian orogenies. Zircons of the Devonian sandstones from the Coastal Cordillera have a similar age distribution but the Grenvillian ages, in one case also the Transamazonian ages are more pronounced and the Brazilian ages are less pronounced. Zircons formed during the Brazilian orogeny were derived from the Amazonian craton, those with Grenvillian ages were transported either from the Sunsas belt on the Gondwana continent to the east or from the Arequipa Massif to the west. Zircons related to the Famatinan event most probably derived from the Arequipa Massif, the only place where respective magmatic arc rocks crop out. Thus, for the Ordovician sandstones of the Eastern Cordillera and the Altiplano a eastern source prevailed, and the Altiplano locality was mainly fed from the Sunsas belt. The Devonian siliciclastic strata were mainly influenced by the Arequipa Massif. Minor influences of eastern sources are documented by the presence of Brazilian zircon ages. The in situ Lu-Hf isotope analysis provides information about crustal recycling. Together with the U-Pb zircon ages, crustal evolution paths can be detected. $\varepsilon Hf(t)$ values of the analysed zircons spread between –20 and +12. Juvenil zircons (<300Ma difference between U-Pb age and Hf model age) were formed exclusively at 0.9-1.5 Ga. Hence, during the Brazilian and Famatinian orogenies we only find evidence of recycling of continental crust and no addition of juvenile crust. A striking feature is the common crustal evolution path of zircons formed during the Grenvillian, Brazilian and Famatinian orogenies. This indicates that the Arequipa Massif with a dominance of Famatinian-aged crystalline rocks has a similar origin to the Amazoinan craton from which we suppose the Brazilian-aged zircons derived.

Distal foredeep sedimentation during the Early-Middle Miocene foreland stage of the south-Central Andes (Manantiales Basin), Argentine Precordillera (32º SL)

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The early-middle Miocene Manatiales Basin (MB) in the Frontal Cordillera is a retroarc foreland basin associated to the tectonic loading of the Main Cordillera along the Ramada and Espinacito thrust belts (Jordan 1996, Cristallini & Ramos, 2000). After basin filling, the region was involved in deformation by the migration of the east-vergent thrusts within the Precordillera (Cristallini & Ramos, 2000). According to this interpretation the MB in the Frontal Cordillera was the proximal foredeep, behaving as a source area during the upper Miocene deposition further east. East of the high Andes, within the Argentine Precordillera, the distal records of the MB are unknown. The reconstruction of the entire basin geometry is important not only for paleogeography but also for flexural analysis, to better constrain the propagation of deformation towards the foreland and to estimate the uplifting history of the Cordilleran belts. The Tertiary stratigraphy of the Riquiliponche creek region (32°7'-32°21'SL - 69°6'-69°WL) in the northern Mendoza Province, is poorly described by available geologic maps (Cortés *et al.*, 2001). The Tertiary strata rest in angular unconformity on the Triassic and are overthrust by the Paleozoic Los Alojamientos Fm. They comprise ~300 meters of playa-lake, aeolian and low-gradient fluvial beds, interlayered by a thick succession of andesitic breccias (~25 m), deposited within a distal alluvial scenario. Paleocurrents are toward the east and clast composition (mainly Triassic) suggests a source area in the west, likely the Frontal Cordillera. The andesitic breccias are thick bedded, massive, matrix supported, and poorly sorted. The composition is nearly completely andesite boulders, cobbles, and pebbles. The average maximum clast size is ~0.5 m and the maximum size >1 m. Major individual beds can be traced for kilometres and have sharp basal contacts ranging from non-erosive to slightly irregular. Oversized boulders are randomly distributed and locally, large clasts project above the top of the bed (protruded clasts). Boulders are supported by a coarse, poorly sorted sandy matrix, which has high proportions of interstitial mud. The oligomictic andesite composition and strong evidences of cohesive and gravity-dominated flows indicate primary volcanoclastic deposits (Fisher & Schmincke, 1994), which can be used to constrain the unit age. Ar-Ar dating on plagioclase yields an average age of 19.64±0.54 Ma (isochron and plateau). On the basis of these new ages, the strata from Precordillera might be correlated to the Chinches Fm. exposed in the Frontal cordillera (likely the Tc1 or Tc2 member of Perez 2001). Given the distal facies association, we interpret the strata of the Precordillera formed part of the distal part of the MB, interrupted by volcanoclastic flows. Further east, between the Peñas range and the borehole Sierra de las Peñas YPF.SJ.SP.es-1, an uncertain Tertiary (traced laterally by 2D seismic sections) is stratigraphically positioned between the Upper Miocene and the Paleozoic. It is formed by distal alluvial facies and might correlate with the horizons exposed in Riquiliponche. This suggests the Early-Middle Miocene distal foreland system (Manatiales Basin) extended likely within the modern broken foreland at these latitudes, as also suggested ~300 km northward by Dávila *et al.* (2007), within the core of the Sierras Pampeanas.

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Quaternary depositional sequences controlled by 100 kyr climatic cycles in the Eastern Niger Delta Margin

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The Niger Delta Margin in the Gulf of Guinea is one of the largest sediment accumulations along passive continental margins, with up to 12 km of dominantly muddy sedimentary units accumulated since Eocene times. This margin is undergoing deformation by gravity driven tectonism due to the presence of a mobile substratum at the base of the sediment fill (Damuth, 1994). Due to very high sedimentation rates during the Quaternary, this deltaic margin offers an expanded record of sea-level and climate changes. This record, however, is complicated by the presence of widespread sediment instabilities, syndepositional faults, fluid escape features. The presence of relevant oil and gas resources together with several sedimentary features formed by active processes and constituting potential geohazards (pockmarks, gas hydrates, sediment waves, polygonal faults, buried mud volcanoes, major normal growth faults, submarine landlsides) ignited a prolific collaboration between industry (Total) and Ifremer within the Erig3D project on a sector of the Eastern Niger Delta Margin. The aim of this study is to establish a sound high-resolution chronostratigraphic framework for this area allowing the reconstruction of sedimentary processes and their control by eustatism and other factors. The study area is located on the continental shelf and slope roughly 65 km offshore on the eastern Niger Delta margin coastline between 150 and 800 m water depth and covers 2350 km^2. The site lies in majority within the translational zone of Damuth (1994), but the shelf domain is included in the extensional zone. Our stratigraphic interpretation is based on: (1) a seismic dataset composed of several 2D VHR seismic profiles with variable resolution (Sparker, Chirp) and four 3D HR seismic blocks (short offset processing); and (2) in situ samples and measurements (4 long piston cores, and 9 CPTU penetrometric tests). The available seismic data set was interpreted on a work station using the Sismage software developed by Total. On seismic profiles, the outer shelf offshore the Eastern Niger Delta Margin displays prograding wedges thickening seaward, separated by seismic discontinuities and their correlative conformities. These prograding wedges have very distinct seismic facies consists of high- angle clinoforms building regional-scale depositional sequences which are locally disrupted by growth faults. We correlated seismic interpretation with absolute dates and proxies such as XRF-derived Ca profile and $\delta^{18}O$ ratio from piston cores, as well as lithologies inferred from CPTU tests. The upper most 5 seismic sequences formed during the last *ca.* 500 kyr BP, in response to glacial/interglacial fluctuations driven by 100 kyr Milankovitch cycles. The high angle clinoforms near the shelf edge correspond to shorefaces/delta fronts formed during glacial lowstand periods. Their present-day position is consistent with published data about subsidence s.l. (including the tectonic component) in the area. This multidisciplinary study provides the first comprehensive view of the Quaternary stratigraphic architecture of the eastern part of the “Niger Delta”, and provides the framework for future sedimentological, paleontological and geohazard studies.

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3D stratigraphic modelling of the syn-rift and sag deposits in the Campos basin (Brazil): implication for its structural evolution

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The South Atlantic Ocean was initiated with a rifting phase during the Cretaceous. Superimposed onto a complex geodynamic setting with rift and sag phases, a major climate change was also recorded during the Aptian while most of the basins were characterised by the deposition of thick evaporites. The objective of the present study is to characterise the production and sediment supply dynamics during this critical period in order to quantify the sedimentary system behaviour in response to climatic and tectonic forcing. It will result in an accurate structural scenario that could be decisive for exploration along the South Atlantic margins. This study is focused on the Campos Basin because a lot of wells, isopaches and depth maps, facies and depositional environment maps, seismic lines are available for the rift and sag phases from published articles. The choice of this basin is also motivated by the numerous recent discoveries and the highly dynamic exploration settings along the Brazilian margin. Starting with a long bibliographic review, the methodology includes five main steps with: (1) the restoration of the stratigraphic architecture using 44 wells data and four seismic lines, (2) the restoration of the sedimentary basin geometry (20 maps), (3) the restoration of the paleogeography during the rift and sag phase (Barremian-Aptian) using 4 maps, stratigraphic charts and structural data. A 3D model has then been built (4) to quantify the accommodation dynamics through time and space in the Campos Basin. 3D stratigraphic modelling (200 x 200 km) using Dionisos (@IFP) have then been carried out (5) to quantify the production and sediment supply dynamics and to optimize the structural scenario. One of the main results of the present study is related with the timing of the sedimentary fill. The first models based on ages of the previous published stratigraphic charts, have revealed a problem with the carbonate production. Unrealistic carbonate production rates with, for example rates of 5000 m/My between 125 My and 122 My (Coqueiros Formation) are needed to reproduce the stratigraphic architecture. We have then adjusted the age of all the main markers from the syn-rift and the sag deposits to tune the production/supply rate within consistent ranges. Timing and structural scenarios have thus been improved. The stratigraphic modelling resulted in three main depositions steps: (1) the rift period for during 130 My to 119 My, present an environment dominated by alluvial fans surrounding several lakes, the mean subsidence rate during this period is approximately 400 m/My. (2) The sag period between 119 My and 112 My is dominated by the occurrence of a huge carbonate platform with production rates about 100 m/My. (3) The final transitional period between 112 My and 110 My is characterised by a thick evaporitic deposits with a production rate of 600 m/My. The sediment supply dynamic from the surrounding Brazilian basins (Santos, Espirito Santo) is very similar to the Campos basin dynamic suggesting a consistent evolution of these basins in term of structural scenario and climate setting. Some differences in the sediment supply dynamic from the West African margin suggest another structural evolution, and/or possibly an alternative response to climate forcing.

Offshore to deep marine sedimentation in the Río Mayer Formation, Austral Basin, Patagonia Argentina

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The Austral Basin in the southernmost part of Patagonia developed between Jurassic and Tertiary times. The initiation of this basin was related to an extensional phase during the Late Jurassic with the accumulation of a thick syn-rift sequence (the El Quemado Complex). Overlying this complex, shallow marine deposits of the Springhill Formation accumulated between the Tithonian and Berriasian in response to an initial transgressive event. Acceleration of the transgression in the Berriasian led to the accumulation of black shales of the Río Mayer Formation (Berriasian to Albian), marking the first episode of offshore to deep marine sedimentation in the basin and the onset of post-rift conditions. The study area is located between Lago Argentino and Lago Viedma in Santa Cruz Province in the Seccional Río Guanaco (S 49º 57' 11''; W 72º 04' 56'') of Los Glaciares National Park. Seven detailed sedimentary sections (1:100 scale) in the Río Mayer Formation have been measured. Preliminary palaeoenvironmental interpretations allow the division of the 350 m thick studied succession into three sections. The lower section is composed mainly of laminated black shales with both tabular and concretional marl levels. Trace fossils are not recorded in this section, but ammonites, belemnites and bivalves are abundant. It is interpreted as having accumulated in a distal platform setting under anoxic conditions. The central section is characterized by bioturbated black marls and shales with a well preserved *Zoophycos* ichnofacies suggesting a slope depositional environment. Body fossils are common, especially belemnites (*Belemnopsis sp*. - Valanginian to Hauterivian). The upper section is marked by massive black shales with intercalations of very fine- to fine-grained sandstones and less frequent conglomerates. In this section both debris flows and distal low density turbidity current deposits were identified. *Zoophycos* ichnofacies and *Ophiomorpha rudis* ichnosubfacies occur in association with moulds of petrified wood containing *Teredolites isp*. The presence of turbidity currents and large trace fossils suggest a more oxygenated conditions. In summary, the Río Mayer Formation developed in response to a regional transgression following Upper Jurassic rifting and half-graben development. The main transgression took place in the Berriasian, and the result was the deposition of the lower section of Río Mayer Formation. The anoxic conditions produced well laminated black shales without bioturbation. As the transgression continued, the central middle section was deposited during the *ca*. Valanginian – Hauterivian when the terrigenous sediment input to the basin was at a minimum and marls were deposited. A very well preserve *Zoophycos* ichnofacies and the rare occurrence of fine sandstones suggest that the environment was at least dysoxic. At the top of this section a maximum flooding surface is recorded by a glauconitic level probably of upper Hauterivian age. After that, the development of two deltaic successions, first the Río Belgrano Formation (Barremian) and then the Piedra Clavada Formation (Albian) advanced from the northern edge of the basin. The common intercalation of sandstone in the upper section could be the basinal expression of these two littoral units. The Piedra Clavada and Río Mayer formations are the same age (based on paleontological evidence) and very similar petrified wood containing *Teredolites isp*. occurs in both units.

Ichnology from de Río Mayer Formation, Austral Basin, Patagonia, Argentina

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The Río Mayer Formation was developed during the Lower Cretaceous in the Austral Basin (Santa Cruz Province, Argentina). It is deposited above either the El Quemado Complex or Springhill Formation and is composed of black shales with thin intercalated fine-grained sandstones, marls and limestones. Abundant information is available on its palaeontological content, especially ammonoids, but detailed ichnological studies are scarce. In the region of Río Guanaco area (S 49º 57' 11''; W 72º 04' 56'') sedimentological and ichnological data were collected. Three main sections were identified and described in detail. The lower section is developed in the Berriasian - Valanginian and is composed of laminated black shales. The middle section is about 40 m thick, consisting of black marls with intercalated black shales developed between the Valanginian to Hauterivian. Finally, the upper section is composed by black shales with frequent thin intercalations of fine sandstones (Barremian to Albian). Ichnologically, 5 ichnogenera that contain 6 ichnospecies were identified: *Zoophycos* isp., *Chondrites targinoii*, *C. intricatus*, *Bergaueria perata*, *Ophiomorpha rudis* and *Teredolites* isp. The most abundant and constant is *Zoophycos* isp., which following different authors (among others, Uchman, 1995, Miller, 2007),was classified in three morphological groups. All of these ichnospecies are grouped in the Río Mayer Formation into two ichnoassociations. The first is found in the middle section, and is a typical *Zoophycos* ichnofacies with *Zoophycos* isp. and *Chondrites* isp. The second ichnoassociation is developed at the end of upper section, containing *Zoophycos* ichnofacies and *Ophiomorpha rudis* ichnosubfacies and *Teredolites* isp. These two last components are shown as the link between the offshore to deep marine sedimentation and a littoral environment.

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Sedimentological development of cheniers. An Holocene example from the Bahía Samborombón, Argentina

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In the Argentinean littoral zone several transgressive - regressive events occurred during the Quaternary. Excellent examples of these events are very well exposed along the Bahía Samborombón locality (S 35º 58' 24''; W 57º 27' 00') in the Buenos Aires province coastal area. Following the stratigraphic scheme of Fidalgo (1979) modified by Fucks (in press.) the studied deposits are included in the Las Escobas Formation. This unit is divided into 3 members, Destacamento Río Salado Mb. (tidal flat, 5.8-7 ka B.P.), Cerro de la Gloria Mb. (beach ridge, ca. 3-8 ka BP) and Canal 18 Mb. (coastal lagoon, 6-7 ka BP). Stratigraphic sections were measured and described in detail for each unit The Destacamento Río Salado Mb is about 0.5 m thick and is composed of silty to very fine-grained sands with wavy stratification. The Cerro de la Gloria Mb in the study area is a bioclastic ridge 200 m wide and 5 m thick oriented subparallel to the modern coastline. The main lithologic components are molluscan shells (+ 70 %) with low proportion of coarse- to medium-grained sand. In cross-section perpendicular to the coastline, the ridge shows lenticular, trough and sigmoidal geometry, eventually there are planar beds. Cross bedding, hummocky cross stratification and parallel stratification are the most common sedimentary structures. The Canal 18 Mb is 3 m thick and is composed of fine- grained sands and silts, usually containing both articulated bivalve shells in life position and tabular levels of disarticulated shells with no preferential orientation. The sea-level rise generated a transgressive surface that marks the beginning of the Destacamento Río Salado Mb in the study area. During this stage the sediment flux from the continent was reduced. This event promoted that in several storm episodes mollusc valves were accumulated generating the chenier, while the finer-grained sediments were washed by tides. When the chenier was completely formed a lagoonal environment was developed toward the continent (canal 18 Mb). Our results show that during the Holocene, Bahía Samborombón was under a period of sediment starvation which generated the landward progradation of a bioclastic bar above the tidal flat deposits. This study provides an opportunity to show the interplay between sea level, sediment input and climate in littoral environments during the mid- Holocene climatic optimum.

Stratigraphy and sedimentology of San Luis Formation, Late Proterozoic - Early Paleozoic of San Luis Province. A first approach

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The Sierra de San Luis is part of the southernmost region of the Sierras Pampeanas. It consists of an igneous-metamorphic basement generated mostly during the Famatiniana orogeny. Its current morphology is a consequence of the Andean progeny. The metamorphic units are distributed into different complexes of variable metamorphic grade from green schists to granulites facies. The rocks of low metamorphic grade are exposed at the surface of the ground in two belts. The oriental belt (the object of this present communication) has a maximum width of 4 km and an extension of 50 km in the NNE-SSW direction, showing transitional contact, or via a ductile shears with schists, and ends at the north border due to thinning. The dominant lithologies are meta- mudstones (both phyllites and slates), m-sandstones, m-conglomerates and acidic m-volcanites, jointly denominated San Luis Formation, which is part of an ancient sedimentary marine basin located in the occidental margin of the Gondwana, and possibly correlated to the Punconviscana Formation., and its age is in the range of 569 ± 20 and 529 ± 12 Ma. The macrostructure of the sequence is of an overturned cylindrical folds- type, of up to the kilometric order. Consequently the measuring of the real thickness of the sedimentary sequence presents great difficulty and it is calculated to be in the order of 3000 m maximum with no decompression. The first results of a basic stratigraphic and sedimentologic study are published in the present paper. This study was carried out via the survey of three sections which are, from south to north: Rio Quinto (SRQ) of a thickness of 1370m; Cañada Honda (SCH) of 2740m and Santo Domingo (SSD) of 2600m. In the total 6700 relieved meters, ten lithofacies have been recognised and these have been grouped into eight facies associations (AF). The section comprised of the oriental belt is divided into six intervals, from base to top: Interval 1 (I1) of 1160m only outcrops on the SCH, it presents alternation of m- graywackes followed by thin layers of phyllites grouped in the AFI and interpreted as a turbidite deposit of lower fan; I2 of 100m surfaces only on the SCH, pebble-like laminated m-mudstones (dropstones) dominate alongside rather subordinated little lenses of grading fines conglomerates, grouped in the AFII, and are interpreted as ice-rafted diamicton and submarine outwash in a zone of maximum proglacial; I3, of 300m, is present in all sections but it is dominated by AFI (Idem I1), AFIII composed by polymictic m-paraconglomerate with scarce development of intercalated phyllites and interpreted as a turbidite system of major channel to a upper fan or possibly a deposit of terminal moraines from the marginal glacial zone, the AFIV composed by fine sabulitic m-sandstones in very amalgamated beds interpreted as deposits of channels and/or lobes of upper to middle fan; and the AFV, composed by fine m-sandstones, m-graywackes and phyllites interpreted as proximal turbidites facies in a system of middle fan; I4, of 60m in the SCH and SSD, composed by a rhythmic succession of phyllites and very fine m-sandstones grouped in the AFVI interpreted as a contourite system; the I5, of 400m, surfaces in SSD, composed by a monotonous succession of carbonaceous phyllites ("Santo Domingo M- Black Shales") grouped in the AFVII and interpreted as deposits of the depocentral zone of a deep marine basin under anoxic conditions; and finally I6, of 1870m, which outcrops in all sections, and is composed mainly by phyllites and very subordinate lenses of very fine m- sandstones, all is grouped in the AFVIII interpreted as deposits from the basin plain with occasional levels of bottom currents. The cyclostratigraphic arrangement present in the San Luis Formation is interpreted as due to a eustatic rise presumably related to the Marinoan- Valanger deglaciation phenomena, which evidence in the sequences would be represented by the AFII and possibly the AFIII.

Stratigraphy of the Caparo and El Horno Formations (Venezuelan Andes), and their possible relations with the end-Ordovician glaciation

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At the south of the Venezuelan Andes, rocks known as Caparo and El Horno Formations of Upper Ordovician (Sandbian) to Lower Silurian (Llandovery)age has been cited since 1924. Many quotes describe the principal lithologies but do not define lithostratigraphic differences between these units, stating that only faunal aspects allow us to differentiate them. Even so the faunal descriptions in these appointments do not have systematic analysis, so stratigraphic order of these units is only biocronological. Our field observations in the Caparo area allow us to define two principal facies associations: the first association with subtle packing, have interbeded light yellow sandy mudstones and light gray muddy sandstones, that alternate with thin light gray claystones, dark yellow friable sandstones and light gray conglomerates. This facies contain abundant fauna of the Sandbian age composed by brachiopods, trilobites, graptolites and less abundant mollusks, corals and bryozoans. Second facies association have a strong packing, with fine grain dark muscovitic sandstones, light green siltstones, dark laminated shales and diamictites with coarse grains (4 to 40 cm) in a fine violaceous gray matrix, diamictite is exposed in ten reference sections and reaches 150 m of total thickness. For the second association, previous authors define a Llandovery age with brachiopods and mollusks. Although, those analysis were done with few and badly preserved fossil samples. With the differences among the associations analyzed, we propose that Caparo Formation is the sequence of Sandbian age. This unit was developed in a shallow to middle shelf in temperate climates. The other facies association with strong packing rocks included the diamictite, are related possibly with the end-Ordovician glaciation (Katian-Hirnantian) extensively known in Africa, Arabia and South America areas. This succession on the south Andean flank belongs to El Horno Formation, with scarce fauna but possibly included in that important global event at final of the Ordovician.

Los Espejos Formation: sedimentology, biostratigraphy and biofacies analysis

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The aim of this work is to present the results from analyzing three profiles from Los Espejos Formation, in the Central Precordillera of San Juan province, Argentina. The three analyzed sections were: Cerro del Fuerte, Loma de Los Piojos, and Ancha creek (in Talacasto). Biostratigraphic, conodont biofacies and sedimentological studies were developed. Specifically, at Loma de Los Piojos section we carried out a detailed sedimentological analysis. From the present study, we concluded that deposits from Los Espejos Formation correspond to a storm-dominated clastic shelf. Deposits are composed of clayey silt materials with sandstone banks which become increasingly thick toward the top. At the top, tabular sand layers are intercalated with coquina banks of lenticular geometry. Identified facies were: proximal shoreface facies (f C) which show lenticular banks of middle fine to coarse sandtones with coquinoids at the top; distal shoreface facies (f A) with lenticular banks of fine to very fine sandstones with interbedded coquinoids; transition to offshore facies (f D) represented by tabular clayey silt banks interbedded with fine to very fine sandstones with hummocky, wavy and flaser structures and parallel lamination; and also by facies of very fine tabular sandstones with monotaxonomic coquinoids at the base (f B) interbedded with f D; finally, offshore facies (f E) with tabular massive fine sandstone banks interbedded with clayey silt banks. At Lomas de Los Piojos section, facies change vertically from offshore deposits or offshore transition deposits to shallower environments of distal or proximal shoreface deposits. We observed four shallowing events in the sedimentary column and interpreted them as facies successions. A regressive pattern is observed all along the outcrops. Coquinoid layers in the Ancha creek section include several conodont species from the *Kockelella variabilis variabilis* Zone, indicating a Gorstian age for the middle and upper section of the profile. The distribution of conodont faunas in each section implies populations adjusted to different bathymetric conditions and preferring muddy or sandy substrates, thus suggesting different conodont biofacies: *Panderodus-Pseudoneotodus* biofacies, *Oulodus/Coryssognatus* biofacies and *Ozarkodina* biofacies. The discontinuity that separates Los Espejos Formation from the overlying Talacasto Formation would comprise a hiatus including the Upper Ludlovian and the Pridolian. This hiatus contrasts with what has been proposed thus far by different authors. The basal boundary of Los Espejos Formation could be associated with an important hiatus recorded in other world regions, referred to as ravinement surface that has been correlated with a generalized regression at the epicratonic and basin areas, culminating in a low sea level system tract (LST). Thus, as Los Espejos Formation presents a Gorstian age in the middle and upper sections of the profile, the lower limit of this formation could be related to the eustatic rise after the generalized regression of said limit, and therefore the age range of Los Espejos Formation could be not older than Ludlovian.

Tectonic significance of basal conglomeratic deposits in the context of the Continental Rift of Southeastern Brazil evolution

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The stratigraphic succession of hemigrabens that comprise the central segment of the Continental Rift of Southeastern Brazil (CRSB) is marked by a thick accumulation of Eocene fluvial deposits, with alluvial fan deposits near the master faults. Stratigraphically below the main Eocene succession, in Resende and Volta Redonda hemigrabens, there are massive or stratified clast-supported conglomerates, consisting of rounded pebbles and cobbles of quartz and matrix ranging from medium to very coarse sand. Cross-stratified feldsphatic sandstones also occur, and thin lenses of massive mudstones, forming sparse levels of intraformational breccias. These deposits are referred as Ribeirão dos Quatis Formation. They are in unconformity over the Precambrian basement and are tentatively dated on early Paleogene. The genesis of this stratigraphic unit is related to a braided fluvial system with intense reworking of the clasts, pointing to low rate of subsidence in an earlier stage or at the initial stage of CRSB opening. This study aims to discuss the tectonic setting of this conglomeratic succession, from geological mapping at 1:25,000 scale, stratigraphic and structural analysis, and the description and interpretation of liquefaction structures observed in these deposits. The Ribeirão dos Quatis Formation crops out discontinuously on SW-NE trending basement hilltops, corresponding to structural highs that limit the main Eocene depocenters. This spatial distribution, associated with facies characteristics, confirms that the conglomeratic succession is older than the CRSB main phase of mechanic subsidence. Structures related to liquefaction were described in several Ribeirão dos Quatis Formation outcrops, in the midst of interbedded conglomerates and sandstones. These structures are presented in the form of conglomeratic beds deformed gradually until reaching vertical orientation. The orientation of the conglomeratic clasts indicates a downward flow direction. In vertical section, they are presented in the form of columnar dykes, reaching up to two meters in height and fifty centimeters wide. These dikes have a NE-SW trend, suggesting NW- SE trending distensional stress. Based on the geometric aspects, such structures are interpreted as fluidization pillars. These structures are induced by liquefaction, with upward escape of water and sediments from underlying sandy layers. This mechanism results in the generation of space, allowing for downward gravitational collapse of the conglomeratic deposits. According to literature, sediments should be unconsolidated and saturated with water for the formation of these structures. The literature also indicates that these structures are activated when the conglomeratic deposits are subject to earthquakes of at least five on the Richter scale. Analysis of these fluidization pillars support the conclusion that the Ribeirão dos Quatis Formation deposits were deformed syndepositionally or shortly after their deposition. The data set presented here indicates that basal conglomeratic succession of Resende and Volta Redonda hemigrabens were deposited in a distensional regime prior to the main phase of the CRSB evolution, with expressions of moderate magnitude earthquakes.

Holocene volcanic ash deposits in the Tafi del Valle Formation (Tucumán, Argentina)

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We have studied the volcanic ash deposits intercalated in the Formation Tafi del Valle in the homonymous valley in the Tucumán Province, NW Argentina. This valley is in the upper basin of a tributary in the western side of the Sali River basin, being located at 100 km west of the capital San Miguel de Tucumán. This is an intermountain basin at 2,000 meters above sea level between two main ranges, the Cumbres Calchaquíes in the North and the Aconquija in the south. Geographically connects the Valles Calchaquies in the west and the Chacopampean Plain in the east. All these systems are part of a morphostructural unit known as Northern Pampean Ranges. The Cenozoic sedimentary sequences underlying the igneous-metamorphic basement of the Pampean Ranges. In this sequences there are also volcanic and volcanosedimentary materials. The sequence culminates in the loess, paleosols, detrital and ash deposits of the Tafí del Valle Formation. This formation was attributed to the Upper Pleistocene (Collantes and Sayago, 1993). We have studied seven stratigraphic sections in different parts of the basin to reconstruct the eruptive sequence. A total of five levels of ash were found. Sedimentary deposits of <1 m of thickness are intercalated between the lower ash levels and also separate them from the upper level. The thickness of the lower levels is centimetric a decimetric However, the thickness of the upper level of ash varies laterally in the valley, from 1 m up to 4 m. This upper level can be subdivided in three units, although there are not any sediment between them. The lower unit is 10-25 cm thick and shows parallel lamination, the middle 0.5 to 3 m thick unit is massive, and the higher 1-2 m thick unit is also massive. This thick ash level occurs in all studied sections. It outcrops discontinuously and covers an approximate area of 44 km^2. Mineralogical composition of ash levels was determined by X-ray diffraction analysis. The different ash deposits show a similar composition with glass as the main component, but there are also abundant quartz, albite and anorthite, while K-feldspar and biotite are more scarce. In addition, K-feldspar is observed in the lower levels while biotite is only detected in the upper. A peat level was found covered by the upper level ash. The radiocarbon dating of this peat gave an age of 4,290 ± 40 yr BP, which allows estimate the maximum age of the most explosive eruption affecting the Valley of Tafí. This age agrees with a previous age dated on a bone found some meters below the upper ash level (8,660 ± 40 BP; Collantes and Sayago, 1993). The ash deposits of the Tafí Valley reveal the existence of several eruptions close in time and probably from the same volcano. The younger ash deposit is the most important, reflecting a highly explosive eruption. The age of these deposits is Holocene. The large areal extent of this ash level allows considering it as an excellent chronostratigraphic marker for Holocene correlation in this region of NW Argentina.

Collantes, M.M., Powell, J. and Sayago, J.M. (1993) Formación Tafí del Valle (Cuaternario superior), provincia de Tucumán (Argentina): litología, paleontología y paleoambientes. XII Congreso Geológico Argentino y II Congreso de Exploración de Hidrocarburos, Actas II, 200-206.

Ephemeral flooding of an erg-margin system, causes and processes; the mid-Cretaceous Iberian Desert System

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The mid-Cretaceous Iberian Desert System (Spain) (Rodríguez-López *et al.*, 2010) extended over an area of more than 16,000 km2 in eastern Iberia, at a palaeolatitude of 25°-30°N, i.e., slightly south of the boundary between the Northern Hot Arid Belt and the Northern Warm Humid Belt. The highlands of the Variscan Iberian Massif along the western margin were the main catchment of this desert system, and to the east it was bounded by the Tethys Ocean. Along the Variscan Massif, ephemeral water influxes and persistent wind activity produced wadi deposits, aeolian dunes, desert pavements with ventifacts and polished cobbles, debris flows and aeolian pods. Thick hyperconcentrated flow deposits are interbedded with aeolian dune sandstones, and consist of reworked aeolian dune sands with floating ventifacts, testifying that ephemeral water influxes eroded aeolian dunes and desert pavements. Three non-exclusive processes may have caused the ephemeral water influxes into the desert margin system: -melt-water fluxes from the high, (intermittently) glaciated Variscan Massif to the desert margin system (cf. Taklamakan Desert), -monsoonal water discharge to the back-erg area (cf. Thar Desert), and -dune damming (cf. Namib Desert). We favour a combination of these processes, i.e., an (intermittently) glaciated Variscan Mountain Belt which thus must have been at least some 3 km high, in combination with monsoonal water discharge and possibly also dune damming.

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Well log data for the recognition and interpretation of paleosols in subsurface sections. The Marília Formation in the São Paulo state, SE Brazil

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The Marília Formation crops out in SE Brazil being the last unit of the depositional succession of the Bauru Basin. The Bauru Basin is an intracratonic basin developed on the greatest basaltic effusion in the world (Serra Geral Formation, Late Jurassic – Early Cretaceous), and was formed during the South America – Africa plate opening. The sedimentary deposits of this basin occur over an area of 370,000 km² in mid-southeast Brazil and have a maximum preserved thickness of 300 m. The Marília Formation is interpreted as an ancient eolian sand sheet succession dominated by eolian ripples, pedogenesis, and few ephemeral channels. This unit is ca 190 m thick and more than 66% of the thickness is formed by paleosols. The Aridisols are the most representative order (84.5%), followed by Alfisols (10.7%), Vertisols (2.7%), and Entisols (2.1%). Fifteen stratigraphic logs, each 6 to 40 m thick, were analyzed in detail and 32 other outcrops were analyzed over an area of 350 km². Facies analyses of the deposits and macroscopic characterization of the paleosols showed that paleosols and deposits are organized in vertical sequences characterized by the cyclical interbedding of these two elements. Well log data is essential for a better understanding and characterization of the lithology and structure of the formations in subsurface, and qualitative and quantitative parameters that enable the recognition and interpretation of paleosols in subsurface sections are presented in this study. The goals of this study are to (1) highlight the importance of the recognition of paleosols from well log sections, and (2) develop a regional architectural model considering the surface and subsurface data. Two methods were applied to the recognition and interpretation of paleosols. The first consists of a statistical pattern of recognition applied to log measurements and their transforms to identify multivariate log signatures that differentiated paleosols from other facies. The second is field measurement and description of stratigraphic logs that assist in calibration of the well log data since most of the wells are uncored. The geophysic unit corresponds to linear and aliasing shapes of the curves of gamma ray and resistivity, indicating the occurrence of predominantly sandy deposits. The paleosols can be differentiated from sandy deposits by the intensity of the resistivity values of the induction profile, which in paleosols is high as its porosity is low. The gamma ray logs distinguish the paleosols from shale horizons that also have high response to resistivity. This gamma ray response is due to the presence of a large amount of calcium carbonate that provides this type of response in geophysical profiles. Calcium carbonate concentration is a distinctive feature of the paleosols and its accumulation in pedogenic profiles can form very hard cemented horizons in Aridisols that can be laterally traced in well logs. This feature is an important factor to stratigraphic correlation with outcrops and with other wells. The prediction of paleosol profiles from nuclear logs in uncored wells are useful aids to outline the complex lateral geometry of the eolian sand sheet succession of the Late Cretaceous Marília Formation

Revisiting the cretaceous stromatolites from the Tarahumara Formation in Sonora, México: new insights

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The geology of northwestern Mexico during the Mesozoic reflects a convergent continental margin. During the Cretaceous, the marine successions of the Early Cretaceous Bisbee Group and equivalents of the Bisbee basin were followed by Late Cretaceous – Early Tertiary arc magmatism of the Laramide orogeny that included batholith emplacement and volcanic successions. One extensive unit in the north-central part of Sonora, the Tarahumara Formation, is a complex succession of heterogeneous rock types including andesitic flows, volcanic breccia, tuff, sandstone, siltstone, limestones (some of them stromatolitic) and chert. Some well-exposed out-crops from the Tarahumara Formation suggest that non-marine environments supported a rich plant biota and stromatolites with a complex assemblage of cyanobacteria and diatoms that grew in shallow, near-shore settings. Over the last years the associated chert from only one locality of the Tarahumara Formation has yielded valuable paleontological information on the early evolution of continental diatoms, cyanobacterial morphotypes and abundant algal and plant remains preserved by silicification; however, the significance of stromatolites as well as other important geological and stratigraphical issues in this region are still open. This work presents new results of the regional geology including new descriptions of stromatolites and a general cartography of this area that clear unresolved questions overlooked in previous reports from Huepac. Special attention is given to stromatolites and their major role as biosphere not only in the early evolution of life on Earth but also as the most reliable biosignatures of fossil microbial life.

Potential of Lake Iznik (NW Turkey) as a paleoclimatic archive

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The tectonic freshwater Lake Iznik is the largest lake in the Marmara Region (NW Turkey). It has a surface area of around 300 km^2, however, a relative small catchment area (920 km^2). The geology of the catchment area is dominated by metamorphic rocks (shales, marbles) in the north and by siliciclastic and carbonate sediments (conglomerates, sand- and siltstones, limestones, dolomites, and marls) in the south. The southern margin of the lake is outlined by one of the major branches of the North Anatolian Fault Zone. This is the reason for the half-graben geometry of the lake, which is filled up by a total sediment package of over 700 m of well-stratified beds. Modern sedimentation takes place within three sub-basins separated by ridges. The sediments which have been deposited during the last 80 years are characterized by a mixture of detrital (quartz, feldspar, calcite and clay minerals) and authigenic (aragonite) minerals. Aragonite precipitation is linked to Mg/Ca ratios around 5 and a high alkalinity of the lake (pH≈9). Organic matter is of mainly autochthonous origin and well preserved (including ostracodes, cladocers, chironomides, diatoms, pollen and spores). Therefore, the lacustrine sediments form a suitable archive for ecological and climatic information (Franz *et al.*, 2006). Data sets of magnetic susceptibility and inorganic geochemistry (e.g., Ca/Ti, Ca/Fe ratios), from a previous coring campaign in 2005, show that the sedimentation during the last 4,500 yrs BP is marked by cyclic variations in siliciclastic input and authigenic carbonate production. Phases with maxima in terrigenous supply reflect higher erosion caused by increased precipitation rates and/or changes in vegetation and land use, whereas the formation of aragonite may due to dryer phases with higher evaporation (Franz *et al.*, 2007). In September 2009, an additional field campaign recovered cores with up to 14 m length from Lake Iznik. Based on seismic profiles two drilling sites were chosen. Until now, these cores have been analyzed for magnetic susceptibility and scanned for the inorganic geochemistry (XRF / counts.sec-1) in 1 cm resolution. The occurrence of a distinct tephra layer (possibly the Y-2 tephra) implies that the longest core IZNLC2/09 covers more than 22 ka. The magnetic susceptibility shows that the record spans the transition from the last glacial period, with high terrigenous input, to the Holocene, with relative lower terrigenous input. This is supported by a positive correlation with the siliciclastic proxies (*e.g.*, Al, Ti, and Fe). Calcium demonstrates an opposite behavior, indicating that its concentration is controlled by the aragonite production within the water column, rather than the detrital calcite input. The ongoing investigations include inorganic (mineralogy, isotopes, geochemistry) and organic (nutrients, pollen, ostracodes) data analysis. To build a consistent age model samples for ^{14}C dating will be recovered systematically and samples for OSL dating are already under analysis.

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Sedimentary record of tectonic and climatic erosional perturbations in experimental coupled catchment-fan system

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We present the results of an experimental investigation for the stratigraphic record characterization of a climatic and tectonic induced perturbation. Following the results of Bonnet and Crave (2003) which suggest that it is theoretically possible to differentiate between the climatic or tectonic causes of surface uplift from records of output sediment fluxes, we design a new experimental device to test this proposition in the sedimentary signal. The experimental device allows the study of a coupled erosion-sedimentation system at laboratory-scale for given uplift and rainfall rates, and throughout a perturbation of these controlling factors. Results from our experiments demonstrate that fan architecture is a good archive for characterizing controlling factor forcing. A decrease in the rainfall rate (or an increase in the uplift rate) is recorded by an increase in the fan slope and the occurrence of some downlap geometries. An increase in rainfall rate (or a decrease in uplift rate) is recorded by a decrease of the fan slope and the development of some onlap, and possible toplap geometries. While this first distinction between onlap and downlap geometry has been performed, the bed and facies stacking pattern allows a discrimination of the forcing nature. While an increase in the uplift rate is characterized by a thickening and coarsening upward package, a decrease in the rainfall rate is characterized first by a thickening and fining upward package followed by a thinning and coarsening upward package. In these experiments, the erosional perturbation induces a typical dynamic of the sediment supply (Qs) and thus of the ratio between the sediment supply and the water supply. It has a direct impact on the transport capacity resulting a unique dynamic of the fan slope, apex aggradation, grain size distribution, thickness of bed, frequency and facies stacking.

Bonnet, S., Crave, A. (2003) Landscape response to climate change: Insights from experimental modeling and implications for tectonic versus climatic uplift of topography. Geology 31: 123-126

New considerations on Permian stromatolites associated with mesosaurs at Santa Rosa de Viterbo (Paraná Basin, São Paulo, Brazil)

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In Santa Rosa de Viterbo (São Paulo State, Southeastern Brazil, coord. UTM 23K, 0259.79 Km E / 7622.65 Km N), in the northeasternmost Paraná Basin, the "PH 7 Quarry" exposes dolomitic limestones with mesosaurs of the Passa Dois Group (Artinskian, Lower Permian). Such reptiles, as well as crustacean carapaces (Liocaris) recognized in thin sections, indicate chronocorrelation with the Assistência Member of the Irati Formation. This stratigraphic unit is characterized by tabular limestones (and occasional lenticular calcareous tempestites) that alternate with bituminous shales in most areas of the basin, but the limestone exploited in the quarry comprises a tabular biostrome of huge stromatolites. Only in the Huab Basin in Namibia, a similar mesosaur- stromatolite association has been recorded. The microbial origin of the limestones in Santa Rosa has been known since 1985, but new data and interpretations are presented. For example, it is now known (also in borehole cores) that the limestone overlies red pelites with chert nodules, possible evaporite molds and conspicuous bioturbation in the uppermost 15 cm. The ichnofossils apparently indicate increasingly restricted conditions and include *Glossifungites*, which suggests the occurrence of an unconformity, possibly between the Tatuí and Irati formations, still under investigation. The limestone starts with a carbonate breccia (12 cm), followed by a predominantly micritic bed (75 cm) with sub-horizontal to slightly wavy and truncated laminations. The stromatolites correspond to the upper part of the limestones and are organized in two successive intervals. They abruptly overlie the micritic bed, sometimes on an eroded surface, or locally show a transition from almost plane to slightly rippled laminations. About 10 cm upwards (but varying much laterally), the stromatolites become gradually pseudocolumnar or domed, very elongated in the N40-50°E direction, with rounded rectangular, parabolic to turbinate vertical sections, and rounded to oblong fusiform transverse (horizontal) sections (height ≤ 160 cm, width ≤ 120 cm, and length ≥ 7 m). Spaces between the columns are no more than a few centimeters wide and filled with calcite or fine reddish sandstones with abundant, occasionally partially articulated, mesosaur bones. In higher positions, some stromatolites tend to branch into parallel ~10 cm wide columns, and a few continue upward as more isolated domes, much more diverse in height (up to 2.1 m), length (3 to 8.6 m) and spacing (3-9 m). Stromatolites are parabolic in transverse cross section with a steeper, more abrupt NE end. Such asymmetry suggests growth under the influence of water flowing from NE to SW. This fact has interesting implications for environmental and paleogeographic interpretations: what controlled such flows? Tides? Currents induced by winds? Temperature gradients?. Although tidal currents could be an attractive alternative, the epeiric sea probably had a very restricted connection to the open ocean, without a significant tide influence. Upwards, the stromatolites present an increasing proportion of red mud until they are finally smothered by red siltstones of the Corumbataí Formation. There are often large chert concretions at this boundary. It is possible that almost all the limestone succession represents a gradual increase of water depth (transgression). Microbial mat development appears to have terminated because of the arrival of this mud (regression). The limestone occupies an area of ~ 4 km^2, thin eastward until it disappears completely, where the Tatuí and Corumbataí Formations are in contact. Southwards, a similar situation probably occurs, as the Irati Formation does not appear again until Porto Ferreira. The limestones with stromatolites may represent, therefore, coeval bioherms with respect to the siliciclastic sedimentation of adjacent areas, or else they were preferentially preserved by fault-controlled subsidence during the Early Permian.

Mixed siliciclastic-carbonatic successions in the Teresina Formation, Permian of the Paraná Basin, southern Brazil

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Mixed siliciclastic-carbonatic successions, including microbialites, are ubiquitous in the Lower-Middle Permian (Kungurian-Roadian?) of the Paraná Basin, namely in the Teresina (=Corumbataí, ~Estrada Nova) Formation of the Passa Dois Group. This unit represents an intracratonic epeiric sea, which was no longer connected to an open ocean due to the Gondwanide Orogen. Proved marine fossils, as well as true freshwater invertebrates, are absent. The Teresina Formation presents a typical aggradacional facies architecture, but detailed correlations reveal that the carbonatic beds vary laterally along short distances. This fact is noteworthy for microbialite bioherm/biostrome modelling applied to oil exploration. The ~280-330 m thick formation presents ~120-140 stacked cyclic siliciclastic coarsening upward successions or shallowing up cycles (~1-6 m thick), which seem to be consistent in wide correlations, composed of: a) lag of fish bones or highly comminuted shells on eroded surface (0-4 cm); b) dark shales (~0-10 cm); c) interlaminated dark shales and very fine sandstones in lenticular, wavy, flaser bedding, usually bioturbated; the wave cross laminated sandy layers become predominant and thicker towards the top (~1-6 m thick); d) fine sandstones with HCS (0-60 cm). Small mudcracks are common and occur even far away from the basin paleomargin. Fossil plants, as well as fern spores, are also recorded in a wide paleogeographic range. In a broad classification, the carbonates are shelly micrites, oosparites, carbonate breccias, coquinas or biolithites composed of microbialites, all with a significant proportion of very fine quartz (and feldspar) grains. Bioturbation and silicification are frequent. There are several types of stromatolites: planar ondulated, pseudocolumnar to columnar, usually short (< 20 cm), sometimes divergent branching, with distinct shapes, margin structures, laminas, various intercolumnar infillings, organized in tabular to domed biostromes. At one outcrop, the stromatolites are superposed by domed thrombolites. Oncoids are abundant and commonly associated to bivalve shell incrustations. The boundaries between siliciclastic and carbonatic beds are generally abrupt, rarely gradacional, sometimes erosive at the base, and waved, cracked or with dissolution evidences at the top. The stromatolites are commonly superposed by dark shales. Many carbonates occur as single beds (usually <40 cm) between cyclic siliciclastic successions or sometimes in apparently random positions. They also occur as complex vertical arrangements without clear internal organizations (usually <2 m thick, exceptionally up to 10 m, including very thin siliciclastic intercalations). About 10 such complex arrangements provide wide stratigraphic correlations, what suggests basin scale controls as intervals of drier climates and consequent higher salinities. However, close located boreholes (~2.5 km apart) show that the carbonates change laterally in composition, thickness, vertical arrangements or even disappear. The stromatolites and oncoids, although present in several stratigraphic levels, usually do not substantiate correlations. In outcrop, some biostromes were observed along ~150 m, but wider lateral distributions apparently cannot be predicted. The lateral variations probably reflect distinct subenvironments, as shifting ooid shoals frequently reworked by (storm) waves, slightly deeper or protected regions with micritic sedimentation, and microbial developments in various settings. Small eustatic variations caused exposition, reworking or total erosion of the carbonates in very large areas due to the low gradient of the intracratonic basin. Considering the almost uniform vertical repetition of cyclic facies and the presence of several intraformational unconformities, it is hard to recognize long term transgressions/ regressions or third order stratigraphic sequences (except the basal 25- 50 m of the Teresina Formation, not pertinent herein).

Taphonomic analysis of Permian stems in Parnaíba Basin (Tocantins, North Brazil)

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Rare taphonomic studies refer to paleocurrent analysis based on petrified stems. The best examples are from Triassic of Arizona, USA, and Jurassic of Xinjiang, China, in addition to some studies focused on stems in volcanoclastics. Thus the Permian stems in the Parnaíba Basin, Northeastern Brazil, are exceptional. This study focuses on three ~1-2 km^2 large areas in Tocantins State, approximately W-E aligned along a distance of ~32 km (designated "central, W and E areas" herein), between Araguaína and Filadélfia, in the Tocantins Fossil Trees Natural Monument (~7° 28'S/47° 55.5'W in the center). The stems occur in a ~20 m thick vertical interval of the Lower-Middle Permian Motuca Formation composed of channel cross-stratified and massive fine sandstones (with the petrified tridimensional stems), flood plain mottled sandy siltstones, followed by lacustrine pale siltstones (with compressed stems) and thin massive or nodular silex. No coarse sediments were observed. Cross stratifications in the central area suggest paleocurrents mainly to NE and secondarily to SE. The fossils are mainly tree ferns, secondarily gymnosperms, sphenophytes and rare other plants, sometimes including basal thick adventitious root mantles or rhizomes, but never attached distal parts. In the E area, rare detached gymnospermous branches, fern petioles and leaves were found. Almost all stems are relatively straight, commonly 15-25 cm thick (not considering the basal or apical parts), up to 11 m long, but many trees may have been taller. They are partially embedded in fine clastics or lay loosely on the ground. The exposed stems are usually fractured into 30- 60 cm long pieces by weathering and the fragments may be displaced from their original positions. Therefore, despite the abundance of logs, only aligned fragments to an extent greater than 2 m were used in the orientation analyses, reducing the sampled orientation data from 178 stems (>1m) to 23 + 23 + 29 stems (>2 m) respectively in the central, W and E areas. Consistent rose-diagrams corroborate that the longer stems certainly maintained their burial orientation. Considering the good preservation of the stems, they probably floated in the channels and were not waterlogged during transport. After each flood water receding, they were stranded on channel-margins. The parallel orientations indicate the directions of the paleochannels, whereas some distinct directions probably represent interference between stems or with obstacles, as well as deposition in small secondary channels. The near absence of compactation rejects deep burial before permineralization. Some stems show an abraded apex, what indicates that they pointed downstream during transport. In relatively large channels, this orientation is usual for straight stems with heavy bases, but it may be opposite for stems with connected branches. In the central studied area, many stems point the apex to the same direction as the paleocurrents indicated by cross stratifications (NE), but some stems are inverted and probably lost their branches after deposition. In the W area, stems point to W or E. In the E area, where thick basal root mantles are common, almost all stems have the apex oriented to SE. They were possibly felled and oriented downstream at the channel margins, without significant transport, and so protected underlying leaves from breakage and decomposition. The differences of paleocurrent directions from one area to another are expected in a fluvial system, but the sinuosity of channels was apparently low. The lack of organic matter-rich mudstones and the almost syndepositional impregnation of plant tissues with silica probably was favored by very alkaline solutions caused by high rates of water evaporation during dry seasons. The notable stem preservation was probably supported in a kind of fluvial fan with ephemeral channels, low topographic gradient, major floods, without reworking despite the low subsidence of the intracratonic basin.

Insights on a continental Middle Permian key-unit in the Southern Alps (The Val Daone Conglomerate, Western Trentino, Italy): facies analysis and geochronological constraints

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The Val Daone Conglomerate (VDC) is a continental clastic unit which crops out eastwards of the central Southern Alps, along the Giudicarie Belt (W Trentino), from the NE sector of the Early Permian Collio Basin to the W, up to the Rendena Valley to the E. This formation lies just above the regional unconformity which marks the stratigraphic boundary between the two Permian major tectonosedimentary megacycles and upwards it grades paraconformably (?) to the fluvial red beds of Verrucano Lombardo/Val Gardena Sandstone, generally related to a Late Permian Age. Recently, a palynological study carried out on the Val Daone Conglomerate suggested a Guadalupian age (Kazanian), owing to the remarkable presence of diversified pollen associations; therefore, this sedimentary unit is to-date the first one ascribed, on palaeontological basis, to the Middle Permian in the entire Southern Alps domain. The purpose of this paper is two-fold: firstly, it aims at illustrating stratigraphical and sedimentological data of this continental formation in the attempt to reconstruct its palaeogeographic-depositional framework; secondly, it looks at providing geochronological data on the last volcanic unit of the Lower Permian 1st cycle, just below the VDC, in order to indirectly estimate the duration of the stratigraphic hiatus between the two main Permian cycles in this area. The studied formation is generally represented by whitish to grayish conglomerates-microconglomerates to medium-grained sandstones, composed of prevailing vein-quartz and volcanic rock-fragments and reaches a maximum thickness of about 100 m. A detailed facies analysis of VDC, was performed on several stratigraphic sections all throughout the outcrop area and testify to a deposition in amalgamated alluvial fan-braided fluvial environments with wide channels and longitudinal bars. This is mainly supported by the repeated lateral and vertical changes of grain size across the entire formation, the considerable number of deep erosive channels in several outcrops, and the presence of cross-stratification/even-lamination structures. Paleocurrent directions, mainly to the N-NNW and lateral changes in sediment size (fining to the E), have allowed to make a distinction, according to the nature of proximal (Riccomassimo Valley), medial (Daone Valley) and distal (Rendena Valley) elements of VDC alluvial fans. In addition, the compositional data indicate that source areas of the sediments were reasonably located to the S-SE sectors. In order to make a comprehensive overview on the geometry of VDC and describe its lateral and vertical stratigraphic relationships, there have been digitalized three geological maps based on new and previous field-mappings, using GIS-software and 3D representation. Two selected samples were collected for geochronological studies: they belong to the Ponte Murandin rhyodacitic lavas (Daone Valley) and to the topmost volcanic rocks, known as Malga Plan Ignimbrites (Rendena Valley). These volcanic rocks were dated by U-Pb LA-ICP-MS zircon method and provided mean concordia ages of 277 ± 2 My (MSWD= 0.047) and of 279 ± 2 Ma (MSWD= 0.16), respectively. Such radiometric age determinations, besides allowing to better define in the central Southern Alps the duration of the time gap between the 1st and 2nd Permian cycles in more than 10 My, are also significant because they allow to link regionally the studied volcanic bodies to the Collio Basin coeval products to the SW and with the Athesian Volcanic Group to the NE.

The impact of Neogene inversion tectonics on the evolution of a reef system in Browse Basin, Australia

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The Browse Basin is one of a series of sedimentary basins on the passive continental margin of Western Australia. During the Neogene, sedimentation in the Browse Basin changed from siliciclastic to carbonate deposition, which was in the beginning dominated by non- tropical organisms, but from the Miocene onward shifted to tropical photozoan carbonates. By the interpretation of high-resolution 3D-seismic data we recently identified a large barrier reef stretching across wide areas of the Browse Basin and mapped its geometry to unravel its evolution. By the interpretation of an adjacent grid of large-scale 2D-seismic lines we aimed to assess dimensions and local variations of this reef system. Soon after the initiation of reef growth a very continuous barrier reef of ~200 km length establishes, thereby forming one of the largest barrier reefs in the Neogene record. It comprises several progradational ridges, before it backstepped and subsequently drowned. Since tropical reefs are living, but relatively immobile ecosystems they are particularly exposed to variations in their surrounding environment. Beyond that they are sensitive to several extrinsic factors as e.g. water depth and siliciclastic input, that can be affected by tectonic activity. During the Neogene the North West Shelf (NWS) moved into the stress field of the Sunda-Banda-arc subduction zone, resulting in reactivation of older tectonic structures. Due to the oblique collision of Australia and the Banda Arc on the one hand and the varying structural configuration of the NWS shelf on the other hand the compression lead to locally differing effects. Our study area is located at the southern end of the Browse Basin. While its northern part (Caswell subbasin) is a wide basin opening towards the sea, in the south (Barcoo subbasin) it is reduced to a narrow passageway pinched between the Leveque shelf and the Scott plateau. Its maximum width is around 100 km. The collisional strain is channelled into the bottleneck of Barcoo subbasin forming a fault-controlled anticlinal zone (Barcoo fault-zone, BFZ) of ~180 km length and between 2 and 20 km width. Deformation style changes along the BFZ and inversion decreases to the north, where the Caswell subbasin opens. The northward decreasing tectonic influence on the sedimentary system provides an excellent case study to assess the importance of the different controlling factors on the evolution and architecture of the reef. Despite the varying tectonic situation, the evolution of the reef system is astonishing uniform, reflecting regional variation only in its progradation rates. The reef evolution and demise shows a strong eustatic signature, which is enhanced by climatic factors.

Sedimentological characteristics of the Quizapú Volcano ashes erupted in 1932, Llancanelo lake region, Mendoza (Argentina)

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The eruption of Quizapú volcano (Eruptive Complex Descabezado Grande, Province of Talca, Central Chile) was one of the major volcanic events in recent times. The eruption –which occurred on April 10-11, 1932-, reached a VEI (Volcanic Explosivity Index) of 5 and produced –as a result of the prevailing westerly winds- a impressive ash dispersion toward the east (in the Pampas region in Argentine territory), even reaching the Atlantic coasts located 1000 km eastward and regions further into the ocean. Environmental and social impacts were very significant (Abraham & Prieto, 1993). According to Kittl, E. (1933) and González (1993) the eruption was Plinian, injecting and circulating into the atmosphere a 15/20 km high, 50 km wide mushrom-shaped column of dacitic tephra (70% SiO_2) with a volume of 25-30 km^3 and a weight of 150 ton/km^2. Volcanic blocks, lapilli, sand and ash fell on the ground with a marked decreasing grain size with distance. Major mineralogical components are light and dark glass, and phenocrysts of hornblende, pyroxene, olivine, magnetite and plagioclase. Field and laboratory activities were carried out in the context of Project MINCyT-ANPCyT-PICT 2006-1311 in the surroundings of Llancanelo lake, located around 100 km eastward of the volcano. Tephra deposits of Quizapú eruption were recognized in outcrops, diggings and sediment cores around the lake. The tephra layer has a regional distribution with a mean thickness of 10 cm, overlying lacustrine and eolian sediments as well as soils. Around 25 selected ash samples were studied by sedimentological techniques, observed under binocular, petrographic and electronic microscope and analyzed with the EDAX microprobe. Grain size distribution shows well sorted medium to fine sands. Bulk mineralogical composition reveals that the ashes are almost exclusively (> 90%) composed of transparent light and dark glass (shards) between 5 and 300 µm in size. Semi-quantitative chemical composition obtained with EDAX microprobe reveal predominance of Si, Al and O (in decreasing order) with the following values: SiO_2: 46.59 to 70.06 % and Al_2O_3: 16.22 to 35.11 %. Minor components are Na_2O: 0.99 to 9.74%; CaO: 1.39 to 4.96%; K_2O: 1.34 to 3.89%; and minor proportions of Fe_2O_3, CuO, MgO, SO_3 and TiO_2. Electron microscope observations reveal shards with varied shapes, either equidimensional (rounded to angular) or elongated to prismatic and irregular, with grooves and different degrees of vesicularity. According to Miwa *et al.* (2009) glass textures can be defined as S-type (massive with smooth/uniform surfaces) and NS-type (non-smooth, irregular, alveolar and vesicular surfaces). Sedimentological and mineralogical characteristics of the Quizapú samples around Llancanelo lake indicate that volcanic processes involved in the tephras deposition were mainly direct fall from the ash clouds with possible pyroclastic flows and surges.

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Channel migration in the middle Amazon River

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The Amazon River is the largest river in the world in terms of annual discharge and drainage area. In Peru the river is known as the Amazonas after the junction of the Marañon and Ucallaly rivers. In this reach the river has been described as having a predominantly meandering and even straight pattern with migration rates up to 400 m yr^{-1}. After entering Brazil, the river is denominated Solimões and not until the junction with the Negro River at Manaus is the name Amazonas used. The Solimões reach has been described as a predominantly anastomosing river with some authors referring to it as having a combined meandering-anastomosing pattern. Migration rates up to 140 m yr^{-1} at Fonte Boa near the mouth of the Japura River have been reported for the Solimões. Downstream of Manaus the river assumes a more stable anastomosing pattern which is reflected by lower migration rates that can reach up to 41.98 m yr^{-1}. The quantification of channel change calculated by others shows a generally decreasing trend from upstream to downstream, with 2% yr^{-1} at Fonte Boa and 0.2% yr^{-1} at the confluence with the Negro River. Then it increases again downstream of the confluence with the Madeira River, with values up to 1% yr^{-1}. The classification of this system into only one fluvial pattern is difficult since two or more patterns can coexist due to its multichannel configuration. Recently a more suitable pattern has been defined for systems like the Amazon, such as the anabranching classification based on a multichannel platform in which the conventional channel patterns can be included. Thus the Amazon is considered as having a general anabranching pattern. In this study we evaluate the channel change and the migration rates, based on remote sensing techniques, of the Amazon between the mouths of the Negro and Madeira Rivers to improve the understanding of its anabranching characteristics. Two Landsat images acquired on July 16, 1978 and August 18, 2009 were selected based on minimal daily water level variations which yielded a maximum period of analysis of 31.5 years. The analysis revealed the erosional tendency of the system, with an increase of the channel area by 14.6% and decrease of the area of islands by 18.9%.This tendency is also corroborated by the pixel class-changes analysis with deposition being up to 4.6% and erosion 13.2%. The percent of channel change corresponds to 17.8% over the whole period with an annual rate of 0.6% yr^{-1}. Maximum migration rates recorded are 59.3 m yr^{-1} (deposition) and 38.2 m yr^{-1} (erosion) the first rate is located at the southwest of the Marati Island while the second is located at the east of the same island. The maximum migration rate affecting the margins of the main channel is found at an erosional area located at the right margin of the Amazon River in front of the community of Novo Remanso with 33.7 m yr^{-1}. Maximum migration in secondary channels are found at the East of the Careiro Parana with 41.6 m yr^{-1} and East of Jacare Parana with 36.7 m yr^{-1} both areas being depositional. The values of channel change and migration rates suggest a very stable system over this period when compared with the reaches of the Solimões River or the Amazon River in Colombia. In Colombia, channel change values have been reported at 27.1% over a period of 20 yrs (1.4% yr^{-1}) and migration rates for erosion at 124.6 m yr^{-1} and for deposition at 73.9 m yr^{-1}. Despite the general stability of the system, a clear migration of secondary channels as well as some areas of the main channel is evident. This migration is also clear when correlated with the scroll bar floodplain. Samples for OSL dating were taken to estimate rates of migration of main sets of scroll bar.

Sr/Ca ratios in the cold-water coral *Lophelia pertusa* - problems and possibilities as a temperature archive

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One of the basic data to understand the climate system and past global changes is the measurement and the reconstruction of seawater temperature. In combination with salinity, the temperature of the ocean controls the density of the water masses, which is the major driving force for the oceans thermohaline circulation system. Geochemical investigations on the cold-water corals *Lophelia pertusa* and *Desmophyllum cristagalli* indicated the potential of these organisms as high-resolution archives of environmental parameters from intermediate and deeper water masses. Some studies tried to use cold- water corals as a high-resolution archive of temperature. However, the fractionation of stable isotopes and elemental ratios are strongly influenced by vital effects, and hence difficult to interpret. Nevertheless, ongoing studies indicate the potential of a predominant temperature dependent fractionation of distinct isotopes and elements (e.g. Li/Mg, Montagna *et al.*, 2009; U/Ca, Mg/Ca, $\delta^{18}O$, López Correa *et al.*, 2008; $\delta^{88/86}Sr$, Rüggeberg *et al.*, 2008). We investigated live-collected specimens of the cold-water coral *L. pertusa* from all along the European continental margin. These coral samples grew in waters characterized by temperatures between 6°C and 14°C. Electron Microprobe and mass spectrometer investigations along the growth direction of individual coral polyps were applied to determine the relationship between the incorporation of distinct elements (Sr, Ca, Mg, S). Cohen *et al.* (2006) showed for *L. pertusa* from the Kosterfjord, Skagerrak, that ~25% of the coral's Sr/Ca ratio is related to temperature, while 75% are influenced by the calcification rate of the organism. However, the Sr/Ca-temperature relation of our *L. pertusa* specimens suggests, that mean Sr/Ca-values of adult specimens are more reliable for temperature reconstructions along a larger temperature range than local high-resolution investigations. Additionally, our results plot along the same line of Sr/Ca-temperature relationship as tropical corals indicating a similar behaviour of element incorporation during calcification.

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Subglacial thermal organization of the northern part of the Patagonian Ice Sheet during the Last Glaciation

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Until now, the Northern part of the Patagonian Ice Sheet (NPIS) (38°-44°S) was interpreted as a west-east asymmetrical ice sheet characterized by; a linear center ice divide (related to the highest summits), with an alpine style glaciation developed to the East, and an ice sheet style to the West (Glasser *et al.*, 2008). These differences were associated with the direction of westerlies, the source of precipitation. The aim of this presentation is a first approach to the subglacial thermal organization (Kleman and Glasser, 2007) of the former NPIS during the last glaciation. Based on remotely sensed data and terrain control, different subglacial and supraglacial erosive landforms were identified and mapped in a zone former occupied by the NPIS (41° to 43°S). They range from mega scale landforms (cirques, troughs and rock basins), meso-scale glacial lineaments (rock drumlins, whalebacks and roches moutonnées) and meltwater channels to micro scale landforms such as striae and p-forms. The subglacial landforms were grouped in different land-systems related to the subglacial thermal regime (ice domes, ice cold patches, ice tributaries, ice-streams, outlet glaciers, mountain glaciers and valley glaciers), the criteria used to distinguish them are; orientation, distribution, form and size of glacial lineaments in valley troughs, distribution, size and morphology of valley troughs, size and morphology of cirques, presence of low altitude pass with linear erosive forms, zones of no-glacial erosion and the relation between subglacial forms with marginal glacial landforms. In order to explain the spatial distribution of landforms, the land systems were temporally related in a complete glacial cycle model (onset, full glaciation and deglaciation). During full glaciation (continental ice sheet), the feeding zones were characterized by various ice domes centered in the highest mountains zones. Their locations were controlled by the structure and previous topography. They form a multiple-discontinuous ice divide, because of the presence of NW-SE and N-S structural valley troughs, which separate them. Ice domes were cold based and drained by ice tributaries that confluence in topography constrained or “Isbrae type” ice-streams (Evans, 1996; Truffer and Echelmeyer, 2003) present in the major valley troughs. Ice streams that flow to the East pass to outlet glaciers which confluence with valley glaciers in the marginal zone, the high relief of this zone produces the bifurcation of the ice mass in various terminal lobes. On the other side, ice streams that flew to the West found less restriction due to the general low relief and could form huge expanded piedmont lobes. At this stage the erosion was concentrated in the major valley troughs, and overdeepenings. During onset and deglaciation, the former zones of ice domes where occupied by mountain glaciers and ice fields, valley glaciers occupied the heads of the troughs, lakes formed in the rock basins and fluvial erosion generated deep gouges in the valley floors. At this stage the glacial erosion passed to the head of the troughs and the top of the mountains, remodeling the previous subglacial landforms and imprinting an alpine style to the landscape. It is concluded that zones of erosion (*i.e.* the source of sediment for the marginal ice land-system) and ice dynamics vary in concordance with the configuration/stage in the glacial cycle. This must be taken into account when the glacial records of the marginal zone are analyzed.

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Early Cretaceous shallow-water carbonate platform development in the Southern Iberian Continental Paleomargin: considerations about the westernmost Prebetic

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Shallow water carbonate platform deposits are the most characteristic sedimentary record of the Lower Cretaceous in the northern part of the Southern Iberian Continental Paleomargin. They crop out making part of the Prebetic in the External Zones of the Betic Cordillera, in southern Spain. Shallow-water inner platform carbonates, locally with continental deposits interbedded, crop out in the outer part of the Prebetic. Five main tectono-sedimentary episodes (K1 to K5) separated by significant changes in basin palaeogeography and mainly controlled by extensional tectonic events have been distinguished (Vera, 2004). Mixed outer platform deposits with ammonite-bearing hemipelagic and shallow-water carbonate platform intercalations make up the innermost Prebetic outcrops. In these inner Prebetic outcrops, where the most distal part of the platform occurs, three clear transgressive-regressive (T-R) cycles from late Valanginian to early-late Albian, which correlate with the K2 to K5 tectonosedimentary episodes, have been recognized (Castro *et al.*, 2008). In the most external part of the margin, closest to the Cretaceous Iberian continental areas, shallow-water carbonate platform deposits developed during the transgressive phase of the T-R cycles. On the contrary, in more distal areas of the margin Prebetic shallow-water carbonate platforms occurred coinciding with the regressive part of the cycles. Three episodes of shallow-water carbonate platform development crop out, each one within a T-R cycle. From the late Albian onwards tectonic subsidence was replaced by a generalized complex thermal subsidence. The tectonosedimentary episode K6 (late Albian – middle Cenomanian) represents the first post-rift sequence which was coeval to a major transgression. The latest Albian–earliest Cenomanian interval recorded a notable terrigenous input (lower member of the Caliza de Jaén Fm), followed by a succession from a carbonate ramp that evolved upwards to a well-structured carbonate platform (upper member of the Caliza de Jaén Fm), deposited during the early Cenomanian. The Caliza de Jaén Fm is the most conspicuous lithostratigrahic unit of the westernmost Prebetic outcrops. These outcrops, the so called Prebetic of Jaén, make up aligned mapable isolated small areas located in the Jaén province (southern Spain), between the extensive Prebetic outcrops of the Sierra de Cazorla and Sierra de Segura to the east and the surroundings of Jaén city to the west. The Aptian- Albian Prebetic shallow-water carbonate platform episodes are only locally recorded in the central part of the Prebetic of Jaén outcrops, whereas the ubiquitous Caliza de Jaén Fm reaches the westernmost part of the outcrop lineation, upto scarce kilometers west of Jaén city. There, in the surroundings of Jaén city the Valanginian to the early Albian are not recorded making up a large hiatus. Resuming of sedimentation in this area drove to the deposition of the Caliza de Jaén Fm, since the latest Albian. The upper member of this formation shows clear west-dipping prograding clinoforms. A progressive westward displacement of the shallow water carbonate platform episodes characterizing the Early Cretaceous of the Prebetic is considered for the Prebetic of Jaén outcrops.

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Crustal recycling along the Paleozoic western Gondwana margin (NW Argentina and N Chile)

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In this study, we trace crustal recycling along the tectonically active proto-Andean west Gondwana margin throughout Paleozoic time. For this purpose, *in situ* LA-ICPMS U-Pb ages and Lu-Hf isotope ratios of 24-140 detrital zircons were obtained from each of 17 sandstones of Cambrian to Permian age from northwestern Argentina and northern Chile. The analytical approach allows the precise characterization of the source rocks. Together with the U-Pb ages, the Hf-isotope composition reveals whether the protoliths derived from material that had been recycled in the crust or represents juvenile mantle material, as would be expected for material produced along active continental margins. Most of the zircons are oval to elongated, 50 to 175 µm long and slightly abraded to rounded. Cathodoluminescence imaging reveals that a majority of the grains has oscillatory zoning, consistent with a magmatic origin. Zircons with only one growth stage are prevalent. Zircon ages of 420 to 520 Ma and 580 to 620 Ma occur in all analyzed sandstones (except for sandstones with older depositional age). These ages correspond to the South American Famatinian and Pampean (Brasilian) orogenies, respectively. The Ordovician Famatinan arc system of the Pampia terrane to the west, Cambrian intrusions in the Eastern Cordillera to the east and Brazilia craton fragments to the north can be assumed to be the main zircon source areas. Additional zircons with ages around 1 Ga suggest transportation from Grenvillian-aged regions of the Western Sierras Pampeanas in the south or from the Sunsás mobile belt in present-day Peru and Bolivia. Transamazonian ages (ca. 2 Ga) imply some detrital input from the Río de La Plata craton to the southeast or the Amazonian craton to the northeast. Zircons with ages < 600 Ma were derived from recycled material. This is indicated by their negative εHf(t) values (-8 to -2; a notation of $^{176}Hf/^{177}Hf$ in the sample compared to chondritic values). Grenvillian-aged zircons mostly have positive εHf(t) (+2 to +10), which indicates a juvenile origin. The crustal residence ages of both zircon groups are between 1.1 and 1.7 Ga. This suggests that the Paleozoic to Neoproterozoic zircon protoliths were recycled from Grenvillian-aged material. One group of zircons with ages of 1500 to 1850 Ma and εHf(t) between -5 and +2 and another group with ages around 2.1 Ga and εHf(t) between +2 and +10 mark a second crustal evolution trend with similar crustal residence ages, here from 2.2 to 2.4 Ga. Our results indicate, as previously also seen in other studies, that few crust formation events have occurred within the last 2 b. y. Orogen-forming processes during the Palaeozoic did not involve input of juvenile mantle material during crustal growth in this part of central South America. Our conclusion is that crustal recycling was a dominant process along the active west Gondwana margin throughout the Paleozoic.

Annually laminated lake sediments in Finland as archives of past climate change

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Varved sediments have been used to evaluate past environmental changes in regional scale, and in some cases, paleoclimate information has been derived from varve structure. The Late Holocene is a period of active expansion of human occupation and land use changes in Europe, and thus most varved lake sediments record poorly climate signal during the past few millennia. Annually laminated lakes that are located in regions with minimal human impact are therefore of great value for paleoclimate studies. The most active period of the hydrological year in Finland is the few weeks during spring when the seasonal snow cover disappears. Snowmelt forms floods in streams and rivers, and about half of the annual runoff is discharged in springtime. Concentration of suspended mineral materials in rivers and streams is controlled mainly by the intensity and volume of spring snowmelt floods. In the boreal forest environment, spring snowmelt floods have strong erosion and transportation capability. In consequence, mineral material is deposited in bottom of lakes during spring, while organic material is deposited from summer to winter. Under favorable conditions this seasonal cycle is recorded in bottom of lakes forming varved sediments. Thickness and density of minerogenic spring flood layer in clastic-organic varves reflect variations in the winter time snow accumulation and spring snowmelt season in Finland. On the other hand, varve total thickness and summer layer thickness in organic varves, where spring flood layers are missing, can be used as a proxy of growing season temperature. Using these two different varve types together it is possible to reconstruct a detailed record of past seasonal climate variations in Northern Europe. During last decade several annually laminated lake sediment sequences have been found from Central and Northern Finland (lat 62-70°N). Varve chronologies covering the last 2-5 kyr have been reconstructed from 5 lakes using epoxy impregnated samples and X-ray radiography and thin sections. Chronologies have been verified by paleomagnetic dating. Physical and chemical properties of varved sediment have been studied by X-ray density, back-scatter electron images, thin sections, mineral magnetism and μ-XRF techniques. Seasonal sedimentation of mineral layers and organic layers shows distinct variations during the last 2000 years. For example, X-ray density data from Lake Kortejärvi (Eastern Finland) shows a minimum in the spring flood activity during the Early Medieval between AD 900 and 1050. During the same time interval, summer layers are thick in the organic varves of Lake Kallio-Kourujärvi. Transition from MCA to LIA is rapid, and both X-ray density and summer layer thickness increase. During the LIA summer layers are relative thin in Kallio-Kourujärvi and mineral spring flood layers are distinct in Kortejärvi. The most important conclusions to be drawn from our seasonal proxy data are that Late Holocene climate and sedimentation in lakes in Finland has been highly variable, and that there are multiple controls responsible for this variability.

The oxygen isotope records from the off-mound sites of IODP Expedition 307 in the Belgica mound province, NE Atlantic

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Challenger Mound is one of thousands of cold-water coral mounds in Porcupine Seabight, which was first drilled in IODP Expedition 307. Sedimentological, geophysical and geochemical analyses focused on the sediments from the on-mound site U1317 sufficiently improved our understanding on origin and growth process of cold-water coral mounds (Foubert and Henriet, 2009; Sakai *et al.*, 2009; Kano *et al.*, 2007). However, less attention was paid for other two sites (U1316 on the mound foot, and U1318 on upslope) that were drilled for building the mound into the regional stratigraphic framework. In order to improve the age model of the two off-mound sites, the oxygen isotope of planktic foraminifer (Globigerina bulloides) was measured for 186 samples from Hole U1316A and 657 samples from Hole U1318B. The sediments below the mound base unconformity (RD1) of both sites record a range of the oxygen isotope values from -1 to 0.9 ‰, which is similar or slightly lower than the Holocene range (~0.6 ‰). This is the typical range for the sediments deposited before the northern hemisphere glaciation, and consistent with the previous assumption indicating the Miocene age [Kano, *et al*, 2007; Louwye *et al.*, 2008). Above the RD1 unconformity, the seismic profiles show that the off-mound sediments largely cover Challenger Mound (Foubert and Henriet, 2009). The oxygen isotopic values of these sediments fluctuate between 1.4 and 3.2 ‰ for U1316A, and between 1.8 and 3.5 ‰ for U1318B. Compared with the range of the on-mound Hole U1317E (0.6-2.4 ‰) (Sakai *et al.*, 2009), the off-mound data generally show 0.8-1.2 ‰ higher than the on-mound data, which means presence of the full glacial signals and lack of the full interglacial signals. The off-mound sedimentation was likely affected by regional current dynamics (Huvenne *et al.*, 2009), and enhanced current during the interglacials resulted in erosive regime in the mound area. We also provide detailed site correlation and age assumption for the off-mound sediment based on the oxygen isotopic results with the sedimentological and stratigraphic data, and discuss the depositional process around Challenger Mound.

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Debris-flow hazard at Al-Baha Descent Mountainous Road West of Saudi Arabia

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Al-Baha descent lies at the western region of Saudi Arabia. It is characterized by harsh territories and sharp cliffs, where elevation reaches up to 2200 meter above sea level. Al-Baha descent road is 50 km-long, and runs along the escarpment steep slopes of Al-Baha descent, where hundreds of natural and man-made rock slopes and tens of tunnels been constructed. Tens of wadi tributaries are emerging from high elevations. As the rocks are tectonic igneous rocks, the wadi tributaries are structurally-controlled and characterized by narrow and steep slopes. The rock masses along these tributaries were classified as medium to poor quality according to NGI and RMR rock mass classifications. Much debris is fallen down and filled the wadis tributaries. Debris flows are relatively common in rainy seasons, and typically flow down over the lower parts of the descent road, along the established structurally-controlled drainage pattern. Owing to typical debris-flow velocities there is little time to provide warning of the occurrence of a debris flow to populations within 10 km of a source area. One debris avalanche is attributed to hydraulic erosion rather than Coulomb shear. Soil matrix suction contributes significantly to slope stability under drained, initial conditions. Loss of soil matrix suction during rainstorms and loss of root cohesion at failure cause a sharp reduction of soil shear strength. Pore-pressure increases triggered the debris avalanches; however, soil depth, soil density, the presence of smooth bedrock discontinuities, steep slope, and root cohesion are shown to be important factors controlling initiation locations. Therefore, people living, working, or recreating along drained channels must learn to recognize potentially hazardous conditions, be aware of the extent of debris-flow hazard zones, and be prepared to evacuate to safer ground when hazardous conditions develop rather than await official warnings or intervention. Debris flow modeling and hazard-assessment studies must be augmented with public education programs that emphasize recognitions favorable for triggering landslides and debris flows if effective hazard mitigation is to succeed. A GIS-based model to predict debris-flow occurrence and main event is presented for a given area and a specified precipitation event. There is an urgent need for developing feasible methodologies of landslide hazard assessment and mitigation, which can be readily tested and implemented under the prevailing conditions. Mass movements mainly debris flow produced during various geological factors were investigated using aerial photographs and satellite images. Data concerning regolith composition and thickness, landslide dimensions, failure slope angle and land use were obtained for 10s of mass movements mapped at 1:2,000 scales. Techniques of GIS, GPS and DEM were utilized to determine the selected debris flow body boundary. Usual estimated hazard and geomorphologic feature and influence of topographical characteristics were related and studied to rate the debris flow hazard. Estimated hazard zones are intended to be related to natural conditions.

Climatic control on the discontinuous sedimentation in central parts of the Late Cenozoic Basins of Atacama Desert

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Abundant radiometric and cosmogenic data from the internally drained basins of Quillagua (19 35 - 22 40 S) and Calama (22 00 - 22 40 S), in the Atacama Desert (northern Chile) have provided absolute ages for the volcaniclastic deposits interbedded within the Miocene sequence as well as exposure ages of erosive surfaces. The resulting chronological framework is crucial to constrain the age of (i) the uplift of Central Andes Cordillera and its Atlantic rain shadow effect, and (ii) the variations on the temperature and intensity of the Humboldt Current along de Chile-Peru coast during the Late Cenozoic, both influencing the climate in the Atacama Region from the Miocene to present. The onset of hyperarid conditions in the Atacama Desert has been related to: (1) the long-term decrease of erosion and tectonic uplift rates, (2) the cessation of supergene alteration of orebodies in the Precordillera, (3) the cessation of the erosion on sensitive landforms of the Coastal Cordillera, and (4) the change of paleosols types in the Calama Basin. We hypothesize that a major consequence of the aridification of the Atacama Desert was that sedimentation in central zones of large basins (such as Quillagua Basin), which are under variable hyperadid to arid conditions (as Atacama was during Late Cenozoic), could tend to be discontinuous, because distal alluvial margin systems deposits reached center basin areas only during main relative wet periods. Assessing the degree of completeness of the sedimentary records in central basin sequences, compared to alluvial sequences accumulated in tectonically active basin margins, would be a powerful tool to constrain climate versus tectonic forcing in the basin sedimentary infill. In the Quillagua and Calama basins, the active sedimentary periods would be recognized by the occurrence in central basin areas of: (1) fluvial fan deposits which correspond to main progradation pulses from the margins basin alluvial sedimentary systems, and (2) fluvial-lacustrine deposits corresponding to longitudinal fluvial (Loa paleoriver) and lacustrine systems expansion episodes, all favored during periods of relative wet climate conditions in the region. Conversely, main sedimentary gaps (as paraconformities between sedimentary sequences) would be generated during relatively arid-non-sedimentary periods. New radiometric, paleomagnetic and petrologic data from Quillagua Basin sedimentary infill, besides with other cronoestratigraphic published data on the same basin and its adjacent Calama basin allows a new accurate reconstruction of alternating periods of active sedimentation and sedimentary gaps, as indicators of relatively wet and arid climate conditions of the for the last 15 Ma in the Atacama Desert. Data from central part of the Quillagua Basin indicates that sedimentary infill is limited to three alluvial-lacustrine sequences, occurring at three short periods at around 7-8 Ma, 5 Ma and 0.15 Ma ago, while most of time is represented by the sedimentary gaps associated to their bounding paraconformities. Sedimentation periods in central parts of the basin could be favored by humid conditions occurred during phases of weakness de Humboldt Current.

Development of play concepts using oilfield analogues (Persian Gulf, Middle East)

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This study focused on reservoir characterization of the Early Cretaceous Sarvak/Mishrif succession in the Persian Gulf area. The goal of the study was to develop play concepts using analogues from producing oilfields. The Cretaceous was a time of profuse carbonate production in the Middle East. During this period, the eastern part of the Arabian plate was covered by extensive carbonate platforms, which currently contain major hydrocarbon accumulations. Early Cretaceous shallow-marine carbonates have been successful exploration targets for more than forty years and they continue to be attractive objectives. Deep-seated salt tectonics, related to the rock salt of the Infra-Cambrian Hormuz Formation, was a major controlling factor for the Middle Cretaceous platform development. Structural deformation and doming is evident in seismic sections and has been related to salt movement during and immediately following deposition of the Sarvak/Mishrif succession. Key cored wells were selected for sequence stratigraphic analysis. Flow units were defined taking into account the calibration between cores and logs and genetic subdivision of the succession. Subsequently, main reservoir/non-reservoir units were tied with seismic facies and geometries in individual wells and later on extrapolated throughout the seismic volume. Finally, the stratigraphic model was integrated with the structural analysis. The Sarvak/Mishrif formation in the study area consists of low-energy distal ramp to moderate- high-energy shallow marine shoals facies, including bioturbated mudstone and wackestone, skeletal wackestone and packstone, skeletal grainstone and grain-dominated packstone, and rudist floatstone and rudstone. The top of the succession is marked by a period of subaerial exposure and porosity generation. The main reservoir interval occurs in the upper section of the Sarvak/Mishrif succession and consists of rudist-rich packstone/floatstone and less common grainstone/rudstone units representing rudist banks within the formation. Traditionally, the crest of these structures has been the focus for hydrocarbon exploration and field development. A close examination of the seismic sections across fields in offshore Dubai, however, shows erosion and/or non-deposition of the Sarvak/Mishrif reservoir on the crest and good reservoir development towards the flanks. Salt-related structures affecting the Sarvak/Mishrif section are also developed elsewhere in the Persian Gulf. Considering Dubai offshore fields as analogue, prospect potential is expected on the flanks of dome structures. Thus, the proposed play concept can be used to explore similar salt-related structures.

Late Quaternary glaciomarine sedimentation in the Arctic bay Isvika, Nordaustlandet, Svalbard

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The Isvika Bay and its surroundings in Nordaustlandet, Svalbard have been studied during the expeditions of the IPY Kinnvika-project in the summers 2007 and 2009. The studied bay (80° N, 18°40'E) is over 100 meters deep, and at present for the most of the year occupied by Arctic sea ice, with only 2 to 3 months of ice free conditions per year. Our main target is to understand the change and variability of the climate system within the nortwesternmost corner of the Barents-Kara Ice sheet during a time slot spanning from Eemian to recent time. The observations comprise sedimentological analyses from exposed coastal sections, biostratigraphical and mineral magnetic analyses of marine cores, CTD-profiling and acoustic properties of the sea floor. OSL and AMS age determinations are applied for chronological control of the strata. The results suggest that the area was overriden by a Late Weichselian glacier which deposited a thin and discontinuous till blanket. Interstadial sublittoral sand related to the Mid-Weichselian interstadial were dated to 38–40 kyr, and an Early Weichselian interstadial to 76–80 kyr. Preservation of older sediments, multiple striae generations and abundant observations of weathered local bedrock material indicate overall weak glacial erosion within the study area. The marine sedimentation rate in Isvika was found to be slow, probably due to strong stratification of the water column, tidal currents and a low rate of organic production. The sediments consist of alternating strata of laminated silty clay, sulfide mud and diamicton intervals. Ice rafted detritus is peppering the record indicating continuous but variable influence of sedimentation by drift ice. Diamicton units are thin, and they have been deposited by basal melt-out without any indications of shearing or deformation of older sediments. A rarely described deformation structure in sulfide mud has been interpreted to indicate instability of gas hydrates, possible due to warming sea floor during the early Holocene climate optimum.

Sedimentology and stratigraphic architecture of the Río Neuquén Subgroup (Cretaceous), Plottier, Neuquén, Neuquina Basin, Argentina

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This paper presents an architectural analyses and a palaeoenvironmental reconstruction of the Río Neuquén Subgroup (Cretaceous), in the mid-east Neuquén province, comprising a 30 to 40 m-thick non-marine succession. Based on constituent facies, bedset geometry, stacking pattern, and bounding surface characteristics, the entire succession can be classified into four architectural elements. Element I shows multi-storey, channel or upward-widening, conglomeratic channel-fills whose maximum thickness exceeds 1.5 m. It is interpreted as deposits of braided fluvial channels, and the multiple- storey character suggests deposition within channel belts with relatively high rates of aggradation relative to rates of channel migration. Element II consists of cut-and-fill deposit (trough and planar cross-stratified sandstone) in the lower part and composite bar deposits in the upper part. Each channel-fill unit is overlain by abundant fine-grained deposits on which weakly developed, hydromorphic paleosols formed or is encased within red–brown silty sandstones floodplain deposits. Shallowness of each cut-and-fill unit, and the predominance of simple- bar deposit collectively suggest deposition from braided streams. Element III shows a fining-upward stacking of single- or multi-storey small-scale (<1.5 m thick) channel fills with limited lateral extent of less than 50 m, or gravelly siltstones with discontinuous gravel sheets and homogeneous or graded lenses, red or yellow–brown fine-grained deposits with calcretes, burrows and paleosols, in ascending order. It is interpreted as channel-margin to floodplain deposits, including crevasse channel fill, crevasse splay and floodplain fines. Element IV is dominated by single storey and multistorey amalgamated sandstone bodies, and is characterized by high- and low-flow regime deposits, isolated or stacked into floodplain deposits. It is interpreted as deposits of ephemeral low-sinuosity river systems. The overall Río Neuquén Subgroup architecture can be resolved into 2 unconformity-bounded cycles interpreted as sequences A y B. The internal stratigraphic architecture corresponding to the Portezuelo Fm is represented by stacked sandstone channel braided (Element II) with little floodplain development. So, the Sequence A starts with the parasequence LAS-I (Low-Accommodation System -Martinsen et al, 1999). The second parasequence consist of sandstone channel braided (Element II) with abundant floodplain deposits and crevasse splay formation (Element III) followed aggradation within the channel belt, which occurred in response to base-level rise. The link between crevasse splays, channel aggradation and base-level rise is interpreted as HAS-I (High- Accommodation System). The Sequence A includes the LAS-I y HAS-I. The top layer of Portezuelo Formation contains laterally extensive channel braided system (Element I) with low channel/floodplain ratio. This parasequence LAS-II (Sequence B). The multistorey, multilateral braided fluvial deposits (Element IV) at the base of Plottier Formation are overlain by extensive sheet-like overbank deposits. The geometry and continuity of the sandy bodies and its proportion in relation to the floodplain deposits suggests periods of low frequency of avulsion/subsidence rate. The large-scale architecture observed is the equivalent to a HAS-II. The Sequence B includes LAS-II y HAS-II. The internal stratigraphic architecture of Río Neuquén Subgroup varies between parasequences and is a function of a combination of subsidence, tectonic, and autogenic controls.

Martinsen, O.J., Ryseth, A., Helland-Hansen, W., Flesche, H., Torkildsen, G., Idil, S. (1999) Stratigraphic base level and fluvial architecture: Ericson Sandstone (Campanian), Rock Springs Uplift, SW Wyoming, USA. Sedimentology, 46, 235–259.

Depositional environments, architecture of, and controls on Cretaceous non-marine successions in the Midwest part of the Neuquina Basin, Neuquén, Argentina

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Cretaceous non-marine successions of the Río Limay Subgroup represent one of the initial foreland basin phases in the evolution of the Neuquina Basin. In northwestern Neuquén province, these are divided into two successive stratigraphic sequences bounded by unconformities, on the basis of facies assemblages and depositional architecture. Subtle changes in the style of sedimentation through these sequences have been identified and are attributed to periodic rises in relative base-level together with changes in subsidence rate and climate, leading to basinward, progradational shifts of the alluvial systems. The palaeoclimate changed from semi-arid (Candeleros Formation) to sub-humid (Huincul/Lisandro Formations) with seasonal wetting and drying, as indicated by the evolved style of the deposition, the abundance of vegetation and the nature of associated palaeosols. Part of the succession (Candeleros Formation), formed in norththward- or northeastward-draining terminal fan systems, and is documented in detail in terms of macroform-scale to stratigraphic-level architecture. The unit is composed of two stacked progradational successions. The successions show systematic variations in the proportion and connectedness of channel sandstone bodies and the distribution of floodplain/channel facies. The basal part of the unit are characterized by single channel belts surrounded by flood basin deposits and the low proportion and connectedness of channel bodies, and the uppermost unit shows increases in the proportion, connectedness, and grain size of channel bodies and basinward expansion of proximal, well-drained floodplain facies. This interval represents a prograding complex (High- Accommodation System-HAS, Martinsen *et al.*, 1999). The Huincul Formation consists of thick sandstone bodies are characterized by superposition of numerous bars and channels, indicative of braided- channel systems and thin sandstone bodies comprise planar beds of massive, horizontally stratified, and trough cross-stratified sandstones, interpreted as sand sheets and splays. Spatial variation in the architecture of this succession has been recognized as stacked and interconnected channel belts (Low-Accommodation System-LAS). The Lisandro Formation, exhibits lacustrine transgressive deposits and a Gilbert-type delta progradational system. The deltas are organized into five vertically-stacked units that display well-developed angular to tangential foresets and preserved topsets, and a suite of internal depositional architectures consisting of alternating progradational and aggradational geometries that were controlled by high-frequency, relative lake-level changes in a subsiding basin (HAS). A maximum flooding surface is identified within the Río Limay Subgroup. The parasequence boundaries display evidence for a basinward shift in facies across a regionally mappable surface that is a parallel unconformity or, rarely, angular, and typically juxtaposes amalgamated braided fluvial channel sandstone (Huincul Formation). The observed sedimentary patterns can be interpreted in terms of fluctuations in the ratio of accommodation space/sediment supply, regulated by repeated basin subsidence, during an eastward progression of episodic thrusting. This together with palaeoclimatic fluctuations exerted the principal controls on stratigraphic architecture. Outcrop data were used to generate static reservoir models of sandbody architecture in subsurface well log data sets.

Martinsen, O.J., Ryseth, A., Helland-Hansen, W., Flesche, H., Torkildsen, G., Idil, S. (1999) Stratigraphic base level and fluvial architecture: Ericson Sandstone (Campanian), Rock Springs Uplift, SW Wyoming, USA. Sedimentology, 46, 235–259.

Salta Group unconformity (Cretaceous-Paleogene), Quebrada de Humahuaca, Argentine Eastern Cordillera

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The Salta Group (Cretaceous-Paleogene) on the N-NE border of the Salta-Jujuy High, Quebrada de Humahuaca, is essentially composed of clastic sediments with subordinated carbonates and evaporites accumulated in diverse sedimentary environments (eolian, fluvial, mud flat, and shallow marine influenced by tides and storms). The thickness of the Salta Group varies between 110 (Reyes-Yala) and 400 m (Tumbaya), so our interpretation of the amount of time of nondeposition is greater than the time represented by sediments, as will be demonstrated. Abrupt facies changes, flooding surface, omission surface, paleosols and fluvial system reactivation are defined. All those features have been used to identify three well-defined sequences (I, II and III). However, the top of the sequence is currently under detailed revision and a fourth sequence (IV) might be defined. The lower boundary of Sequence I -the base of the Salta Group- is an erosional unconformity with the Chalhualmayoc Formation (upper unit of Mesón Group, Mid-Upper Cambrian). Sequence I comprises stacked, fining-upward successions of dunes and interdunes cycles. These facies are laterally related to fluvial sandstone. In the Quebrada de Humahuaca and neighboring areas, Sequence II lays over Sequence I and an erosional surface is present between them. However, in the same sections (for example, Quebrada Noque, Maimara), Sequence II is laying over the Chalhualmayoc Formation. This unconformity is defined by a fluvial surface reactivation of episodic floods in semi-arid zone. Sequence II has been divided into two sections: a lower clastic section, and an upper carbonatic section. Sequence II covers a greater area of distribution than Sequence I. An exposure surface with palaeosol horizons and carbonate rhizoconcretions has been identified in Sequence II. The development of that surface is older than the limestone accumulation in a litoral-shallow marine environment which was affected by tides and storms. The lower limit of Sequence III is an erosional unconformity. In this region, Sequence III clearly overlies Sequence II. Sequence III consists mainly of continental clastic sediments of fluvial origin with periodically active channels. The presence of superposed palaeosols is remarkable. Likewise, the presence of carbonate nodules and rhizoconcretions are characteristic of Sequence III. Near the borders of the Salta-Jujuy High, these features made it possible to identify minor unconformities associated with local variations of the basal level, probably related to climate changes. A fourth Sequence (IV) can be identified at the top of the Salta Group, laying over Sequence III (erosional unconformity) and underlaying Quaternary deposits (angular unconformity). Two stages of sedimentation are identifiable. The first stage corresponds to a strongly erosive fluvial system with abundant bed load with palaeosol clasts from Sequence III. The second stage corresponds to siltstone and fine- silty sand aggradation associated with a floodplain; these facies are associated with ephemeral stream deposits.

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Lower Cretaceous mixed carbonate-siliciclastic depositional sequences of the Araripe Basin, Northeastern Brazil

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The Cretaceous Araripe Basin has a multi-story evolution, encompassing four stratigraphic sequences: pre-rift, rift, post-rift I and post-rift II. The post-rift sequences (Late Aptian/Cenomanian) crop out along the escarpments of an EW plateau elevated 1000 m above sea level (Chapada do Araripe). The Late Aptian to Early Albian (Alagoas local stage) post-rift I sequence lies unconformably over the lower Cretaceous rift and pre-rift sequences. This pre-Aptian angular unconformity is widely recognized across the Eastern Brazilian marginal basins, where it is also referred as pre-breakup unconformity. The post rift sequence I is composed by the Barbalha and Santana formations, in which three depositional sequences bounded by disconformities can be identified. The earlier depositional sequence begins with fluvial deposits made up of sandstones, with interbedded reddish fine-grained facies and thin layers of conglomerates of the Barbalha Formation. The whole sequence presents a fining upward pattern, ending in a ten meter-thick interval of fossiliferous black shale of lacustrine origin. This interval, known as Batateira Beds, has great lateral continuity, high organic carbon content, and thin beds and laminae of limestones. The top bed of these limestones is brecciated and sulfide mineralized. Clast-supported conglomerates and sandstones overlie disconformably the Batateira Beds starting the second stratigraphic cycle, which has also a fining upward pattern. Fluvial facies are superposed by a laterally continuous succession of fossiliferous limestones and green shales, tens meter-thick, deposited in large and shallow lakes (Crato Member of Santana Formation). The end of this cycle is marked by the presence of discontinuous gypsum bodies and black shales (Ipubi Beds), deposited contemporaneously to late Aptian evaporites of the Brazilian marginal basins. The gypsum beds are lenticular in shape and up to 30m thick, and their depositional environment considered similar to the modern salinas of South Australia. The evaporite section is covered disconformably by a transgressive- regressive cycle. The facies succession comprises thin layers of immature conglomerates, white sandstones, laminated limestones and green shales, originated in sea-influenced estuarine/lagoon environments, belonging to the Romualdo Member of the Santana Formation. The transgressive stacking pattern culminates in a short-lived Early Albian sea ingression and the maximum flooding surface is represented by ravinement surfaces covered by thin beds of coquinas made up of reworked marine shells and echinoids accumulated during rapid sea-level rise. The coquina beds are mantled by poorly fossiliferous sandy and silty shales accumulated during subsequent regressive highstand systems tract. The direction of marine flooding is controversial, and three alternatives have been already proposed: from southeast (Sergipe basin), north (Potiguar basin), and west (Parnaíba basin). Because of paleocurrents in the Barbalha Formation indicate continental paleodrainage towards southeast, we concluded that marine waters transgressed northwestward, from the eastern marginal basins to the interior of Northeastern Brazil.

A regional positive carbon isotope excursion on carbonates from the Permian Irati Formation, Paraná basin, Brazil

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The intracratonic Paraná basin extends over most of the southern part of South America and has a maximum thickness of 8 km. Six supersequences are represented in this basin, ranging from Late Ordovician to Late Cretaceous. The Irati Formation, which is part of the supersequence Gondwna I (Carboniferous-Permian), extends throughout most of the basin and is divided into the lower Taquaral Member, composed of siltstones and gray claystones, and the upper Assistência Member, formed from organic-rich claystones intercalated with limestone lenses. In the present study we present carbon and oxygen isotope in carbonates from a 30 m section located in the Northern part of the basin. Samples from the upper part of the section have $\delta^{18}O$ isotope values around to –8‰, while samples from the lower part of the profiles have values around –5‰. In contrast to the oxygen isotopes, the $\delta^{13}C$ values display a strong positive excursion in which the values range from – 7.0‰ to +12.7‰. Samples with high carbon isotope values, which are found mainly in the middle part of the lower profile, are characterized by centimeter-size dolomite layers intercalated with organic-rich shalestones. Sections with similar carbon pattern profiles and a well-defined positive excursion have also been described in profiles placed north of the Ponta Grossa Arch, mostly in the southern portion of São Paulo State. The isotopic similarity among these sections indicates that this positive carbon excursion is a regional feature and may be correlated with other Permian excursion observed in other basins. In contrast, isotopic data from the southern portion of the Ponta Grossa Arch do exhibit positive $\delta^{13}C$ values, but quite distinct isotopic profiles suggesting that this arch played a major role in the dynamics of the Irati basin. We suggest that the part of the Irati basin placed northern of the Ponta Grossa Arch was much more restricted and present an evolution quite distinct from that of the southern part. This interpretation is also supported provenance studies based on mineralogy, geochemistry, as well as, Nd and U-Pb isotopes, that show a strong contribution of Brasília Belt Neoproterozoic terrains as one of the main source region for the Irati black-shales from the northern part of basin.

The Southeastern South America Ediacaran-Cambrian Camaquã Rift System and a proposed transcontinental taphrogenic basin

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The Ediacaran-Cambrian Camaquã Rift System is composed of several volcanic-sedimentary rifts outcropping from Southern Uruguay to Southeastern Brazil (Piriápolis, Barriga Negra and Sierra de Aguirres rifts in Uruguay, and the Camaquã, Itajaí, Castro, Camarinha, Pico de Itapeva, Eleutério and Pouso Alegre rifts in Brazil), which are deformed by brittle faults and preserve thick volcano-sedimentary successions related to anorogenic granitic plutonism, including large batholites (e.g. Pelotas Batholite in Uruguay and Southern Brazil). Historically, this basin system has been interpreted as molasses (e.g. foreland, strike-slip and others) related to the pre-ediacaran neoproterozoic Brasiliano Orogens, the contemporaneous granites being interpreted as sin- to post-tectonic intrusions from an orogenic magmatic arc. In the present decade, several works published by our group have demonstrated, through field relationships and tectono- sedimentary evolution analysis, the anorogenic character of this basins and the independence of the rifting events to the Pre-Ediacaran Brasiliano Cycle, given the nonconformity with the brasiliano metamorphics as well as with the sedimentary covers of the cratonic regions. This rift evolution and its relationship with the contemporaneous granitic plutonism is also found in northeastern Brazil, leading to the hypotheses that the Camaquã Rift System ranges from southeastern to northeastern South America (e.g. Jaibaras Rift), represented by isolated remainings preserved from Phanerozoic erosion and representing a transcontinental intraplate structure similar in dimensions to the modern East African Rift System, defining an anorogenic event that affected the South American East during middle Ediacaran to Cambrian: The Camaquã-Jaibaras Taphrogenic Event.

Complex clinoforms and shelf to basin floor sediment distribution patterns in the Eocene forearc Tyee Basin, Coast Range, Oregon

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The late Early Eocene to Mid Eocene (Ulatisian – Narizian) Tyee Basin in the Coast Range of southern Oregon was a forearc depocenter that accumulated a thick succession of extremely sand-rich sediments. Development of Tyee basin originates from a complex interaction between subducting Farallon Plate and the North American Plate. The basement for the Tyee succession is a basaltic seamount/volcanic island terrane known as the Siletz River Volcanics that became accreted to the continental block (North American Plate) in Early Eocene. It has been proposed that prior to accretion of Siletz Volcanic Terrain an Early Eocene subduction zone was present between the present day Siletz Volcanic Terrain and the continental block. Following accretion of Siletz River Volcanic Terrane the subduction zone stepped out further to the west, to the present day inner continental shelf of Oregon. The Tyee Forarc Basin formed east of this new zone of active subduction. The Tyee Forearc Basin was probably of similar dimensions as some of the present day forearc basins associated with Sunda Trench. The Tyee basin-fill consists of a series of prograding/aggrading, shallow-to-deepwater shelf-margin clinoforms that were strongly influenced by the tectonic geometry of the basin and pre-existing basement configuration. A range of fluvial as well as river- and tide-influenced deltaic deposits accumulated on the relatively narrow but highly aggrading Basin-margin clinoform topsets by the repeated cross-shelf transits of high-supply rivers and deltas. The deepwater slope deposits include fine-grained turbidites and sandy turbidites that developed in multiple large-scale, slope channel systems. These slope channels, in turn, fed extensive, axially-oriented, large volume submarine fans on the basin-floor with turbidite aprons that stretched back onto the lower slope. The Tyee Basin has experienced post-Early Eocene clockwise tectonic rotation of more than 60˚ and at present the basin has a north-south oriented configuration. A series of alluvial-neritic-bathyal clinothems have been reconstructed as the key architecture of Tyee stratigraphy by systematically adding facies details of outcrop information from longitudinal (dip-oriented) and transverse (strike-oriented) basinal transects. Distribution of shelf/deltaic and deepwater slope facies belts indicate a complex, migrating shelf-edge geometry for the Tyee margin, as also supported by paleocurrent data within Tyee clinoform topsets. Major sediment transport direction across the narrow Tyee shelf varies from west-north-west in the eastern area to north in the western area. Similar variation in sediment transport direction can be observed within the very large turbidite channels systems of the deepwater slope. In contrast, the major sediment transport and growth direction of the extensive fan deposits of Tyee is uniformly northwards with minor local variations. Gravity and magnetic data and limited seismic data from Coast Range of Oregon show the presence of prominent, basaltic basement highs, some of which have been interpreted as preexisting features within the Siletz River Volcanic Terrane. The observed variation in shelf-slope growth direction vs. basin floor fan growth within the Tyee basin has been impacted by these basement structures. It is probable that the anomalously high thickness of Tyee fan succession (up to 2000m) is result of focusing of sand-rich sediment into relict topography resulting from the inactive Early Eocene trench.

Mid-late Holocene fluvial evolution of the Arno coastal plain (Tuscany, Italy)

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Mid-late Holocene successions buried beneath modern deltaic and alluvial plains represent excellent archives for developing high-resolution stratigraphic studies and reconstructing palaeogeographic changes occurred in the recent past. A large number of core data and piezocone tests were used for the first time to reconstruct the mid-late Holocene palaeohydrography of the Arno plain (western Tuscany, Italy), considerable for its relations with protohistoric and historic human activities. Special attention was focused around the city of Pisa, characterized by a very high density of subsurface data and by the presence of several archeological sites spanning from the Iron Age to Late Medieval times. The data set consists of 35 continuously-cored boreholes (10-m100 deep) and hundreds of well logs. Sediment mean grain size, sand composition, texture, color, sedimentary structures and accessory materials combined with stratigraphic correlations along cross-sections, transverse to the Arno River course, allowed to identify the main depositional facies and architectural elements recorded within the upper 15-20 meters of the Late Holocene sequence. The overall late highstand fluvio-deltaic succession, underlain by laterally extensive lagoonal deposits, is composed of isolated to amalgamated, 2-8 m-thick channel sand bodies within predominant flood-basin fine-grained deposits. Four channel-belt units (I-IV), clustered at distinct stratigraphic levels ranging in age from late Neolithic time to the Middle Ages, were recognized defining a crono-stratigraphic succession of fluvial events. Although an overall aggradational architecture is documented, as expected from strongly subsiding areas under highstand sea-level conditions, Units I and II erode the underlying lagoonal deposits up to 4 m. Proximity to the coast suggests a possible control driven by small-amplitude sea-level fall. Integration with absolute ages derived from radiocarbon dating and archeological artifacts enabled the elaboration of palaeogeographical maps, reporting the main modifications that affected the drainage network during the mid-late Holocene due to autogenic and allogenic processes and anthropogenic activity. Between pre-Roman age and the XII century AD, the Arno plain showed a complex palaeohydrographic system (Units I-III). According to historical sources and geomorphological maps based on photograph and satellite image analysis, our stratigraphic data evidence that Pisa emerged at the confluence of two large rivers, Arno and Auser, an old branch of Serchio River. Only one active fluvial course, almost coincident with the present Arno River, is recorded after the XII century AD (Unit IV), when the Auser was embanked and forced to flow northward to reduce flooding risk. Our results confirm that late highstand successions constitute excellent archives to establish the fluvial responses to climate and anthropogenic changes in areas with abundant archeological sites. They also corroborate the validity of a stratigraphic-based approach to reconstruct the palaeohydrography of modern deltaic and alluvial plains.

Delta stacking pattern and climate change in a tectonic lake: a case study of Lake Biwa, Japan

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The relationship between sedimentation processes and climate change during the last 300 ky in Lake Biwa was investigated based on sedimentologic and tephrochronologic studies of two borehole cores. Lake Biwa is an ancient temperate-latitude lake, located in the central part of Japan Arc, and is tectonic in origin. The lake is occupying an area of 678 km^2 with a maximum water depth of 104 m. The catchment area is about 3131 km^2 and the annual precipitation is about 1900 mm. Nearly two-thirds of precipitation input is lost by outflow through the Seta River, the only surface outlet, and the remainder of the input is lost through evaporation (Kotoda and Mizuyama, 1984). Uplifting is still occurring, documented at the river outlet, so tectonic movement is a key factor controlling the lake level. It was suggested by morphologic study of terrace sediments (Ohashi, 1975) that the river has always been a water outlet. The subsurface structure of Lake Biwa, studied since the 60s confirms this. Lacustrine clay has been deposited since 0.43 Ma (Mayers *et al.,* 1993). Two boreholes (BIW08-A and BIW08-B) were drilled at 48 m and 53 m water depths in the central part of Lake Biwa from April to May of 2008. The sequences recovered at BIW08-A and BIW08-B are 71.75 m and 100.30 m in length, respectively. Site BIW08-B is located about 500 m northwest from Site BIW08-A and further away from the lakeshore. Over twenty tephra layers were found within the two sequences. Most of them were identified as widespread tephra deposits and utilized for core-to-core correlation and age estimation. The age of the oldest tephra layer is 213 ka at 60.55 m of BIW08-A, and 295 ka at 88.50 m of BIW08- B. These cores mainly consist of massive clay with vivianite, a lacustrine clay deposited in central part of the lake. On the other hands, sandy deposits were observed in the lowermost part (below 63 m core depth) and the middle part (around 42 m) of BIW08-A and the lowermost part (below 89 m core depth) of BIW08-B. In these sandy horizons, alternations of fine to medium sand with cross-stratification and mud clasts as well as clayey silt with plant fragments and organic matters were present. These alternations show upward-coarsening pattern with rootlets occuring at the uppermost part. Based on the cross bedding indicating unidirectional currents and upward-coarsening pattern and so on, sedimentary environment of these sandy deposits are suggested to be lacustrine delta-front. The depositional ages of these deltaic deposits are 350-300 ka, 250-220 ka and around 120 ka. Average sedimentation rate after 295 ka is estimated to be 0.3 m/ky. However, at around 220 and 120 ka, the sedimentation rate is exceptionally high (0.6 to 1.0 m/ky). These intervals correspond to the deltaic deposits and correnpond with interglacial periods (MIS 5,7,9). Relative lake-level in this area was rising stepwise due to tectonic uplift of the outlet, Seta River (Miyata *et al,* 1990), and the increase in sediment supply formed deltas during the interglacial periods. It is not relative lake-level but sediment supply that mainly controls development of these deltas in Lake Biwa.

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Slope failure on passive continental margins: Insights from IODP Expedition 308, Northern Gulf of Mexico

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Expedition 308 of the Integrated Ocean Drilling Program (IODP) logged, drilled, cored, and made in situ pressure measurements in the Ursa Region off the Mississippi Delta, Gulf of Mexico, where rapid sedimentation, overpressure, and slope instability are interwoven. Multiple submarine slides over the last 60 ky, which are preserved as mass transport deposits (MTDs), record retrogressive failures that mobilized along extensional failure planes and transformed into long- runout flows. Retrogression proceeded from an initial slope failure that created an excavated headwall, which reduced the horizontal stress behind the headwall and resulted in normal faults. Fault blocks progressively weakened until the gravitational driving stress imposed by the bed slope exceeded soil strength, which allowed the soil to flow for more than 10 km away from the source area. This retrogressive erosion process continued at each subsequent headwall. The resulting MTDs have lower porosity (higher bulk density) relative to non-failed sediments because the failure process destroyed the original grain fabric. MTD base and top surfaces are imaged as high amplitude reflections in seismic data as a result of the density contrast between MTDs and the non-failed bounding strata. Overpressures measured with penetrometers reach 70% and 60% of the hydrostatic effective stress in the first 200 meters below seafloor (mbsf) at Sites U1322 and U1324, respectively where MTDs are located. Coupled sedimentation-fluid flow models predict that some slides were initiated by rapid sedimentation and overpressure alone, while others must have been triggered by external forces such as earthquakes. In all cases, overpressures preconditioned the slope for failure. IODP Expedition 308 has enhanced our understanding of geohazards and margin evolution by illuminating coupled processes of sedimentation, fluid flow, and deformation on passive continental margins.

Layering in fallout deposits of explosive eruptions. Learning from the 1991 Hudson eruption in Patagonia

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The 1991 explosive eruptions of Hudson volcano in southern Chile produced about 3 km3 (dense rock equivalent) of basaltic and trachyandesitic pyroclastic material mostly deposited as a multilayered tephra. The paroxysmal phase (Aug 12-15) involved three separate events with a maximum ~25-km-high eruption column. Tephra from this paroxysmal phase of the eruption was directed southeast in an elongate plume. Fall deposits extended to the Malvinas Islands ~1,500 km to the south in a narrow band almost 370 km wide that covered ~100,000 km2 of southern Patagonia. The plume associated with the paroxysmal phase produced a multilayered deposit composed of alternating layers of fine ash and pumice lapilli. The stratigraphy from the paroxysmal phase of the 1991 eruption is quite complex, and many well-defined fall units are traceable up to 50 km from source. About twenty-two well-defined beds up to coarse lapilli in size are present 30 km SE from the vent. Nine ash layers are present in Los Antiguos, 120 km east southeast from the vent. Stratigraphic complexity within Hudson fall deposits was produced by three concurrent factors. First, the three eruptive pulses that occurred during the paroxysmal phase of the eruption. Second, the development of a “wandering plume” that repeatedly crosses the main dispersal axis as a result of a changing wind direction. Third, wind reworking of ash after de eruption. The first two factors developed graded layers composed of lapilli and ash; the third resulted in better sorting and lamination of fine pumice or ash layers. Recent simulations using the lagrangian ash tracking model PUFF demonstrate that changes in the wind direction during an eruption can result in dramatic changes in the direction of the plume. The resultant ‘wandering plume’ may impact the grain size being deposited from fine ash that typifies the edges of the plume to the pumice lapilli that dominates the center of the plume. This depositional regime could produce a multilayered deposit composed of alternating fine and coarse units, similar to the base of the Hudson stratigraphy. The shifting plume in the earlier stages of the phase II eruption has also produced a much wider overall deposit than would be expected from a plume with a relatively fixed transport direction. Hudson’s case helps to understanding layering in ancient fallout deposits.

First investigations of tsunami deposits in the Dominican Republic: Playa Cosón, Península de Samaná

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Fine-grained, yellowish orange sand, deposited during one of the 1946 tsunami events (which occurred on 4th and 8th August, respectively), was detected at Playa Cosón at the northern coast of the Samaná peninsula. This tsunami sediment was observed on a small, NW-SE orientated stripe, located between 230 and 260 m landward of the present shoreline (mapped by hand-dug trenches and hand drilling). It was investigated in detail by means of sedimentological, mineralogical and foraminiferal analyses. The strongly carbonatic, slightly cohesive tsunami sediment disconformably overlies yellowish brown, carbonate-free, silty clay. A well-defined upper contact separates this sediment from the overlying dusky brown, carbonatic, sandy loam. The thickness of the tsunami sand layer is generally between 10 and 15 cm, with an observed maximum of about 40 cm. Filling of pre-existing topographic lows (e.g. crab holes) by the tsunami sand is evident. A SW-directed flame structure was observed in one of the trenches. The tsunami sediment completely lacks sedimentary structures and appears as homogeneous, massive layer. This is also proven by grain size analyses, showing no distinct variation in both, lateral and vertical directions. Mean grain size ranges from about 215 to 230 µm, with sorting between 0.61 and 0.65 (moderately well sorted, sorting coefficient according to Folk & Ward, 1957). Recent beach sands, which were also analysed for comparison, show a more heterogeneous grain size distribution (mean grain size: 163 – 264 µm, sorting: 0.4 – 0.8). A very small amount (0.2 – 1.5 %) of silt and clay (< 63 µm fraction) is present in all tsunami sand samples, but absent in Recent beach sands. Mineralogical analyses by X-ray diffractometry demonstrated that the tsunami sediments are almost pure carbonate sands, with only traces of quartz. High Mg-calcite, with a Mg content of about 17 %, is the dominant mineral phase (mainly due to the abundant occurrence of corallinacean algae), followed by aragonite. Calcite is not detectable in bulk samples. The < 63 µm fraction, however, is dominated by calcite, followed by high-Mg calcite, aragonite, quartz, chlorite, expandable clay minerals, kaolinite, muscovite/illite, paragonite, gibbsite, boehmite, goethite, hematite, feldspar and an unidentified 9.4 Å mineral (talc?). Kaolinite, gibbsite, boehmite, goethite and hematite are typical minerals of soils in humid tropics. Additionally, small amounts of gypsum were observed in some samples. The mineralogical composition of Recent beach sands is qualitatively and quantitatively similar to that of the bulk samples of the tsunami sand. With the exception of the carbonate minerals and gypsum, the mineralogy of the underlying brown silty clay is qualitatively similar to the < 63 µm fraction of the tsunami sediment. Foraminiferal analyses clearly imply that the source area for the tsunami sediments was not only the beach environment. This is already indicated by the fact that foraminifers from the Recent beach are often impregnated with grey to black organic matter, whereas those from the tsunami sediment are free of such impregnation. The foraminiferal assemblage is dominated by Ammonia, Triloculina and Quinqueloculina, all commonly found in Caribbean lagoons and shallow water areas. Other genera, known from similar environments, like Elphidium, Amphistegina, Peneroplis, Archaias, Vertebralina and Textularia also occur in minor to moderate proportions. However, a few individuals of taxa, originating from middle to outer shelf areas (Reussella, Cibicidoides, Siphonina), were also identified. One individual (Nuttalides) comes from bathyal to abyssal depths. In summary, shallow water sediments represent the main source for the studied tsunami sand, as proven by the mineralogical composition, foraminifers and the frequent occurrence of corallinacean algae. In addition, small contributions of middle to outer shelf areas can also be detected.

Interpreting *Lithocodium aggregatum* Elliott 1956 and *Bacinella irregularis* Radoičić 1959 as two ulvophycean green algae (?Order Ulotrichales) with a heteromorphic life cycle (epilithic/euendolithic)

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Lithocodium aggregatum Elliott (1956) and *Bacinella irregularis* Radoičić (1959) are two of the most widespread microproblematica with biosedimentary potential of the Late Jurassic-Early Cretaceous epeiric sedimentary record. These enigmatic microorganisms have been the subject of controversy during the last 50 years, especially concerning their possible relationship or synonymies. *Lithocodium aggregatum* was originally described by Elliott as a siphonal (= non-septate filaments) codiacean alga from the Lower Cretaceous of Iraq. Its codiacean (= udoteacean) nature was accepted by many subsequent authors, whereas others proposed a sponge or red alga origin. Among the most widely accepted views is its interpretation as a lituolid foraminifera or as having a microbial (= cyanobacterian) origin. New material of *Lithocodium aggregatum* from the Lower Aptian of the western Maestrat Basin (E Iberian Chain, Spain), together with detailed illustrations of Elliott's original material, yielded new insights into its biogenic nature and morphological interpretation, allowing for an emended diagnosis. Given that the original description of *Lithocodium aggregatum* is ambiguous, a detail from the holotype is chosen as an epitype to serve as an interpretative type (article 9.7 ICBN). *Lithocodium* is re-interpreted as a filamentous-septate heterotrichale ulvophycean alga (?order Ulotrichales) exhibiting a heteromorphic life cycle consisting of two phases: an epilithic gametophytic and an unicellular euendolithic sporophytic stage (*Gomontia*-stage). The epilithic stage is described in terms of a basal prostrate and an erect filament system. In cases of sculptured or fissioned substrate surface, *Lithocodium* may develop a cellular chasmoendolithic basal part. Last but not least, the prostrate filaments may grade into an irregular final stage with large vesicular cells, which were often misinterpreted as *Bacinella irregularis*. The suprageneric position (family) of *Lithocodium* cannot be fixed precisely at the moment. Its assignment to the class Ulvophyceae is justified by the postulated occurrence of a *Codiolum*-stage in its life cycle. Modern taxa that can be compared with *Lithocodium* such as *Eugomontia* Kornmann or *Gomontia* Bornet and Flahault are included in the order Ulotrichales Wille. Several (though not all) Late Jurassic references cannot be included in the emended diagnosis of *Lithocodium* as they are morphologically different; the same holds for all the Late Triassic reports. The key for the understanding of *Bacinella irregularis*, which has commonly been regarded as being cyanobacterian/microbial in origin, is the holotype figuration showing regular branching cellular structures. *Bacinella* is interpreted and redescribed as a purely euendolithic ulvophycean alga which bores into either *Lithocodium aggregatum* or the substrate below *Lithocodium* crusts. As a consequence of this reinterpretation, the microcrystalline cellular structures or meshworks from Triassic and younger strata which have commonly been referred to *Bacinella irregularis* need revision. These filamentous microfabrics often occur in well-sorted pack- to grainstone textures, where they bind and trap small bioclasts and peloids. Such microfabrics were also termed "bacinellid", "bacinelloid", "bacinellimorph" structures or just "Bacinella threads". Filamentous fabrics forming foam-like structures are also known from modern subtidal environments, where they were described as "filamentous fabrics"; they are most likely "microbial" in origin, i.e. microbial mats. In any case, these biosedimentary structures can no longer be termed *Bacinella irregularis*; they should rather be referred to simply as vesicular or cellular fabrics. Details of the species-specific life histories of the two algae *Bacinella* and *Lithocodium* are still unknown.

Sediments of the Dead Sea: detailed sedimentology and identification of varves, laminae, and event layers

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Full Address: GFZ German Research Centre for Geosciences, Section 5.2, Climate Dynamics and Landscape Evolution, Potsdam, Germany Israel is situated at the juncture of arid, semiarid and Mediterranean Climates. Geologically it lies along the major tectonic Syrian-African Rift Valley (Dead Sea Transform, DST), creating a vulnerable physical environment. The Dead Sea (31°30'N, 35°30'E) is a terminal lake draining one of the largest hydrological systems in the Near East. The sediment in the Dead Sea basin is composed of alternating fine layers of detrital clay layers and authigenic aragonite, with intercalated sand, halite and gypsum layers. The succession, composition and thickness of these layers are mainly controlled by changes in precipitation/evaporation ratio and runoff/evaporation ratio, thus making it an ideal candidate for palaeoenvironment studies. A first record of limnological changes in the Dead Sea basin, in terms of sea level variations reflecting regional palaeoclimate variations during the last 10 ka, has also been reconstructed, using multiple, well dated sediment cores and profiles recovered from three sites on the western Dead Sea shore (Ken-Tor *et al.*, 2001; Migowski *et al.* 2004). A series of abrupt changes in lakes level, largely correlatable to other records in the circum-Mediterranean (Migowski *et al.*, 2006) testify to the sensitivity of the lake level to the regional hydrology. The global teleconnections responsible for these abrupt changes are currently being invetigated. The main objective of our investigation is to identify event (e.g. flood, dust storm, and palaeo-seismite) layers in Dead Sea sediments and to establish Holocene time series of these event deposits. To achieve this goal, the different phases of sedimentation (clastic to evaporitic) which are related to periods of abrupt seasonal changes in rainfall/evaporation in the northern Dead Sea region are identified by means of petrographic thin section analyses, X-ray fluorescence element scanning and high-resolution magnetic susceptibility measurements. The geochemical investigations reveal the element composition of the sediment laminae. This discrimination allows the characterization of different types of sediment sequences (i.e. limnic, fluvial, eolian sediment) in respect of their origin. The resolution of the resulting set of multi-proxy data is below 1.0 mm thus allowing identification of individual event layers down to microscopic scale. The material chosen for investigations is taken from the sediment cores from Ein Feshka, Ein Gedi and Ze'elim on the western shore of the Dead Sea. Results from previous low resolution studies on these cores will be integrated. In addition to establishing long time series of individual extreme events, the expected data will allow for recognising decadal- scale variability in the eastern Mediterranean climate system during the Holocene. A further aim of this study is to calibrate the rock magnetic records, especially the magnetic susceptibility record with its high temporal resolution, versus the sedimentological and geochemical results, thus enabling the use of this parameter as a proxy for arid periods in further studies of Dead Sea sediments.

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An integrated approach for unraveling the sequence-stratigraphic significance of sharp-based marine sandstone bodies. A case study from the Upper Mulichinco Member (Lower Cretaceous), Neuquén Basin, Argentina

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Sharp-based shallow-marine sandstone bodies encased in offshore mudstones can develop in a wide range of sequence-stratigraphic conditions including normal regression, forced regression/lowstand, punctuated transgression or normal transgression. Yet, an unequivocal interpretation can be hard to achieve without having multiple datases. This contribution documents sharp-based, elongated sandstone bodies occurring within the Upper Mulichinco Member (Valanginian) in central Neuquén Basin, Argentina. Sharp-based units overly regressive siliciclastics successions composed of offshore mudstones and offshore-transition muddy sandstones, deposited within a broad epeiric sea. Sandstone bodies are in turn abruptly capped by transgressive skeletal carbonates. Sedimentological, architectural, ichnological, thaphonomical, and palaeocological data both from sandstone bodies and surrounding deposits were integrated in a small area (40 km^2) in order to unravel the sequence-stratigraphic context and evolution of these units. Sharp-based sandstone units occur at three distinctive intervals within a 70-m thick succession. They are 3-7.5 m thick and exhibit well-defined lateral pinch-outs, outlining N-S elongated bodies, at least three times longer than wide (e.g. 3 km x 1 km). Individual bases of sandstone bodies are sharp and flat for kilometers. They are marked by oyster- dominated shell beds as well as passively-filled Thalassinoides burrows attributed to a *Glossifungites* Ichnofacies suite. Basal shell beds extend beyond sandstone bodies pinch-outs and they have bored and encrusted sandstone cobbles throughout the area. Internally, the Mulichinco bodies are composed of clean, fine-grained sandstones and are not graded or they fine slightly upwards. A vertical transition from cross-stratified, to cross-laminated, to bioturbated sandstone facies is recorded in some cases. Large-scale, low-angle cross-stratified sets (from top to bottom of body), dipping to NE and NNE are also locally observed. Bioturbation varies from moderate to very high and is dominated by *Ophiomorpha* burrows. Sandstone units are sharply capped by thin (< 1 m) skeletal floatstones and wackestones. This upper contact is also locally demarcated by *Thalassinoides* burrows attributed to a *Glossifungites* Ichnofacies. Basal bounding surfaces of these sandstone bodies indicate that normal regressive conditions were interrupted by a period of significant erosion. Erosion of underlying siliciclastics extended far beyond the area where the sandstone bodies were formed (or finally preserved), suggesting that relative sea-level dropped even further down dip (i.e. during falling plus lowstand conditions). During the initial transgression borers and epibenthic oysters developed on sandstone cobbles exposed in the sea floor and winnowing resulted in fossil concentration. Thus, the basal shell beds are demarcating a transgressive ravinement surface. Available sand previously transported during falling/lowstand conditions was redeposited on the shallow eperic sea as north-south elongated sandstone bodies during early transgression. Bodies migrated laterally to NE and they were covered by 2D-dunes and ripples migrating both parallel and obliquely with respect to body axes. Intense bioturbation coupled with finer sands at the top of some units is suggestive of an abandonment phase. Eventually, sandstone units were covered by low-energy skeletal carbonates representing maximum transgressive conditions and minimum terrigenous supply both from the land and from palimpsest sediments. Mulichinco sandstone bodies resemble in many ways transgressive Quaternary shelf ridges and sheets so common in modern shelves. Thus, the integrated approach and findings of this study might help identifying truly transgressive sandstone bodies in ancient shallow-marine successions that are almost absent in the recent literature.

Mixed carbonate (transgressive) / siliciclastic (regressive) cycles deposited in a shallow-water ramp: the Upper Mulichinco Member (Valanginian), Neuquén Basin, Argentina

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This study integrates sedimentological, ichnological and palaeoecological analyses in order to better understand the origin of a mixed siliciclastic- carbonate succession deposited during the early Late Valanginian in the back-arc Neuquén Basin (Argentina). The studied succession, or Upper Mulichinco Member, accumulated within a shallow and broad marine ramp setting (epeiric sea) under long-term highstand conditions. The unit (150 m thick) is dominated by siliciclastic sediments interbedded with sharp-based, carbonate-rich deposits representing < 25% of the total succession. The siliciclastic packages consist of meter-scale coarsening-upward successions (2-8 thick). They typically begin with laminated mudstones at the base grading upward to bioturbated muddy sandstones and lenticular, very fine-grained sandstones with HCS. Fine-grained sandstones having SCS occasionally occur at the top of the coarsening- upward units. Siliciclastic facies have trace fossils attributed to *Cruziana* and *Skolithos* Ichnofacies, but low or null macrofossil content. The carbonate-dominated packages have sharp and locally erosional basal surfaces (with up to 2 m of relief). Basal surfaces are also demarcated by the presence of robust *Thalassinoides* burrows penetrating into the underlying sediments attributed to represent a *Glossifungites* Ichnofacies. Carbonate-dominated deposits (0.30- 3.4 m thick) mostly consist of massive micrite-rich floatstones characterized by gravel-size shells, poorly sorted finer bioclasts and very fine terrigenous sand (glauconite is also common). Shell concentrations are interpreted to represent parautochthonous and autochthonous fossil associations based on skeletal preservation. Epibenthic associations are common at the base of carbonate packages. Although they are typically dominated by cemented oysters and gregarious serpulids, corals and colonial serpulids are locally abundant. These epibenthic-dominated associations are commonly replaced upwards and laterally by endobenthic-dominated associations, composed of shallow- and deep-burrowing bivalves, and irregular echinoids. These, in turn, are capped by silty wackestones where moulds of deep-burrowing bivalves in life position are closely spaced. The siliciclastic coarsening-upward successions of the Upper Mulichinco Member are interpreted to represent progradational events on a wave- and storm-dominated offshore to shoreface system, characterized by relatively high rate of terrigenous supply. In turn, the attributes of the contact between the siliciclastic and carbonate deposits suggest extensive erosion of the sea floor that created widespread firmgrounds colonized by crustaceans and suitable for development of cemented, epibenthic macrofauna. These discontinuity surfaces bounding the carbonate deposits are believed to represent transgressive surfaces of erosion during drowning of the siliciclastic system. Low net sedimentation rates favored epifaunal communities and glauconite formation. Despite transgressive conditions, carbonate productivity and physical reworking of bioclastic material favored areas where endobenthic-dominated associations developed. Eventually, the entire carbonate system was drowned during continuous relative sea- level rise leaving behind wackestones with in situ bivalves (condensed shell beds). The turnaround from transgressive to regressive conditions is marked by the reappearance of siliciclastic mudstones on top of carbonates. Results of this study highlight that high-frequency fluctuations in relative sea level (probably in the range of 40-100 k.y.) produced carbonate- dominated transgressive hemicycles followed by siliciclastic regressive hemicycles in a shallow ramp. Although similar stratigraphic patterns have been found in Neogene to Recent better calibrated successions of New Zealand and Mediterranean regions, ancient examples as this lower Cretaceous case study have not been to date widely reported.

Growth and architecture of last deglacial reefs from Tahiti (French Polynesia). I.O.D.P. #310 Expedition « Tahiti sea level »

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The study of coral reef systems that developed during the last deglaciation (23,000-6,000 cal. yr BP) is of major interest both for the reconstruction of climatic and environmental changes associated with the last deglacial sea-level rise and the evaluation of the impact of those combined changes on reef growth modes and architecture. Tahiti is a volcanic island characterized by slow and regular subsidence rates and located at a considerable distance from the major former ice sheets and corresponds, therefore, to an ideal site to obtain an unbiased continuous record of sea-level change and reef development during the last deglaciation. The 600 m of drill cores (recovery >90%) that were retrieved from 37 holes along transects ranging from 40 to 117 m water depth (IODP Expedition #310 "Tahiti Sea Level" [1 to 3]) represent a unique opportunity to investigate accurately the impact of sea-level and environmental changes on reef development. The objectives of this study are: 1) to reconstruct the evolution of the biological composition of reef frameworks in time and space, 2) to quantify the contribution of each reef component (i.e. corals, coralline algae and microbialites) to the reef frameworks, and 3) to analyse the combined effects of sea-level and environmental changes on reef growth and demise. Reef growth and anatomy were reconstructed based on radiometric dating (U-series and ^{14}C AMS) carried out on the various reef builders (i.e. corals, coralline algae and microbialites), the sedimentological and paleobiological analysis of reef cores and thin sections, and the 3D analysis of the reef frameworks based on X-Ray Computed Tomography (CT) data. The last deglacial reefs from Tahiti are comprised of two distinctive biological communities which were characterized by a similar scenario of development throughout the sequence, involving a diachronous development and a lack of direct competition [4]: 1) Initial frameworks were formed by coralgal communities including seven assemblages characterized by various growth forms (branching, robust branching, massive, tabular and encrusting); 2) Microbial communities developed later in the primary cavities of those frameworks, a few meters (1.5 to 6 m) below the living coral reef surface, where they heavily encrusted the coralgal assemblages to form microbialites; their relative abundance depends on the porosity of the initial coralgal frameworks which is controlled by coral growth forms and packing. The changes affecting coralgal communities through time coincide with abrupt variations in reef growth rates and characterize the response of the upward-growing reef pile to a non-monotonous sea-level rise and coeval environmental changes. No major break in reef development occurred between 16,000 and 10,000 cal-yr-BP [5]. Reefs accreted mostly through aggradational processes at growth rates averaging 10mm.yr-1, thus precluding any catastrophic impact on reef development such as the temporary cessation of reef growth as it was reported in the Barbados record [6]. An incipient drowning and a general backstepping of the reef complex have been evidenced during the 14,600-13,900 cal-yr-BP time window implying that reef growth gradually lagged behind sea-level rise.

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High-resolution stratigraphy and pollutant history of water reservoir sediments for the last ~70 years; the Brno Dam; Moravia, Czech Republic, Europe

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Dams and artificial reservoirs serve as ideal traps for suspended sediment in the rivers. Usually, uninterrupted sedimentary record is preserved in the dams since the dam was built, providing a suitable sedimentary archive to study the history of heavy-metal pollution. The Brno Dam is located on the river Svratka (the river Morava catchment area) in the Czech Republic (Central Europe). The Brno Dam is relatively small, with total volume 21×106 m^3. Construction works were finished in 1940. Stratigraphy of dam sediments was studied from 5 cores marked BP1-BP5. The cores were taken into 1-m foil liners using a percussion drilling. The cores were cut lengthwise, described and photographed. The core data were supported by ground penetration radar (GPR) profiles. Based on 137Cs dating we calculated the average sedimentation rate. Magnetic susceptibility (MS) and X-ray densitometry were used to assess a stratigraphic framework. The stratigraphic features of cores inferred from colour variations between layers were quantified using digital image analysis and visible-light reflectance spectrometry. X-ray fluorescence and cation exchange capacity were used to to trace the pollution history. The lacustrine sediments rest on the pre-dam deposits with a distinct onlap geometry. The GPR reflectors are slightly inclined, which indicates downstream accretion due to the activity of unidirectional underflows as the main carriers of sediment particles in the dam. The thickness of dam sediments is very variable. The thickness is 2.2 m in the proximal parts of dam (core BP2) but only 0.1 m in the distal part of dam near the dike (core BP5). Sediments consist predominantly of silty sands, silts, clay and organic matter. In all X-ray images, there is a distinct boundary between underlying fluvial and overlying lake sediments. X-ray images of the lacustrine sediments show thin lamination (cores BP1, BP2). The dark layers comprise silty clay with organic substance while the pale laminae correspond to silt and sand. Lamination is poor or absent in cores from the distal parts of the dam. MS values are relatively low and their variation is largely related to grain size (low values in sandy layers, high values in clayey layers. ^{137}Cs dating revealed several peaks, the sharpest one is located at depth 62-65 cm (core BP2) and 82-86 cm (core BP1). This peak agrees with fallout from the Chernobyl reactor accident (year 1986). A linear age model was proposed based on the ^{137}Cs dating and the basal unconformity of the lacustrine sediments (1940). X-ray fluorescence analysis provides the proxy data for the main element concentrations. All measured elements show changes in concentration after dam filling. The values of silicon are higher in sandy layers. They agree with zircon values. Potassium is more common in finer particles (micas) while titanium shows elevated concentratons in the silt fraction. Heavy metals contents increased after building of the dam (1940) in all measured cores (BP2, BP3 and BP5). Zinc show delayed peak compared to lead. The maximum concentrations of heavy metals were attained during 1960s. Concentrations of lead start to decrease at the beginning of 1980s. The concentrations of heavy metals are higher in clay layers. In upper part of the core are raised concentrations of sulphur and phosphorus. This may indicate anoxic conditions in dam sediments. Concentrations of heavy metals show correlatable patterns and they can be used as independent tool for cross-core correlation.

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High-resolution paleoceanographic reconstruction in the Korea Strait region using Sr/Ca of scleractinian coral

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Geochemical composition of massive coral skeletons has been used as a common proxy for seasonal to decadal scale climate variations in tropical/subtropical regions. Sr/Ca ratio of coral skeletons is especially useful for reconstruction of past sea surface temperature (SST) since it varies depending only on SST. *Favia sp*. (Family Faviidae), a hermatypic massive coral, is distributed from tropical to higher latitude regions, even in the Korea Strait, located at 34N, despite the low SST of the area. Thus, *Favia* can serve as a high-resolution paleoenvironmental archive in the East Asia marginal seas including the Korea Strait. For paleo-SST reconstruction of the Korea Strait region, a 90 cm-long core of living *Favia speciosa* and a 5.5 m-long drill core of coral mound were collected from Iki Island, Japan in 2007. The top 28 cm interval of modern *Favia* core and 5 cm long fossil *Favia* (2820 yr BP) were selected for the measurement of Sr/Ca and then SST reconstruction. The analytical works are still in progress. So far, the determined Sr/Ca of the modern coral revealed 21 annual cycles attributed by seasonal environmental changes from 1987 to 2007. Such a clear seasonality seems likely to reflect SST variations. The temperature dependence of Sr/Ca was estimated -0.0388 mmol/mol/C, which may demonstrate the possibility of stopping of coral skeleton growth in winter. Sr/Ca of 2800 year-old fossil *Favia* also showed seasonal variations, indicative of their potential for a paleo- SST proxy. SST seemed lower in 2820 yr BP judging from its higher summer maxima than the modern one. The similarity of winter maxima between Sr/Ca of the fossil and modern corals indicates the lower limit of temperature that corals can calcify. With completion of Sr/Ca measurement for modern *Favia* coral, it is possible to reveal SST variations of the study region for the past 41 years. This study is expected to enable to evaluate global warming in this region quantitatively.

Seasonal change of sedimentary facies and ichnogenera in Ganghwa Intertidal Flat, Gyonggi Bay, South Korea

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The southern tidal flat of Ganghwa Island is formed in the head area of Gyonggi Bay of western central Korea in which three large rivers merge. The bay is characterized by development of large (ca. 100 km) and wide (15-35 km) elongated sand bars in its mouth, indicating strong influence by sediment discharge directly from the rivers. As tide has semi-diurnal pattern with spring tidal range up to 10 meters, the sedimentary bodies are interpreted typically as a type of deltaic to estuarine macro-tidal-flat system influenced both by high river inputs and strong tides. The flat area is surrounded by several islands, resulting in partly protected area from strong waves approaching from western offshore (Yellow Sea). Main tidal channel and a few small tidal creeks are well developed in the southern part and in the eastern part, respectively. The tidal flat has been also influenced by seasonal variation of river discharge which is here mostly concentrated during summer season from June to August. Three-type sedimentary facies of tidal flats (mud, mixed and sand flats) are well developed on this flat. Compared to other tidal flats in the western coasts of Korea, the seasonal change in surface sediment distribution is, however, not clear except for slight seasonal migration of facies boundaries among sand, mixed and mud flats. Both flat boundaries migrate landward from early winter to early summer, resulting in wide expansion of sand-flat area on the outer intertidal flat. Combined process of wave and tide is a main process for net deposition during this period. Mixed flat has prograded rapidly from late summer, probably caused by tidal re-arrangement of riverine suspended sediment supplied in summer season. Retreat of mixed flat area starts from early fall and continues until next middle summer when riverine suspended sediment is supplied again to the flat by tidal processes. On the other hand, mud flat is prograded until early winter and is in turn retreated from middle winter when the suspended sediment supplied from rivers would be deficient. The seasonal change of flat facies suggests that riverine supply of suspended sediment would be the main controlling factor in facies distribution of the Ganghwa intertidal flat. Eleven sedimentary facies can be classified based on detailed analysis of sedimentary structure and composition in the relief peels of tidal-flat deposit. Planar cross-laminated sand (facies Scp) and climbing ripple- laminated sand (facies Scl) are interpreted as the deposits formed by migration of 2D ripples by tidal current. Facies Sct (trough cross laminated sand) is formed dominantly by migration of 3D ripples by combined currents of wave and tide. Facies Sct and Scp are commonly alternated with each other. Facies Sp (parallel laminated sand) is mainly formed by upper-flow-regime plane bed. Heterolithic mud/sand facies of M/St (thinly interlayered), M/Sf (flaser bedded), M/Sw (wavy bedded), and M/Sl (lenticular bedded) are formed by tidal cycles. Most massive facies of Sm (massive or highly bioturbated sand), Zm (massive muddy sand or sandy mud) and Mh (Homogeneous Mud) seem to be deformed by extensive bioturbation. Alternated facies of Mh/Zm occur mostly in the facies migration zone. According to dominant ichnogenera, the intertidal flat can be also divided into three zones: muddy sediment (Psilonichnus), mixed sediment (Bivalve burrow and Lockeia) and sandy sediment (Echiurus burrows, Lockeia, Cylindrichnus, Skolithos and Cryptic bioturbation). Especially, Potamocorbulalaevis (mixed sediment) and Echiurus burrows (sandy sediment) are observed only in specific sediment type. Each zone also follows migration pattern of seasonal sedimentary facies. The Bioturbation Index (BI) indicates the significant seasonal variation on the mixed flat between 3.3~4.1 km.

Transport behavior of spring-summer high-concentration suspended sediment and formation of summer mud flat in the Doouri Open-coast Tidal Flat, Southwestern Korea

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The open-coast Doouri tidal flat on the southwestern coast of the Korean Peninsula shows a seasonal change: mud flat is the dominant surface sedimentary facies during summer, but it is mostly eroded and changed into sand-flat surfaces in the winter season. The summer mud flat covers nearly the whole tidal flat except for the tidal beach, measuring more than 20 cm in thickness. As wave force increases continuously from fall, mud-flat facies start to change into sand-flat facies. In general, mud flat facies are formed on the upper intertidal flat by vertical settling from settling- and scour-lag effects, resulting in continuous thickening of surface mud layers toward the shore. The mud flat of the Doouri tidal flat shows, however, no specific change in thickness with direction, and the seasonal inflow and outflow of large quantity of fine sediment are observed there instead. Understanding how the flat surface shows a seasonal change in sedimentary facies with repetitive deposition and erosion, and which depositional process is responsible for such rapid formation of mud layers, is very important for the interpretation of sedimentation on the tidal flat. A 1.44-m-long pole apparatus (ASM-IV) with 1 cm sensor interval capable of measuring high-resolution suspended matter was installed on the tidal flat for more than 3 months to figure out the transport behaviour of fine-grained suspended sediment. A high-concentration layer (>4 g/l) developed near the seabed from mid-May and then its concentration is increased in August up to more than 8 g/l (sometimes more than 10 g/l), belonging to an initial fluid-mud state. This high-concentration layer is generally formed in the water column up to 30 cm above the bottom. A higher concentration layer is formed during spring tide than during neap tide. The high-concentration layer developed near the seabed in summer is thicker during flood tide than ebb tide, and it increases in thickness during fall when wave energy increases. On the other hand, its thickness is larger during ebb tide and the suspended sediment concentration is much higher than that of summer. The high- concentration suspended mud layer formed in the lower part of Doouri tidal flat during the summer season might be caused by both high water temperature and weak wave force. A large amount of suspended sediment seems to be transported onto the intertidal flat by tidal currents, consequently sometimes forming a fluid mud near the base of the tidal flow. In general, fine-grained sediments move in suspension and deposit on the upper intertidal flat mainly during slack water periods. The fluid-like mud is generally developed in subtidal zones and/or on the margin of or within tidal channels of estuarine environments. On the contrary with such general observations, the layer of high- concentration suspended sediment (or fluid mud) was observed in the middle-flat surface of the Doouri tidal flat in this study. The sedimentation caused by the formation and movement of these layers would explain the rapid and wide formation of the summer mud-flat facies in this area. High-concentration suspended and/or fluid-mud layer development could be an important sedimentation mechanism for the short-term (or seasonal) change of fine-grained surface sedimentary facies even on the tidal-flat surface as in Doouri case. These features warrant further detailed studies of the formation and transport behaviour of fluid mud or high-concentration suspended layer on intertidal flats.

Hydrothermal dolomites along faults/fractures in the Aptian–Albian platform carbonates, Ramales area, west of Karrantza Valley (N.W Spain): petrographic and geochemical results

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Aptian-Albian carbonates (Basque-Cantabrian Basin, NW Spain) were deposited on the rift-related footwall crests of active tilted blocks resulted during the Mesozoic opening of the Bay of Biscay and North Atlantic. This rock succession (up to 500 m in thickness) is affected by N-S, E-W, NW-SE and NE-SW oriented normal and strike-slip faults. These faults acted as fluid flow conduits to selectively dolomitize these carbonates in the El-Moro and El-Mazo blocks, Ramales area (west of Karrantza valley). Field studies show dark grey coloured dolomite exposures along the faults and/or fractures, while host limestone exhibits light grey to off white colour. Linear fault restricted dolomite and irregular dolomite bodies in the basinal and platform settings respectively, indicate that lithology mechanically controls the geometry of the dolomite bodies. These dolomitization processes resulted in replacive and void-filling dolomite phases, spatially related with various calcite cements. Various transects across the main faults and/or fractures containing dolomite show that different dolomite facies exhibit systematic variation away from the fault/fracture (i.e., nonplanar and zebra and zebra-like dolomite facies existing near the fault, while planar dolomite present away from the fault). Paragenesis of these dolomites indicate their development over different dolomitising events. These dolomite facies are variably reworked and show neomorphism and cataclastic deformation. Several phases of calcite cement pre- and post-date the dolomitisation events. Pyrite, galena and sphalerite are also locally observed. Zebra and zebra-like dolomite shows the most depleted values with $\delta^{18}O$ varying between -18.6 to -15.2 ‰V-PDB and $\delta^{13}C$ between -0.7 to +1.6‰ V-PDB compared to non-planar and planar dolomite which show overlapping stable isotopic ratios ranging from -18.7 to -11.5‰ $\delta^{18}O$ V-PDB and -2.6 to +1.9‰ $\delta^{13}C$ V-PDB. In the nonplanar dolomite phase, unzoned bright luminescent exhibits more depleted $\delta^{18}O$ values (-18.84 to -15.82 ‰V-PDB) while rimmed and dull luminescent phase show less depleted $\delta^{18}O$ values (-15.45 to -12.28‰V-PDB), indicating different temperature conditions of their formation. The broad range and highly depleted values of $\delta^{18}O$ are interpreted to reflect multiphase dolomitization and dolomite recrystallization. Limestones close to the dolomites show depleted $\delta^{18}O$ values (similar to those of the dolomites), implying isotopic resetting during dolomitization and large scale fluid migration. Sr isotope analyses indicate that dolomite phases possess a signature ranging between 0.70820 and 0.70850, which conclude that dolomitising fluids interacted with radiogenic lithologies. Microprobe analysis also indicate that the centre of the dolomite rhombs are usually Fe-rich (1.6 to 1.9 wt. %) as compared to their external zones and the dolomite cement (Fe: 0.0 to 0.6 wt.%). The Mg content in the void-filling, non-luminescent calcite is high (0.9 to 1.3 wt.%) as compared to luminescent, replacive calcite (0.1 to 0.8 wt.%). Fluid inclusion analyses show homogenization temperature (Th) values range from 120 to 200°C and estimated salinities between 10 and 24 eq. wt. % NaCl for zebra and nonplanar dolomites, which confirms very hot dolomitizing fluids and hence the hydrothermal origin of the investigated dolomites. Parent fluids chemistry was determined using dolomite-water fractionation equation, indicating high salinity values (21 eq. wt. % NaCl) and thus validating fluid inclusion results. This contribution (field observations, petrographic and geochemical studies) helped in understanding the superposition of various diagenetic events during dolomitisation, characterization of reservoir heterogeneity, documenting the characteristics of hot, saline dolomitizing fluids and related fluid flow history. The above stated results lead to the construction of proposed conceptual model for the formation of these hydrothermal dolomites.

Eocene-Oligocene transition paleosol stable isotope record from the Ebro Basin (NE Spain)

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Terrestrial environments are particularly sensitive to both temperature and precipitation changes and can preserve long-term archives of global change. In particular, paleoclimatic records derived from paleosols provide crucial information for interpreting regional climatic conditions, and can provide insights into the teleconnection between high latitude glacial events and climate trends at lower latitudes. To achieve this goal, the non-marine paleoclimate records need to be integrated with marine records on a global basis. This in turn requires robust high-resolution chronologies of long continuous sequences, so that the climatically driven depositional and geochemical trends can be reliably correlated at both regional and global spatial scales. The Ebro Basin (Spain) meets this criterion and is of particular interest among the circum- Mediterranean (i.e., peri-tethyan) alpine foreland basins because a robust magnetostratigraphy-based chronology of these deposits has allowed precise location of the Eocene-Oligocene transition. The Eocene-Oligocene transition is characterized in the marine realm by a significant positive $\delta^{18}O$ shift (Oi-1 event), which has been attributed to global cooling and the growth of the Antarctica ice cap. Thick late Eocene-early Oligocene fluvial sequences, including carbonate nodule- bearing mudstones (paleosols), crop out extensively in the Eastern Ebro Basin. To examine how the Eocene-Oligocene transition was recorded on land, carbonate nodules from 23 paleosols were sampled spanning the transition interval. $\delta^{18}O$ and $\delta^{13}C$ analyses of the nodules were measured at Michigan using a MAT253 IRMS with a KielIV autosampler. Individual paleosol carbonate nodules were micro-sampled to eliminate concerns about diagenetic alteration and multiple nodules per sampling level (n=3) and multiple spots per nodule (where possible) were analyzed to ensure reproducibility. Analytical uncertainty was ±0.04‰ for both $\delta^{18}O$ and $\delta^{13}C$ based on a three-standard calibration. $\delta^{13}C$ values ranged from -4.23 – -6.51 and $\delta^{18}O$ values ranged from -5.43 – - 6.95 (both V-PDB scale). There is no significant shift in either $\delta^{18}O$ or $\delta^{13}C$ across the Eocene-Oligocene transition; the mean $\delta^{18}O$ composition is -6.23 for both the Eocene and Oligocene, and $\delta^{13}C$ values shift only slightly from a mean of -5.12 ±0.61‰ in the Eocene to - 4.74 ±0.42‰ in the Oligocene, a change that is statistically insignificant. If conditions had aridified and cooled significantly across the Eocene- Oligocene transition, both $\delta^{13}C$ and $\delta^{18}O$ should have a positive shift, with $\delta^{18}O$ values shifting due to cooler conditions and $\delta^{13}C$ values becoming significantly heavier because in an all C3-plant world, heavier $\delta^{13}C$ values are most typically associated with water stress. In addition, previously published paleotemperature estimates from the same sequence also indicate no significant temperature change, which is consistent with the $\delta^{18}O$ results. Though marine records indicate a significant climatic shift across the Eocene-Oligocene transition, many other non-marine records are consistent with the relatively minor change indicated in the Ebro Basin. Records based on fossil mammal teeth in Argentina and Europe, and previous paleosol records in North America and Europe all indicated only minor cooling/aridification associated with the Eocene-Oligocene transition. That the non-marine records in both hemispheres and on three continents indicate minimal changes suggests that much of the marine $\delta^{18}O$ shift is associated with ice sheet growth at higher southern latitudes and that the climatic change at lower latitudes was less significant.

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Tectonic inversion of the western part of the Gunsan Basin, Yellow Sea

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The western part of the Gunsan Basin in the Yellow Sea exhibits structural complexity related to extension and inversion tectonics during the Cretaceous to Tertiary. Based on interpretations of seismic profiles and restored cross-sections, successions can be divided into three tectono-stratigraphic units, separated by two erosional unconformities: (1) syn-rift unit (?Late Jurassic–Eocene); (2) post-rift unit (Early Miocene); (3) thermal subsidence unit (Middle Miocene–Quaternary). The syn-rift unit is characterized by NW–SE trending normal faults with planar to curved geometries. The Kachi fault forms an intrabasinal ridge, which separates an asymmetric half-graben in the hanging-wall from a domain of tilt-blocks on the foot-wall. Sedimentation of the syn-rift unit was controlled by normal faults in the Cretaceous–Eocene. The fault- controlled basin fill was dominated by alluvial to fluvio-lacustrine sediments with subordinate volcanics. The syn-rift sedimentation continued to the Eocene and ceased with inversion, uplift, and erosion during the Oligocene. The Oligocene inversion of the Kachi fault resulted in the reverse-slip reactivation of the normal faults and folding of the syn-rift unit in the hang-wall side, whereas little deformation occurred on the foot-wall side. The post-rift unit unconformably overlies the syn- rift unit, characterized by fluvial sedimentation. A large portion of the Early Miocene unit was eroded in the hanging-wall of the Kachi fault due to the reverse-slip reactivation. This inversion occurred simultaneously with the deposition of the upper part of the Early Miocene succession, as suggested by syn-tectonic growth strata. The thermal subsidence unit shows flat-lying strata with relatively uniform thickness, formed in a fluvio-deltaic environment. It was deformed by a broad anticline with relatively steep forelimb above the buried Kachi fault. This suggests local deformation, associated with the reactivation of the Kachi fault. The anticline was truncated by an unconformity at shallow depth and overlain by horizontal strata of marine origin.

Neoproterozoic glaciations in Northeastern Brazil: cap carbonates and carbon isotope stratigraphy

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Carbonate formations overlying diamictites or BIF in the Rio Pardo Basin, Rio Preto, Sergipano and Seridó belts and Jaibaras Basin have been, likely, deposited in the aftermath of Neoproterozoic glaciations. Basal dolomitic limestones of the Serra do Paraíso Formation, Rio Pardo Basin, rest on basement rocks or immature arkoses (outwash of diamictites) of the Panelinha Formation. They show planar stromatolites and are replaced upsection by limestones with tepee-like structures/ breccias. $\delta^{13}C$ values for basal carbonates are ~ -5‰, followed by dolostones with -2‰ to +3‰, rhythmites with +3.5 to +6‰ and limestones with values ~ +9‰ upsection. The Rio Preto Belt comprehends a cratonic domain (São Desidério Formation), an internal domain (Serra da Mamona and Riachão das Neves Formations) and a central domain (glacial marine Canabravinha diamictites). Basal São Desiderio Formation carbonates display $\delta^{13}C$ values from +1.2 to + 2.2‰, replaced upsection by values ~ +12‰ and sometimes ~ +16‰ in organic matter-rich limestones. Composite $\delta^{13}C$ pathways for both, Serra do Paraíso and São Desiderio formations, are typical of cap carbonates. There are two cap carbonates in the eastern Vaza Barris Domain, Sergipano Belt. Jacoca Formation carbonates rest on Ribeiropolis Formation diamictites, and younger Olhos D'Agua Formation carbonates overlie Palestina Formation diamictites, both couplets metamorphosed in sub-greenschist facies at 628 ± 12 Ma. In the western Vaza Barris Domain, Acauã Formation dolostones rest on Juetê Formation diamictites. $\delta^{13}C$ values for Jacoca and Acauã carbonates cluster around -5‰. In the Olhos D'Agua Formation, -5‰ values in basal carbonates are replaced upsection by values ~ 0 ‰ followed by values ~ +9‰. The Acauã Formation displays 87Sr/86Sr ratios ~ 0.7073, and Jacoca and Olhos D'Agua Formations, values 0.7077 - 0.7081. Jacoca Formation is Cryogenian and Olhos D´ Água and Acauã Formations are Ediacaran. BIF at Jucurutu, Florânea and São Mamede, Seridó Belt, Rio Grande do Norte and Paraíba are overlain by amphibolite-facies Jucurutu marbles. Basal marbles of this formation exhibit $\delta^{13}C$ values from -7 to -5‰ with a shift to +4 to +10‰ upsection, typical of cap carbonate deposition. Low-grade carbonates of the Frecheirinha Formation, Jaibaras Basin, Ceará, rest on slates of the Caiçara Formation and locally rhythmites overlie itabirite although the weathering has precluded seeing a sharp contact between these two units. Marls in the base of the carbonate sequence show negative $\delta^{13}C$ values (-8 to -1.2‰) which are replaced upsection by positive values up to +3.7‰. BIF overlain by Jucurutu and Frecheirinha formations were likely deposited in glacial environment and overlying carbonates, respectively in the aftermath of one Cryogenian and Ediacaran glaciations. $^{87}Sr/^{86}Sr$ ratios for Jucurutu Formation (~ 0.7074) and Frecheirinha Formation (~ 0.7075) carbonates do not allow an unambiguous age assignment. On the contrary of other studied cap carbonates in northeastern Brazil (e.g. Sergipano and Seridó Belts and Rio Pardo Basin), no $\delta^{13}C$ value > + 3.7‰ has been recorded in the Frecheirinha Formation, suggesting an Ediacaran age for this carbonate sequence. Jucurutu and Frecheirinha are the two northernmost Neoproterozoic cap carbonates known in Northeastern Brazil and in which BIF, instead of diamictite, is overlain by cap carbonate.

Neoproterozoic cap carbonates in the Rio Pardo Basin and Rio Preto Belt, Bahia, Brazil: carbon-isotope stratigraphy

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The Rio Pardo Basin, southeastern border of the São Francisco craton, Bahia, has been partially involved in the folding of the Araçuaí Belt and metamorphosed in the greenschist facies. Dolomitic limestones (~100m thick) in a proximal section of the Serra do Paraíso Formation with planar stromatolites are in contact with the gneissic/granulitic basement, at Serra do Paraíso Farm, and replaced up section by gray/dark limestones (~40m thick) that crop out along the BA-120 highway. Next to Santa Maria Eterna village, in a distal section, gray limestones show breccias and Conophyton bioherms (?) or tepee-like structures similar to what is observed in post-Marinoan cap carbonates in central Brazil. Carbonates of the Serra do Paraíso Formation overlie an immature arkose of the Panelinha Formation near the Pau Brazil locality. This immature arkose overlies, by its turn, diamicite that rests on top of the basement and that exhibits carbonate clasts in a clayey matrix. The Rio Preto Belt, northwestern border of the São Francisco craton, is subdivided into: (a) cratonic domain (São Desidério Formation); (b) internal domain, limestones overlain by clastic rocks, marls and limestones (Serra da Mamona Formation); (c) north of Barreiras village, limestones are overlain by arkoses, feldspathic quartzites, graywackes and rare carbonate intercalations (Riachão das Neves Formation). In the central portion of the belt, the Canabravinha diamictites probably was deposited in glacial marine environment. The above formations are respectively equivalent to the Sete Lagoas, Serra de Santa Helena, Três Marias and Jequitaí formations (Bambuí Group). C and O isotopes were analyzed in 278 carbonate samples from the Serra do Paraíso and São Desidério Formations aiming at a high- resolution isotope stratigraphy. $\delta^{13}C$ values for carbonates with planar stromatolites at Serra do Paraíso Farm are ~ -5‰ and jump upsection to + 8 to +9‰. At the eastern portion of the Agua Branca Range, a section of dolostones displays $\delta^{13}C$ values ~ -2‰. Near Santa Maria Eterna, limestones with conophytons (or tepee-like structures) display values ~ 0‰. At Toca da Onça Quarry, dolostones display values from + 1 to + 3‰ and at the western side of the Agua Branca Range, gray limestones from a sequence of rhythmites exhibit values from +3.5 to +6‰. Finallly, a section to the north of Pau Brasil locality shows values from +7 to +9 ‰. In the Rio Preto Belt, representative sections of São Desiderio Formation have the following values: at Derocal, reddish dolomitic argillites display $\delta^{13}C$ values from +2.5 to +5‰, where at Mineração do Oeste quarry limestones show $\delta^{13}C$ values from +1.2 to + 2.2‰ in the first 16m changing abruptly upsection to values between +10 and +12‰ in organic matter-rich limestones. At Sítio Rio Grande, limestones show $\delta^{13}C$ values from +13.5 to +15‰ in the first 30m and from +14 to +16‰ in the upper 15 m, organic matter-rich limestones. The composite $\delta^{13}C$ pathways for the Serra do Paraíso and São Desiderio formations are typical of cap carbonates and the latter approaches that of the Sete Lagoas and Lagoa do Jacaré formations described elsewhere.

Iron Formation, Jucurutu Formation amphibolites-facies cap carbonate and C-isotope stratigraphy, Seridó Belt, Northeastern Brazil

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Iron formations associated with Neoproterozoic glaciations are an important pillar of the Snowball Earth hypothesis. These formations are thought to represent the accumulation of Fe+2 in an ice-capped anoxic ocean. Banded iron formations of the Ferro do Bonito Mine (Jucurutu town), Serra da Formiga (Florânea town) and Riacho Fundo (São Mamede town) in the Neoproterozoic Seridó Belt (itabirite and iron ores, actinolite- or cummingtonite-itabirite, and tremolite schist), state of Rio Grande do Norte, are overlain by Jucurutu marbles under which glacial diamictites have never been observed. It is likely that these iron formations have been deposited in glacial environment and that Jucurutu carbonates have been deposited in the aftermath of one of the Neoproterozoic glaciations. Diamictites near the Ouro Branco town and Serra dos Quintos near Parelhas town exhibit clasts up to 0.6 m long (augen-gneisses, quartzites and bi-gneisses) in a fine-grained clay matrix. Some authors maintain that these diamictites are stratigraphically situated between Jucurutu and Seridó Formations, although this interpretation is not consensual. At Cruzeiro da Maniçoba locality, relatively pure pink dolostones of the Seridó Formation, with fining- and thinning upward succession, probably represent a second, younger cap carbonate. Marbles of the Jucurutu Formation are usually represented by pure carbonates with CaO from 46 to 52% and rather low MgO that locally shows values up to 4.7%. Al_2O_3 and SiO_2 are usually low and with limited variation. In marbles of the Seridó Formation a more pronounced chemical variation is observed, sometimes with higher MgO contents in basal dolostones. Marbles from the Jucurutu Formation (drill holes 34 and 78, Ferro do Bonito Mine) exhibit $\delta^{13}C$ values from -12 to -5‰ in the first 20 m. A shift to positive values (+4 to +10‰) is seen upsection as in typical pathways for cap carbonates. Surprisingly, $\delta^{13}C$ values for carbonates that overlain itabirites at Riacho Fundo and at Cabeço da Mina (Florânea) are virtually all positive. Perhaps, the difference of C isotope behavior between basal carbonates at Mina do Bonito (negative) and Riacho Fundo and Cabeço da Mina (positive) reflect the topographic control during deposition. At Cruzeiro da Maniçoba, pink dolostones show $\delta^{13}C$ values around -4‰. Positive $\delta^{13}C$ values (~ +9‰) in marbles of the Seridó Formation have been observed elsewhere. Therefore, C isotope stratigraphy for carbonates of the Jucurutu and Seridó Formations support their deposition as cap carbonates. In both cases, negative $\delta^{13}C$ values are followed upsection by positive values. Strontium isotope ratios for Jucurutu carbonates display consistent ratios around 0.7074 and for the Seridó, between 0.7074 and 0.7076. These values suggest deposition of these two Formations in the Sturtian II interval, although similar values also occur in the Ediacaran (Gaskiers Ice Age, 580 Ma, to which ferruginous deep-waters were also associated). Highly metamorphosed carbonates may have C and Sr isotope patterns severely complicated by the level of recrystallization. Seridó belt marbles, however, seem to make a case where it was possible to obtain near primary C and Sr isotope data. Carbon-isotope chemostratigraphy suggests Neoproterozoic age for Seridó belt carbonates (635–580 Ma interval).

Tephrostratigraphy study in a deep-sea sediment sequence off the South Chilean Margin since the late glacial period

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A detailed tephrostratigraphy study supported by accelerator mass spectrometry (AMS) 14C dating and stable isotope and geochemical analyses has been carried out for a deep-sea core collected off the Chonos-Taitao archipelago (southernmost Chile). The deep-sea core MD07-3088 (46°04.30 S; 075°41.23 W; 1536 m below sea level; 18.9 meters length) was recovered at about 46°S in the northern Patagonia and close to the main Andean volcanic sources of the southern volcanic zones (SVZ). Counting of glass-shards along the core reveals the existence of thirtheen ash-layers over the last 22 cal ka BP. The origin of these tephras layers was determined by comparing their age and geochemistry with tephra detected in terrestrial deposits and from 8 lagoon sequences (Naranjo and Stern 1998; Haberle and Lumley 1998). Geochemical results display a good correlation with the products of the Cerro Hudson, whose past eruptions have been previously discriminated and dated in the surrounding area by 14C dating method. In particular, we recognize in the deep-sea core MD07-3088 four of the seven main eruptions of the Cerro Hudson volcano previously described on land. Amongst the remaining 9 tephras layers, corresponding to different volcanic episodes, they were discovered for the first time. Two events occurred during the Holocene and the deglaciation respectively, whereas the remaining 7 episodes during the last glacial period. These results provide a better understanding and a preliminary assessment of the past eruptive activity of the volcanoes from the southern volcanic zone, especially for the Cerro Hudson since the late glacial period. On the other hand, in addition to their direct interest in volcanology, the identification of the ash layers in core MD07-3088 is a powerful tool for stratigraphic and chronologic correlation of climatic, events in the studied area. Infact, thanks to the marine vs on land tephra correlation, this study offers the opportunity to estimate past sea surface radiocarbon reservoir age changes, a prerequisite to establish a common and robust chronological framework between different paleoclimatic archives.

Climatic variability off the South Chilean margin since the late glacial: estimation of the sea-surface reservoir ^{14}C ages

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The region of Aysen Fjords is an area composed of a complex island and channel landscape formed by extensive ice erosion from the North Patagonian ice field (Norte Hielo Patagonico) that covered this area during the last glaciation. Today, the ice field is located near the mountain top of many of the higher altitudes extending over 4200 km^2. This region is situated within a zone of high precipitation, generated by the ocean–atmospheric control of the Southern Polar Front that moves seasonally between 50°S (summer) and 40°– 45°S (winter). It is also a zone of important volcanic activity in the Andes chain marked by thirteen Quaternary large volcanic centers, forming the southern volcanic zone (SVZ). Hence, this region constitutes a key zone to better understand the variability of the atmospheric and oceanic circulation systems and to elucidate their roles in the climate changes at regional and global scale. For this topic, we have selected the deep-sea core MD07-3088 collected off the Chilean region of Aysen fjords between the northern Chonos archipelago and southern Taitao peninsula at about 46°S in the northern part of Patagonia. We present here preliminary results dealing on quantitative estimates of marine reservoir 14C ages (sea surface - atmosphere ^{14}C differences), necessary to establish a common chronological framework for marine, continental and cryospheric paleoproxies, and crucial to understand the ocean- atmosphere climatic system. Radiocarbon (AMS ^{14}C) dates of tephra, contemporaneously deposited over the Northern Patagonia marine and terrestrial regions reveal that sea-surface reservoir ^{14}C ages were estimated at 1320 and 975 years at the early deglaciation and before the Antarctic Cold Reversal period respectively. By contrast, at the beginning and during the Holocene were estimated at 920 and 790 years respectively. Such R(t) variability is probably attributed to changes in the South Pacific intermediate and deep thermohaline circulation at the time of the onset of the last deglaciation.

Modelling deposition patterns of turbidity events in the Alger Canyon and adjacent Algerian margin.Tracking the 2003 Boumerdès earthquake event

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A numerical model is used to simulate turbidity events in the Lager Canyon and adjacent algerian margin in order to identify potential sediments sources, characterize gravity driven flows in the Alger turbiditic system and deduce the resulting deposition patterns. The simulations are constrained by a geological setting interpreted on the basis of multibeam -derived bathymetric and backscatter maps, grain size of superficial deposits, location of telecommunication cable breaks occurred on May, 21, 2003 (Dan *et al.*, 2010). The Algerian margin is submitted to a compressive tectonic regime due to the active deformation between the Eurasian and African plates associated to an important seismicity. Earthquakes along the margin are thought to be the main factor generating submarine gravitational instabilities and turbidity currents (Dan *et al.*, 2008; Cattaneo *et al.*, 2010). Reversely turbidites along th emargin are thought to be a potential record of paleo-seismicity. Remarkable gravity driven submarine flows are known to have been generated by earthquakes in the last 1000 years, deep-sea cables breaking being the evidence of events such as the 1954 Orleansville earthquake and the more recent 2003 Boumerdes earthquake (Mw 6,9). The 2003 earthquake related turbiditic event is well constrained by 28 recorded cable breaks along the margin. Together with morphosedimentary analysis, this data sustains the perception that turbiditic events develop on the continuity of main submarine canyons incised in some cases from the mouths of coastal rivers. In order to identify the source of the Boumerdes turbiditic event, several hypothetical events are simulated with an Eulerean finite elements processes-based numerical model that solves sediment transport, erosion, deposition, water entrainment and sediment settling. Hypothetical sources are identified on the basis of canyons locations, scars dues to sediment failure, bathymetric gradients and seismic acceleration mapping of the 2003 earthquake. The sensitivity to the initial source condition (location, volume, sediment concentration and granulometric composition) is investigated and discussed in terms of flow properties and deposition patterns. Simulated flows show encouraging agreement with observed data. Sediment transport capability of the flows in the Alger Canyon agrees with the observed remainning sediment granulometry on the canyon talweg. Deposition patterns agree with interpreted sediment sinks and the thickness of simulated deposits agrees with turbidites recorded in cores. Single sources on the slope develop into spatially constrained turbidity flows down slope. The spatial limitation of such flows is determined by morphological barriers (as the continental slope it-self) and Coriolis acceleration. Multiple cable breaks along the margin may only be understood by a disperse combination of sources in the area submitted to significant seismic acceleration during the Boumerdes earthquake.

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New tools for the direct observation and quantification of turbiditic events along the Var Canyon

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On the French Riviera, the Var Canyon and its turbiditic system are highly active due the direct connection to the Var River. Sediment laden gravity flows, some associated to sediment failure, others generated by hyperpycnal currents, have been shown to occur more than once a year (Khripounoff *et al.* , 2009). It is one of the few canyons where turbidity currents were described from both direct in situ measurements and well-documented historical events (1979 Nice airport event and associated submarine cables breaking). Due to this high regularity and frequency of sediment-laden events, and to the fair accessibility of the area, the Var Canyon is used as a natural laboratory for turbiditic processes. Two years of continuous measurements were obtained, at several locations, with mooring lines equipped with current meters and sediment traps (Khripounoff *et al.*, 2009). These observations were compared to shallow cores retrieved before and during the period of continuous measurements (Mas *et al.*, in prep.). It is in this global setting that we have developed two new tools to track sediment-laden flows in canyons and turbiditic channels. The first tool is a Langragian Buoy called Ibsen (Inflow Buoy for Sediment ENtrainment). The entrainment data of the IBSEN buoy was calibrated with flume tests. A buoy has a slightly negative buoyancy (few grammes) in Mediterranean deep-sea conditions. It stays at rest on the sea floor until a denser, cooler and/or sediment-laden flow entrains it down the canyon. IBSEN records its immersion (hydrostatic pressure) and water temperature through time. On the basis of the bathymetric map and a hypothetical path along the Canyon, immersion evolution may be converted in location and speed. The second tool, Aniitra (Ancrage of Non-Intrusive Instruments to Track and Record under-water Avalanches), is a 75 kHz ADCP (current meter) deployed across the Canyon at 350 meters above the Canyon floor and oriented downwards in order to record the vertical structures (65 levels every 5 min) of the flows in the canyon axis. The system was anchored at two points on the canyon walls to prevent damage or loss of the equipment by violent turbidity currents as in the past (Khripounoff *et al.*, 2003). A small ADCP (300 kHz) was also installed on a classical vertical mooring line in the vicinity of Aniitra in order to provide detailed flow structure closer to the floor. Several events were observed between Dec. 2008 and Feb. 2009. The differential mooring locations together with ADCPs and the Ibsen buoys provided a quantification of the mean speed of turbidity events, its spatial structure and vertical distribution. Spatial reconstruction of the flows gives 5 km long turbidity currents. Pick flows are around 100 m thick with near bottom current speeds reaching 1 m/s (5 min mean). IBSEN buoys pick displacement also reached 1 m/s. Sediment entrainment capability of the flows and related shear stresses at the sediment interface may be deduced from both ADCP current profiles and IBSEN displacement. The correlation with Var river run-off shows that some events are due to increasing sediment discharge of the Var river while others are generated out of flood picks. Their record at the down-stream moorings give evidence of sediment failure as an origin of some of the flows. The correlation with other instruments moored along the canyon (single point current meters, sediments traps...) shows how promising these new tools are to improve the comprehension of turbiditic events in the Var Canyon, its relations to the Var river dynamics, the slope failures along the canyon, and related deposits. Also, the collected data set provides useful constrains to validate numerical models.

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Modelling gravity flows in the Var turbiditic system due to mass movements and hyperpycnal river runoffs

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A numerical model simulating gravity driven sediment-laden flows is applied to the Var turbiditic system to simulate mass movements and hyperpycnal flows at different time-space resolutions. The Var Canyon, in eastern Mediterranean French coast and its turbiditic system are highly active due to the direct connection of the Var River. Sediment driven gravity flows, some associated to mass movements, others generated by hyperpycnal currents, as described and modelled by Mulder *et al.* (1997), have been shown to occur more than once a year (Khripounoff et al, 2009). Due to this high regularity and frequency of sediment-laden events, the Var Canyon deserves to be considered as a natural laboratory for turbiditic processes. The sedimentary and morphological features, evolution and global description of the Var canyon and deep-sea fan was widely described in the recent past (e.g. Savoye *et al.*, 1993). Also, the Var Canyon is one of the few canyons where turbidity currents have been described from both direct in situ measurements, and well documented historical events (1979 Nice airport event and associated submarine cables breaking). The numerical model used in the present study solves momentum equations, flow thickness evolution and sediment transport for several granulometric classes. Accounting for Coriolis acceleration, water entrainment, particles settling, non-linear friction (ranging from visco- plastic to full developed turbulence), erosion, deposition and morphological evolution of the bed, the model is able to simulate flows from the first instants of a mass movement to the final settling and flow damping. Model results are compared to in situ data from three moorings anchored along the Canyon. Two ADCP current profilers (75 kHz, 300 m ; 300 kHz, 30m) were deployed in a single mooring location in order to provide current speed and vertical structure of the flows. The model is used to simulate the 1979 Nice event and two hypothetical submarine landslides predicted by slope instability analysis (Leynaud, 2010). The results are being used to hindcast the 1979 induced tsunami and to predict the sensitivity of the near coast to near-shore generated tsunamis. The resulting turbidity flow and deposition is compared to those obtained by hyperpycnal flows induced by the Var river runoff. Model simulations agree to most of the interpretations and conclusions from precedent studies in the Var turbiditic system. New insight is nevertheless provided by the simulation of different sources and resulting flow momentum. Heterogeneity of the sediment record, flow paths and depositional patterns should be interpreted more on the basis of event variability than on system evolution. Model results are also in agreement with recent observations on sediment cores collected on the Var levee, which highlight the relationships between the evolution of the turbidite overflows and the fluctuations of glacial conditions in the Var drainage basin throughout the last deglaciation ; source evolution had been more determinant than sea level changes.

Geologic and seismic modeling of La Jardinera Turbidites Neuquen basin – Argentina

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The representation of geological scenarios as three-dimensional (3-D) numerical models provides an excellent quantitative environment for the comparison between outcrop analogues and subsurface interpretative models. The comparison can be extended to the field of synthetic seismic, optimizing the interaction between the outcrop analogue and the subsurface data. The quality of the numerical model is, however, to a large extent, dependent on the quality of the quantitative geological knowledge that is used to build the model. Methodology: The classic approach of facies, facies associations and depositional environments was applied over the surveyed geologic profiles. Afterwards, field profiles were referred to a stratigraphic datum and, in the next step, the data was loaded into the software for well correlation and stratigraphic interpretation. Sequence boundaries and other stratigraphic features were interpreted and, subsequently, facies and geologic/geometric objects were refined within the sequences. The model was submitted to boolean simulation and after several interactions the 3D resulting geologic model was converted to synthetic seismic cube using Wicker-type wavelets. The studied area is located near the southernmost border of the Neuquén basin, Argentina. Sedimentation there spans from the Pliensbachian to the Early Callovian (Leanza, 1992). A thick succession consisting of about 1100 m of deep-marine strata is followed by around 550m of shallow-marine facies. Finally, this marine interval is unconformably overlain by a sequence of the continental facies. From base to top, eight depositional sequences, spanning from 1 to 7 Ma, were identified. The first two depositional sequences are bounded by a major key stratigraphic surface that delineates the abrupt deposition of a relatively thick (up to 400m thick), sandy turbidite succession (La Jardinera Turbidites, Gulisano & Pleimling, 1995) over fine-grained, deep water marine deposits. The sediments correspond to deposits from gravity flows of three types (Paim *et al.*, 2008). The modeled geometries include relatively small channels in the slope, well-developed lobes in the slope rise and proximal basin plain, and lobe fringes and basin plain deposits related to type-1 system, a fluvial-fed turbidite system. The model is restricted to deep-marine sequences, informally denominated as follows: • Molles10 (Pliensbachian to Lower Toarcian): correspondent to the initial transgressive phase; the succession is characterized by the following facies association: basin floor shale and rarer lobe fringe facies, slumped towards the upper part of the sequence; • Molles20 (Middle Toarcian to Lower Aalenian); it comprises mostly sandy turbidite lobes, including the major part of the classic La Jardinera turbidite; • Molles30 (Middle to Upper Aalenian): it includes proximal (slope), sandy turbidite channels and distal (slope rise), sandy turbidite lobes, and laterally associated fine-grained strata; • Molles40 (Upper Aalenian): proximal to distal, gravelly- to sandy- turbidite channels deposits and associated inter-channel, fine-grained, usually slumped beds (slope). Both geological and seismic 3D models successfully represent the vertical stacking of distinct, distal to proximal geometric elements of the type-1 gravity flow system as well as their downstream changes within each depositional sequence.

High-resolution taphonomy of the Paleozoic obrution deposits from eperic settings of Paraná Basin, Brazil: the paleobiological consequences and paleoecological implications of abrupt burial

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Obrution beds contain assemblages of benthic organisms, typically preserved in situ. These beds are generally interpreted as well resolved fossil concentrations (time-averaging of hours to days), providing faithful records of original benthic communities. Microstratigraphic, sedimentologic and taphonomic analyzes of four Paleozoic obrution beds (Baitaca, Ferraz, Tambaú, and Tiarajú beds), Paraná Basin (Tubarão and Passa Dois Groups; Lower to Mid Permian), Brazil, show, however, that such deposits are genetically complex and can may undergo substantial time-averaging. These bivalve-dominated assemblages were generated by background processes (substrate erosion, reworking and winnowing) and episodic process (sediment blanketing tied to storms). Three distinct types of obrution beds were recognized on the basis of their internal complexity, taphonomic signatures, degree of taphonomic feedback, temporal resolution, and other sedimentologic and stratigraphic evidences. Single Event Obrution Deposit-SEOD are internally simple (Baitaca bed; Rio do Sul Formation, Early Permian) and normally the infaunal bivalves preserved in life position are not associated with other bioclasts. In general, infaunal suspension feeding bivalves are preserved in thin (< 15cm) siltstone layers representing mass mortality horizons. Shells are associated with escape structures (downward or upward) reflecting animal movement due to substrate degradation or aggradation. The beds are associated with HCS structures suggesting an origin above and/or at the storm wave base. Composite Obrution Deposit-CMOD are internally more complex (Ferraz bed, Teresina/Corumbataí Formations, Mid Permian), being represented by thin bioclastic rich sandstone beds (20-50cm) recording several episodes of winnowing and rapid deposition. Their internal complexity is indicated by the heterogeneous preservation of fossils, the co-occurrence of taxa with different habitat preferences and microstratigraphical discontinuity surfaces. Basal contacts are erosive and in situ articulated bivalves with preserved ligament are common in the tops of the beds. Shells are preserved out of life position, indicating reworking and subsequent rapid final burial of living invertebrates. Condensed Obrution Deposit-CNOD are represented by thin shelly pavements or coquina-like concentrations in which the tops were colonized by semi-infaunal bivalves (Tambaú bed, Corumbataí Formation), both covered by massive mudstones, and preserved in life position, suggesting extensive taphonomic feedback. CNOD includes centimeter-scale concentrations (15-20cm) with loosely packed bivalve shells preserved as discrete beds intercalated in transgressive laminated siltstones or mudstones (Tiarajú bed, Teresina Formation, Mid Permian). Their complex history is indicated by the: substantial variation in shell preservation, mixture of bivalves with different modes of life, and mixture of pristine shells (in situ articulated) with articulated reworked ones with sparitic infillings that differs from the surrounding siliciclastic matrix, showing that shells with distinct taphonomic signatures and histories have become mixed together. The degree of time-averaging in the three types of shell beds probably varies from hours/days (in SEOD) to thousands of years (in CNOD). The obrution record is a mixture of two records and its temporal and spatial resolution is dependent on the previous taphonomic history of a buried horizon that represents the pre-burial sediment-water interface. The obrutionary bed is inherently biased, as supported by the fact that only organisms that belong to particular ecological guilds (infaunal or semi-infaunal, suspension feeders) and sometimes with a particular age class are preserved in life position in a single horizon. These examples re-emphasize the potential bias that storm sedimentation may introduce in the fossil record, producing an over-representation of infaunal, sessile suspension feeding fauna.

Solubility and speciation of Iron present on top soil from the Puna-Altiplano area

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During the last decade a great deal of effort has been devoted to establish the effects of mineral dust on global and regional climate. In this sense, it is recognized that wind-blown dust has the potential to significantly influence the biological activity in the oceans (the "iron hypothesis") and the regional climate by blocking the sunlight and changing cloud properties (radiative forcing effect). In order to evaluate the effect of mineral dust from Southern South America(SSA), Prospero *et al.* (2002) recognized three main source areas that are correlated with the arid diagonal: Puna-Altiplano (PAP) (15 ° -26 °S), west-central Argentina (27 º -35 ºS) and Patagonia (39 º - 52 ºS). The Puna region reaches the highest elevation (average 4400 m) and at the latitude of ~25°S it is crossed by the subtropical jet stream (tropospheric westerly). This stream reaches its maximum intensity during winter and early spring, allowing the development of huge storms which deflate large amounts of sediments. Between 1995-2008, a total of 50 surface soil samples were collected from the areas recognized by Prospero *et al.* (2002) with the aim of defining mineralogical, chemical, isotopical and textural characteristics. In the present work 5 samples from PAP were studied in order to determine the speciation and availability of Fe. With the goal of evaluating the biogeochemical balance of Fe in the ocean, studies of sequential extractions were carried out. It has been shown that the mineralogy (Journet, et. To 2008) and the particle size (Ooki, et. To 2009) are critical in solubility studies. Therefore, the samples were divided into three fractions according to particle size (<63, <11, <5 mm). Sophisticated analytical tools (i.e., µXRD, µXRF and Mossbaüer spectroscopy) were used to determine chemical and mineralogical composition. Moreover, availability studies were performed by using continuous flow analysis and GAAS detection. The results emerged from this study will be useful to improve models and to gain insight on the iron cycle in the upper ocean.

Reconstruction of high altitude Holocene alpine environments and glaciers fluctuations using organic and clastic signals in proglacial lake sediments (Bramant and Blanc Huez lakes, Western French Alps)

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Present-day global warming potential consequences reinforce the need for investigating glaciers fluctuations and palaeoenvironmental reconstitutions during the Holocene. Two high altitude proglacial lakes (2500 m a.s.l) located at 45°N in the Grandes Rousses Massif (lakes Blanc Huez (LBH) and Bramant (LB)) were recently selected to reconstruct environmental changes over the Holocene. According to historical data, glaciers extension in this massif during the Little Ice Age was restricted to the upper catchment areas of these two small lakes. In addition, Saint-Sorlin glacier, draining into LB, is instrumented since 1957 and considered as representative for the NW Alpine region. The multiproxy approach used to investigated these lacustrine basins included seismic profiling (3.5 kHz), piston coring, radionuclide and radiocarbon dating together with a high resolution analysis of clastic and organic sedimentation (laser grain size, magnetic susceptibility, gamma-density, XRF core scanning and continuous diffuse spectral reflectance). A detailed organic analysis (Rock Eval pyrolysis and quantitative organic petrography) was also performed on lacustrine sediments, soils and geological formations in order to document the specific organic tracers of each compartment. In LBH, the upper clastic unit covering the last 5900 years reflects the dominating contribution of fine-grained glacial sediments and the autochthonous algal production (grey amorphous particles). It corresponds to the Neoglacial period in this part of the Alps. A progressive transition towards an organic rich basal unit (Total Organic Carbon (TOC) =5%) essentially made of soils tracers (red amorphous particles) and pollens suggests here reduced glacier activity, pedogenesis and the development of a vegetation cover in the massif between 10000 and 5900 cal BP. Downstream the Saint-Sorlin glacier diffluence, the LB lacustrine sedimentary sequence is characterized by glacial varves over the last 4000 years and by two organic intervals, as shown by the higher TOC values (>2%) and Inc/Coh ratio from XRF measurements, dated between 4160-3600 and 3300-2850 cal BP. These organic intervals are composed of soil and pollen particles and reflect periods characterized by smaller glaciers than today allowing the development of soils and vegetation cover at high altitude. Moreover, the identification of copper and lead metallic contaminations at the base of the LB core during the Early Bronze Age (3870-3770 cal BP) is correlated to an archaeological site in this part of the massif documenting the development of mining activity in the Alps. These findings suggest that rapid environmental changes (glacier retreats, timberline fluctuations and pedogenesis) probably favoured the development of human activities at high altitude.

Congo-Zaire detrital supply variability during the last 200 ka: A possible explanation for the longitudinal migration of the Zaire Fan depocenters

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A recently published geophysical study of the Zaire Fan architecture points out a longitudinal migration of depocenters which shows a cyclic organization through time, better expressed in the Axial Fan (210 ka BP- actual), with cycles of down-fan and up-fan movements reflecting prograding-retrograding cycles (Marsset *et al.*, 2009). These cycles seem to correlate amazingly with the contemporaneous humidity fluctuations that affected the western tropical African continent (Jahn *et al.*, 2005). These correlations suggest that both the channel lengths and the avulsion process are controlled by climate changes that appear as a major forcing factor throughout the Quaternary. In order to test this hypothesis, a clay mineralogical study, using X-Ray Diffraction methods, has been realized on hemipelagic sediments contemporaneous with the deposition of the Zaire Axial Fan (core KZai- 02). It allowed us to precise the variability of detrital transfers from the western African continent toward the Zaire Fan, in relation with climatic fluctuations through the last 200 ka. Gingele *et al.* (2001) have indeed demonstrated that an increase of the Kaolinite/Smectite ratio (K/S) in the Zaire Fan sediments through time could be interpreted as an intensification of Congo-Zaire detrital supplies. In our sedimentary record, since the end of the MIS6 glaciation (~130 ka BP), each rapid increase of the K/S ratio is contemporaneous with a climatic transition from a cold to a warm phase. Such climatic warming is thought to be able to amplify the humidity transfer toward the continent, generating a raise of rainfalls that provokes fluvial floods. During warm periods, the decreasing of the clay mineral ratio is interpreted as a combination of the rising sea level that could increase the selective sorting (the kaolinite settles more rapidly than the smectite) and of a lesser influence of the detrital supplies from the Congo-Zaire River (the continental vegetation is then well developed and favors infiltration rather than runoff). During cold periods, the K/S is rather low which indicates a reduced fluvial influence. The wind contribution is more important at that time since climatic conditions are more arid. The kaolinite deposited in the Zaire Fan sediments, during cold periods, indeed originates from sub-Saharan areas and is transported by trade winds. Congo-Zaire detrital supplies therefore fluctuate in response to climatic conditions that affected the continent through the last 200 ka. This detrital variability could then be an explanation for the longitudinal migration of Zaire Fan depocenters.

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Morphology and feeding of modern volcaniclastic deep sea fans off La Réunion Island: source and triggering of turbidity currents

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Even if deep-water turbidite systems have been widely studied throughout the world ocean, volcaniclastic deep-sea fans are few observed compared to silicoclastic systems. Turbidite deposits and sedimentary structures like canyons or channels are visible off volcanic islands such Hawaii or Canary Islands, but no well-detailed turbidite system was described with a "Source-to-Sink" approach. The data collected off La Réunion Island, during the cruises FOREVER (2006), ERODER1 (2006) and ERODER 2 (2008), led to the discovery of five modern volcaniclastic deep-sea fans. These cruises provided a complete data set including swath bathymetry and backscatter imagery, echosounder profiles and gravity cores. For the first time on the flanks of a major volcanic island, high resolution mapping enable the identification of five turbidite systems whose source are the five main rivers of the island. The deep-sea fans off La Réunion Island have various sizes and morphological characteristics, depending of their feeding structure and their maturity. A large feeding canyon with a very steep slope characterizes the Salazie fan. The Saint-Joseph fan, the smallest one, is connected to the Langevin River and the Remparts River. The Mafate fan is an elongated and relatively symmetrical system fed by the Galets River. It is coalescent with the Saint-Denis fan, a small confined fan. The wider fan, named the Cilaos fan, extends over an area of more than 15000 km^2. This system seems relatively complex in term of sedimentary architecture, with a canyon area in direct connection with the Saint-Etienne River, an upper-fan composed of sediment waves and lobate bodies and an extended channelized system in the lower-fan. It has been strongly influenced by the morphology of the submarine slopes of the volcanic edifice and of the surrounding seafloor (Saint-Ange, 2009). In December 2009, new high-resolution swath bathymetry data were collected in shallow marine area to image the canyon heads of three of the five fans and to characterize morphological features at the connection between river mouths and canyons. Concerning the Cilaos sedimentary system, three types of canyon head are identified off the Saint-Etienne River mouth: (1) incised canyons network directly connected to the present river delta, (2) scarps located on the upper slope resulting from local submarine slope instabilities at the south of the main canyon, and (3) small canyons connected to the sandy littoral bar of "Etang-Salé" in the northern part of the river mouth. The present-day feeding of the Cilaos turbidite system is dominated by the hydrodynamic and sedimentary processes linked to the Saint-Etienne River floods. The triggering of gravity processes by hyperpycnal flows is highly probable. The morphological features identified at the canyon head suggest that, for this system, hyperpycnal flows are not the only process feeding the Cilaos canyon. We propose that wave dynamic and slope instabilities also play a role for the triggering of turbidity currents and participate to the incision of the canyon. Our results suggest that the geometry of the discovered turbidite systems mainly depends both on the topography of the abyssal plain and on the feeding mode.

Saint-Ange, F. (2009) La sédimentation volcaniclastique en contexte de point chaud (île de La Réunion, Océan Indien). PhD La Réunion.

Sedimentology and stratigraphy of the modern Cilaos volcaniclastic turbidite system, offshore La Réunion Island

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Dismantling of isolated volcanic edifices in oceanic context is considered to occur by large mass wasting processes (flank landslides, debris avalanches). Erosion of volcanic islands also plays an important role in the dismantling process. In marine environment, erosion and transport are often dominated by gravity sedimentary processes generated by turbidity currents. In spite of numerous studies dedicated to Canary or Hawaii islands, no well-developed turbidite system (with canyons, lobes and levees) has been previously described around such volcaniclastic systems. The recent exploration of the submarine slopes off La Réunion Island during several cruises (2006 FOREVER, 2006 ERODER 1, and 2008 ERODER 2 cruises) reveals for the first time the presence of five large turbidite systems extending to more than 200 km from the island (Saint-Ange, 2009). The results presented here are focused on the first detailed description of the Cilaos turbidite system located in the southwest of the island. This study contributes to provide new insights for the understanding of volcaniclastic deep sea fans. Swath bathymetry, backscatter imagery, and echosounder profiles have been used to characterized the morphology of the Cilaos turbidite system. The sedimentological variability has been characterized thanks to the study of several gravity cores. Granulometry measurements, Multi-Sensor Core logger and XRF logging have been performed along each core interval. Analyses of planktonic oxygen isotopes have been used to constrain the stratigraphic framework. The modern Cilaos deep-sea fan is 250 km long and extends over an area of more than 15000 km2. This fan is located in the continuity of the Saint-Etienne river mouth. Three main parts are identified on the mapping of the present morphology of the fan: the canyon area, the proximal fan, and the distal fan. Two main canyons merge in a single-wide valley, feeding the main body of the Cilaos fan. A large field of sediment waves characterizes the transition between the canyon and the fan. The proximal fan shows diverse sedimentary structures like channels and lobate structures. In the deepest area, the distal fan consists of a narrow channel ending in the Mahanoro fracture zone. The cores collected along the Cilaos turbiditic system show sandy turbidite deposits composed of volcanic sands, with various grain sizes and deposition thicknesses. The correlation of cores with high-resolution seismic data (3.5 kHz) contributes to identify a transparent unit composed of hemipelagic clay which extends over the distal fan. The occurrence of these hemipelagic sediments with the low sedimentation rates observed in this part of the Indian Ocean (Schlich *et al.*, 1974) suggests that the distal part of the fan is currently inactive. Based on the analysis of planktonic oxygen isotopes, it appears that the activity of the distal fan abruptly ended at about 135 kyr BP, i.e. close to Termination II. On the other hand, the presence of wide sandy turbidite deposits along the proximal fan attests to a more recent activity of turbiditic currents. During the last glacial cycle, the turbidite activity preferentially contributed to the development of the proximal fan.

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Sedimentology and ichnology of inclined heterolithic stratification developed in a tide-influenced, fluvially dominated channel: Fraser River, British Columbia, Canada

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Inclined heterolithic stratification (IHS) is developed on a laterally accreting in-channel bar form in the tide-influenced, fluvially dominated reach of the Fraser River, British Columbia, Canada. A fining-upward profile with an increase in mud bed thickness and mud content, from the shallow subtidal to the upper intertidal zone defines the vertical bar succession. There is an increase in the number of mud beds and the lateral continuity of mud beds on the downstream side of the bar. Compared to the distribution of IHS on fluvial bar forms, sand-mud interbeds are more regularly distributed in this tide-influenced setting. Conversely, the degree of rhythmic interbedding typical of tide-dominated point bars is not observed. Sand deposition occurs during high discharge (e.g., snowmelt freshet), and laminated mud beds are deposited during low flow (ambient flow conditions). This cyclicity is observed in the ichnology of the system, where burrows are evident in mud beds, but not in sand beds. Where burrows occur in sand, they extend down from overlying mud beds. Burrows are mainly diminutive, vertical forms, reflecting a very low diversity of burrowing organisms in the channels. The variability in the sedimentology and ichnology of the upstream and downstream sides of the bar may prove to be a valuable tool for predicting the lateral and vertical extent of mud beds in similar IHS deposits in the rock record. In particular, the results of this research may aid in predicting sand and mud distributions in the hydrocarbon-hosting IHS deposits of the middle McMurray Formation, Western Canada Sedimentary Basin.

Variability of modern meandering fluvial and tidal estuarine systems: a re-examination of lithofacies models

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FLUVIAL MEANDERS. Research on modern meandering fluvial and tidal estuarine channel deposits over the past 30-years has demonstrated considerable variability of lithofacies that still has not been incorporated into textbooks and other educational products. The upward and downstream grain-size fining of fluvial sandy point bar deposits has been well documented, and is often considered as a “one size fits all” facies model for meandering channels. In contrast, an understanding of silt-dominated counter point bars deposits is still in its infancy. Counter point bar deposits in low gradient rivers (e.g. 0.00004, 4 cm/km) always form downstream of point bar deposits, beyond the channel crossover or scroll pattern inflection, and may constitute up to 50% of the area in a meander lobe or meander belt. These heterolithic alternating thin sand and thicker silt beds form by lateral accretion, usually in the down-valley direction along regional dip. Our borehole data suggest these deposits vary considerably from those of point bar deposits, and thus are characterized by distinctive petrophysical properties (e.g., porosity, permeability, reservoir body connectivity, etc). TIDAL ESTUARY MEANDERS. Actively meandering tidal estuary channels and their deposits are less understood. Tidal estuaries include the lowermost reaches of river systems influenced by oceanic tides, exhibiting either a flow reversal, as occurs in the lower meandering Chehalis and Willapa river estuaries of SW Washington State, U.S.A. and the Daule and Babahovo river estuaries of Ecuador, or a waxing and waning regime of unidirectional flow, as occurs in the lower Fraser River, B.C., Canada. Heterolithic meandering tidal channel deposits commonly form in meso tidal settings (2-4 m spring tide range, North American classification). In rivers where flow reversals do not occur, but fluvial flow fluctuates as a result of tidal influence, point bar deposits consist of sand; counter point bar deposits have not yet been studied (Fraser River, Canada). On the other hand, meandering tidal channels that exhibit flow reversals can have heterolithic (distinctive sand-mud couplets) vertical successions in both point bar and counter point bar deposits (Willapa River, Washington State and Daule and Babahovo rivers, Ecuador). Here, each sand-mud couplet likely represents one year of sedimentation, attributed to one dominant annual fluvial flood cycle responsible for the sand bed and a mud bed attributed to deposition of suspended load during the remainder of the year. In some subtropical regions, two annual fluvial flood cycles in a given year may be expected. In contrast to pure fluvial meander bend deposits, both point bar and counter point bar deposits in tidally influenced meanders can be characterized by repetitive sand-mud couplets. Because of their similar heterolithic vertical sequence, it would be very difficult to separate point bar from counter point bar deposits from core only. In a specific meander, mud beds tend to be thicker distally (fining distally). In the Chehalis River, which experiences flow reversals in the reach studied, we observed clean sand in the point bar, but increased heterolithics distally in the counter point bar deposits. All of the examples with tidal reversals had remarkable similarity to those exposed in the open pit mines of the extensive Alberta Oil Sands (1.6 trillion barrels). From our experience, considerable variability exists within meandering river lithofacies, whether they be fluvial or tidally-influenced, suggesting much more field research is needed.

Evidence for upland glaciation in Western Tropical Pangaea

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The Late Palaeozoic (Late Carboniferous-Permian) archives the greatest glaciation of the Phanerozoic, marked by evidence for continental glaciation in all the southern high-latitude (Gondwanan) continents. In contrast, the low-latitude tropics have long been considered warm. Evidence for glaciation, however, can be elusive, especially for cases of upland glaciation, wherein lack of accommodation space typically precludes preservation of ice-contact indicators. Here, we summarize new evidence for hypothesized upland glaciation and periglacial conditions in parts of the Permo-Carboniferous Ancestral Rocky Mountains of western equatorial Pangaea (western U.S.). Within a palaeo-highland of the Ancestral Rocky Mountains, an exhumed valley of late Palaeozoic age preserves a basal diamictite with clasts exhibiting macro- and microstriations, and striations also occur on the subjacent Precambrian surface. The age of the canyon is inferred on the basis of provenance attributes, palynomorph content, and paleomagnetic inclination data from strata within the basal fill of the canyon. Permo-Carboniferous conglomeratic strata that onlap the western side of this paleolandform have been previously interpreted as nonglacial alluvial fan strata, but the most proximal strata (<3 km from the palaeo-highland) exhibit features suggestive of subaqueous deposition, including lonestones inferred to record ice-rafting in an ice-contact lake. Beyond 3 km from the palaeo-highland, these strata record fluvial deposition dominated by flood deposits, but record minimal chemical weathering, consistent with proglacial deposition. Quartz sand grains recovered from this and other Permo-Carboniferous highland-proximal strata of the Ancestral Rocky Mountains exhibit grooves, troughs and similar microstriae consistent with a glacial origin. Also within upland- proximal coarse clastic strata, palaeosurfaces occur that exhibit randomly oriented polygonal cracks, inferred to record periglacial (frozen ground) conditions. Finally, voluminous loessite strata that accumulated proximal to uplifts of the Ancestral Rocky Mountains record massive production of dust derived in part from the highlands, and commonly characterized by minimal chemical weathering. Tropical glaciation is permissible even in warm tropics, given sufficient elevation to achieve the requisite cold temperatures. However, depositional systems emanating from these uplifts terminated at sea level, and estimates for ice terminus elevations derived from applying maximum reasonable fluvial slopes result in maximum values (<<1200– 1800 m) significantly lower than those of the Last Glacial Maximum. If these inferences are correct, they would indicate globally cool temperatures, at least during the intervals recorded by upland glacial and periglacial conditions. This result would also imply more widespread glaciation in the late Palaeozoic tropics, given the global orogenesis and thus widespread mountains associated with Pangaean assembly during this time. Hence, more evidence should exist for upland glaciation, but identification of such deposits may be elusive, especially if cold conditions existed only briefly and/or episodically.

Stratigraphy and first dating of the Las Arcas Formation in the Santa Maria Valley, Salta Province, Argentina

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The Santa María Valley is a tectonic NNW-SSE depocenter located in NE Catamarca, NW Tucumán and SE Salta. It is limited by the Aconquija Ranges and the Cumbres Calchaquíes to the east and to the west by the Quilmes Ranges. The general stratigraphy of this region begins with a Lower Cambrian to Precambrian metamorphic and igneous basement (Ruiz Huidobro 1966, Toselli and Rossi 1998, Toselli et al 1999) and continues with the Cenozoic strata. The Cenozoic units are composed by the Saladillo Formation (Paleogene; Galván and Ruiz Huidobro 1965; Bossi *et al.* 2001) and the Santa María Group (Neogene; Ruiz Huidobro 1960, Galván and Ruiz Huidobro 1965) divided into the San José, Las Arcas, Chiquimil, Andalhuala and Corral Quemado Formations. Above them lies the Yasyamayo Formation and Quaternary deposits. The study was carried out in the Las Arcas Formation in the Totoritas Creek that is a tributary creek of the Santa María River in southern Salta Province. The outcrops begin with yellow-greenish mudstones of the San José Formation that passes transitionally to siltstones and sandstones red beds belonging to the Las Arcas Formation. A ~820m stratigraphic log was measured and sampled on this unit. The column begins with red fine lacustrine sediments which gradually passes into orange-red coarse sandstones and conglomerates. According to the stratigraphic correlation Las Arcas Formation has been assigned as Middle-Upper Miocene. In the outcrops of the Totoritas Creek, at 47 m from the base of the first red bed a tuff is intercalated in the siltstones strata. This tuff was dating by Ar-Ar method and the results indicate an age between 8.79 +/- 0.14Ma. A magnetostratigraphic study is also being carried out in the Las Arcas Formation. The preliminary results suggest the presence of a magnetic component carried by ilmenohematites and titanomagnetites. These studies will give information about the age of the unit, deposition timing and sedimentary rates.

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Environmental evolution of the Argentinian Dry Chaco for the last 200-years reconstructed using lacustrine sediments

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Despite the growing number of paleoenvironmental studies in South America, important regions of the continent still lack of such studies. Research in these regions would supplement existing paleoenvironmental interpretations and close the existing spatial gaps with high-resolution proxy records. In this context, here we present the environmental reconstruction for the last 200 years of the Argentinian Dry Chaco using a high-resolution multi-proxy approach of the lake sediments of the Laguna Yema. Laguna Yema is located in the Bermejo department of the Formosa Province, Argentina (24º21 S - 61º20 W, at 155 m a.s.l.). The lake has a relatively circular shape, it occupies an area of about 1.3 km^{2}, an approximate water volume of about 256 Hm^{3}, and the mean water depth is 3.5 m. The lake remains completely mixed throughout the year, with a slight thermocline developed during the austral winter. The main water input and output is the Teuquito river, a detachment of the Teuco River, one of the most important river systems of the northern Argentina. In July 2008, four replicated cores following a NW - SE transect were retrieved using a gravity UWITEC core sampler. The obtained cores had a length which ranged between 185 mm and 410 mm. One core located in the central part of the lake (LY3.3) and another one situated in the margin (LY4.1) were selected to conduct the paleoenvironmental studies. A detailed lithological description was carried out on these cores and they were characterized using X-ray diffraction (XRD, 1 sample every 5 mm) and an AVAATECH XRF core scanner (one measurement every 0.3 mm). The gray colour curve was calculated on the digital images obtained from these cores. The chronological framework of these records was constructed using 4 AMS ^{14}C dates. The statistical treatment of the datasets allowed us to unravel the main sedimentological processes that have triggered the input, distribution and settlement of the main sedimentary particles. XRD showed that the retrieved sediments of the Laguna Yema are made up of variable proportions of quartz, clay (illite) and plagioclase (microcline and albite) whereas XRF dataset showed that these sediments contain a variable proportion of organic matter (Br profile was used as organic matter indicator). Redundant analyses (RDA) showed that the XRF element distribution depended on the location of the core. Nevertheless, most part of the XRF chemical elements were associated to the illite. These statistical analyses also showed that, at least, two different transport mechanisms (fluvial and eolian) were responsible for the input and distribution of the terrigenous particles. Principal Component Analyses (PCA) on the XRF datasets allowed us to reconstruct the evolution of the lake level (first eigenvector associated to the fluvial input sediments) and of the precipitation (second eigenvector associated to the eolian input sediments) for the last 200 years. These environmental reconstructions will help to fill the spatial gaps and will allow us to gain a better understanding of past climatic oscillations in South America.

Holocene environmental evolution of the Bermejo River Basin in Central West Region of Formosa (Argentina)

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Bermejo River Basin covers 122 800 km2 and has its source in the Argentine-Bolivian Andes, forming a huge alluvial fan of 650 km long whose apex is located in Embarcación city (Salta). The basin is characterized by high seasonality and wide precipitation variability and includes two different regions: the Humid Chaco (1,200 to 750 mm/year) and the Semiarid Chaco (750-500 mm/year). The geology of the upper basin, in the Cordillera Oriental and Subandean Ranges, is characterized by a series of north-south elongated mountain chains, composed mainly of sedimentary and epimetamorphic rocks (Iriondo and Paira, 2007). In this zone, rapid mass movements are continuously generated, becoming an important mechanism of landscape development and providing large volumes of sediments to the Chaco rivers (Brea *et al.*, 1996). This work focuses on understanding the recent mechanisms in the construction of the Bermejo River alluvial fan and the regional climate history in central-west Formosa province, by integrating geomorphological analysis and mineralogical and textural sedimentary sequences of palaeochannels. At the same time, we will be able to supplement and adjust the interpretation of high-resolution temporal sequences Laguna Yema (Speranza, 2009). Geomorphological analysis were made by interpretation of satellite images (Orthorectified Landsat Thematic Mapper Mosaics, and CBERS-2 IRM and CBERS-2B CCD2XS) and verificated in the field. Also, in addition to the description of the successional stages of vegetation, three palaeochannels with temporarily different features were chosen. Each perforation was made with a percussion core sampler for poorly consolidated fine sediments (LY-I: with coordinates 61º 17W - 24º 15S; LY-II: 61º 23W - 24º 26S, and LY-III: 61º 43W - 24º 5S), to depths of 7, 5 and 4 m, respectively. We conducted a lithological description of the sequences, textural and mineralogical analysis. Both the texture and mineralogy resulted strongly related to the material properties of the upper basin. Displayed traits reveal the intermittent activation of ancient channels and their great lateral mobility. These parameters allowed the reconstruct of the regional environmental variations, related to paleoclimate, hydrology, and local and geomorphological stability, and correlated with previous studies of high resolution in Laguna Yema.

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The onshore preservation potential of tsunami deposits – examples of recent events from Peru

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Tsunami are common events in ocean basins including subduction zones. Surprisingly the sedimentary onshore record of tsunami is very limited. The reason for this may be that (1) either not all tsunami are capable of eroding and depositing sediments, (2) we are not able to identify deposits as the result of a tsunami and/or (3) tsunami sediments have limited preservation potential. We re-surveyed locations of the three most recent regional tsunami events in Peru (1996 Chimbote, 2001 Camana, 2007 Pisco-Paracas) in order to determine the preservation potential of texturally diverse fine gained, siliciclastic tsunami deposits in different coastal environments. The most common sedimentary features were (1) (graded) layers of coarse sand, some including shell fragments or rock fragments, (2) sometimes imbricated shell layers, (3) heavy mineral laminae, (4) mud caps and (5) muddy rip-up clasts. Directional structures like imbricated shells gave information of both the presence of runup and backwash deposits. Along the arid coasts of Peru, aeolian erosion and transport are the most important coast shaping processes. Fine grained tsunami sediments will be mobilized and re-deposited, and sedimentary structures or grain size trends will be lost soon after an event. This is proved by the fact that all sediments deposited by the Chimbote-Tsunami and about half of the sediments of the Camana-Tsunami were already eroded, eleven and six years, respectively, after the event. There are no seasonal rain falls along the Peruvian coast. In case of the Chimbote Tsunami, increased water discharge of periodic rivers after the annual snow melt in the high Andes or in the former case also during the El Niño event of 1997/98, additionally may have eroded large volumes of coastal sediments into the sea. Our re-surveys show that muddy deposits like rip-up clasts and mud caps have a higher preservation potential than sandy sediments. This is caused by the cohesion of the mud particles that makes the deposits less susceptible to aeolian processes due to the fast hardening of the mud layers in the dry Peruvian climate. Furthermore, run up deposits of the last wave of the tsunami wave train and backwash deposits have a higher preservation potential than deposits of earlier waves. This is because runup deposits might be eroded by subsequent inundating waves or by the backwash. Co-seismic tectonic movements generally cause the development of disequilibrium beaches, which may locally entail increased rates of erosion or deposition. In case of the Chimbote-Tsunami, local co-seismic uplift was recorded at Puerto Santa, where the coastline was shifted about 60 m in seaward direction. Subsequent post-seismic subsidence led to a shift in the depositional facies and an increase in the normal post-tsunami sedimentation rate. Considering recent events, human activity, such as the use of beach and tsunami sand for rebuilding coastal structures, and the use of wood or sea grass deposited in swash lines as combustible, is an additional limiting preservation factor of these tsunami indicators. The low preservation potential of onshore tsunami sediments plays an important role in the use of inverse models of deposition of tsunami sediments which attempt to calculate the magnitude of past events. These models use input parameters, such as the grain size distribution and deposits thickness. Since the preserved thickness may not be equal to the original thickness of the tsunami deposit, and because the amount of erosion may be unknown, inverse models only give minimum values of tsunami flow speed and flow depth.

Comparison of earthquake-triggered turbidites from an active and a passive continental margin

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Strong earthquakes can trigger the deposition of thick turbidites in coastal areas such as fjords. By collecting cores in these specific areas, the history of strong earthquakes can thus be extended past historical records. Here we will compare the characteristics of decimetre- to meter-thick turbidites identified in sediment cores collected on board the R/V Marion Dufresne II in an active (cores MD07-3108 Casq, MD07-3107, Reloncavi Fjord, 41°S Chile) and a passive margin (core MD99-2222; Saguenay Fjord, 48°N, Eastern Canada). In both settings, the area was struck by large earthquakes during historical times, including the 1960 earthquake (M=9.5) in Chile and the 1663 earthquake (>7) in Québec. In both cores, the high-resolution physical properties of the sediments measured using a multi sensor core logger in conjunction with sedimentological, paleomagnetic and geochemical analyses allowed the identification of rapidly deposited layers (RDL) contrasting sharply from the above and overlying bioturbated sediments. In both cores, several RDL are characterized by a sharp basal contact, a coarse base and a normal grading typical of classical turbidites. Based on the available chronology and geological setting of both coring sites, these turbidites were most likely triggered by earthquakes. In addition, in core MD99-2222, several other RDL have a similar normally graded basal bed, but are overlain by a coarsening-upward unit that underlies a fining-upward unit, interpreted as a deposit of flood-induced hyperpycnal flow. By analogy with the deposits that followed the AD 1663 earthquake, such beds are inferred to result from the breaching and rapid draining of a natural dam generated by an earthquake- triggered landslide. The thickest turbidite of both fjords is associated to the largest known historical event (1960 in Chile and 1663 in Eastern Canada), whereas a clear reduction of the number of turbidites is recorded in the Eastern Canadian record in the Late Holocene and not in the Chilean record. This observation highlights the two types of setting (passive vs. active margin), where most of the earthquakes in the Saguenay Fjord followed deglaciation, remobilized glaciomarine clays and were likely related to glacio-isostatic rebound compared to major subduction earthquakes remobilizing deltaic sediments in historical times and throughout the Holocene along the Chilean margin.

Turbidite deposits deformed by sand remobilisation: a case study from the Panoche Giant Injection Complex (San Joaquin Valley, California, USA)

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This paper provides insights of a sedimentological study of turbidite deposits that acted as the main feeders for sand intrusions (e.g. sedimentary dykes and sills) composing the Panoche Giant Injection Complex (PGIC - Upper Cretaceous-Palaeocene, Great Valley Sequence, San Joaquin Valley, California). At the present time the PGIC represents the largest injection complex documented in outcrop, covering an outcrop area of 300-400 km² and recording an upward remobilisation of a huge volume of sand (> 15 km³) through a 1200 m thick mudstone-dominated succession. The turbidites are represented mostly by single slope channels and channel complexes. They display a degree of post-depositional deformation which varies greatly between different units and laterally or vertically even within a single unit. The more intensely deformed units are characterized by: 1) very sharp top surface with cm- to dm-scale steps and scallops, which are erosive convex upward segments crosscutting the overlying mudstones; 2) asymmetric/irregular shape resulting from the variation of the degree of fluidisation and sand remobilisation within the same sandbody; 3) wing-like structures (generally low angle dykes) departing from one or both lateral margins; 4) lump-shaped geometry (characterising especially cluster units of modified channels and extremely irregular sills and dykes), which probably record the loss of significant volume of sand. Internally the modified channels are composed predominantly of poor cemented and homogenised sandstones. In these sandstones, it is possible to recognise sand-remobilisation and water-escape structures such as pipes (up to a few metres long and 0.1-0.2 m), mega-pillars (up to 50 cm) and a highly inclined bandings. Where more cemented, the sandstones constitute beds which form very complex strata frameworks, displaying high-angle to vertical surfaces and/or metre- scale symmetric folds. Sandstones showing preserved primary depositional features (undeformed bedding and internal lamination) could be associated with the homogenised sandstones. They occur as irregular well cemented concretions located beneath the top surface, and they usually represent the unique evidence of a primary depositional origin of the sandstone units. The direct observation of the relations between the sand intrusions and their parent beds allows to define a genetic model for the PGIC emplacement. This is based on the: 1) timing and modality of overpressures development and mudstone seal fracturation; 2) hydrodynamic characters of the fluidised sand flow during the injection. An important implication of this study concerns the similarities that have been noted between the sand injections and the depositional remobilised sandstones. In several cases, the internal architecture and the external geometry of the remobilised depositional units can be modified to such extent that distinguishing them from the pure injected units is problematic. This highlights the problems arising for case studies in which only subsurface data (e.g. cores, 2D seismic) are available. In these cases, due to the common lack of clear evidences, there is the strong risk of an over-estimation of the pure injected sandstones compared with the modified depositional sandstones. This could cause serious consequences in elaborating valid predictive models for basins rich in sand injectites.

Paleoenvironmental conditions during the Late Barremian – Early Aptian in the Umbria-Marche basin

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The Early Aptian pelagic realm witnessed an oceanic anoxic event (OAE 1a or "Selli event") and the widespread deposition of organic-rich sediments. We investigated the section of Gorgo a Cerbara, Italy, where OAE 1a is particularly well documented in the form of the Selli level. In this section, the upper Barremian and lowermost Aptian sediments already contain a series of thin, laminated and organic- carbon (Corg) rich layers, which may provide evidence of paleoenvironmental disturbances before the Selli event. We investigated carbon and oxygen-stable isotopes, phosphorus content, clays and bulk rock mineralogy and redox-sensitive trace elements (RSTE), in order to reconstruct paleoceanographic changes preceding the Selli event. During the late Barremian, despite the presence of laminated shales, no perturbation is observed in the δ^{13}C record indicating that these brief periods of enhanced TOC preservation did not have sufficient impact on the marine carbon household to deviate δ^{13}C records and are not the consequence of major climate change. Around the Barremian–Aptian boundary, Corg rich layers become more frequent and are correlated with a negative excursion in both δ^{13}Ccarb and δ^{13}Corg records. They may result from a warming period as indicated by the δ^{18}O and clay- mineral records. During the earliest Aptian, the same records indicate that this warming trend is reverted into a cooling trend, which then is followed by an important warming step near the onset of OAE 1a. During this time period, some of these Corg-rich layers are enriched in redox-sensitive trace elements (RSTE; As, Mo, U, Co and V). These RSTE enrichments progressively increase towards the Selli level. They are also depleted in Mn and have a Corg/Ptot ratio higher than the Redfield ratio. These proxies indicate that the organic-rich intervals were the consequence of progressively stronger oxygen deficiency. The warming step near the onset of OAE 1a is associated with the well-known negative spike in δ^{13}Ccarb and δ^{13}Corg records, an important peak in P accumulation, RSTE enrichments and Corg/Ptot ratios indicating the prevalence of anoxic conditions. The Selli level itself documents a general cooling phase, and the first arrival of kaolinite, which may be either reworked from older deposits or an expression of the importance of warm and humid conditions during OAE 1a, in spite of the cooling trend. Since the late Barremian, correlations are also observed between TOC, P and biogenic silica contents, indicating links between P availability, productivity, and TOC preservation. The Gorgo a Cerbara section is interpreted as a document of the progressive impact of paleoenvironmental change related to the formation of the Ontong-Java plateau, which started already around the Barremian-Aptian boundary and culminated into OAE 1a.

Recovering the last 1 Ma paleoclimatic and paleoseismic histories of the Dead Sea Basin by ICDP drilling of the central deep basin of the modern lake

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The Dead Sea Basin (DSB), at the lowest continental elevation on Earth, has been intermittently filled by several water-bodies during the Neogene-Quaternary periods. The size and composition of the water- bodies reflect the climatic-hydrologic condition in the large drainage area and in the Levant. Moreover, the DSB is located at the desert fringe between the Mediterranean area and Sahara-Arabia desert belt, thus capturing paleoclimatic information from both climate zones. In addition, the DSB was the locus of prehistorical human evolution and migration, which was apparently related to climate conditions and significant hydrological changes in the region. The history of water bodies in the Dead Sea Basin commenced with the ingression of the Mediterranean Sea into the incipient rift valley during the late Neogene. This ingression, forming the Sedom Lagoon, led to the deposition of thick sequences of salts (e.g. the Sedom Formation) and production of Ca-Chloride brines. After the disconnection of the Sedom Lagoon from the Mediterranean Sea, a sequence of lakes filled the basin. The hydrologic-limnological conditions in the lakes are reflected in the mineralogical and geochemical compositions of sediments deposited from the lake (e.g. primary aragonite or gypsum) and lake level elevations. Tectonic activity along the Dead Sea transform fault (e.g. seismic events) perpetuated the steep morphology. The seismic events left their imprint in the lake sediments (e.g. formation of seismites) opening the possibility to monitor patterns of earthquake recurrence and intensity. During the past 15 years we devoted extensive efforts to document the limnological and paleoseismic histories of the lake inventories mainly by working on the exposed marginal terraces and sections that were uplifted by the Sedom diapir. We focused our studies on the establishment of high-resolution chronologies (by U-Th and radiocarbon methods) of the sedimentary sequences that were combined with high- resolution limnological (e.g. lake levels) geochemical, sedimentological and paleoseismic data. I will summarize the central findings of these works in my talk. Now, we are well equipped with knowledge on the margins of the lakes and on the analytical methods required to perform a comprehensive study of the past 1Ma that hopefully would be recovered by the ICDP drilling operation. The drilling and the forthcoming studies are designed to comprise a multi-national and multi-institutes project. The leading scientists of the various groups are: Amotz Agnon (Hebrew University), Daniel Aritzegui (University of Geneva); Achim Bauer (GFZ-Potsdam); Steven L. Goldstein (Columbia University), Geralrd Haug (ETH-Zurich), Emi Ito (University of Minnesota) and Yoshinoro Yasuda (Institute of Japan studies, Kyoto).

Variability of provenance across the Mu Us Desert (Northern China) from analysis of heavy minerals and single zircon grains

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The Mu Us Desert, located in the Ordos Basin in Northern China, has been hypothesised to be a primary or intermediate source of the vast loess deposits lying on the Chinese Loess Plateau immediately south. Testing of this hypothesis requires characterisation of the sources of sediment in the desert, which would also in turn shed light on the processes controlling sandy desert formation in the region. Large areas of the desert are currently covered by partially to fully active transverse dunes oriented NE-SW, reflecting transport by northwesterly winter monsoon winds. It has generally been assumed that the Mu Us dune sand is sourced from underlying Quaternary aeolian and fluvial sands, which in turn are believed to be ultimately sourced from underlying Cretaceous aeolian sandstone. However, there has neither been a direct quantitative test of this hypothesis, nor characterisation of variability in geochemical signatures in sediment across the basin. Further, the only provenance work conducted on the Mu Us sands has used bulk geochemical analysis, which is inherently limited when there is a possibility of multiple source regions with contrasting signatures contributing to the sediment. Here we present heavy mineral assemblages and detrital zircon U-Pb dates from modern Mu Us sediments across the desert and from underlying sand bearing strata. The results allow us to interpret variability in the source regions geographically, test specific hypotheses over the origin of the desert sands, and provide an important check on the variability of a widely used tool for provenance analysis across a single desert system. The results show that there is variability across the desert sands, with some contrasts to previously hypothesised sources. These findings will be discussed in terms of interpreting detrital zircon data, as well as in terms of the implications for the origin of the Mu Us sands, and in turn Chinese loess. Finally, attempts will be made to characterise areas displaying common source characteristics and interpret these in terms of the climatic, erosional and transport processes responsible.

Examining the timing of sand transport from land to the abyssal plain

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Sand deposition in the deep sea both operates today and is evidenced in the geologic record. Deep sea sands are a direct link between erosion on land and marine deposition, via sediment transport events and processes. As such they not only provide records of the climatic and environmental triggers responsible for sand movement, but of the denudation of mountain belts and surface process controls. Submarine canyons are major conduits for sediment originating from the continent to abyssal plains. However, some questions of considerable importance to interpreting these sediments and their transport down canyons remain: 1) How long does it take sand to be transported down canyon? 2) Does transport occur in one event, or as a series of pulses? 3) Over what frequency do these processes operate? 4) What are the mechanisms responsible for these events? 5) How much mixing of sediment is there down canyon or is sand transported in discreet parcels? 6) Is sediment 'stored' in canyon systems for significant periods of time? 7) Can sedimentation events be identified and attributed to a specific cause? Reliable dating of sand movement is critical to answering many of these questions. Unfortunately, until recently there has been a lack of applicable methods that can date sand movement on modern to Holocene timescales. However, recent advances in optically stimulated luminescence (OSL) dating have made the technique a candidate for application to submarine canyon sands. Here, we present results of OSL dating of submarine sands from the upper to middle parts of the Monterey Canyon off the coast of California, alongside foraminifera radiocarbon dates from the same cores. Remotely Operated Vehicles equipped with vibracoring equipment based at the Monterey Bay Aquarium Research Institute have taken cores from the Monterey Canyon. Data from gamma multi-sensor track scanning has been used to target sub sampling for OSL dating. There are a number of complications with OSL dating sediments from this environment including potential disequilibrium in the isotopic decay series of U and Th (potentially causing age overestimates) and potential partial exposure of sediments prior to 'canyon entry'. Analysis of modern samples, as well as MC-ICP-MS and laboratory gamma spectrometry analysis of radioisotopes, suggests these potential effects are not significant. The OSL dating results indicate a complicated situation of sediment transport with sediment sequences showing mixing of sand grains that entered the canyon thousands of years apart, sometimes kyr storage of grains, and complex chronostratigraphy. However, classic fining upward turbidite sequences seem to display similar 'canyon entry' ages for all grains in sand layers and suggest extremely recent transport from the photic zone, at least until depths of 1100 m.

Effects of topography on lofting gravity flows: Implications for the deposition of deep-water massive sands

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Hyperpycnal flows are generated in the marine environment by sediment-laden fresh water discharge into the ocean. They frequently form at river mouths and are also generated in proximal ice-melting settings and are thought to be responsible for transporting a large proportion of suspended river sediment onto and off the continental shelf. Hyperpycnal flows are an example of gravity currents that display reversing buoyancy. This phenomenon is generated by the fresh water interstitial fluid being less dense than that of the ambient seawater. Thus after sufficient particles are sedimented the flow can become positively buoyant and loft, forming a rising plume. Here we present results from physical scale-modelling experiments of lofting gravity currents upon interaction with topography. Topography, in the form of a vertical obstacle, triggered a localised lofting zone on its upstream side. This lofting zone was maintained in a fixed position until the bulk density of the flow had reduced enough to allow lofting along its entire length. The obstructed lofting zone is associated with a sharp increase in deposit thickness. By inference these experimentally established lofting dynamics are applied to improve understanding of the potential for hyperpycnal flows to deposit deep-water massive sands. This study provides a depositional mechanism by which large volumes of sand can be deposited in the absence of traction and the fines removed, leaving thick deposits of structureless sand with a low percentage of mud. This conceptual model for the first time provides a framework by which the geometries of certain deep-water massive sands may be predicted within specific depositional and basinal settings. This is crucial to our understanding of massive sand deposits in modern and ancient turbiditic systems and in the commercial evaluation of hydrocarbon potential of such sedimentary successions.

Fluid mud generated grain size breaks controlled by seafloor topography: examples from the Moroccan Turbidite System, offshore NW Africa

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Sharp surfaces across which there is an abrupt upward decrease in grain size (grain size breaks) have been observed in turbidites from numerous disparate locations around the world, including both ancient outcrops and modern cores. Understanding how these grain size breaks form is important because they are a departure from classical models of turbidite evolution, which describe progressively finer sediment being deposited from waning flows to form a smooth fining upward trend. Here we present unusually detailed analyses of grain size breaks from the Moroccan Turbidite System, offshore Northwest Africa. Over the last 200,000 yrs this system has hosted some very large events with volumes exceeding 100 km3. Excellent core control, from over 300 shallow piston cores, coupled with a strong chronostratigraphic and geochemical framework has enabled extensive correlation of individual turbidites for ~2000 km. Such detailed field data enables grain size breaks to be documented in across flow and down flow directions, confirming that the missing grain sizes are found long distances down slope. These proximally bypassed grain sizes are found within very thick mud caps (up to 5m). The architecture of the mud caps is strongly controlled by topography with turbidite mud preferentially ponding into very subtle topographic lows. The volume of this bypassed material is impressive exceeding 150km3 in some turbidites. From ten separate turbidite events recording over 350 grain size transitions from sand to mud ~75% were sharp grain size breaks. This shows, rather than a phenomenon, grain size breaks are the dominant form of sand to mud grain size transition and highlights their importance in turbidite transport and depositional processes. Grain size breaks typically occur at ~100 µm overlain by finer silt/mud of ~10 µm. Two facies are observed underlying the grain size break; 1) mud-poor sand with sedimentary structures (ripple cross-lamination, planar lamination and structureless) indicating a turbulent flow regime and deposition in a grain-by-grain fashion; 2) mud-rich sand displaying no sedimentary structures and chaotic sorting indicating a laminar flow regime and deposition by freezing en masse. In both cases grain size breaks are frequent and overlain by typically ungraded silty mud but can also display various degrees of normal grading. The ungraded mud caps have a significant and consistent silt component vertically through the deposit. This is interpreted as a product of a laminar flow trapping intermediate silt grains within its matrix then freezing en masse. Normal grading found in the mud caps is interpreted to be the product of a turbulent flow regime. Overlying muddy facies that record normal grading progressing into ungraded sediment is interpreted as flows transitional between turbulent and laminar. Using this scheme grain size breaks from sand to mud and their overlying muddy facies are plotted over entire individual flow deposits with detailed sea-floor bathymetry. This shows subtle changes in sea-floor gradient (<0.01˚ to 0.02˚) to be a primary control on grain size break development and the deposition of muddy facies overlying the grain size breaks. Grain size breaks identified in this study are frequent, occurring throughout the Moroccan Turbidite System. They are interpreted to be the product of cohesive (laminar) mud layers developed at the rear of the decelerating turbidity current, which trap intermediate grain sizes and bypass them many kilometres downslope. The rheology of the mud layer is transitional between laminar and turbulent, which is primarily controlled by sea-floor gradient. This study shows grain size breaks to be an important tool in understanding turbidite flow structure and evolution.

Evolving deep marine depositional system on a deforming hanging wall basin slope and floor during rift climax, north Wadi Baba, Egypt

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Hypothetical tectono-stratigraphic models for deep-marine rift-climax successions predict that as fault displacement rates reach their maxima, sedimentation rates are outpaced resulting in fining-upward mudstone-dominated sediment-starved intervals. While useful in driving forward our understanding of deep-marine rift basin development, the current group of models have tended to focus on shallow marine strata and case studies where fault traces are planar. This paper aims to use a superbly exposed deep marine rift-climax outcrop, with complex three-dimensional (3D) fault geometries, from the Gulf of Suez, Egypt, to test the current group of hypothetical tectono-stratigraphic models. A detailed sedimentological field investigation integrated with Light Detection and Radar (LIDAR) data of the early Miocene, North Wadi Baba area, El Qaa Basin reveals a system dominated by coarsening upwards lenticular turbidite and debrite sandstones and conglomerates. Gravity flows were shed from both transverse and axial slopes and reveal evidence of channelized and unconfined flows, local ponding, sediment bypass and flow deflection against fault-generated submarine topography. The area was also prone to wholesale collapse of the transverse footwall slope, probably driven by tectonic shaking. Eight lithofacies reveal a complex array of sediment sources including ephemeral river- and delta-mouths, reefs, beaches, cliffs and storm-prone shelves. Several rare laterally extensive marker beds have been used to demonstrate the spatio-temporal evolution of the system. Isopach maps, cross-sections, palaeocurrent and sedimentological data reveal unusual sediment patterns and subsidence distributions with time that do not conform to growth fold and fault patterns, a function of 3 normal faults, which appear to be episodically and independently active. This study reveals a much coarser grained system than predicted and a previously unknown level of complexity in sediment-types, -processes, -thickness patterns and -distributions probably driven by complex 3D fault evolution and hinterland physiography. If there is depositional linkage between rift shoulder basins and rift centre basins, then it is likely that coarser grained deposits may be found in rift centre basins than previously speculated.

Late Cenozoic bi-polar glacial history - perspectives from mineralogical characteristics of high latitude sub-seafloor sediments

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Polar ice is an important component of the earth climate system, affecting global sea level, ocean circulation, heat transport and marine productivity among other things. Since their inception, the high latitude ice sheets appear to have been variably dynamic in response to global climate change. There is a clear connection to global climate evolution but also elevated topographies can have influence on formation of Cenozoic early glaciers. Based on a close relationship between ice- sheet evolution, sea-ice cover and sedimentation, sediment characteristics including clay mineralogy, quartz grain surface textures and heavy mineral contents can be used to evaluate onset of glaciations and critical climate transitions in the Arctic Ocean and Antarctica including the Eocene/Oligocene and Miocene/Pliocene periods. Ocean research drilling into the Antarctic continental shelf and basins in Prydz Bay has well indicated several basic states of the East Antarctic ice sheet. The inland ice sheet has reached sea level as early as ~37 Ma ago. The following phase lasting more than 20 Ma was with a less stable ice cover characterized by strong cyclic waxing and waning. Later from ~14 Ma to present time indicate that the Antarctic ice sheets became more stable, however, varying considerably in size in both hemispheres in response to global climate warmth e.g. during early Pliocene. The middle Miocene climate cooling seems to coincide with the increased kaolinite occurrence and high angularity and conchoidal fractures in quartz sand grains in the central Arctic Ocean sediments probably due to continental ice generation and increased erosion on land. Critical is to obtain evaluation of the nature of initiated glaciers possible continental ice at the Arctic margins during Plio-Pleistocene after pronounced interglacials e.g. by inferring glacially generated quartz sand grain surface microtextures and related sedimentology from the Arctic Ocean sediments. The heavy mineral fluctuation can well reflects changes in the amount of sea ice formation which correlates with climate variations and the general the fresh-water input from the continent. Extensive number of studies of Cenozoic glacial history has been successfully fulfilled by exploiting the internationally collaborative research program: the (Integrated) Ocean Drilling Program. Records of the onset of glaciations concerning the Arctic Ocean and Antarctica, however, are still relatively sparse and future expeditions and ocean research drilling proposals focused to these areas are needed to obtain the above mentioned objectives.

Slide activity along the eastern slope of the Gela Basin (Sicily Channel): first results from RV Maria S. Merian Cruise MSM-15/3

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With increasing awareness of oceanic geohazards, submarine landslides are gaining wide attention not only because of their catastrophic impacts (e.g. landslide-induced tsunamis), but also because they can be directly related to primary trigger mechanisms including earthquakes, rapid sedimentation, gas release, or clathrate dissociation, many of which represent geohazards themselves. Despites many insights gained from various research studies reconstructing distribution, frequency and magnitude of submarine landslide and related investigations of slope stability condition and trigger mechanisms, many open questions persist why a given slope fails catastrophically whereas another remains stable. This may partly be explained by the fact that failure planes are often located in depth inaccessible by conventional (gravity and piston) coring and in situ testing devices and we therefore often lack groundthruthing of the geophysical data and samples for further analysis. Hence, scientific drilling is needed to illuminate the nature of critical processes governing the stability of ocean margin slopes and failure initiation at critical depth, which eventually will reveal the means for future hazard assessment from submarine slides. Here we aim at presenting first results from RV Maria S. Merian expedition MSM 15/3 during which two distinct slides complexes offshore South Sicily (Italy) are investigated by drilling, coring and logging critical subsurface intervals using the new MARUM Sea floor drill rig (MeBo). On the eastern slope of the Gela Basin, two landslides complexes ("Twin Slides") have previously been identified on the basis of side-scan sonar, Chirp seismic profiles, swath bathymetry and shallow core data and described as multiple failures that are likely controlled by specific stratigraphic surfaces acting as glide planes and high pore pressure gradients generated by high sediment accumulation rates (Minisini *et al.*, 2007; Minisini and Trincardi, 2009). A systematic MeBo drilling transect from the undisturbed slope apron to the depositional area of these landslide masses now recovers up to 55 m long cores, retrieving, for the first time, the failure planes and stacked mass-transport deposits. This will allow for (i) dating the occurrence of landslides, (ii) investigating the stratigraphic context in which failure develops and (iii) testing a number of hypothesis regarding the trigger mechanisms, such as the weakness of clayey deposits, the liquefaction potential of the interbedded non-cohesive sand and/or ash layers, and the buildup of pore pressures due to high accumulation rates.

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Linking flow properties of partially channelized turbidity currents to the morphodynamics and texture of submarine levees

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Levees are the primary elements of self-formed submarine channels, yet in comparison to channel thalwegs little is known about their morphodynamics. Motivated by observations of levee stratigraphy in seismic data and levee morphodynamics observed in physical experiments we have developed a levee growth model. This model couples a simple advection settling scheme for suspended sediment with a vertical suspended sediment profile for partially-channelized turbidity currents. Use of an advection-settling scheme for is supported by small advection length scales for settling sediment in overbanking flows compared to most levee widths. The channelized (parent) suspended sediment concentration profile in our model is defined for multiple grain sizes using a two-layer method. Suspended sediment concentration below the height of the velocity maximum is defined by the Rouse equation, while the concentration above this height is defined by a near-Gaussian relationship. In our model only the current fraction situated above the elevation of the levee crest is used in the advection settling calculation. As a result early levee growth is associated with coarse and relatively stratified overbanking flow compared to later periods of growth when channel relief is greater. We use this model to link channelized flow properties to both levee morphology and texture. The evolution of levee morphology, specifically levee taper, is shown to depend on the Rouse number of the parent flow with high Rouse number flows corresponding to steep levees. Initial exploration of levee texture has focused on the distribution of particle diameters in the parent flows. We find that a flow composed of a narrow distribution of particle diameters results in a coarser levee than a flow with the same median grain size but broader particle size distribution.

Quantifying the influence of channel sinuosity on the depositional mechanics of channelized turbidity currents: A laboratory study

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Here we present results from a suite of laboratory experiments that highlight the influence of channel sinuosity on the depositional mechanics of channelized turbidity currents. We released turbidity currents into three channels in an experimental basin filled with water and monitored current properties and the evolution of topography via sedimentation. The three channels were similar in cross-sectional geometry but varied in sinuosity. Results from these experiments are used to constrain the run up of channelized turbidity currents on the outer banks of moderate to high curvature channel bends. We find that a current is unlikely to remain contained within a channel when the kinetic energy of a flow exceeds the potential energy associated with an elevation gain equal to the channel relief; setting an effective upper limit for current velocity. Next we show that flow through bends induces a vertical mixing that redistributes suspended sediment back into the interiors of depositional turbidity currents. This mixing counteracts the natural tendency for suspended-sediment concentration and grain-size to stratify vertically, thereby reducing the rate at which sediment is lost from a current via deposition. Finally, the laboratory experiments suggest that turbidity currents might commonly separate from channel sidewalls along the inner banks of bends. In some cases, sedimentation rates and patterns within the resulting separation zones are sufficient to construct bar forms that are attached to the channel sidewalls and represent an important mechanism of submarine channel filling. These bar forms have inclined strata that might be mistaken for the deposits of point bars and internal levees, even though the formation mechanism and its implications to channel history are different.

Scale dependant compensational stacking of channelized sedimentary deposits

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Compensational stacking, the tendency for sediment transport systems to preferentially fill topographic lows through deposition, is a concept widely used in the interpretation of the stratigraphic record. Recently a metric was developed to quantify the strength of compensation in sedimentary basins by comparing observed stacking patterns to what would be expected from simple, uncorrelated stacking. This method uses the rate of decay of spatial variability in sedimentation between picked depositional horizons with increasing vertical stratigraphic averaging distance. Initial exploration of this metric utilized reduced scale physical models and stratigraphy imaged in 3D seismic data. In this work we utilize the compensation index to quantitatively describe the architecture of stratigraphy exposed in outcrops. The two field sites analyzed include 1) the Carboniferous Ross Sandstone composed of channel and lobe turbidities and 2) Cretaceous/Paleogene Ferris Formation composed of sediment deposited in a distributive fluvial system. Analysis of these data sets indicates that compensation is a scale dependant process. In both data sets the architecture of stratigraphic packages with thicknesses less than one channel depth are best described as either random or anti-compensational. In contrast, stratigraphic packages in excess of one channel depth in thickness are strongly compensational. Results from this analysis are compared to physical and numerical models which indicate that the handoff from random to ordered (compensational) stratigraphic packaging is related to 1) the time scale of channel avulsion and 2) autogenic processes which lead to clustering of channel bodies in the subsurface.

Channel changes of the Lower Yellow River during the second half of the past century

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The Yellow River is widely known as a "hanging river" due to its high sedimentation rate (the current channel bed is about 2.74 m higher than the out-bank plains in average) in the lower reach. Understanding the variations in channel patterns and their influence factors is crucial to regulate potential flooding risk in this critical region. In this paper, we compared the changes in discharge, suspended sediment delivery rate, median grain size, sedimentation rate, channel planform and cross-section, and channel width/depth ratio during 1950-1999 from gauging stations in Huayuankou, Gaocun-Sunkou and Lijin that represent the braided, meandering and straight channel sections, respectively. During this period, frequent internal channel variations dominated in the braided channel section. The channel bed was continuously raised as a whole, but experienced strong erosion in certain time mainly influenced by the operation and closure of the Sanmenxia Dam. The straight channel section was relatively stable due to restricted lateral migration by the solid artificial levees in both banks. Instead, channel aggradation was the dominant process and erosion only happened when channel avulsions occurred in the river mouth. The meandering channel section between the upstream braided and downstream straight channel sections was formed as a result of stream self-adjustment. Rapid lateral migrations were observed during this period, but the extent of the migration was restricted by artificial levees. Sediment aggradation on the channel bed and floodplain was apparent. Since 1970, the channel shrunk remarkably in all sections due to the increased use of water resources and the decreased precipitation in the Yellow River basin. Recently, the migration of the channel is limited, even the lower portion of the braided section seems to be a meandering channel.

Deposits of flows transitional between turbidity current and debris flow

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The relationship between submarine sediment gravity flows and the character of their deposits is poorly understood. Annular flume experiments were used to investigate the depositional dynamics and deposits of waning sediment-laden flows. Decelerating fast (>3 m/s) flows with fixed sand content (10 vol%) and variable mud content (0-17 vol%) resulted in only four deposit types. Clean sand with a mud cap that resembled a turbidity current deposit (turbidite) formed if the flow was sufficiently turbulent when deposition began, or if the muddy fluid had insufficient strength to suspend the sand. The clean sand could contain structures if mud content was low (<6%) and the deceleration period was > 300 s. Ungraded muddy sand with a mud cap that resembled a debris-flow deposit (debrite) formed if the flow became laminar before sand could deposit. Clean sand overlain by ungraded muddy sand and a mud cap formed either from a transitional flow or by late-stage settling of sand from a muddy suspension. These deposits resemble enigmatic submarine flow deposits called linked debrite-turbidites. The experiments provide a basis for inferring flow type from deposit character for submarine sediment-laden flows.

Atmospheric carbon dioxide concentrations during the Cretaceous

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Various lines of evidence suggest that temperatures in the mid- Cretaceous were among the warmest in the Cretaceous. To understand a role of CO_2 as a driver for the warmest mid-Cretaceous climates, records of past pCO_2 should be reconstructed from geochemical proxies. Pedogenic carbonate has been known as a good proxy for reconstruction of the Cretaceous pCO_2. However, because detailed long-term Cretaceous pCO_2 records from pedogenic carbonates are lacking for the Albian-Santonian, whether the mid- Cretaceous pCO2 levels had increased or decreased is still under debate. The Cretaceous Gyeongsang Basin in Korea contains several pedogenic carbonate-bearing strata, ranging in age from Aptian to Santonian, deposited under the semi-arid paleoclimates thus filling the gap in the pedogenic carbonate record. The large uncertainty of pCO_2 estimation based on pedogenic carbonates may be derived from assumed values of soil-respired CO_2 concentration (S(z)). In order to estimate the reliable CO_2 concentrations for the Cretaceous, reasonable S(z) must be assumed. In this study, we present the carbon isotope data of pedogenic carbonates formed during the Aptian to Santonian in the Gyeongsang Basin and the high resolution Cretaceous pCO_2 trend by combining with those of the literature. The carbon isotopic values of the pedogenic carbonates in the Gyeongsang Basin range from -8.2‰ to -3.7‰. pCO_2 estimates derived from pedogenic carbonates using S(z) values of 2000 ppm V for semi- arid paleoclimates show a wide variation from 500 ppm V (Aptian to early Albian) to 1500 ppm V (mid Albian to Santonian). Combination of the pCO_2 levels derived from pedogenic carbonates of the Gyeongsang Basin with recalculated values of the literature data suggests that global pCO_2 level changed from a low level during the Berriasian through early Albian (<1000 ppm V) to a high level during the mid-Albian through early Campanian (1000~2000 ppm V), and then to a low level during the mid-Campanian through Maastrichtian (< 1000 ppm V).

Energy Resources: Gas hydrates

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With a view to fuel security, gas hydrates has great potential to get a deal of global attention because of their enormous carbon content as methane natural gases that offer an additional energy resource for the world.Clathrate Hydrate is represented by general formula M*N H2O where M is a molecules of Hydrate forming gas , and N is the ratio that indicate the the quantity of water molecules to 1 molecule of gas (N varies from 5.75 to 17). Methane hydrate (white gold) is a crystal fuel which releases 164 unit volume of methane gas from one unit volume of gashydrate. It is generated from both thermogenic and biogenic origins and found in permafrost & seafloor. Gas hydrates are ice-like crystalline structures, non-stoichiometric in which gas molecules are caged within a specific lattice structure formed from hydrogen bonding of water molecules. BSR (Bottom Simulating Reflector) indicator of presence of seafloor gas hydrate mimics structural identity and stability at a high pressure and low temperature. The overall reaction for the production of methane is (CH2 O) 106 (N H3)16 (H3PO4) ◊ 53 CO2 + 53 CH4 + 16 NH3 + H3PO4 Biogenic and thermogenic methane can be distinguished by the values of ratio difference of carbon (13) and carbon (12) isotopes on a particular sample. Its value is in the range (-55% to -85%) for biogenic and (-25% to -60%) for thermogenic.Also for biogenic gas, the ratio of methane to sum of methane & ethane is >1000 where as for thermogenic it is < 100. For organic diagenesis to occur, sedimentation rate should be rapid (in the order of 30 mts in one Ma) for the burial of organics. The total organic content (TOC) in the sediment should be greater than 0.5 %. The residual methane concentration should be greater than 10ml. per litre of wet sediments for the formation of hydrate. The pressure temperature phase equilibrium envelope of hydrate may be significantly affected by the enrichment of salt concentration, heavier hydrocarbon, and make up of the clays / sediments themselves. Hydrates will be depleted in Chloride ions and enriched in Oxygen (18) isotope, while the water environment of hydrate formation should be enriched in chloride ions and depleted in Oxygen (18) isotope. Gas Hydrate has been recognized in drilled cores but their presence over large areas can be detected more effectively by seismic reflection methods. Gas Hydrate are usually inferred on seismic profiles by Large amplitude bottom simulating reflector (BSR), which occur near the sea floor, Cutting across underlying dipping strata. The velocity inversion at the BSR caused by moving from high velocity hydrate cemented sediments to low velocity water or gas filled sediments below. The polarity reversal of the BSR with respect to sea floor, Blanking zone above the BSR due to addition of gas hydrates into pore fluids. However the blanking at Blake Ridge is attributed to the relative homogeneity of the sediments than to hydrate cementation or to diagenesis beneath the BSR. The occurrence of a BSR in seismic reflection data is the most important indicator of hydrates in marine sediments. However, hydrates can exist without creating a BSR if there is no underlying free gas or if the hydrates do not appreciably stiffen the sediment matrix. The weak reflectivity observed above the BSR (blanking) =Acoustic blanking indicates the absence of any signal because of increased transmission and obliteration of sediment impedance structures owing to the general replacement of pore water by hydrate, therefore, the zone with acoustic blanking characteristics is also referred to as the hydrate stability zone which is defined as the sedimentary package which contains the gas hydrates. Some of the blanking is not obvious, because the acoustic blanking is related to the hydrate cementation in the sediments; the degree of blanking is proportional to the amount of hydrate in the pore space.

Thin bed detection by wavelet seismic signal processing

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Wavelet analysis , known as a mathematical microscope, has scope to cope with non stationary signal to delve deep into geophysical seismic signal processing and interpretation for oil & gas exploration & production : Petrophysical imaging for oil & gas reservoir ,Advanced Seismic Stratigraphy: A Sequence-Wavelet Analysis Exploration- Exploitation,high resolution subsurface imaging. Non-Stationary statistical Geophysical Seismic Signal Processing (GSSP) is of paramount importance for imaging underground geological structures and is being used all over the world to search for petroleum deposits and to probe the deeper portions of the earth. For extraction of informations from signals with the help of time-frequency representation & transformations for rectification of uncertainty principle limitation by wavelet 1st,2nd & 3rd generation. Jean P Morlet (French Geophysicist pioneer) first generation wavelet analysis for high resolution; Second generation wavelet transform (SGWT)/lifting scheme for super resolution; third generation wavelet - a Complex Finite Ridgelet Transform (CFRIT),to achieve the forensic dissection, morphological features from micro/nano scalar of surface topographic data. Since wavelet transformations can better identify the abrupt changes in cyclicity common in nature, they become important tools for seismic stratigraphy.The wavelet decomposition of a seismic signal involves simultaneous representation of its time and frequency characteristics. The key advantage of the wavelet transform (WT) over the conventional Fourier transform is that it can not only provide insight on the combined temporal and spectral characteristics of signals, but it can also localize the target information in the time—frequency domain simultaneously. Complex Wavelet Transform is used to rectify & pacify limitations; shift sensitivity, poor directionality, and absence of phase information. These extensions are highly redundant and computationally intensive. "Uncertainty Principle", which states that, we cannot exactly know what frequency exists at what time instance , but we can only know what frequency bands exist at what time intervals . Joint Time-Frequency analysis is applied on non stationary signal to get high resolution and to resolve constraints of uncertainty principle.The Teager-Kaiser energy associated with wavelet transform to generate a joint time-frequency representation, which can be used as a nonlinear energy tracking of the seismic waves.Current status of Wavelet Transforms, which is being employed in upstream sector, are Diplet, Ridgelet(Radon & Wavelet), slantlet, Curvelet, phaselet,beamlet, contourlet,caplet, Seislet in addition to Continuous Wavelet Transform , Discrete Wavelet Transform , Complex Wavelet Transform , TT-Transform , S-Transform . Tuning Effect : A phenomenon of constructive or destructive interference of waves from closely spaced events or reflections. At a spacing of less than one-quarter of the wavelength, reflections undergo constructive interference and produce a single event of high amplitude. At spacing greater than that, the event begins to be resolvable as two separate events. The tuning thickness is the bed thickness at which two events become indistinguishable in time, and knowing this thickness is important to seismic interpreters who wish to study thin reservoirs. AmplitudeVersus Frequency(AVF) : The resolution limit of seismic data is a complex issue that involves not only wavelet frequency, phase characters, and data quality (S/N), but also criteria on how to measure resolvability. The Spectral Decomposition method provides a robust and phase-independent approach to seismic thickness estimation. Spectral Decomposition increases the resolution needed to detect a particular stratigraphic unit. Compactly supported non-orthogonal wavelets do not have phase distortion problem and provide a better choice for seismic data processing.

Sedimentation patterns in piggyback basins of the Argentine Precordillera (30º LS) during the Andean orogeny

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During the Andean orogeny the large foreland basin of Bermejo (Argentina) was formed between 29º and 31º LS. It evolved from the Late Oligocene- Early Miocene to the present under a high tectonic activity which the uplifted the Precordillera orogenic belt. The continuous eastwards migration of the orogenic front led to the formation of numerous thrust slices exposing Early Paleozoic rocks on their hanging walls. Several piggyback basins were formed on top of those slices, whose stratigraphy, evolution patterns and relationship with the foreland area have not been studied to date. In this contribution we analyze the Tertiary deposits of the Rodeo-Iglesia and La Tranca piggyback basins, which comprise the Cuesta del Viento and Rodeo Formations. The Cuesta del Viento Formation is composed of monomictic breccias with thick mudstone intervals and thin intercalations of polimictic conglomerates. This unit is covered by conglomerates, sandstones, mudstones and different types of pyroclastic deposits included in the Rodeo Formation. Three sequences (CV-1 to CV-3) were recognized in the Cuesta del Viento Formation. The lowermost (CV-1) consists of monotonous successions of massive monomictic breccias dominated by low-grade metamorphic clasts from the underlying Yerba Loca Formation. This unit corresponds to the wedgetop stage and was accumulated in piedmont environments. CV-2 is made up of a thick interval of massive and laminated mudstones with minor polimictic conglomerates and sandstones. This sequence interpreted as the deposit of lacustrine and microdeltaic environments during the onset of the uplift of the Caracol range. At this time the La Tranca basin acted as an open piggyback setting. CV-3 is characterized by thick levels of mudstones (playa lake facies) intercalated with monomictic breccias (piedmont deposits) formed in a closed piggyback basin. Breccias increase to the top indicating the progradation of piedmont sediments onto the playa lake system. The Rodeo Formation overlies a paleorelief carved on the Cuesta del Viento and Yerba Loca formations, and is divided in four sequences (RD-1 to RD-4). Conglomerates and sandstones of the RD-1 sequence fill the basal relief and represent the deposits of gravelly and sandy braided river bars. This stage represents a base level adjustment due to recovery of sediment transference downstream. RD-2 is closely related to an explosive volcanic episode which produced extensive sediment supply and the drowning in the basin. Its gravelly and sandy deposits were formed by lahars, ash and block-flows and surges, as well as by fluvial reworking during the recovery of base level. The Colangüil uplift and the later restarting of the La Tranca-Rodeo sediment transference produced an incision surface that bounds RD-3. This sequence comprises the complex infilling of strongly incised sandstones and fine- to coarse-grained conglomerates. Cliff structures and intrabasinal blocks are commonly found at the bottom of the channels indicating a low-accommodation confined stage. These conditions evolved to an unconfined moderate-accommodation situation marked by amalgamated sandstones. To the top, thick playa lake and microdeltaic deposits were developed revealing a possible closure of the Rodeo Basin. RD-4 starts with the abrupt progradation of gravel lobes that mark the base of the sequence rather than incision surfaces. The most conspicuous components of this sequence are isolated channels fills closely associated with crevasse splay and extensive floodplain deposits formed in anastomosing fluvial systems. The sequence RD-4 is recorded in both basins suggesting a connection between Rodeo and La Tranca areas. However, muddy-saline playa lake deposits placed on top of the Rodeo Formation suggest a new closure of the Rodeo Basin.

Integrated paleocurrent analysis of northern and southern borders of Amazon Sedimentary Basin, Brazil

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The Amazon sedimentary basin covers an area of about 500,000 km^2 in the Brazilian territory, distributed through the states of Amazonas and Pará. The sedimentary content of the basin is composed of a significant sedimentation of Paleozoic age, between the Ordovician and Permian periods, and another sequence with Mesozoic-Cenozoic ages. In this context, the paleocurrents of the following Formations were analyzed: Maecuru (Mesodevonian), deposited under fluvial-shallow marine environment, Ererê (Mesodevonian), deposited under shallow marine environment, Curiri (Neodevonian), generated under the glaciomarine influence, Monte Alegre (Neocarboniferous), deposited under a coastal environment with partial fluvial-deltaic influence and Alter do Chão (Cretaceous) deposited under fluvial-lacustrine sedimentation. According to Miall (1999), in a basin, four main points can be evidenced from the paleocurrent analysis: 1 -Paleotalus direction, which reflects the subsidence, 2 -Sediment supply direction; 3 -Geological unit's geometry and 4 -Nature of sedimentary environments. In order to measure the sedimentary structures indicating paleocurrents like tabular and trough cross-stratification, climbing ripples and ripple marks, five fieldworks were accomplished at the Amazon Basin. On the Southern border of the basin, the regions of Tapajós and Xingu rivers were visited and a profile in the Trans-Amazon highway between the cities of Altamira and Itaituba was run. To the basin Northern border, Trombetas and Monte Alegre regions, were studied. The data analysis started with the facies analysis of the formations through the elaboration of stratigraphic columns, descriptions of sedimentary facies, contact relations and geometry of the units. Aiming to recognize the direction of the main measurements for each formation, diagrams of the rosettes with the respective attitudes collected for each formation were constructed, by use of Stereonet software. In order to analyze if the paleocurrent directions are related to different depositional environment conditions, specific rosette diagrams for each facies were also built. The full analysis of the paleocurrent data also enabled the assessment of the sediment supply direction, and related the dispersion of the data with the specificity of the facies. As for the Southern border, the homogeneity of the sediment contribution from outside the basin (S-SE) to inside the basin (N-NW) was observed, possibly denoting sediment transportation from the Amazon Craton. As for the Northern border, the homogeneity contribution coming from outside the N-NW basin to inside the S-SE basin is well marked in Trombetas River and the region of Monte Alegre for Maecuru and Ererê Formations. However, the configurations of paleocurrents in Curiri and Monte Alegre Formations in these regions indicate a contribution that points to out of the basin, with supply direction from S-SW to N-NE. The influence of glacial-fluvial environments in the sedimentation of Curiri Formation during the Neodevonian period supports the hypothesis of paleogeographic changes altering the geometry and direction of depositional supply. The relation with the paleogeography of the Northern border of the Amazon basin, during the Pennsylvanian period in the context of Gondwana, suggests that the epicontinental shallow sea - where the Monte Alegre Formation was deposited - could be linked to other basins in N-NE or even the same basin could have a "paleoborder" further north resulting in this change of direction in supplying. Alter do Chão Formation's paleocurrents show the influence from the Andean chain in the sedimentation of the Amazon Basin, indicating a contribution for the two borders from W to E, but in Monte Alegre region the main contribution still points to an anomalous sedimentation pattern, from S-SW to N-NE, to out of the basin.

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Jurassic stromatolitic buildings of the Russian Plate

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Stromatolites are most abundant in Precambrian sedimentary rocks, where they have been used for stratigraphy. Therefore Phanerozoic ones much less studied in the East-Europian Platform and in the Moscow Syneclise nobody ever described Jurassic stromatolites. We first discovered these ones in the study of the construction site of the shopping center (Tsvetnoy bul, 15) in Moscow at the end of 2007. We first identified a variety of stromatolitic structures and buildings at several levels (Upper Callovian - Oxfordian). Then, during 2008-2009 was collected extensive material on Jurassic stromatolites Russian plate (from several sections of Moscow, village Kamennaya Tyazhina, quarries near the station Gzhel and Nikitskoe (Moscow region), v. Mikhalenino and city Makariev (Kostroma reg.). According to the classification of Raaben and Semikhatov (2000), these stromatolitic buildings belong to the morphological types of nodular and stratiform stromatolites and associated with various suites of the Upper Callovian-Oxfordian. The enclosing rocks are usually clay or silty clay. Initial substrate mostly was served limestone and marly pebbles, sometimes macrofauna. The first stromatolitic layers enveloped the relief of the substrate then later expanded to the clay. Callovian stromatolites made up of complex forms, including various crusts, breccia fragments of stromatolites and surrounding rocks and layered constructions, with total thickness of up to 0.35 m. The Lower and Middle Oxfordian stromatolitic buildings have a hemispherical shape, often with uneven surface, and different size (from several cm to 20-30 cm in diameter). Sometimes, these nodules or hemispheres are connected forming continuous stratifications, often enveloping bottom paleorelief. Most of the nodules or crusts have irregular complex lamination with opposing growth components domes and they are usually buried in the sediment not in the original position (inclined, overturned). This indicates the shallow-water conditions and active hydrodynamics. The buildings often contain serpulidae, large bivalves *Pinna sp*. and others, gastropods *Bathrotomaria sp*., brachiopods and roots of crinoids *Cyclocrinus insignis* (Trautschold), indicating that they were formed under conditions of normal salinity. The stromatolites are composed of thin alternating layers or laminae of carbonate material (sometimes ferruginous or pyritized), glauconite and phosphate, are rarely entirely phosphate. In some case, there are an admixture of terrigenous material, fauna and its fragments. Lamination is distinct, clearly visible both in the samples and in thin sections. Laminas configuration are convex, sometimes breaking down into short microcolumns (diameter 0,05-0,5 mm). The thickness of the lamina varies from a few microns to 1-2 millimeters. The Upper Oxfordian stromatolites represent complex of separate nodules (with prominent concentric lamination) of relatively small size (5-10 cm) and stratiform stromatolites, with total thickness of 0,05-0,2 m, tracing permanently tens to hundreds of meters. Their composition is mainly glauconitic with various quantity of carbonate material. This complex is also the regional datum throughout the Russian Plate ("The Oxfordian glauconite horizon"). The analysis of the studied Jurassic stromatolitic buildings morphological diversity, as well as facial features, and modern conditions favorable for the growth of stromatolites, made it possible to formulate the following conclusions. Callovian stromatolites were formed in the lower part of the littoral zone with a periodically active hydrodynamics and partly in the sublittoral zone with more passive environment, the Lower and Middle Oxfordian ones were growing in the littoral zone with changing the hydrodynamics at the unstable slump substrate. The Upper Oxfordian stromatolites were formed in constantly passive subtidal conditions, under slow sedimentation on a flat stable substrate, resulting in their predominantly stratiform morphology.

Sulphur and Carbon isotopic variation in the Lower Carboniferous: evidence for OAEs

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The issue of carbonate associated sulfate (CAS), or sulphur trapped within the matrix of carbonate minerals, has attracted a significant attention because of the possibility of utilizing this source of sulphur to refine the oceanic sulphur isotopic ($\delta^{34}S$) curv. This curve is at present based mainly on the analysis of evaporite minerals. In addition to the improvement of the $\delta^{34}S$ curve, $\delta^{34}S$ analysis of CAS can also provide information regarding oceanic and diagenetic processes influencing carbonate sediments. For example, dolomites found within zones of sulphate reduction may have distinctive $\delta^{34}S$ values unrelated to oceanic signatures. In contrast if dolomites have oceanic values, this may constrain the mechanism and timing of dolomite formation. In this study we have used the $\delta^{34}S$ of CAS from a section of partially dolomitized carbonates of the Lower Carboniferous Madison Formation in Wyoming. These rocks show a significant positive carbon isotopic shift in the Tournasian-Osagean, which can be correlated not only between numerous outcrops in the Western United States, but also to sections in Belgium and Russia. It has been suggested that this positive excursion represents a world wide change in the $\delta^{13}C$ of the oceans, perhaps linked to the ocean anoxic events (OAEs), similar to those documented during the other time periods such as the Cretaceous. However, unlike the Cretaceous, there are no physical records of the deposition of organic material in deep ocean basins during the Early Carboniferous as the deep-sea record no longer exists. In order to explore this possibility in greater detail we have examined the record of $\delta^{34}S$ across this pronounced C isotopic shift. The results show a strong positive correlation between $\delta^{34}S$ and $\delta^{13}C$ and therefore strongly link the origin of the $\delta^{13}C$ excursion with changes in the S cycle. A similar association has been recently noted in some OAEs in the Cretaceous (Jenkyns, personal communication). The explanation for this positive correlation is probably that during periods of the formation or large amounts of organic material (which caused the oceanic $\delta^{13}C$ values to increase), large ocean basins became anoxic, thereby preserving the organic carbon. In these basins the dominant mode of organic material oxidation was through sulphate reduction. During this process the lighter isotope of sulphur is preferentially incorporated into sulphide minerals leaving water masses, in which the sulphate is only partially reduced, enriched in ^{34}S. This enriched sulphate becomes periodically mixed back into the oceans thereby producing the positive $\delta^{34}S$ values in the carbonates deposited at this time. The association documented in the Madison Formation may indicate that OAEs were also present during the Early Carboniferous as well as other portions of the geological records such as the Cretaceous, Jurassic, Ordovician, and Silurian.

Are diatoms a reliable tool for d^{18}O analysis to be used for paleoclimatic reconstructions?

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The d^{18}O composition of diatoms from lacustrine records is commonly used for reconstructing the temperature and d^{18}O value of forming waters. However, in order to further constrain the reliability of these reconstructions, some methodological points need to be assessed: (i) Effect of cleaning procedures on the accuracy of d^{18}O-diatom measurements and reproducibility obtained with the IR-laser fluorination technique; (ii) Calibration of the fractionation factor between d^{18}Olacustrine diatoms and d^{18}Oforming water; (iii) Impact of silica deshydroxylation, that might occur during sedimentation on the d^{18}O signal. We tested two chemical treatments and the effect of temperature (40-70°C) during the cleaning protocol. We evidenced that, whatever the cleaning protocol used, organic matter oxidation reaches a maximum while silica dissolution is minimal, leading to stable d^{18}Osilica values between 50 and 60°C. We develop a new method based on the IR laser- heating fluorination technique, after a controlled isotopic exchanged (CIE) procedure. The long term reproductibility is lower than or equal to ±0.54‰ (1 SD; n=47; CIE=11). d^{18}O analysis of freshwater diatoms and water samples from Lake Annecy water column (years 2006-2007-2008) give a temperature-dependant relationship between d^{18}Odiatom and d^{18}Olakewater close to the previously published ones. Whereas regression lines obtained from different calibration studies are shifted, the similar magnitude of the diatom-temperature coefficients determined is promising, supporting its use as a valuable tool for interpreting variations in d^{18}O values from fossil lacustrine diatoms in temperate lakes. Finally, experimental simulation of complete deshydroxylation, coupled with sub-actual and fossil diatoms from a sedimentary record recovered from Lake Annecy are similarly investigated for testing the potential diagenesis effect on the d^{18}O signal.

Divergent flow of water and sediment in lowland coastal settings

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A typical workflow for routing water and sediment through lowland coastal settings would involve six important steps. 1) Obtain daily discharge of the main trunk river flowing into a deltaic setting. 2) Develop an appropriate Digital Elevation Model (DEM) of the lowland coastal setting. 3) Classify the coastal sedimentary environments including zones that receive episodic floodwaters. 4) Develop a flow grid (channel network) of the coastal environment, including both river and tidal channels. 5) Verify the flow grid with remotely sensed river channel information (satellite imagery, areal photography). 6) Delineate the sub-catchments across the coastal setting. 7) Alter the flow grid to allow for splits and joins and flow segmentation through the various distributary channels. 8) Proportion the discharge of the main trunk river through the flow segmentation. 9) Acquire the hydrological conditions for each sub-basin. 10) Model the water discharge through each sub-basin. 11) Model the sediment discharge through each sub-basin. A series of problems with this workflow need further study: 1) Flow grids are now based on convergent flow at odds with most coastal settings. 2) Flow grid DEMs do not take into account channel depth needed for water routing through the coastal zone. 3) Modern flow routing models do not parameterize the reality of stop banks in terms of levee height. Sub-pixel features such as stop banks are ignored. 4) These flow routing models used in the coastal zone should be based on height of the water surface, and thus the hydraulic head and momentum of the channel flow. 5) DEMs and their flow grids need to be corrected for the jungle canopy.

The death of a delta: the sad story of the Indus Delta

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The Indus, once the breadbasket of civilization, has changed completely under the influence of human engineering. During more natural conditions the Indus Delta was composed of numerous (9) distributary channels that migrated across its delta plain allowing for widespread sedimentation. Surveys over the last 200 years demonstrate the high mobility of these early distributary channels. To better use precious water resources on the upstream Indus floodplain, water that once flowed to the delta is now intercepted through an elaborate irrigation system. Presently most of the water, sediment and nutrients no longer reach the delta. The consequence is an accelerated level of delta subsidence that has led to widespread shoreline erosion, increased salinization of cultivated land and loss of wetlands. As a further consequence, tidal currents have come to dominate the system, tearing through the tidal flats at an enormous rate. This presentation will walk the audience through the 19th and 20th century changes on the Indus delta and floodplain focusing on the natural response to a system in transition from a river-dominated coastal system to a tide-dominated coastal system

Tidal bar facies and stratigraphy revealed by drilled-core analysis: an example from macrotidal seaway channel, Asan Bay of Korea

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Tidal bar is an elongated linear sand body commonly situated in estuarine or deltaic shallow marine environments. It differs from tidal dunes or tidal deltas in that it migrates sideways relative to dominant flow direction, thereby forming lateral-accretion deposits. By contrast, tidal dunes migrate in the direction of the current, generating forward-accretion deposits. In a recent year, many attempts have made to distinguish correctly between tidal bars and tidal dunes for accurate paleogeographic reconstructions and proper reservoir modeling. In spite of such an effort, internal structures and larger-scale architectures of the bars themselves are still poorly known due to shallow subaqueous occurrence and the resulting difficulties of adequate explorations. Particularly, few coring and seismic studies have been undertaken. In this context, a geophysical survey using a Sparker and a Chirp seismic system was carried out across the elongated sand bar in a seaway channel of the macrotidal Asan Bay, Korea. About 30 m long of two drilled cores and numerous box-cores taken on bar-top were examined to highlight sequential developments in response to a fall and a rise in local sea-level. The bar is about 15 km long and 2-5 km wide with a relief of 15 m. Morphologically it is a linear sand ridge with asymmetry in cross-section, steeper on the northern flank and gentle along the southern side. Its width increases seaward and tapers out landward. The area is characterized by a macrotidal regime with a tidal range of up to 9 m and maximum current velocities of around 2.1 m/s. Waves are small as the channel is protected by numerous small bedrock islands. There is little input of fresh water. In the seismic profiles, the bar itself is acoustically either semi-transparent or chaotic and it overlies on relatively strong horizontal reflectors. However, the bar, in some cases, shows northeast-dipping progradational reflectors, representing lateral accretion characters. Facies analyses of two drilled-cores revealed that the bar can be divided into 11 facies and these can be then grouped into 4 facies assemblages: 1) fluvial deposit, 2) gravel lag, 3) tidal mud, and 4) sandy bar, in ascending order. The stratigraphy of the bar deposit shows two units of the upward-coarsening successions, each commencing with gravel lags being overlain by tidal mud and sandy bar top. The erosional bounding surface between two successions is interpreted to be a regional late Pleistocene-Holocene unconformity formed by top-truncation of a pre-existing bar deposit, not by alternating of growth and abandonment. Overlain unconformably by granitic basement, basal oxidized sandy silt and tainted gravel layers are probably alluvial in origin, having been deposited during sea-level lowstand prior to marine transgression. Such an oxidized stiff layer is probably missing in between two successions by truncation occurred during the regressive phase. Thus, the tidal bar is interpreted to be erosional in origin and was formed in recurring tide-dominated setting over, at least, two sea-level cycles. However, relatively thick late Holocene covers lying on pre-Holocene flat-floored ridge seem to be depositional, showing prograding seaward in the period of late Holocene transgression previously established in the area. Particular interest here is the prograding bar under transgressing sea condition which the delivery of sediments from any rivers is limited.

Morphological changes of the Holocene Tenryu River delta, Japan

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Cuspate delta of the Tenryu River facing the Pacific Ocean in the main island of Japan has beach ridges. The morphology of the delta complex shows changes in orientation and continuity of beach ridges. The delta located in front of Pleistocene terraces whose seaward edges are thought to have been sea cliffs at the Holocene climatic optimum. Ridges I to VI locate from the paleo-sea cliffs to the present coast. The orientation of Ridges I to IV are parallel to the paleo-sea cliffs, but Ridges V and VI are oblique to them and parallel to the present cuspate coast. This distribution of beach ridges implies that delta morphology changed after the formation of Ridge IV. The objective of this study is to reconstruct temporal and spatial development and morphological change of the Holocene Tenryu River delta on the basis of Ground-Penetrating Radar (GPR) survey and Optically Stimulated Luminescence (OSL) dating. GPR survey was conducted across the Ridge VI which distributes along the present coast. The cross-shore GPR profile revealed the sedimentary structures and stratigraphic units. The beach ridge succession consists in stabilized foredunes that overlie progradational foreshore and upper shoreface sediments. In the foreshore sediments, cyclic units are recognized. The lower and upper boundaries of those units are seaward dipping truncation surfaces that are downlapped by clinoformal bed surfaces. Comparing those surfaces with seasonal changes of recent foreshore topography in this region, truncation and clinoformal surfaces are interpreted as erosion surfaces formed by high waves during typhoon seasons and accretional surfaces related to the foreshore accretion in moderate wave seasons. Therefore, periodicity of those units corresponds with annual migration of foreshore and related delta complex. The progradation rate estimated from the specific cross-shore length of those stratigraphic units is about 6 m/year, which is consistent with previous estimation from paleography and old map analyses. OSL dating was applied to 60 K-feldspar samples obtained at 5 points of Ridges III and IV. Ages of Ridges III and IV are 4743±881 yr BP and 1416±74 yr BP respectively. Those ages are consistent with beach ridge ages reported from other strandplains in Japan, e.g., Sendai, Kujyukuri, and Miyazaki. This implies that those beach ridges were stabilized by eustatic regressions related to fluctuations of global climate after the Holocene climatic optimum. Sediment fluxes supplied from The Tenryu River were quantified on the basis of sediment volumes between the beach ridges dated by OSL. The sediment flux after 1.4 ka is 10.3×10^5 m^3/yr, which is consistent with the progradation rate estimated by the GPR profile and much larger than the fluxes before. The fluxes during 6.0-4.8 ka and 4.8-1.4 ka are 4.7×10^5 and 3.5×10^5 m^3/yr, respectively. This abrupt increase of sediment supply from the Tenryu River is thought to cause the change of delta morphology to a cuspate form.

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Vorticity distributions over combined-flow ripples

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Combined flows, which commonly refer to a combination of unidirectional and wave-induced oscillatory flows that are omnipresent in natural environments, generate bedforms on sandy bottoms. Combined-flow bedforms are abundant in coastal and lake environments, and many of the associated ripple marks are also found in rock records. The relationship between bedform sizes and hydraulic conditions has been extensively investigated in both field and laboratory studies, because bed roughness affects the dynamics of the bottom boundary layer and sediment transport. From a geological point of view, the topography of bedforms as well as their sizes is an important tool in interpreting ancient sedimentary environments. In comparison with the number of studies on bedform sizes, few experimental studies have focused on the relationship between the topography and hydraulic conditions of combined-flow bedforms. Based on those limited studies, it is known that the crests of combined-flow bedforms tend to be rounded when the unidirectional component is strong enough. However, very little is known about velocity fields over movable beds under combined flows, particularly in relation to the characteristic rounded shape of crests. This study presents the results of Particle Image Velocimetry (PIV) analyses on fluid motions over combined-flow bedforms. A recirculating flume (length of 12 m, width of 0.2 m, and depth of 0.5 m) was used in this study. This flume has a plunger-type wave generator at one end and a wave absorber at the other end. Current direction can be controlled by a combination of plumbing and a slurry pump. The bed material was well-sorted quartz sand with a median grain diameter D = 0.2 mm. Bedforms develop from a flat horizontal mobile sand bed 4 m long, 0.2 m wide, and 0.05 m thick. After bedforms had fully developed over the test section, two-dimensional flow fields and bed topographies were observed. A metal halide lamp with a slit was placed just above the water surface to illuminate a vertical slice of the water column. The fluid and sediment motions near the bed surface were recorded by a high speed camera at a frame rate of 500 Hz. For each observation, 2,000 frames were obtained, and one complete period was selected for analysis. The seeding material used included ion exchange resins, as well as entrained sediment. A commercial PIV software application (Dipp Flow, Ditect Corp.) was used to obtain velocity vector maps. 2- dimentional vorticity distributions were calculated based on the velocity distributions and the temporal changes of those were analyzed. Once the current component exceeds a threshold, the ripple profiles change to form round-crested shapes. This threshold differs with the period of the wave components. Two characteristic fluid motions were revealed in the PIV analysis. In the wave-dominated cases, the vortices are shed on both sides of the ripple crests. A shed vortex is usually convected to the opposite side of the crest and caught by the following opposite-side vortex, restricted within twice the height of the ripple crests. In the other current-dominated cases, vortices are shed only on the downstream side of crests. Shed vortices spend longer time under downstream flow than in wave dominated cases. Therefore, they convected for longer distances in an upward and downstream direction and the characteristic height they reach is more than 3-5 times of the ripple height. Suspended sediments are correspondingly advected higher and diffuse wider in a wave period. Thus, the characteristic rounded crest in the current-dominated case can be attributed to the one-way vortex motion and more spatially uniform distribution of suspended and settling sediments.

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Basin-filling succession trend analysis based on basin mass balance

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Basin-filling successions and subsidence patterns of around 40 sedimentary basins in SE Asia, North America, Europe and northern Africa were compiled to examine basin-filling succession trends, depositional system stacking patterns and their control factors. The results reveal that basin filling succession patterns can be categorized into several types for each tectonic type of sedimentary basins, if the succession is determined as combination stacks of transgressive, regressive and aggradational trends. Passive margin/rift basins can be categorized into four basic types: simple transgression case, transgression to late regression case, transgression to early regression case and aggradation case. Foreland basins can be categorized into two basic types: eroded sediment supply-dominant T-R cycle case and thrust load subsidence-dominant case. Strike-slip basins can be categorized into three basic types: aggradation case, early deepening to late aggradation case and early aggradation to late deepening case. Intracontinental sag basins show aggradational stacks of small cycles in most cases. Basin subsidence analysis reveals that each tectonic basin type comprises own characteristics of subsidence patterns; namely, passive margin/rift basins show rapid subsidence and subsequent exponential decrease, foreland basins show a convex up pattern, strike slip basins show short lived, rapid subsidence, and intracontinental sag basins show long lived, gentle subsidence patterns. It is interpreted that basin-order mass balance between subsidence patterns and sediment accumulation creates characteristic basin filling succession trends. In the case of passive margin/rift basins, if subsidence rate is much larger than sedimentation rate, the simple transgression case on a continuous underfilled trend may occur. Pure passive margin basins can be categorized into this case. If the sedimentation catches up with decreasing subsidence, the transgression to late regression case occurs. The aggradational case in rift basins with fluvio-deltaic sediments is a particular pattern that basin subsidence rate and sedimentation rate are totally balanced or on an overfilled trend. This type of rift basins characteristically occur offshore China, Vietnam, Thailand and Malaysia, where tremendous amounts of clastics are supplied from the monsoon Himalaya region. It is expected that this categorization of basin-filling succession trends provides useful information for evaluation of reservoir and source rock potential of sedimentary basins.

Tectonic control on shape variability and temporal changes in forearc submarine fan systems during Pleistocene along the Nankai Trough subduction zone, central Japan

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Detailed distributions and architecture of Pleistocene submarine fans were reconstructed for total seventeen depositional sequence units using 2D/3D seismic and well data for the 200 x 50 km area in the Tokai- Kumano forearc basins along the Nankai Trough subduction zone, central Japan. Six seismic facies, indicating depositional elements of a submarine fan, were identified for each sequence unit. In the 3D seismic areas, depositional elements were displayed using 3D visualization technique. Finally, all information was mapped and compiled to reconstruct a depositional model of submarine fans for each sequence unit. The obtained maps reveal that twelve submarine canyons from the main land of Japan functioned as fixed feeder systems, along which submarine fans were formed in the forearc basins. Submarine fan architecture changed through Pleistocene time in response to changes in tectonic regime and sediment supply conditions. During earliest Pleistocene time, braided channel-style submarine fans were dominant possibly due to coarse clastic supply and relatively steep basin gradient as an early stage of forearc basin development. During Early to Middle Pleistocene time, small radial fan-type submarine fans were dominant, being confined within parallel troughs of synclinal depressions, which were formed by compressional deformation related to plate subduction activity. The depositional territories in the synclinal depressions shrank toward the compression maximum phase at around 1 Ma, and then gradually widened again after this event. These parallel troughs were connected by conduit channels, through which clastics were supplied downward. In contrast, tectonically inactive western basin was characterized by muddy sheet-like submarine fans without any depositional lobes, resulting from muddy clastic supply and relatively flat basin topography without any deformation. During Late Pleistocene time, elongated channel-levee system-type fans became dominant, as slope gradient partly increased due to a seamount subduction event underneath the forearc territory. It is concluded that the depositional style of submarine fans were strongly controlled by tectonics in terms of sediment supply variation and basin shape deformation related to plate subduction activity, although depositional sequences were clearly formed in response to glacio-eustatic sea level changes during Pleistocene time.

New insights into submarine sediment density flows and their deposits

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Submarine density flows are arguably the most volumetrically important process for moving sediment across our planet; a single flow can transport ten times the annual sediment flux from all the World's rivers. Understanding these flows remains a grand challenge as they are notoriously difficult to monitor directly. Much of our understanding is therefore based on their deposits. Here we outline a novel and relatively simple classification of submarine flows based on their deposits. This classification scheme incorporates new insights from long distance correlations of individual flow deposits, and high speed laboratory experiments. Turbidites are deposited progressively in a layer by layer fashion by turbidity currents, from which larger and smaller grains segregate. Debrites are deposited predominantly by en-masse consolidation during which larger and smaller grains do not segregate. Low density turbidity currents deposit rippled and planar sand (Tc and Td divisions) overlain by turbidite mud (Te division) that commonly forms thin (< 40 cm) beds. Turbidite mud deposition is complicated significantly by cohesive (colloidal) bonds that develop at times between fine mud particles. This leads to a rich variety of behaviour including mud bypass, large distance flow reflection and ponding of thick mud within basinal lows. High density turbidity currents, in which hindered settling is important, often deposit stepped laminated (S2), massive (Ta) and finely planar laminated (Tb) sand that typically form the basal parts of thick beds. We differ from Lowe [1982] in attributing finely planar laminated sand (Tb) to deposition from laminar shear layers at the base of high density flows, and we show that these laminated intervals tend to form the core of thick beds rather than being part of a thin upper drape. Highly mobile low strength fluid debris flows form thin (< 2 m) muddy- sand debrites, and can deliver large volumes of sediment to the further fringes of submarine fans. These fluid low strength debris flows often form after transformation from turbulent flow, with flow transformation triggered by small amounts of mud. They achieve long run out distances due to low yield strength rather than by basal layers with high pore fluid pressure that lubricate flow. High strength (traditional) mud-rich debris flows produce thicker cohesive debrites that extend down slope from an initial slope failure. We conclude by presenting new field data showing that en-masse deposition of clean sand by debris flow can also occur, but the origin and mobility of these clean sand debris flows is as yet poorly understood.

Emplacement dynamics of submarine volcanic debris avalanches: new insight from 3-D and 2-D seismic reflection and TOBI sidescan surveys; Montserrat, Lesser Antilles

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Volcanic debris avalanches resulting from volcano flank collapse include some of the largest mass flows on Earth. Emplacement of debris avalanches into the ocean around volcanic islands can generate hazardous tsunamis, and the magnitude of these tsunamis has been the subject of vigorous debate. A better understand of how volcanic debris avalanches are emplaced is needed to assess tsunami hazard, as the magnitude of the tsunamis is critically dependent on emplacement dynamics. Here we will report on a potentially unique field data set that will be collected offshore from the island of Montserrat in the Lesser Antilles during April and May 2010. The data set will include the first 3-d seismic reflection survey of volcanic debris avalanche deposits, as well as a grid of 2-d seismic reflection profiles and a TOBI sidescan survey. Two debris avalanche deposits will be mapped out in detail to the southeast of Montserrat. These two deposits represent by far the volumetrically most important events during the last 200 ka for the Soufriere Hills volcano. We seek to understand how these debris avalanches ran up neighbouring sea floor topography, the presence or absence of lubricating layers at the base of the avalanches, how underlying sea floor was destabilised, and hence how these debris avalanches were emplaced. Our work will provide key site survey data for IODP Proposal 681 that aims to core and date these avalanche deposits. The ongoing (1995 to present) eruption of the Soufriere Hills volcano on Montserrat has been monitored in arguably unprecedented detail. The longer term history of the volcano has been constrained by an unusually comprehensive set of shallow sediment cores from around the island. This analysis of volcanic debris avalanche deposits will help to complete a benchmark data set for an andesitic island arc volcano.

Low and high concentration sediment gravity-flows in deep-sea basins: rheology and numerical modeling

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The hydrodynamics of turbidity currents are difficult and expensive to study in the natural environments, whereas laboratory experiments are limited to small-scale, shallow water flows carrying very fine-grained sediment. Numerical simulations based on hydraulic mathematical models can be used to obviate these difficulties, while integrating data acquired from the nature and laboratory experiments. Computational fluid dynamics (CFD) is a tool for numerical solution of the physical equations describing fluid flow and sediment transport. The method has been widely applied in the engineering branches of fluid mechanics, but has thus far been little used in sedimentological research and reservoir studies. Novel CFD software, called MassFLOW- 3DTM, has been developed and successively used to construct a three-dimensional model for the simulation of turbidity currents, including their internal hydraulic characteristics and the erosion, transport and deposition of sediment. The three-dimensional model employs a fixed Eulerian grid of rectangular finite volumes, and the turbidity current is modeled by a multi-phase, drift flux flow method. The sediment dispersion is treated as a continuous phase and its variable spatial volumetric concentration is calculated. The erosion, drifting and lifting of sediment particles are calculated in terms of tensors superimposed on the sediment advection with turbulent fluid. We suggest a new algorithm for the combination of two different processes: high-concentration (debris flow) and low-concentration (turbidity currents) sediment-gravity flows. This algorithm involves critical solid fraction which separates these processes on “hard suspension” and “soft suspension”. Within “hard suspension”, when we have solid fraction above critical value, we use Coulomb friction model to include friction/lubrication effects of the dispersed phase. By using this algorithm we can model deposition and erosion effects with less dependence on the empirical formulas. The constitutive laws of dispersed phase can be derived from the conservation equations and thermodynamic laws.

Petrography and geochemistry of the Cambrian Araba Sandstone, Northern Eastern Desert, Egypt

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Integrated petrographical and geochemical studies were carried out on the Cambrian Araba sandstones exposed at Gebel Somr El-Qaa, northern Eastern Desert, Egypt. The main purpose of the study is to elucidate the sandstone provenance, weathering/alteration signatures, paleoclimate and tectonic depositional setting. The Araba Formation is composed mainly of reddish brown to grayish white, fine- to coarse-grained sandstones with frequent intercalations of sandy mudstone, pebbly sandstone and basal conglomeratic beds. These sandstones rest nonconformably on the peneplained Precambrian basement rocks. Modal analysis of the present sandstone indicates the dominance of quartz grains, variable amounts of lithic fragments, minor feldspar, and traces of accessory minerals, including muscovite, zircon, tourmaline and rutile. Quartz grains are dominated by monocrystalline (av. 41 %) undulatory type, whereas polycrystalline varieties are less abundant (av. ~10 %), pointing to derivation from both metamorphic and plutonic sources. Feldspars are minor constituents (av. 1.6 %) and dominated by K-varieties (microcline and orthoclase) and less commonly plagioclases. Lithic grains (av. 6 %) show a wide range of variation, and are essentially of felsic metamorphic origin; followed by sedimentary quartzite, granites and volcanic rock fragments. The Araba sandstones are mainly classified as quartzarenites to sublitharenites, although they were originally subarkoses and sublitharenites. This is based on the estimated oversized pores and moldic patches filled with kaolinite and calcite cement, indicating that the feldspar content was greater at the time of deposition. Geochemical analyses of the major and trace elements indicate that the Araba sandstones are relatively enriched in SiO_2, Ba, Sr and Zr, suggesting their mineralogical and chemical maturities. Silica is mostly incorporated into quartz grains, whereas the majority of major and trace elements are commonly associated with clay minerals and metal oxides. Both Ba and Rb are positively correlated with K_2O, suggesting their association with K-bearing minerals. The sandstones are characterized by a lower values of $Fe_2O_3^*+MgO$, Al_2O_3/SiO_2 and a higher ratios of $K_2O/Na_2O>>1$ and $Al_2O_3/(CaO+Na_2O)$, which agree well with the petrographic data that revealed the abundance of quartz and the dominance of K-feldspar relative to plagioclases. This suggests that the present sandstones are largely quartz-rich sandstones that derived mainly from plate interior or stable continental areas and deposited on passive continental margins. The higher values of CIA (av. 94 %) and PIA (av. 96.8 %) imply that the Araba sandstones were subjected to significant chemical weathering at the source area and/or probably intensive alteration and removal of alkalis during diagenesis. These data are also supported by higher MI values (av. 88.4 %). The Al_2O_3–$CaO+Na_2O$–K_2O ternary diagram presents that the Araba were subjected to high degree of chemical weathering, which led to preponderance of aluminous clay minerals such as authigenic kaolinite and illite. The chemical maturity diagram shows that the sandstones detritus were mostly released under humid climatic condition. These texturally mature Cambro-Ordovician sandstones over northern Gondwanaland are attributed to intensive chemical weathering of the Pan-African continental basement in warm-humid climate. The remarkable enrichment of SiO_2 (>70 %), higher K_2O/Na_2O ratio, high proportions of Zr, Ba and Sr trace elements and low concentration of transition elements such as Cr, Ni and V, as well as, $Fe_2O_3^* + MgO$ suggest the cratonic interior and/or recycled orogenic settings for these sandstones and indicate derivation from a deeply weathered granitic-gneissic terrain.

Sedimentation dynamics in Lake Peipsi (Estonia, Europe)

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Understanding patterns in the formation of lake sediments has been the main focus of many paleolimnologic studies. Lake Peipsi is at the border between Estonia and Russia and is one of the largest lakes in Europe (3,555 km2). The average depth of the lake is 7.1m with a maximum of 15.3m. The northernmost and largest part of the lake is Lake Peipsi sensu stricto. It is connected to the southernmost part, Lake Pihkva, via Lake Lämmijärv. Shallow depths and large surface and drainage areas make L. Peipsi extremely sensitive to climatic fluctuations and other environmental changes. Long-term observations dating back to the beginning of 20th century have shown that the water level in L. Peipsi changes cyclically. Considerable water-level fluctuations (maximum amplitude up to 3.0m) in the lake cause changes in both the surface area (up to 850km2) and volume (up to 11.15km3) of the lake. A great role in the sedimentation and re-suspension of bottom and coastal deposits in L. Peipsi is played by lake ice. Almost every spring, ridges of pressure ice up to 10m high are pushed forward against the shore, shaping the coast, re-depositing older sediments and transporting huge boulders. Lake ice and small icebergs can carry coarse material to distal areas of fine-grained sediment accumulation. Detailed L. Peipsi surface sediment studies showed high variability in sediment composition. On the basis of grain size the surface sediments can be classified into three groups: sand (coarse-grained sediments in the lake's southern part and in nearshore areas), mixed sediments (mainly till and varved clay in the northern part of the lake) and silt (in the central part, mainly within the 8m depth contour). These granulometrically-characterized groups of deposits have distinct spatial distribution that is determined by the complicated current system in the lake. The lithologic characteristics of sediments clearly reflect the impact of currents in the lake: (1) in the nearshore area, the erosion of sandy shore sediments takes place through longshore transportation; (2) in the central deeper area, deposition of fine-grained particles prevails, which are transported by complicated current systems from nearshore areas distally and mixed with autochthonous organic material. For example, the only outflow from the lake (Narva River) promotes longshore drift to the east along the northern coast of L. Peipsi. As a result of longshore erosion, modern lake sediments are absent or till and varved clays are covered only with a thin layer of residual sediments. Water level fluctuation and ice are causing rapid erosion in some years with exuberant growth of reed and bulrush and accumulation of fine material along the coastal zone in other years. This brings about great changes in the shoreline location on a yearly basis. Both water erosion and hummocky ice have changed the coast landscapes, but in different ways every year. In the lake basin itself, the uneven glacio-isostatic uplift has caused a slow movement of the water mass towards the south. It means that in the near future erosion of the northern coast will diminish and large areas in the southern coast will be flooded. Sedimentation in the lake is controlled by different forms of energy input from currents and waves. Thus, water depth, source region, and transportation distance have an important role in sediment distribution in L. Peipsi.

Mid to Late Holocene evolution of transgressive dunefields from Northern and Mid-littoral of Rio Grande do Sul, Southern Brazil

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The northern and mid-littoral of the Rio Grande do Sul (RS) coast, from Torres to Mostardas counties, presents progradational, aggradational and retrogradational barriers with transgressive dunefields covering them. With the attempt to understand the evolution of these dunefields during the mid to late Holocene, 26 cores along 9 profiles in this coastal stretch were made and their stratigraphy and sedimentary facies described. Within the cores, the aeolian phases were recognize when there was a paleosol layer separating them, showing a stabilization phase in between the aeolian activity phases. These layers rich in organic matter were dated by AMS 14C giving the age of aeolian stabilization phases. The preservation of an aeolian activity phase depended on the increase in moisture, which induced the development of vegetation and soil on top of the aeolian phase, preventing the erosion. The northern dunefields, placed over progradational barriers are relatively smaller and have less sand, so they respond faster to small changes in climate and can be stabilized faster, facilitating the preservation as the barrier prograded. In the mid-littoral, with the barrier retrograding or staying approximately in the same place, the aeolian deposits were vertically stacked. The dunefields are very large and the amount of sand is much higher, thus, it takes longer to start the dunefield stabilization and vegetation growth, making them more susceptible to wind erosion. Three major periods of soil formation and dunefield stabilization were found: from 4820 to 3970 yr cal BP, in 2760- 2460 cal yr BP and from 1570 to 710 cal yr BP. These periods coincide with periods where the literature cites in this area an increase in moisture. This coincidence of soil formation and wet climate indicates that the climate might be controlling dunefield evolution on the RS coast since 5000 yr BP. Despite the major variations in climate and phases of soil formation (intervals of 500 to 1000 yrs), it is known that high frequencies of climate change (interannual to interdecadal) can start a new dunefield phase, or completely stabilize it. The stratigraphic data of the three most representative cores were correlated, and along with the available dates from soil layers and the facies description, 10 phases of aeolian activity and stabilization were recognized for the mid- littoral of the RS coast: • Phase 1 stabilized in 4820-4450 cal yrs BP. • Phase 2 stabilized after 4820-4450 cal yrs and before 4390-4090 cal yrs BP. • Phase 3 stabilized from 4390-4090 to 4230-3970 cal yrs BP. • Phases 4 and 5 stabilized after 4230-3970 cal yrs BP and before 2760- 2460 cal yrs BP. • Phase 6 stabilized in 2760-2460 cal yr BP. • Phase 7 stabilized in 1570-1410 cal yr BP. • Phase 8 stabilized after 1570-1410 cal yr BP and before 920-710 cal yr BP. • Phase 9 stabilized in 920-710 cal yr BP. • Phase 10 stabilized after 920-710 cal yr BP and before the modern phase. Such high frequency soil formation could be the result of high frequency events of climate change, such as SO and NAO, which started to occur on the RS coast since 4000 yr BP).

Linking process and depositional architecture in large rivers: an integrated field and modelling approach

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Little is known about the processes, dynamics and deposits of the World's largest multi-thread rivers and whether they differ from smaller (less than 1 km wide) channels. This paper reports on an integrated field and numerical modelling campaign on the sandy Rio Paraná, Argentina – the World's 6th largest river. Bathymetric and 3D flow data were taken in a 38 km long, 4 km wide reach using single-beam echo sounders, acoustic Doppler current profilers and dGPS. Results demonstrate that the main channels of the Rio Paraná, at low flow, are dominated by dunes up to 3.5 m high and less common unit bars 2-5 m high, with some up to 10 m high. Analysis of satellite images from 1973-present shows that mid-channel bars develop from an amalgamation of unit bars that stall at barheads and wrap around bartails. However, in the Rio Paraná, and unusually for such a large and dynamic river, new mid-channel bar formation is relatively infrequent and is often associated with flow divergence at, or near, established vegetated islands. The deposits of seven, km-scale, mid-channel bars were characterised by ~43 km of Ground Penetrating Radar (GPR), and ground truthed by suction cores. The internal structure of mid-channel bars is dominated by: (i) decimetre to sub-m high, stacked dune sets, (ii) up to 7 m thick, high-angle, bar margin sets, and (iii) decimetre-thick ripple sets, most commonly, but not exclusively found at the bartop. Re-activation surfaces on bar margins are common. The input of a significant finer, suspended sediment load, from the Rio Paraguay, leads to a change in the depositional architecture of the bars immediately downstream, with larger scale cross-stratified sets being less frequent. The fieldwork has been complemented by numerical modelling of flow, sediment transport and morphological change in the 38 km study reach using a combination of 3D Computational Fluid Dynamic (CFD), Reduced Complexity (RC) and Delft3D depth-averaged models. The models show a good match between field and modelled flow distributions. Simulated channel change is characterised by talweg shifting, but does not indicate the significant influence of migrating unit bars. Ongoing modelling is quantifying the impact of unsteady discharge on bar formation and simulating bar evolution in a 10 km sub-reach over ~30 years, in order to test if the process of bar evolution matches the rate and form of change observed in the satellite record.

A constrained African craton source for the Cenozoic Numidian Flysch; defining an atypical foreland basin deep marine series

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Within underfilled foreland basins, deep-marine clastic sediments are typically synorogenic and sourced from the uplifting orogenic wedge. Here we present the results of a multiproxy review (Thomas *et al.*, in press) assessing the provenance of the Oligo-Miocene Numidian Flysch which constrains an atypical cratonic source for this regionally important formation. The Numidian Flysch was deposited into the Maghrebian Flysch basin, a remnant of the Neo-Tethys ocean. Its provenance has remained a controversial subject since the 1960's, with suggestions of both the active northern and cratonic southern margins, represented by the European AlKaPeCa domain and the North African margin respectively. Given the regional extent of deposition, a cratonic provenance has important implications for the controls upon Numidian Flysch sedimentation, and also the western Mediterranean in terms of foreland basin slope architecture, evolution and drainage. The Numidian Flysch crops out within the Alpine fold-and-thrust belt in Spain, Morocco, Algeria, Tunisia and Italy. Sediments include a variety of density flow deposits recognised in upper-slope incisional channels, lower-slope channel and overbank environments and basin-floor depositional lobes. Four lines of evidence are commonly used within the provenance debate, including; the structural position of Numidian Flysch nappes; the petrology of sandstones; Zircon geochronology of sandstones; and the orientation of palaeocurrents within density flow deposits. Petrographic analysis of basin sandstone formations defines both a distinct quartzarenite Numidian Flysch petrofacies and an immature heterolithic flysch which contains volcanic, porphyry and metamorphic clasts. Within the Alpine fold-and-thrust belt, Numidian Flysch nappes are thrust upon African margin units, while they are in turn overlain by nappes of the immature flysch petrofacies. The structurally highest nappes contain European crustal blocks from the northern limit of the basin. This structural progression therefore constrains the Numidian Flysch as deposited proximally to the African margin, with an immature flysch domain deposited proximally to the northern edge of the basin. Furthermore, published studies of Numidian detrital zircon suites show age ranges of 2.15 to 1.65 Ga, and 570 to 510 Ma. These age ranges correspond to the African-Eburnian and PanAfrican tectonic events respectively. In contrast, published detrital ages from immature flysch domain in Sicily show a Hercynian age range of 310 to 290 Ma which is typical of European basement. A comparison of palaeocurrent studies demonstrates no statistically significant orientation, while comparison to analogue foreland basins demonstrates that flow is commonly axial and therefore of limited value in provenance studies. These lines of evidence therefore constrain an African craton source with large volumes of sediment shed northwards to the basin via a passive margin. This is contrary to most foreland basins, in which a majority of synorogenic flysch sedimentation is sourced from and controlled by the rapidly uplifting orogenic wedge. Numidian Flysch deposition correlates with a general switch from carbonate to clastic successions in North Africa and we suggest that Atlas uplift of the margin coupled with a humid climate controlled the timing of deposition.

Thomas, M.H.F., Bodin, S., Redfern, J. and Irving, D. A constrained African-craton source for the Cenozoic Numidian flysch: Implications for the palaeogeography of the western Mediterranean basin. Earth Science Reviews, In Press, Accepted Manuscript.

A detached lobe complex within the early Miocene Numidian Flysch of Sicily

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In Sicily, mapping and broad correlation of the early Miocene Numidian Flysch across thrust sheets allows for the reconstruction of a large scale, sand-rich, submarine fan system. The Numidian Flysch was deposited into the Maghrebian Flysch basin, a foreland basin remnant of the Neo-Tethys ocean, the slope architecture of which is almost completely unknown. The Numidian Flysch outcrops throughout the western Mediterranean within the Alpine fold-and-thrust belt. Sediment was sourced from the African craton and transported northwards into the basin via the passive margin (Thomas *et al.*, in press). A proximal to distal trend is observed along an axis in central Sicily from north to south, ranging from upper slope to basin floor deposits. In northern Sicily, stacked incisional channel complexes up to 400 m in width and 90 m thick represent an upper slope environment characterised by flow bypass. To the south, a belt of channelised sandstones and associated overbank deposits also evidences a mid fan channel belt in excess of 3.5 Km in width. In central Sicily however, stacking patterns reveal a lobe complex which can be traced laterally for 3.6 Km and contains in excess of 17 individual stacked lobes which are described here. Major sandstone packages vary from 2 to 35m thick, are correlatable for up to 2.6 Km, and thin upwards through the 650 m succession. They contain stacked and vertically amalgamated graded turbidites evidencing strong lateral confinement of flows. Several packages are observed to disappear laterally, either pinching within fine grained sediments or being truncated by successive packages such that they are interpreted as discrete channelised belts which offset stack. Between these packages are stacked coarsening and thickening upwards sequences consisting of Bouma style turbidites, ungraded frictional debris flows and hybrid flow deposits. The sequences are capped by either distributory channels, typically 3 m thick and 7 m wide, or by the laterally extensive sandstone packages. Total sequences range from 5 to 35 m in thickness and are interpreted as proximal, progradational lobes. Within each lobe sequence, minor incisional channels evidence multiple depocentres. Stratigraphically above this section is an 80 m thick section of massive coarse grained gravel beds. They are highly amalgamated with large scale incisional surfaces interpreted as channel and scour surfaces. Erosional remnants are also observed. This sequence is interpreted as a channel-lobe-transition-zone which caps the lobe complex within a progradational trend. Overall this sequence denotes a lobe complex which is detached from a slope fan and the base of slope can therefore be inferred. A downstream evolution of dominantly frictional debris flows to turbulent and hybrid flow types is observed across the channel-lobe-transition-zone. Bypass of flows is thus important within the slope and channel-lobe-transition-zone. The apparent contradiction between low flow efficiency and intense bypass is interpreted as the result of strong flow stratification and oversteepening of the slope due to the encroaching orogenic wedge. Rapid switching of lobe depocentres are interpreted as the results of rapid avulsion and the introduction of oversize or ultracoarse flows to the lobe environment.

Thomas, M.H.F., Bodin, S., Redfern, J. and Irving, D. A constrained African-craton source for the Cenozoic Numidian flysch: Implications for the palaeogeography of the western Mediterranean basin. Earth Science Reviews, In Press, Accepted Manuscript.

Sulfur cycling in the Early-Middle Ordovician Argentine Precordillera: implications for a fluctuating oxycline in a greenhouse ocean

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The Ordovician represents a time of pronounced increase in biodiversification as well as a drastic shift from global greenhouse to icehouse climate. Since carbon and sulfur isotope records are linked through biogeochemical processes that are sensitive to changes to the marine environment, coeval chemostratigraphic profiles for carbon and sulfur can help constrain changes in ocean conditions associated with such events. $\delta^{13}C$ and $\delta^{34}S$ are recorded by the precipitation of marine carbonate (carb) and trace carbonate- associated sulfate (CAS), organic carbon burial, bacterial sulfate reduction (BSR), and subsequent pyrite burial. Here, we present the first coeval, high-resolution carbon and sulfur isotope profiles for Early to Middle Ordovician marine carbonates in the Argentine Precordillera, which include the La Silla, San Juan, Gualcamayo, Aguaditas and Las Chacritas formations. $\delta^{13}C_{carb}$ profiles are in good agreement with published global and regional δ13C curves that show relatively stable isotopic compositions commonly associated with greenhouse climates (Buggisch *et al*. 2003; Saltzman, 2005). $\delta^{34}S_{CAS}$ profiles show short-term variation (6‰ over 10-30m) superimposed over a longer-term trend (9‰ over 100m). Long-term δ^{13}Ccarb variation is sympathetic to changes in δ34SCAS in the San Juan Formation, where the magnitude of δ^{34}SCAS variation is greater than δ^{13}Ccarb variation. This suggests the dissolved inorganic carbon reservoir was much larger than the marine sulfate reservoir and, therefore, more resistant to changes in isotopic composition. Sympathetic behavior is not present the overlying Aguaditas and Las Chacritas formations, where δ^{13}Ccarb shifts to relatively enriched values and δ^{34}SCAS to relatively depleted values. A ~6‰ depletion in average δ^{34}SCAS in the deep water Aguaditas Formation may reflect platform drowning and enhanced delivery of reoxidized sulfide to the sulfate reservoir. Short-term δ^{34}SCAS variation is similar in both duration and magnitude in lithologically heterogeneous (San Juan and La Silla formations) and homogenous sections (Table Head Group, W. Newfoundland, unpub. data), suggesting that δ^{34}SCAS reflects an oceanographic signal. δ^{34}SCAS reflects a balance between BSR, pyrite burial and sulfide reoxidation, which are related to the availability of organic carbon and reactive Fe and the extent of ocean anoxia. Organic carbon and reactive Fe concentrations in the Gualcamayo, Aguaditas, Las Chacritas formations indicate both are non-limiting for BSR. Short-term δ^{34}SCAS variation, therefore, likely reflects changes in pyrite burial rate, perhaps related to fluctuation of the marine oxycline and the extent of ocean anoxia. In this scenario, a shallow oxycline (i.e. increased anoxia) enhances pyrite burial and decreases SO_4 availability and a deep oxycline (i.e. decreased anoxia) reduces pyrite burial and increases SO4 availability through reoxidation of sulfide. The preservation of short- term changes in δ^{34}SCAS suggests marine sulfate concentrations that were much smaller than modern (28 mM) and likely similar to those estimated by (Horita *et al*. 2002) (5-12 mM). To improve estimates of sulfate reservoir size during the Early to Middle Ordovician, we are currently working to constrain sedimentation rates with high-resolution dating of K-bentonites from the upper San Juan Formation, Gualcamayo and Las Chacritas formations.

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A new outcrop-based model for the spatial and temporal variation in submarine channels: facies, architecture and sequence stratigraphic implications

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The San Fernando Channel System is a superbly exposed late-Cretaceous age submarine channel system located on the Pacific coast of Baja California, Mexico. High-resolution mapping and extensive system-wide correlation panels, coupled with detailed sedimentology studies and high-resolution photomosaic interpretation, have shown that the system comprises a distinct hierarchy of stratigraphic units. These units range from individual architectural elements up to the entire channel system. Extensive outcrops have allowed a detailed submarine channel model to be proposed which describes architecture and facies spanning outcrop to seismic scales. Channel complex sets are the largest mappable components within the system and are basally-bounded by system-wide erosion surfaces. Each set shows a consistent stratigraphic evolution comprising 3 distinct stages each of which are characterised by distinct channel complexes. Channel complexes in Stage 1 are predominantly coarse-grained, highly amalgamated and confined within an extensive composite erosion surface. Individual complexes show a distinct evolution from basal bypass/erosion channel-fill through to graded and aggradational channel-fill. Heterolithic, inter-channel regions between channel complexes in Stage 1 are rarely preserved due to erosion from subsequent channel complexes and are commonly only found in more marginal areas. Debrites within Stage 1 are commonly restricted to the basal areas of individual channel complexes. Stage 2 is dominated by channel complexes which are finer-grained, less amalgamated and laterally flanked by overbank/levee deposits. Individual complexes show a distinct evolution from extensive graded/neutral channel fill (extensive lateral accretion bar forms) through to aggradational channel fill. Fine-grained debrites occur at specific stratigraphic intervals within channel complexes in Stage 2 and are *not* restricted to the basal regions of channel complexes. Heterolithic regions between channel-fill sediments in Stage 2 comprise discrete packages, some of which are architecturally different from overbank/levee sediments in that they occur in small scour-based fining-upwards packages. Although vertical connectivity is generally better between channel complexes in Stage 1, the vertical connectivity in Stage 2 is enhanced by sliding within intra-channel heterolithics. Stage 3 relates to the shutdown and gradual abandonment of the system and is dominated by fine-grained turbidites and well developed condensed intervals The stratigraphic variation observed within the channel system is linked to sea-level fluctuations. However, throughout the system, local contemporaneous faulting is shown to have a high degree of control on the location of sedimentation and commonly overrides the *normal* sea-level influenced depositional evolution. Local faulting is also shown to profoundly affect both the local channel-fill type and the stacking patterns of architectural elements and channel complexes. Stacking patterns of individual channel complexes are generally more predictable in Stage 2 than in Stage 1 which is attributed to the variation in relative confinement of the individual channel complexes.

The characteristics of fluvial deposits and petroleum reservoirs within a low-accommodation systems tract—a case from the outcrops of Changcheng System of Meso-Proterozoic in Jixian Tianjin, China

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Meso-and Neo-Proterozoic of Huabei Platform is present in Jixian Tianjin, China. Changzhougou Formation of Changcheng System of Meso-Proterozoic(1800Ma)forms on top of a subaerial unconformity below which there are Archaeozoic metamorphic rocks. Changzhougou Formation is characterized by the presence of multi-storey scouring- filling channels at the base and less mature coarse-grained conglomerates and sandstones with large trough crossbeds and wedge-shaped crossbeds, the occurrence of siliceous and iron cements, and the absence of marine facies.On the basis of the evidence listed above,Changzhougou Formation is identified as a linkage of braided stream deposits near source areas,where sedimentation is independent of the influence of marine base-level changes. In this case, the usage of the lowstand-transgressive-highstand sequence stratigraphic model lacks the evidence of shoreline transgressions or regressions.The solution to this problem is the introduction of low-and high-accommodation systems tracts to describe fluvial deposits, which are defined on the basis of fluvial architectural elements and changes of amounts of fluvial accommodation. Changzhougou Formation outcrops show there are scouring-filling structures at the base and large trough crossbeds and wedge-shaped crossbeds forming a multi-cycle profile. These features indicate that low accommodation conditions result in an incised-valley-fill type of stratigraphic architecture composed of fluvial conglomerates and sandstones with a general lack of floodplain deposits, which is the product of high-energy braided streams. Furthermore, these features reflect low rates of creation of fluvial accommodation and an increase in depositional energy, and a regime of progradation of the coarse terrigenous sediments being delivered from the source areas into the developing basin. At the top,coupled with the increase of mud, high accommodation conditions result in thin belts and lenses of fine-grained sandstones. Moreover, the change from the low-accommodation systems tract to the overlying high-accommodation systems tract is gradational rather than abrupt. The features of Changzhougou Formation within a high accommodation systems tract show that channel fills are isolated within fine-grained floodplain deposits, reflecting higher rates of creation of fluvial accomodation, coupled with a decline in depositional energy, and a regime of aggradation of channels. The best petroleum reservoirs of Changzhougou Formation are related to the low-accommodation systems tract, where there are overlaid multi-storey braided channel fills with a good connectivity between individual sandstone bodies.At the base of Changzhougou Formation, there is an unconformity, where stratigraphic traps relating to the unconformity may develop. Lithologic reservoirs may be found in the high-accommodation systems tract as well, as belts and isolated lenses of channel fills surrounded by fine-grained floodplain deposits. Since well-developed continental sedimentary systems may be found widespread in China, the introduction of low-and high-accommodation systems tracts may predict petroleum reservoirs within fluvial systems. A similar case in Eastern China is the fluvial deposits of Guantao Formation of Miocene in Bohai Bay Basin. The lower of Guantao Formation displays low accommodation conditions result in multi-storey coarse-grained braided channel fills which are proven reservoirs, while the upper of Guantao Formation shows high accommodation conditions result in a gradual increase of mud and fine-grained sandstones with poor continuity.

“Black Mats” and extinctions: The Pleistocene-Holocene transition climatic crisis in central Argentina

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In fluvial valleys of central Argentina, particularly in the pampas plains and pampean hills, the basal part of the Holocene is characterized by a dark, organic rich horizon that coincides with the almost complete extinction of megamammals and, consequently, represents a dramatic environmental change. In North America, similar levels were indentifies since the Sixties and named “Black Mats”, with uncalibrated radiocarbon ages between 11,000 and 9,700 BP. These levels seal the Clovis sites and the last Rancholabrean fauna specimens. They were deposited in shallow ponds and saturated soils. As geological and hydrological processes show a consistent pattern in space and time, Black Mats were thus interpreted as the evidence of global climate change resulting from the onset of a humid and cold phase around 12,900 BP. Similarly, in central Argentina, basal Holocene valley facies consist on organic black clays and silts, containing abundant shells and diatoms. Laterally, they interdigitates with inundation plain silts and hydromorphic soils with fine prismatic structure. These decimetric intervals also indicate a strong increase in wetter conditions and shallower underground water tables. They seal the greenish Lujanean deposits and the correlative loess bearing the last pampean megamammals and the associated evidences of human exploitation. Numerous conventional C14 dates were selected from literature and several new targeted samples of shells and the organic fraction of sediment were dated by AMS, taking into account reservoir effect and humates rejuvenation. At Luján, Arrecifes and Quequén Salado rivers the base of the lacustrine black interval was dated on 11.1, 12.3 and 11.3 ky 14C cal. BP, respectively. The peripheral hydromorphic soils were dated in 9.1 ka 14C cal. BP. Therefore, with the available information, the Black Mats are dated between 13 and 10 ky BP. The detailed facies analysis allows defining a satured soils/wetland/lacustrine belts transgression over terminal Pleistocene alluvial silts, eventually associated with a thin level of lacustrine ravinement. It is characteristic a strong subaquatic pedogenesis and perturbation of Pleistocene deposits by wetland and nearshore communities. These processes allowed the percolation of clays and colloidal complexes rich in organic fractions, by diffusion and directly trough decayed root network, up to one meter below. The exogenous younger organic compounds extensively contaminated the upper part of Pleistocene sediments and combined with relictic collagen of mammal’s fossil bones, producing important age inversions. This event, of continental scale, is then critical to understanding the Pleistocene extinctions and the ecology and population changes that took place in the Pampas. Several authors accept that the environmental imbalance caused by the warming at Termination I weakened mammal populations, but they attributed their effective extinction to human hunting activities, since mammal populations had already survived habitat expansion-retraction cycles. After detailed sedimentological observations of the Pleistocene-Holocene boundary, regional correlations and targeted dating, it is here concluded that the key differentiating factor from other glacial termination periods in this area is the sudden settlement of humid conditions. This change has three essential characteristics: first, a particular rapid onset that caused a cascade of ecological imbalances. Second, a significant seasonal and humidity change with a dramatic impact on ecosystems. Third, these new conditions lasted for several centuries making changes irreversible at the biological time scale. Combined, all contributed to megamammal’s impossibility to readapt, while humans are considered as already in equilibrium with this fauna, but, as other smaller mammals, with successful adaptative capabilities.

Loess and reworked loess: first evidences of the presence of OIS 4 deposits in northeastern pampas valleys

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Historically, the infill of valleys carved on the Pampean loessic plateau were attributed to terminal Pleistocene and Holocene fluvial-lacustrine deposits, traditionally denominated “Lujanense” and “Platense” stages. Holocene deposits were well known and extensively radiocarbon dated since the late seventies, while the base of the “Lujanense” was unknown in most of Pampean outcrops except in the type section near the town of Luján. One of us (MJT) obtained in 2004 the first 14C date for this interval, confirmed by additional AMS datings and the following year by an unpublished OSL date (JLS) of 38.6±5 kyr BP. These chronological data allowed us to correlate the basal greenish “Lujanense” beds with OIS 3 interstadial, after AMS calibrated ages and an OSL age between 33.3±0.3 kyr BP, and 47.5±0.4 kyr BP at the top and base, respectively. This Depositional Sequence was named Lower Green Luján and Jauregui Member of the Luján Formation, with base at 50/55 kyr BP and top at 30 kyr BP. The underlying massive reddish siltstones were also traditionally considered the loessic “basement” and attributed to the “Bonaerense” Stage or Buenos Aires Formation. Except for Ameghino and Mignone, who recognized the presence of lenticular conglomerates, these deposits were misinterpreted, not indentified at all and/or ignored by others authors. Seven kilometres southwest of the town of Luján we recognized the presence of these relictic conglomerates with crude planar cross stratification and reddish sands, overlaid by brownish red silts and silty clays. These upper intervals frequently show amalgamated Bt levels, characterized by small prismatic blocks with manganese oxides patinas and root like calcretes. They were strongly eroded at the onset of the Lower Green Luján Sequence. These deposits, at least for the studied area, seem to represent the first infill of valleys, because they were only detected in the lowermost part of first order rivers and main distributaries. This explains the scattered and rare outcrops. We also discover small outcrops of identical facies in the Reconquista, Arrecifes and Pavon rivers. In interfluves, it correlates with the Buenos Aires Formation loess and loessoid deposits and, toward the coast, it erodes and covers marine sediments of the OIS 5e interglacial highstand, incorporing shell fragments (upper Pascua Formation, OSL dated at 67.6±5.4 ky BP). Recently, we obtained, at the type locality of Flandria, two preliminary OSL dates for the fluvial section, 67±6 kyr BP and 72.5±10 kyr BP, confirming OIS 4 ages. This unconformity-bounded unit was denominated Depositional Sequence Buenos Aires 3 and Flandria Member of the Buenos Aires Formation with base at 70-75 kyr BP and top at 50-55 kyr BP. The basal discontinuity, the channel lag conglomerates and the redeposited loess material were interpreted as a response to the onset of glacial lowstand of 70-75 kyr BP (Nahuel Huapi I advance), and the increased and continuous periglacial input of dust under cold and dry conditions.

The climatic signature of OIS 4 to OIS 1 stadials and interstadials in Pampean valleys: geomorphology, depositional sequences and C14/OSL dating

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The Pampa valleys infill were analyzed in terms of facies and unconformity-bounded units and dated by AMS and OSL. Here we present a depositional sequence and chronological model, generated after the Lujan and Salto/Arrecifes River banks, selected as reference sections and lately confronted against other Pampean valleys outcrops. These valleys were shaped following the uplift of the older Ensenada loess plateau, resulting in deep incisions and well developed calcic pedocomplexes at the top. The erosion-non deposition event probably extended between 650 and 150 kyr BP. The valleys fill consist of six fluvial sequences that record global climatic changes. Pleniglacials OIS 4 and OIS 2 are characterized by reddish loessoid channel bar fill facies originated from periglacial dust storm material contrasting with interstadial greenish facies of OIS 3 and terminal OIS 2, and with grayish OIS 1 deposits. These Depositional Sequences (DS) are DS Buenos Aires (75-50/55 kyr BP) (Flandria Member of Buenos Aires Formation). It represents the first known infill of valleys and consists of a basal calcrete conglomerate followed by massive red sandy silts and overbank pedogenized reddish silty clays. Outcrops are very rare and relictic. They correlate with the cold OIS 4 and, in the interfluves areas, with the Buenos Aires Formation loessoid deposits. DS Lower Green Lujan (50/55-30 kyr BP)(Jauregui Member of Luján Formation): It begins with a layer of a calcrete conglomerate containing abundant bone fragments, mostly rounded and broken, as well as shell remains It can abruptly and laterally disappear by erosion. We found upwards massive, greenish silts and fine sand lenses. Exceptionally, tabular cross stratification was observed. It is supposed to represent amalgamated minor sequences of the (OIS 3) interstadial. Xanthium sp. moulds indicate wetter and temperate conditions. DS Red Lujan (30- ~17 kyr BP)(La Eloisa and La Chumbiada Member of Lujan Formation). Over the eroded top of greenish clastics of the precedent sequence, channel lag of rounded calcretes were deposited, followed by thick silts and reddish fine sands, showing conspicuous decametric surfaces of oblique accretion. These accretion complexes are mainly composed of re-deposited loess in channel bars as dust input increased dramatically again under pleniglacial conditions of OIS2 (LGM). It is represented by a mantle of massive loose eolian silts in interfluvial areas. DS Upper Green Luján (~17-13 kyr BP)(El Rincon and Guerrero Member of Luján Formation). The basal conglomerate is frequently absent, grading to sandy silts and massive green silty clays bearing skeletons of megamammals. The top is sealed by basal Holocene black mats indicating the mass extinction event. It is correlated with the “Older Dryas” and “Allerød” periods of the Northern Hemisphere. DS La Plata (13-3/2,5? kyr BP)(La Plata Formation): It could start with a intraclast conglomerate, but it is mostly constituted of gray, dark silts (El Salto Member); light gray to white marls and diatomites (Molino Quemado Member). The basal wetland/lacustrine black organic horizon represents a sudden shift to humid conditions followed upwards by whitish marls evidencing a warmer and drier period starting around 10 kyr BP. DS Areco (3/2,5? kyr BP-Present) is represented by historic and modern flood gray muds related with the incision process. The last subtle uplift phase, probably related with a glacioeustatic rebound component, induced a relative fall of the sea level. The search for equilibrium plus wet conditions caused a deep incision. All these sequences correlate laterally with amalgamated loess and agradational paleosoils of interfluves areas or pampas. Except for the basal discontinuity of the Areco Sequence, we deduce a dominant glacioeustatic control on sequence boundaries, as facies analysis reveals relative base levels drops contemporaneous with Patagonian glacial advance and Antarctic dust/isotopic record.

Mode of fluid migration in the accretionary prism of the Nankai Trough seismogenic zone; 129I distribution in the pore waters from the IODP NanTroSEIZE Stage 1

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Integrated Ocean Drilling Program (IODP) Expeditions 315 and 316, parts of the multistage Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) Stage1, cored the Kumano forearc basin sediment downhole to the upper accretionary prism and the accretionary prism including fractured/brecciated zone induced by the subduction processes in the Nankai Trough, Japan. Pore waters collected from these sediments preserves a complex history of fluid-rock interaction and migration through the porous fluid pathway and the entire sediment body. Recently developed long-lived radioisotope analysis of dissolved iodine (129I) has been useful to extract geochronological signature from pore water geochemistry. Here we focus on the pore water regime, in terms of the age using dissolved 129I, covering the lithologic boundary and fault/thrust system across the Nankai Trough seismogenic zone, and show the concentration of dissolved I with Cl and Br, and iodine age distribution through the different sedimentary system. The 129I data remarkably exhibits age variation constrained by the sediment property and the long term migration of fluids along the fluid pathway in different modes. The 129I/I ratios provide ages for the iodine source formation generally of 30 Ma to 45 Ma, iodine older than their host sediments dominates in entire accretionary prism. Significant increases of 129I/I ratio (decrease in age) are found just above the lithologic boundary between the forearc basin and accreted sediments, and near the megasplay fault zone branching from the interface of the Philippine Sea plate subducting beneath the Eurasian plate. The former represents limited migration of ascending deep fluid beyond the lithologic boundary where sediment porosity drops discontinuously from 60% to 50%, fluid escapes preferentially along the lithologic boundary. The latter is a result of fluid migration from the root of the megasplay fault on the Philippine Sea plate, relatively young iodine delivered from the subducting plate is responsible for the observed high 129I near the shallow region of the megasplay fault. The 129I dating of pore water describes well the mode of fluid transport constrained by accretionary processes in the Nankai Trough.

Salinity fluctuations and evaporate basin palaeogeography - bromine and facies record in the Upper Permian salt formation (Na1 unit) in Poland (Central Europe)

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Bromine (Br) content data from salt sections enabled detection of salinity fluctuations in an evaporite basin and the regionally widespread, well- defined ones were used as nearly isochronous markers for basin-wide correlations in the salt formation (Tomassi-Morawiec and Czapowski, 2007). The Upper Permian (Zechstein) basin in Poland (PZB), being the marginal part of giant European Zechstein Basin (EZB), developed several evaporite episodes with salt accumulation (4 salt formations) in evaporate basins of varied palaeobathymetry, determined by earlier depositional layers of carbonates and sulphates. The representative basin is the first one, in which the Zechstein Oldest Halite Formation (Na1, a few to 200 m thick) was deposited. It was, from the start, differentiated as a deep central part, open to the west, and the margins with sulphate shoals separating the local subbasins up to 60-110 m deep (Czapowski, 1987; Czapowski, 1995; Czapowski. 2007; Czapowski *et al.* 1994). Salt sections of stratiform non-tectonised salt deposits there represent a variety of evaporitic lithofacies (environments) from an open salt basin facies replaced successively – due to intense chloride accumulation – by these ones accumulated within both salt lagoon and salt pan settings. By employing numerous Br analyses and facies data of the most complete sections from the "outer" subbasins of the northern basin margin, located basinward from sulphate shoals system, we noted only 1-2 general primary brine fluctuations and more constant (deep facies) conditions due to almost free exchange of fresh and concentrated brines with the basin centre (Tomassi-Morawiec, 2003). The "inner" subbasins, lying behind the shoal barrier, evidenced higher average Br value and up to 4-5 salinity fluctuations because of limited brine exchange over and through the barrier and also because of the strong effect of evaporation in the shallower waters. Similar shoals on the SW basin margin were obliquely oriented so there was no real barrier for brine exchange and the salt sections both from the "inner" and "outer" depressions evidenced an average lower Br value and only 1-2 brine fluctuations, reflecting the more general regional salinity variations (Tomassi-Morawiec and Czapowski, 2007). Local very low (<20 ppm) Br content indicated accidental salt recycling by fresh brines and eventually meteoric waters but on the other hand, high Br values reflected a sporadic isolation of local subbasins. The fragmentary salt sections of central basin part are characterized by low average Br content comparable with those one from SW margin (Tomassi-Morawiec and Czapowski, 2007). In conclusion, only 2 regional salinity fluctuations were observed in the deeper evaporite basin discussed earlier (the central and SW basin sections), reflecting the phases of fresh brine inflow from the western EZB into the PZB. However the differentiated palaeomorphology of basin margins (particularly the northern margin) locally limited such restricted waters from producing more salinity fluctuations in the deep facies successions.

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Stratigraphy and mineralogy of the first abandoned mine tailing of the Concordia Mine, Salta, Argentina

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The Concordia underground mine (Pb, Ag, Zn) is located at the western portion of Salta province, 3770 m above sea level in the Puna region, where the climate is arid. The mine is located 15 km from San Antonio de Los Cobres village, and it was abandoned in 1986 without any planning for its closure. Hence, the waste dumps, tailings and mine machinery were abandoned in situ and are exposed to weathering since that moment. Nowadays the mine is water-filled and the groundwater is in contact with the sulfide minerals generating acid mine drainage (AMD). The Concordia river heading is located within the mine, where the water pH is low (3-4). However, the pH of the stream during their pathway changes to neutral values until reaching the San Antonio River. Then, this river crosses the San Antonio town and finally flows into the Salinas Grandes closed basin. During the mining activity the wasted material was stored in four tailings. These tailings, with a thick of around 3-5 m, cover an estimated total area of 20000m2. After the mine activity finished, the Concordia stream passed through the tailings eroding some of the sediments and metallic minerals deposited there. This study focuses on the stratigraphy and mineralogy of the first tailing. The volume of wasted material acumulated is around 4500 m3. In this tailing three levels were identified. The upper level, 68 cm thick, is medium - fine grained sand, grayish yellow color. In this level, rock fragments and the following minerals were identified: quartz, pyrite, Fe oxides and scarce zircon. Also nordstrandite (Al(OH)3) and szomolnokite (Fe2+(SO4)•(H2O)) were identified by X-ray diffraction. The second level, 49 cm thick, is composed by medium grained sand, grayish green color. The mineralogy is similar to the level A. The lower level, 38 cm thick, is composed of medium fine-grained sand, gray color. In this level, quartz, pyrite and rock fragments were identified. Romboclasa (HFe3+(SO4)2•4(H2O)), rozenite (Fe2+(SO4)•4 (H2O)), szomolnokite (Fe2+(SO4)•(H2O)) and anglesite (Pb(SO4)) were recognized by X-ray diffractometry. The percentage of pyrite present in the first tailing is between 0,9 and 2,2 %. The only clay mineral found on the whole samples is illite. Preliminary obtained data indicate that secondary minerals are the result of precipitation from tailings pore-water oversaturated on SO42-, Fe2+ and other heavy metals. Oxidization generated by surface conditions transforms pyrite into melanterite, then melanterite is transformed into rozenite, by decreasing humidity, and then into szomolnokite. The absence of melanterite on the obtained data agree with arid conditions in this zone.

Petrography and diagenetic processes of the upper part of the Guadalupe Group (Upper Cretaceous) at the central area of the Eastern Cordillera, 190km NE Bogotá, Colombia

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The Guadalupe Group (or Allogroup) is a primarily sandy unit with a middle shaly section, over and underlaid by shale units corresponding to the Guaduas Formation and the Chipaque Formation respectively where its type locality is the Bogotá area. In this study petrography was used as a tool to complement and refine the data obtained from a previous sedimentology work conducted at the top of the Middle Guadalupe Alloformation and at the base of the Upper Guadalupe Alloformation in the central area of the Eastern Cordillera (Mongua, Boyacá) 190km NE Bogotá; classification and description of the collected data took place in order to establish sedimentation environments and petrofacies, propose a diagenetic model and determine the source area of this unit. The Middle Guadalupe Alloformation at the town of Mongua was deposited in an offshore environment with a predominance of plane-parallel claystones, some fosilliferous with intervals and/or lenses of very-fine-to-fine-grained sand. On the other hand, the Upper Guadalupe Alloformation was deposited in an environment that ranges from lower shoreface up to backshore in a gradual progradant succession to the top; it's lithology vary from fine-to-coarse-grained plane-parallel to massive quartz sandstones with good sorting and roundness, some bioturbated and mottled with occurrences of fossiliferous levels, presence of phosphates and burrows. The diagenetic model proposed consists of a closed system with an internal buffer where the unit was affected by early diagenesis at 2km depth. This process includes stages of precipitation of autigenic minerals and several generations of calcareous and siliceous cement. The chemical reactions during the diagenesis process took place initially in an oxidation zone and afterwards in a reduction zone. Cementation stages varied within samples and weren't always present in all of them. The following diagenetic model was established from observations of neomorphism, alterations, mineral replacement and shape/type of the boundaries between crystals of the minerals. 1. Autigenic feldspars precipitation. Feldspars exhibited idiomorphic shapes, also filling pores and replacing preexisting minerals. 2. Hematite, goethite and first-generation calcareous cement ("poikilotopic cement"). Textures exhibited from this cement are typical of an early diagenesis. 3. Glauconite precipitation. The presence of glauconite marks the system's entrance to the "reduction zone". 4. Quartz overgrowth and siliceous microcrystalline cement precipitation. Microcrystalline cement was observed surrounding and affecting feldspars, glauconite, quartz crystals and overgrown quartz. 5. Autigenic, coarse-grained muscovite precipitation. 6. Pyrite and second-generation calcareous cement precipitation (irregular-textured cement) which were associated with a stage of organic matter degradation. This cement affects the majority of framework elements. 7. Third-generation calcareous cement (equant cement) precipitation. Formed by possible reabsortion, reprecipitation and destruction of calcareous fossils; this cement is only restricted to fossiliferous levels. At this point the system cooled off. There was an overall reduction of primary porosity due to burial, compactation and cementation. However some interparticle secondary porosity was generated from mineral dissolution as well as intraparticle secondary porosity from empty foraminifer's chambers. Despite the presence of autigenic minerals, there's a predominance of quartz crystals with straight extinction in the framework's composition which reflects the sediment provenance; fragments of volcanic rocks plus zirconium and tourmaline don't constitute more than 1 and 2% of the total composition of the rock respectively, therefore the source area of the Guadalupe Allogroup is the Guyana Shield.

The role of calcareous algae and microbial mats in the Cretaceous platform of the Cupido Formation, northern Mexico

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The Cupido Formation (CF) is part of an extensive carbonate platform deposited during the upper Hauterivian to lower Aptian times from northern Mexico to Florida, USA. The CF show a high variation in thickness and conformably underlying the Taraises Formation and overlying La Peña Formation. The Cupido Formation outcrops in several localities around the states of Coahuila and Nuevo León, northeast Mexico, and represents a shallow marine carbonate platform found as wackestones-packstones of rudists, bivalves, calcareous algae and small microbial mats fragments preserved in different geometrical planes along with other microbiota. This unit has been studied to document the aperture of the Gulf of Mexico, and most of previous work clearly shows that this formation had a complex structural and diagenetic geological history. However the information is more limited regarding the role of microbial mats and calcareous algae in the build-up and stabilization of these ancient reefs, especially in a time marked by changes of the sea level and the subsequent development of intermittent epeiric platforms under the influence of the Coahuila and Tamaulipas platforms along with periods of siliciclastic sedimentation. This work focus on the role of microbial mats and calcareous algae in conjunction with sedimentation patterns for the development of these organic reefs, providing a paleoenvironmental reconstruction based on a detailed cartography of the locality of Puerto Mexico, Coahuila.

Fluvial-aeolian interaction deposits: elements and clues for recognition

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In semiarid-arid continental settings the interplay between fluvial and aeolian processes produces a particular environment known as "fluvial- aeolian interaction system" (Langford, 1989). Although their deposits are common features in many desertic areas few examples from the sedimentary record have been described and studied (Langford and Chan, 1989; Newell, 2001; Veiga *et al.*, 2002). Fluvial-eolian interaction environment has a complex regime where fluvial-deposited sediments are sporadically formed and afterward exposed to wind reworking. On the other way, remobilized aeolian deposits by subaqueous currents are deposited as fluvial units. Fluvial-aeolian interaction processes take place not only below arid-semiarid climatic conditions but also in more humid climates. However, most of fluvial-aeolian deposits occurs at the margin of dunefields and erg and associated with ephemeral alluvial systems. This work presents several features of fluvial-aeolian deposits, both modern and ancient, with examples from upper Quaternary and Tertiary units (La Rioja, San Juan and Mendoza provinces, Argentina). Modern cases correspond to the Guandacol river and to the Gualilán playa lake. The first is an ephemeral high-energy gravelly-sandy braidplain with aeolian landforms (Tripaldi & Limarino, 2008). Gualilán playa lake is an intramontane basin with climbing dunes and ripples associated to the piedmont (Suriano, 2010). Ancient examples were studied in the Vallecito and Vinchina formations, thick tertiary redbed successions of the Sierras Pampeanas and the Precordillera. These rocks represent interaction deposits included in erg sandstones and fluvial units. Other examples come from upper Quaternary succession (Tripaldi *et al.*, 2010). In the studied deposits a very close interfingering of aeolian and fluvial levels was recognized. Remarkable features include: 1) inversely graded laminae (wind ripple); 2) sandy levels made up of unimodal, symmetrical or positive asymmetric, well to very well sorted sand; 3) open packing, high porosity and very low matrix percentage; 4) lack of muddy intraclasts, parting lineation and erosive surfaces in the aeolian beds; 5) massive or very poorly laminated beds of sand, silty sand or sandy silt (loessoid deposits) due to fluvially reworked aeolian beds; 6) high index ripple forms with coarsest grains at the crest, 7) bimodal, fine to very coarse- grained (occasionally granule) sandstones, with parallel to low angle cross-lamination and inversely graded laminae.

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Early-mid XX century aeolian reactivation in the western Pampas

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The western Pampean plain of La Pampa and San Luis provinces (western Pampa) is covered by a mantle of late Quaternary aeolian sandy deposits, including dune fields and sand mantles. The present climate is characterized by arid-semiarid conditions with mean annual rainfalls ranging from 750 to 250 mm. This precipitation occurs mostly during spring and summer months associated with an intensified South Atlantic Convergence Zone (SACZ; Doyle & Barros 2002). The low level meridional jet transports warm and moist air, derived from tropical forests and humid lowlands of Bolivia and Brazil, southward along the eastern margin of the Andes (Wang & Paegle, 1996). The aeolian sandy deposits are the dominant parent material of the surface soils, consisting of A,C horizons developed under a psammophityc and xerophytic woodland vegetation cover, which is deeply modified by agriculture. Recently obtained OSL dates indicate that major eolian activity occurred during the LGM whereas several episodes of aeolian reactivation took place during the Holocene. The most recent episodes, yielding ages from ca. 95 to 65 yr AP (Tripaldi & Forman, 2007), dates back from the early-mid XX century. It involved renewed deflation of blowouts and parabolic dunes. High angle cross-stratified beds are frequently observed in several localities suggesting dune migration due to high sediment availability under a sparse vegetation cover. At some places, present soils are buried by these aeolian deposits (Szelagowsky *et al.*, 2004). The most sensitive areas for aeolian activity were those anthropogenically modified either by tillage, grazing, quarrying and housing. Historical lower precipitation values along with increasing aridity index have been reported from central-western Argentina (Scian & Donnari, 1997; Compagnucci *et al.*, 2002). This variability is possibly linked to the two dominant midsummer low-level circulation patterns of negative (positive) precipitation anomalies during weak (intense) SACZ and warmest (coldest) SST in the subtropical western South Atlantic Ocean (Barros *et al.*, 2002). South American early-mid XX century dry periods and the associated aeolian reactivation is synchronous with drought events of North American (Cook *et al.*, 2007) adding new information to the proposition of a likely interhemispheric linkage (Herweijer & Seager 2008).

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Mobility and stability of sand seas in the subtropical hot deserts and in the middle-latitude hot and cold deserts

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Sand seas in the subtropical hot deserts and in the middle-latitude hot and cold deserts are either fixed or fully active. Fixed sand seas include those of Australia, Kalahari in South Africa and the Kara-Kum and Kyzil-Kum in Central Asia, while the active varieties are found in the Sahara, Namibia or the Taklimakan Desert of China. It is generally assumed that all stabilized sand seas were active during their period of formation and became fixed due to climatic changes. A second assumption postulates that stabilized sand seas can reactivate as a result of severe drought. Thus sand seas in areas with scant rainfall will be active. Although many conceptual models of stabilized- dune activation are discussed in the literature, none of them involves quantitative data on the reduction of vegetation cover resulting from drought intensity and duration. In our work in the Negev desert, we concluded that after a prolonged drought that brings the average annual rainfall down to 60-50 mm, the vegetation cover will be close to zero and the stabilized dunes can reactivate, provided there is no bio-crust. Another limit on sand-dune vegetation is wind power, which increases or decreases coverage with the cube of wind velocity. Wind power is therefore one of the most important climatic factors determining the formation and activation of sand dunes (Tsoar 2005). Our hysteresis model (Yizhaq *et al.*, 2007; Yizhaq *et al.*, 2009) explains the bistability of active and stabilized dunes under the same climatic conditions, provided that rainfall is sufficient to support dune-stabilizing vegetation cover. Hence, stabilization will prevail when the average wind power is weak, but the active state will be observed when the wind erosion is too high to allow germination of shrubs or grass. The above models dealing with rainfall and wind power can explain why all sand seas in the subtropical hot deserts and in the middle-latitude hot and cold deserts are stabilized in areas where the average annual rainfall is above 60-80 mm and active in areas with less rainfall. According to luminescence dating of sand dunes in central Australia and the southern Kalahari, dunes were active in episodes during most of the past 120 ka (Fitzsimmons *et al.*, 2007; Stone and Thomas, 2008). The sand seas of Central Asia (Kara-Kum and Kyzyl-Kum) were active during the first half of the Holocene and then stabilized (unpublished data). Reactivation of the above mentioned sand seas took place after a long drought that brought the average annual rainfall below 60 mm. These droughts have occurred together with grazing of ungulates that broke the bio-crusts, a process that facilitates reactivation.

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Trace fossils in Quaternary highstand, shoreline, carbonate high-frequency sequences from Western Australia

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High-frequency shoreline carbonate sequences formed during interglacial highstands are well developed around the world in mid to low latitudes. They commonly take the form of reefal limestones, as in the Red Sea, many parts of the Caribbean, in SE Asia and western Australia, but elsewhere, in the Mediterranean, notably the north coast of Egypt, Bermuda, and western Australia, carbonate grainstones (aeolianites) dominate, commonly bioclastic and/or oolitic. In western Australia, calcarenites of the last 4 interglacial highstands (MIS 5e, 7, 9 and 11), forming the Coastal or Tamala Limestone, are well developed in the area of Perth, and reefal carbonates of the last interglacial highstand (MIS 5e) occur at various locations along much of the western coastline of Australia. The calcarenites of the different highstands show similar features, with marine facies reaching 10 metres in thickness and aeolian facies up to 50 metres. The sequences have a basal erosion surface upon earlier deposits, which usually show evidence of pedogenesis and exposure. Shallow-marine and shoreface grainstones, locally quartz-rich, show a range of sedimentary structures: cross and flat bedding, herring-bone cross-bedding and SCS. Shallow channels filled with cross-bedded sands also occur, and represent rip-channel fills. A distinctive nodular, bioturbated facies also occurs commonly. Overlying flat-bedded and low-angle cross-bedded sands with truncation surfaces are foreshore deposits. The marine facies pass up into aeolianites with large scale cross-bedding and pinstripe bedding, as well as abundant pedogenic features, notably vertical rhizocretions up to several metres long. Trace fossils are a feature of the shoreface-foreshore facies and also occur in the aeolianites too. The basal transgressive facies are characterised by echinoid burrows (*Scolicia*), as well as crustacean burrows of *Psilonichnus*, *Thalassinoids* and *Ophiomorpha*, and some the bivalve-generated *Siphonichnus*. The overlying regressive mid- shoreface facies are extremely bioturbated, even rhizoturbated grainstones with burrows (e.g. *Ophiomorpha*, *Siphonichnus* and others), from crustaceans and bivalves. This distinctive nodular facies is interpreted as sea-grass meadow facies and this is supported by the presence of foraminifera characteristic of the modern sea-grass areas, which are common offshore Western Australia. The inner shoreface facies is characterised by *Conichnus* (from sea anemone), as well as *Skolithos*, *Ophiomorpha*, *Diplocraterion* and *Monocraterion*. Thin shell beds, often rich in euryhaline bivalves, locally occur, in some cases above sea-grass sands, or within rip-channel fills. Other shell beds show the effects of tidal and storm currents. Lower foreshore facies are characterised by *Skolithos* and *Ophiomorpha*. Apart from prominent rhizocretions and calcified rootlets, the aeolianites also contain footprints, especially in the flat-lying, pinstripe, interdune facies. Trace fossils relate closely to depositional facies and provide useful information on environments and relative sea-level change. Coupled with microfacies analysis. These Quaternary sequences form prominent north-south ridges on the Perth coastal plain, and represent rapid transgressions followed by highstand progradation over around 10,000 years. 90% of the late Quaternary here is represented by subaerial exposure.

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Carbonate fabrics in tufa: microbes, diatoms, crystals, significance, Derwent Valley, NE England

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The processes of formation of tufa, the textures and mode of crystal precipitation, and role of the biofilm-EPS, are closely analogous to those which appear to have been involved in the formation and diagenesis of many ancient microbial buildups and stromatolites-thrombolites. Tufa is a microcosm of carbonate deposition and diagenesis and helps provide guidance on the interpretation of ancient textures. Barrage tufa is well-developed in several streams in an area of Upper Carboniferous Coal Measures in the northeast of England near Newcastle. The barrages occur in side streams to a major river (River Derwent), and the tufa-dams have a width up to 5 metres, and a height up to one metre above the stream floor. Many barrages have a vertical or stepped downstream side and a more gentle upstream side into the quieter pool area, where ragged, 'old' inactive tufa occurs along with terrigenous mud and sand, and twigs and leaves. Three major depositional surfaces are developed on the tufa: 1) the upper surface of the dams, where water flow is strong, generally has a smooth, black surface (from erosion during floods) with pendant, tongue-shaped growths developed on the downstream side of the barrage-crest; 2) pale to dark brown streaky tufa of calcified filamentous yellow-green algae (Vaucheria), cycanobacteria and rare bryophytes, forms in areas of less energetic water flow around the dam crest and just below; Vaucheria tufa also forms in the quieter pool area, and 3) a dark, usually black, cindery surface with mm-sized pustules, forms in quieter areas where water depth reaches 40 cm; this usually develops upon Vaucheria tufa. The barrages form as a result of the accumulation of pebbles in riffles, and the trapping of tree branches and twigs, as well as leaves during the autumn fall. Detrital vegetal remains are quickly coated with peloidal aggregates, leading to a continuous micritic calcite crust, suggesting the former presence of a biofilm. Columnar calcite develops syntaxially on the micrite crystals, leading to the formation of thicker crystal crusts and spherulitic structures. The filamentous alga Vaucheria is soon coated by micritic calcite crystals, which develop into larger crystals with terminations. The dark pustular tufa is noteworthy for the occurrence of manganese-iron impregnated 10µm-thick coats within the tufa calcite, probably representing pauses in calcareous tufa growth, and the presence of striking Fe-Mn impregnated-coated branching filaments of probable Fe-Mn bacteria. These structures are very similar to those found in red Palaeozoic mud-mound limestones (Frutexites) and red pelagic limestones. The tufa calcite is noteworthy for its commonly bright cathodoluminescence, indicating the presence of manganese and suggesting precipitation in suboxic conditions. CL reveals crystal growth zones and possibly areas of dissolution-reprecipitation. Tufa formation is a relatively rapid process. Glass slides are coated to a thickness nearly 1 mm in 3 months and in some cases a progression can be demonstrated of colonisation by diatoms, then precipitation of calcite in association with cyanobacterial filaments such as Phormidium and Oscillatoria, as well as EPS. SEM study reveals the role of EPS as a nucleation site, the primary nature of the columnar crystals, and the intimate association of crystals and calcified cyanobacteria. The processes here are similar to those reported from modern stromatolites, and indicate the close involvement of microbial and abiotic processes in carbonate precipitation.

Paleoenvironmental framework using microfacies analyses of a nautilid concentration, Agrio Formation, Neuquén Basin, Argentina

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The presence of an exceptional accumulation of nautilid shells in sediments belonging to the Agrio Formation has been previously reported. The objective of this work is to analyze the microfacies of the beds that contain the nautilids and to compare them with the deposits above and below the exceptional nautilid accumulation. The logged section was accomplished at El Salado locality, and was assigned to the middle-upper part of the Pilmatué Member of the Agrio Formation, belonging to the Holcoptychites agrioensis biosubzone (Early Hauterivian). The sediments located below the nautilid bearing beds are heterolithic deposits exhibiting a thickening and coarsening upward trend. They are composed of interstratifications of sandstones, siltstones and claystones. Overlying the heterolithic deposits, up to three amalgamated limestone beds with nautiloids were identified. They are covered by gray bioclastic limestones. The limestones with nautilids were interpreted as amalgamated storm deposits in a ramp environment (Cichowolski 2008). Petrographic studies were performed to the heterolithic deposits, to the beds containing nautilid shells and also to the limestones located above the nautilid levels. The heterolithic and nautilid levels are made up of allochemic sandstones and sandy allochemic limestones. The identified allochems in both types of samples are fragmented oysters and other bivalves, serpulids, echinoderms, and abundant bioclastic debris. Most of the bioclasts are abraded and highly fractured but without signs of important bioerosion. Instead, micritization of ooids, grapestones and intraclasts suggest certain degree of rework of the original facies. Some samples show a linear pattern of the allochems and micas and some show chaotic arrangement of the fragmented bioclasts. The main siliciclastic components are quartz and feldspars with minor volcanic and sedimentary lithics and micas. The proportion of siliciclastic and carbonate material is variable from sample to sample. Using the Mount (1984) scheme, the origin of these mixed samples is probably facies mixing for the heterolithic levels and punctuated mixing for the nautilid level. Through this process sediments are transferred between contrasting depositional environments during rare, high intensity sedimentation events, like the storms. In that case we suggest that the benthic communities were disrupted by major storm but they recovered rapidly on fair-weather conditions. Petrographic studies made on samples located few meters above the nautilid beds allowed us to classify them as bioclastic wackestones to packstones, with a wide variety of bioclasts remains and grumose micrite. The identified bioclasts are: bioeroded and fragmented oyster shells, echinoderm plates and spines, gastropod sections, serpulids in longitudinal and transversal section, and a high proportion of undetermined highly fragmented bioclasts. It is remarkable the presence of calciespheres and scarce reworked and micritized oolites. Few monocrystalline quartz, plagioclase and glauconitic grains were identified as siliciclastics material in the samples. The observed microfacies are similar to those described previously for open marine facies for the Agrio Formation and can be classified as RMF7 from Flügel (2004). These microfacies are indicative of deposition on a middle ramp environment. The microfacies study clearly discriminates between the fair weather prograding deposits and storm facies from the normal middle ramp environment.

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Granulometric and geochemical characterization of fossil carbonate oozes: field studies and precipitation experiments

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Carbonate ooze, or micrite, its lithified counterpart, forms a main constituent of limestones throughout Earth History. Despite considerable research, the origin of micrite remains a major problem in carbonate sedimentology. Similar to other limestone components, micrite is polygenic in origin. In addition to this, when lithifying, carbonate oozes undergo dissolution and reprecipitation processes. The consequence is the addition of variable amounts of secondary carbonate (micro-)cements and/or the diagenetic recrystallization of micritic carbonates. These processes are both rapid and, volumetrically and geochemically important. Depending on primary mineralogy, the volume and geochemistry of secondary (micro-)cement, and the diagenetic regime, the geochemistry and mineralogy of micritic rocks will deviate in variable degrees from the original composition of unconsolidated. Nevertheless, despite the often poor knowledge about their origin and diagenetic history, matrix micrites often form the backbone of numerous geochemical studies. Being aware of this problem, the study focuses on the origin and isotopic fingerprint of specific component classes within carbonate oozes and lithified matrix micrite. This study is based on a granulometric separation focuses on fossil micrite samples from an intact Jurassic platform transect in Morocco and will also be applied to complete platform transects representing different time slices. The goal is to physically separate specific components of micrite and to investigate their origin, mineralogy, grain morphology and geochemistry. Specifically, the absence (?) of planktonic organisms in the Palaeozoic is expected to result in a different micrite mineralogy in comparison to Jurassic or modern counterparts. It is acknowledged that neither method can compensate for any post-depositional diagenetic alteration of aragonitic or high-Mg calcitic oozes. However, it is believed that this study represents an important step towards a more complete classification (granulometrical, mineralogical, geochemical) of the various type of components contained in carbonate oozes of different geological settings (age, carbonate factory, biota, chemical composition of the ocean, etc). In addition, precipitation experiments attempting to artificially lithify carbonate ooze are under way.

Lithostratigraphic evolution of sedimentary strata entering the Nankai subduction margin of SW Japan: A summary of results from IODP NanTroSEIZE expeditions

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The Nankai Trough is located off the coast of southwest Japan, where the Philippine Sea plate (Shikoku Basin) is subducting beneath the Eurasian plate. The margin's Kumano transect is the focus area for the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE). This multi-disciplinary, multi-stage, multi-expedition project was designed to improve our understanding of seismogenic processes along the plate interface. The drilling component of NanTroSEIZE Stage 1 included Expeditions 314, 315, and 316 of the Integrated Ocean Drilling Program (IODP). Together with the results of a 3-D seismic-reflection survey, coring and logging-while-drilling generated a wealth of new information about the stratigraphic and structural evolution of the margin. For example, the frontal thrust zone of the accretionary prism is dominated by packets of sand and gravel turbidites that probably accumulated within a trench-floor axial channel system prior to their accretion in the early Pleistocene. The accretionary prism becomes progressively older toward land, and a time-transgressive unconformity separates the prism from the overlying slope apron. Some parts of the accretionary prism, however, are anomalously mudstone-rich, and their inferred depositional environment remains enigmatic. Another unexpected discovery is the existence of an unconformity between the base of the trench-wedge facies and the top of the upper Shikoku Basin facies. Submarine slides may have removed those strata from the flank of a seamount prior to burial beneath the trench wedge. IODP Expedition 322 was organized to sample and log all of the incoming sedimentary strata and upper igneous basement of the Shikoku Basin seaward of the Nankai subduction front. Coring was conducted at two sites during September-October 2009: Site C0011 on the northwest flank of a prominent bathymetric high (Kashinosaki Knoll) and Site C0012 near the crest of the knoll. When viewed as a pair of sites, it is clear that the condensed section at Site C0012 displays significant reductions in unit thickness for all parts of the stratigraphic column, relative to Site C0011. Recovery of the basal pelagic claystone in contact with pillow basalt constitutes a major achievement at Site C0012. From this we know that the age of igneous basement is older than 18.9 Ma. After intervals of pelagic and mixed volcaniclastic/siliciclastic sedimentation, deposition of sandy turbidites commenced at approximately 14.4 Ma in the lower Shikoku Basin. The subsequent transition into a hemipelagic facies is reminiscent of a similar lithologic transition at other sites in the Shikoku Basin, but the hemipelagic ages are different: roughly 6.0 to 4.0 Ma at ODP Site 1177 versus 12.8 to 9.1 Ma at Sites C0011 and C0012. The middle Shikoku Basin facies lies above the hemipelagic interval and is unique to the Kumano transect area, based on its age (upper Miocene) and high content of tuffaceous and volcaniclastic sandstone. The closest volcanic sand source at the time was probably the Izu-Bonin arc. Basement architecture clearly modulated sedimentation rates throughout the history of the Shikoku Basin. Relief on the seafloor, however, was never high enough to completely prevent the transport and deposition of sandy detritus atop Kashinosaki Knoll. Transport of sand to Site C0012 may have resulted from thick turbidity currents and/or upslope flow of gravity flows. With respect to the overarching goals of NanTroSEIZE, characterization of the frictional, geotechnical, and hydrogeological properties of middle and lower Shikoku Basin facies will be especially important because those strata end up within the seismogenic zone of the plate boundary. For an electronic copy of the Preliminary Report go to: [www.iodp.org/scientific-publications]. Citation: Underwood, M.B., Saito, S., Kubo, Y., and the Expedition 322 Scientists (2009). NanTroSEIZE Stage 2: subduction inputs. IODP Prel. Rept., 322. doi: 10.2204/iodp.pr.2009.

Influence of a volcanogenic flood event on alluvial depositional system, the Holocene Niigata Plain, northeast Japan

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Numazawa volcano in northeast Japan erupted most recently at about 5 ka, emplacing at least 4 km^3 of valley-confined ignimbrite (Numazawako eruption). The ignimbrite dammed the Tadami River, temporarily impounding > 1.6 km^3 of damlake water that was catastrophically released by dambreak (Kataoka *et al.*, 2008). Pyroclastic material resedimented by the flood is widely distributed along the Tadami and Agano Rivers as deposits of 10s of meters thick as far as the coastal Niigata Plain more than 150 km downstream of the volcano. The Niigata Plain facing the Sea of Japan is a typical coastal plain with multiple coastal sand dunes. The alluvium of the Niigata Plain was formed by the progradation of two coexistent depositional systems. In the Agano River area, the depositional system was composed of a delta system with strong inference of fluvial environments. The subsided area in the western part of the Niigata Plain has been formed by a barrier- lagoon system (Urabe, 2008). In the Agano River region, sedimentary processes of pumiceous sediments (lahar deposits), derived from the 5 ka Numazawako eruption, have been analyzed using the existing borehole dataset and facies analysis of the sediment cores. The lahar deposits show the different sedimentary facies at a plain margin, flood plain environment, river mouth and coastal area, and shallow sea environment. At the plain margin, fine-grained hyperconcentrated flow facies is recorded in sediments of the low-elevated fluvial terrace. In the plain, coarse-grained flood sediments, 3 to 5 m thick, are widely distributed above the horizon of flood plain sediments before 5ka. The coarse grained pumiceous sediments of 5 to 8 m thickness are interpreted as deposits under delta front to delta plain environments in the river mouth and coastal area. Sandy silt deposits (pro-delta facies) including the pyroclastic material (horizons of high-concentrated volcanic glass shards and heavy mineral particles) are distributed in the shallow sea area. The enormous pyroclastic sediments transported by the flood event induced the rapid progradation of delta system of the Agano River region. The sediments brought into the shallow sea also caused the progradation of the barrier system and changed the coastal landform of the Niigata plain. The progradation rate of the depositional system changed from the 1 km/1000 year to the 3 km/1000 year by this event. Understanding of large-scale pyroclastic resedimentation can thus greatly contribute to evaluate and predict the sediment discharge and hazards created by a volcanogenic flood and its aftermath in alluvial plains.

A multidisciplinary study of the Cacheuta Basin, Mendoza, Argentina

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The present study utilized a multidisciplinary approach, 3G (Geology, Geophisics, Geochemestry), Paleontology and Sedimentology to evaluate and predict the occurrence and distribution of petroleum systems active in this important area. Oil and source rock geochemistry and paleoentological data are integrated within a geological and geophysical framework, and combined with recent 2.5D thermal modeling results to understand facies and thermal variability across the basin resulting in a realistic evolutionary model. The Cuyo Basin is a pericratonic landlocked intermountain rift basin covering an area of about 40,000 km2 and containing about 6 km of sediment. It is situated on the southwest flank of the Pampean Massif, east of the Andean Cordillera, and northeast of Precordillera foothills. The basin is formed by several smaller rift formed during the Triassic as a result of post-orogenic relaxation and extension that continued into the early Jurassic. Waxy oils produced from Triassic and Tertiary strata constitute one of the oldest and most important petroleum resources in Argentina and are primarily derived from organic-rich shales of the Late Triassic Cacheuta and Potrerillos formations deposited in freshwater lacustrine and fluvial-lacustrine environments. Significant hydrocarbon generation only occurred during the last 10 Ma. following a rapid subsidence episode with thick Tertiary sediments. More than 150 different species of palynomorphs including variegate floras rich in “Dicroidium” characterize the Potrerillos and Cacheuta formations and coeval equivalents. These highly diversified associations are dominated by austral forms (Gondwanide), but also contain cosmopolitan and boreal elements that have been attributed to Middle to Late Triassic age.

GeoHazard risk mitigation strategy for a subsea Nile Delta gas development

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Over the last 250,000 years the Nile Delta has undergone numerous large scale sea level fluctuations along with cycles of rapid sediment deposition and erosion. These conditions have produced a current day seafloor that is a complex combination of features resulting from fluid/mud expulsion, landslides of all proportions, and the incision of deep submarine canyons. BP Egypt and partners RWE-Dea and EGAS have embarked on an ambitious program of gas developments on the Nile Delta. This presentation describes how BP Egypt is managing the potential geohazard constraints to its development projects. The strategy employed focuses to ensure that geohazard risks are understood & quantified. Extensive geophysical and geotechnical data are acquired and interpretations are made. Studies are undertaken to understand the potential impact of seismogenic events, resulting in potential Tsunamis and other external factors. Modelling is performed to understand the stability of the soils. Further modelling is performed to understand the risks to the various subsea architectural components of the gas field. A ground model is created and used to appropriately design the subsea facilities and layout to mitigate the geohazard risks. The resulting calibrated ground model provides the development flexibility in the placement of subsea facilities while optimising costly future geophysical data acquisition and geotechnical investigations. This model is then handed over to the design and construction contractors.

Changes in lake sediment structure and composition caused by short-time water-level changes

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Present research compare the sediment records of Lake Martiska (NE Estonia, N 59°15´45´´, E 27°34´13´´, area 3.5 ha, maximum depth of 8.5 m) with well-documented historical changes in human impact to identify the factors dominantly affecting the sediment lithological composition. Kurtna area lies in a transitional zone between densely populated and heavily industrialised oil shale mining and processing region and a sparsely inhabited territory with large forests and mires. Lake is closed and fed by groundwater and atmospheric precipitation. According to the monitoring data one very specific phenomenon influencing the development of L. Martiska - since 1950s the lake level drops 3.5 m due to groundwater abstraction because of oil shale mining. Since 1991 the production of oil shale has continuously declined, and the use of environmentally friendlier technologies has led to the restoration of the natural state of the lake environments and causes the water-level recovering. Eight sediment cores up to 24 cm long were collected to study the impact of the water-level changes to the sediment structure. Grain-size distribution was measured with the Fritsch Laser Particle Size "Analysette 22". To get reproducible results of grain-size distribution in studies of allochthonous siliclastic matter from organic rich cohesive lake sediments the autochthonous matter must be eliminated. Complicated problems arise in the case of fine-grained material where secondary side-effects in the sedimentation environment as well during the pre-treatment process (flocculation, damaged grains, etc.) could seriously affect the reliability of the obtained grain-size spectrum. Different pre-treatment methods for grain-size analyse from organic rich sediments were tested and new reliable work-flow was developed. The water-level fluctuations are reflected in the mineral matter concentration of the sediment and in grain-size variations. The regression of the water-level has resulted in extensive erosion and redeposition of sediments, changes in the distance to the shore and displacement of the erosion–transport–accumulation zones. The eroded matter consists of fine grain sands (limnoglacial sands embracing the lake), as well as of previously accumulated lacustrine sediments. In sites deeper than 3.5 m lacustrine sedimentation took place during the whole regression phase. Two studied cores became above the lake level and erosion and accumulation of organic matter took place mainly as humic substance. In these cores the consistence of sediment grain- size is close to the values of bulk limnoglacial sands around the lake. In the cores from deepest part of the lake the increase of the mineral matter concentration and the coarse fraction begins at a depth of about 14 cm, reaching a maximum value at 7 cm (Φ50 value 6.0; coarse silt). This layer accumulated in 1992-1994 when the water level was lowest. During the rapid subsequent transgression in the second half of the 1990s, it can be expected that shoreline erosion would reduce, while normal lake sediment accumulation would increase. By using the multivariance analysis three main periods (in good accordance with monitoring data) from all cores can be separated: stable sedimentation before regression, regression and transgression.

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Late Aptian- Early Albian glacio-eustacy and environmental change on the Arabian Plate: a global message

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The mid-Cretaceous carbonate succession of the Arabian Plate is interrupted by a phase of exposure and condensed siliciclastic sedimentation spanning the Late Aptian and Early Albian. This marked change in sedimentation pattern is attributed to a glacio-eustatic sea level fall, dramatically documented with incised valleys in offshore Qatar and extensive lowstands in the UAE and Oman, and was followed by a phase of condensed, iron-rich siliciclastic sedimentation at the end of the subsequent sea level rise. Based on an integrated subsurface dataset including seismic, wells and core material a sequence stratigraphic model of the Late Aptian – Early Albian of the Arabian Plate has been constructed. Two areas are highlighted. In seismic of offshore Qatar a large incised valley system is observed, penetrating approximately 40 meters into the underlying Early Aptian Shu'aiba carbonate platform and reaching a maximum valley width of 8 kilometers. Core showed that the fill sediments are of latest Aptian age and consist of plant material-rich, bi-directional cross-bedded, medium-grained sandstones changing upward to bioturbated sandstones, interpreted as an estuarine transgressive back fill succession. The overlying thin highstand deposits consist of oolitic ironstone, glauconite and sandstones. In seismic in the UAE, a well expressed lowstand with prograding clinoforms has been observed, which was time equivalent to channel incision in Qatar. Constrained by age dates and 3D geometrical control a quantitative sea level curve has been constructed. The fast and high amplitude fluctuation in a tectonically calm setting strongly supports a glacio-eustatic control mechanism. Examples are given how the Arabian Plate Late Aptian sea level curve and sequence stratigraphic model may serve to reinterpret hitherto poorly understood Aptian stratigraphic patterns on other tectonic plates

Sedimentary imprint of the 2007 Aysén earthquake and tsunami in Aysén fjord (Chilean Patagonia)

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On 21 April 2007, the Mw: 6.2 Aysén earthquake caused several subaerial mass movements (landslides, rockfalls) along the slopes of Aysén fjord. The three most voluminous of these triggered several tsunamis. These landslide-induced tsunamis not only destroyed small villages, houses and salmon farms along the shores of the fjord, but also resulted in 3 casualties and 7 missing persons. The earthquake had its epicentre at a depth of < 9 km below the fjord. It was the most important earthquake of a seismic swarm, which had lasted 3 months (starting on January 22) and in which more than 7000 earthquakes were registered. Intensities as high as VIII to IX were recorded around the epicentral zone, i.e. where the landslides occurred. In Puerto Chacabuco and Puerto Aysén (at the end of the fjord) intensities of VII were recorded (Naranjo *et al.*, 2009; Sepulveda and Serey, 2009). This type of mass movements and their related tsunamis can leave an event-deposit in the fjord's sedimentary record. Such deposits and the processes forming them have been described by several authors. However, coupling the nature of these deposits to 'what occurred on which slope' and to earthquake intensity is a complicated assignment. Historical records are often incomplete and only range back in time a few hundred years, depending on the region. As such, examples where the original processes are well documented are scarce. In order to gain a better insight in the sedimentological characteristics of event deposits caused by landslide-induced tsunamis, we conducted a multidisciplinary study of the recent sedimentary infill of Aysén fjord. By studying the 2007 event-deposit with multibeam bathymetry, high- resolution reflection seismics and a multiproxy analysis on 20 short gravity cores, we aim to fingerprint this deposit in the highest detail. Multibeam bathymetry and reflection seismics are used to map out the occurrence, morphology and thickness of the deposit throughout the fjord, and gravity cores are taken to ground-truth the geophysical data. Sedimentological characterisation of the event-deposit is achieved by combining CT-scans, high-resolution (1 mm) grain-size analyses, XRF- scanning (1 mm) and magnetic-susceptibility measurements (2.5 mm) of the sediment cores. The deposit is very heterogeneous in space and has a varying thickness (centimetre- to metre-scale). The internal structure varies between parallel laminations, fine cross-bedding, ripples and homogeneous, with grain sizes ranging from fine clay to gravel. Different phases in the deposition can be correlated between most of the cores and thereby allow us to gain an insight into the evolution of this deposit. Comparing this complex sedimentary imprint with eye-witness reports, field observations, records of seismic- shaking and macro-intensities allows us to better understand the processes forming these deposits.

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Sepulveda, S.A. and Serey, A. (2009) Tsunamigenic, earthquake- triggered rock slope failures during the April 21, 2007 Aisen earthquake, southern Chile (45.5 degrees S). Andean Geology, 36(1): 131-136.

The imprint of historical megathrust earthquakes in lake sediments from South-Central Chile

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With a moment magnitude of 9.5, the 1960 Valdivia earthquake in Chile is the strongest earthquake ever recorded. Apart from material and human losses, the earthquake not only caused tsunamis on the large glacigenic lakes, but also catastrophic landscape changes along the almost 1000 km long rupture zone (including the lakes' catchments). Superficial as well as deep-seated landslides occurred in the area that was most strongly affected by the earthquake. The earthquake also triggered the Cordon Caulle volcano to erupt and it generated a mudflow that dammed Lago Pellaifa causing a permanent rise of the lake level of 8 m. In 1575 the same rupture zone produced an earthquake with similar effects and the flooding of the city of Valdivia after the breakthrough of a landslide-dammed lake (Lago Riñihue) caused even more casualties than the earthquake itself. These historically documented giant megathrust earthquakes alternate with smaller-scale earthquakes, during which only a part of the rupture zone was activated, such as the earthquakes of 1737 and 1837. Lake sediments are capable to record earthquake-related processes within the lake basin (e.g. seiche, tsunami), as well as landscape changes (e.g. slides) in the drainage basin of the lake. The intensity and type of landscape change can be better reconstructed using lake sediments than by only studying the geomorphology of the region, as the lacustrine archive potentially covers longer time periods and temporally resolves processes in the catchment area down to the season. The occurrence of several large lakes in the Chilean onshore area parallel to the 1960 rupture zone (as well as that of the 1575, 1737 and 1837 earthquakes) offers the possibility to study the effects of each of these earthquakes in different parts of the affected region. In 2008 and 2009, several short gravity cores (max. length: 1.2 m) were taken in 8 different lakes. Several analyses were carried out on some or on all of the cores, such as GeotekTM multi-sensor core logging on whole cores, high-resolution photography, point-sensor magnetic-susceptibility, high-resolution grain size, XRF- and μ-XRF scanning and thin-section analysis. The cores consist near entirely of varved background sediments, interrupted by event deposits. Most of the cores contain four distinct event deposits, which could be dated and attributed to historical earthquakes by means of varve counting. The impact of the 1575 and 1960 earthquakes are present in almost every core covering this time interval, while the 1737 and 1837 earthquakes only left an imprint in some of the sedimentary basins. The 1960 earthquake is represented in the lacustrine archive by mass-wasting deposits, homogenites and turbidites. The impact of the seiche, which affected Lago Panguipulli and Lago Pellaifa according to historic documents, is clearly recorded in the short cores of these two lakes. Also the provenance of sediments within event deposits (Lago Pellaifa) and background sediments (Lago Calafquén and Lago Riñihue) was determined. The varves, which consist of couplets of diatom-rich and clay-rich lamina, are generally thicker just after an event and gradually become thinner over the following two to three decades. In addition, the elemental composition and geochemistry of the varves changes in some lake records after the event deposits. By analyzing the pre- and post-event varves, we are able to study the effect of the landscape changes caused by each event (earthquakes, as well as volcanic eruptions). Varve thickness, mineralogical composition and chemical composition (μ-XRF) enable us to qualify and quantify the landscape changes linked to each of these catastrophic events for several drainage basins, and to better understand how such events finally get encrypted into the sedimentary record.

Rapid climate oscillations during the last glacial-interglacial transition: A high-resolution geochemical study on sediments from Lake Gerzensee (Switzerland)

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Here we present a new high-resolution geochemical study on sediments of Lake Gerzensee (Switzerland) covering the late glacial to early Holocene. A stable isotope record combined with X-ray fluorescence (XRF) core scanning provides a basis for the evaluation of environmental forcings and feedbacks of climate change in Europe during the last glacial-interglacial transition and enables the detailed comparison of different high-resolution paleoclimate records in the circum-Atlantic region. The sediment of Lake Gerzensee comprises mainly shallow water carbonates and some molluscan shell debris, but very little organic matter and detrital material. Stable isotope stratigraphy was established on cleaned samples containing only authigenic-formed carbonates. To cancel out erratic sedimentation features and sampling artifacts, four parallel $\delta^{18}O$ records were correlated and stacked based on pollen assemblages and stable isotope composition. The final correlation highlights the sedimentological variability and validates some consistent signatures throughout the lake. The resulting stacked record mainly reflects the overall features and, therefore, is most suitable for comparison with other climate records. Since conventional radiocarbon dating could not be performed and provided that changes in $\delta^{18}O$ in Greenland and Europe occurred simultaneously, the age-depth model was established by wiggle matching the Gerzensee and Greenland isotopic records. With a sampling resolution down to 0.5 cm the resulting data set yields a temporal resolution of ~10 years (early Holocene and Bölling-Alleröd) to ~35 years (Younger Dryas). This allows for the reconstruction of abrupt and extreme climatic changes, such as three century-scale cold events during a general cooling trend of the Bölling-Alleröd warm period. We use XRF core scanning for attaining high-resolution (down to 0.2 mm) records of the elemental composition in the sediment cores. Since specific elements and element ratios often characterize specific lithological properties (e.g. Al, K, Rb, and Zr for erosive material), XRF analyses can indicate the sediment origin. The comparison of $\delta^{18}O$ and XRF data allows us to determine the response mechanisms and timing of the sedimentary system to climate change. We notice that the glacial phase is dominated by detrital material, which gradually decreases during the Oldest Dryas and the Bölling-Alleröd, while the carbonate fraction abruptly gains importance during the Oldest Dryas. In addition, we observed different environmental impacts during the Bölling-Alleröd cooling events, e.g. in erosive input, lake productivity, and sedimentation rates. While the abrupt cooling during the Aegelsee Oscillation is expressed by higher detrital input and lower lake productivity, the gradual and longer lasting Gerzensee Oscillation seems to have a minor influence on the sedimentary system. The detected higher Sr/Ca ratio during the Oldest Dryas and Bölling-Alleröd is likely caused by changes in weathering conditions during deglaciation. Comparison of the Gerzensee record to other marine (e.g. Cariaco basin), lacustrine (e.g. Ammersee), and ice core (e.g. NGRIP) data sets shows strong similarities and helps to investigate and quantify the centennial scale cooling events during the Bölling-Alleröd warm period within different geographical positions and climate impacts. Further work will include the establishment of more high-resolution geochemical records from Swiss lake sediments to enable the distinction between local and system specific signatures versus large-scale environmental and climatic changes.

Paleosol development in response to extrinsic and intrinsic factors: The Mata Amarilla Formation (Upper Cretaceous), an example of Southern Patagonia

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The aim of this contribution is to study the extrinsic (tectonic, climate and eustasy) and intrinsic (paleotopography, paleodrainage and relative sedimentation rates) controls over paleosols development. The Mata Amarilla Formation is framed within the Austral foreland basin, which is located in southwestern Argentina. Its shape is elongated N-S; the eastern border is parallel to the Chico River. The western tectonic boundary is the Patagonian Andes, and the southern boundary is the Scotia plate. The study area is situated around the town of Tres Lagos, southwest Santa Cruz Province. Detailed sedimentological logs, facies analysis, pedofeatures and soil horizons description were useful for interpreting palaeoenvironment and paleosol development. The Mata Amarilla paleosols have hydromorphic characteristics and are grouped within the gleysols group. This designation refers to gray, greenish- gray to olive green colors, which reflect the reduced state of iron oxides. These paleosols have features consistent with seasonal humid tropical climates, in concordance with the beginning of the greenhouse period during the Cenomanian, which continued throughout the Upper Cretaceous to the Oligocene. The Cenomanian is an important period in the evolution of vegetation, as there was a change from mesophytic flora to angiosperm dominance. These changes are also recorded in the paleosols, since the Cenomanian pedogenic processes are very similar to recent processes. Previous studies in the Mata Amarilla Formation allowed the definition of three sections that represent different accommodation/sediment supply conditions. These changes are inferred to be promoted by relative sea-level oscillations in response to the tectonic evolution of the Austral fold and thrust belt. The lower and upper sections of the Mata Amarilla Formation are characterized by histosols associated with low gradient coastal environments (lagoons, estuaries and distal fluvial systems). A special type of Histosol with acid sulfate properties, such as jarosite, rhizoliths, mottles and nodules was developed in the coastal plain. In the lower portion of the middle section, a thick paleosol associated with the Maria Elena Petrified Forest is developed. This level is composed of vertic Alfisols and Vertisols. In the eastern part of the study area there are in situ fossil trees associated with anastomosing river deposits, while to the west fossil tree trunks are pseudotransported related to meandering rivers. The rest of the middle section is characterized by Vertisols and Inceptisols developed on distal and proximal fluvial floodplains, respectively. Summarizing, the type of paleosols and drainage conditions developed in the three sections responded to extrinsic factors, while the variations in the middle section might respond to intrinsic factors within the fluvial system. Finally, a sequential stratigraphic model for paleosols succession for the Mata Amarilla Formation was developed. This model contrasts with the classic model developed by Wright & Marriott (1993), in that the Mata Amarilla model does not have incised valleys, and transgressive system are composed of very poorly drained soils. Models are similar in that during the first stage of forced regression a thick paleosol develops. In contrast, the rest of the regressive stage of the Mata Amarilla Formation is dominated by low to moderately mature paleosols. The classic model works well during major eustatic changes that occurred during icehouse periods, while the Mata Amarilla model could be extrapolated to other sequences deposited during climatic optimum conditions.

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Distinguishing tsunamis shell bed deposit using sedimentologic and taphonomic features: an example from (Lower Upper Cretaceous) Southern Patagonia, Argentina

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The criteria by which the deposits of tsunamis are distiguished from other deposits, including storm surge, have been controversial for more than 10 years. The Mata Amarilla Formation of the Lower Upper Cretaceous of Southern Patagonia, has excellent tsunami deposits in its lower section, and this work presents details of their sedimentological and taphonomical character, as well as a model of temporal stages that led to their deposition within a lagoon. This work results from detailed sedimentologic logs and facies analysis, together with the study of its paleontological content and taphonomical attributes. The sediments are composed of alternating white sands and mudstones, with interbedded bioclastic accumulations in the lower section. The depositional environment was represented by a lagoon bounded by shallow marine bars. These fine-grained sediments are sporadically interrupted by tsunami events represented by coquinas, bioclastic sands and shell pavements with allochthonous and autochthonous mollusk associations from freshwater and marine habitats. Some areas of the lagoon became exposed, thus enabling the development of vegetation on the substrate and generation of pedogeneic processes. Subsequently, a forced regression occurred when a fluvial system invaded the lagoon area, representing the beginning of deposition of the middle section of the Mata Amarilla Formation.

Variation of the coast line between the years 1969 and 2008 of the Fort Beach - Itamaracá Island, Pernambuco, Brazil

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The coastal environment in northeastern Brazil develops several ecosystems controlled by coastal dynamic agents, such as winds, waves or marine currents, tides, associated with the geology and geomorphology present. The energies that work on coastal environments force an adjustment in some quick, in coastal morphology, changing the profile of beach that change according to the morphological and sedimentological characteristics of each area. This dynamic interferes directly in the position of the shoreline and is characterized by variations in relative sea level, dispersal of sediments, storms, tides and especially the sediment. In areas where sediment supply is continuous, the result is the advancement of the position of the coastline. Unlike when the supply of sediment to the beach is smaller than the migration for both the inner shelf adjacent to the side, particularly if the bays are observed the retreat of that line and is characterized as an erosion process (Meek, 2003). For display, identification and monitoring of the evolution of the shoreline over the years been used images like Landsat quicklook and the Quickbirds and georeferenced aerial photography for the horizontal datum SAD 69 South area 25. The images were georeferenced and integrated using the software ArcGIS 9.2. The delineation of the coastline was made based on remote sensing images and aerial photographs. In this study we compared aerial photographs from 1969 and 1970, Landsat satellite images from August 2001 and quicklook Quickbirds of 2007 and 2008. Between the years 1969 and 2001 was observed an improvement of the coastline from the sea on the order of up to 153.8 meters. Already between August 2001 and January 2007 there was a setback, causing an erosion of about 94.6 meters. Between January 2007 and February 2008 there was some stabilization occurring but an erosion in the area closest to Fort Orange (about 60 m) and accretion of material with an advance of up to 38.6 meters in the far north. It is observed that between 1969 and 2008 there was an advance of the shoreline of the order of 130.1 meters, despite the erosion that took place between 2001 and 2007. The coast of Pernambuco despite suffering on a large area with the erosion problem, which most often is caused by human intervention, is composed of a natural protection, the reefs, which cut north to south the inner shelf, in almost the whole coast. In Itamaracá there is the practice of artisanal fisheries, where fishermen use the reef for the placement of "corrals" fishing (artisanal way to trap the fish). In mid-2001 these corrals were removed and replaced in 2003. It is shown that with the practice of fishing using this medium, has become a tool of protection to it, reducing erosion and contributing to the advancement of the shoreline toward the sea.

Coastal islands of Cabo Frio (Rio de Janeiro, SE Brazil) and their influence on the local sedimentation pattern

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The presence of islands in shallow as well as in deep waters results in the occurrence of typical oceanographic features. Islands may influence the local circulation by generating eddies, convergence and divergence zones; by promoting intense mixing of surface waters; by inducing local upwelling that changes the sub-surface distribution of nutrients, water temperature and, therefore, the biological productivity. In addition, islands may create either trapping or transporting mechanisms of suspended particulate matter (SPM), being of great interest in studies related to the dispersion of pollutants, larvae and eggs, and to the understanding of sedimentation processes, which affect the local topography. The study area lies between Cabo Frio e Cabo Búzios, Rio de Janeiro state, SE Brazil. This region trends roughly to NE-SW and it is characterized by the occurrence of sandy beaches of variable length that are separated by extensive rocky cliffs and promontories. These are mostly made up of Precambrian and Cambrian rocks that are intruded by igneous dykes and plugs of Meso-Cenozoic age. A series of offshore islands, also roughly trending to NE-SW, complete the coastal scenario. The outer limits of these islands lie at water depths between 20 and 30 m. The main goal of this study was to look for evidence of the coastal islands' influence on the local circulation, on the distribution of water properties as well as on the sedimentation processes. Field work was conducted in April 2008; data were collected in thirty-two stations distributed into seven transects roughly perpendicular to the coastline. The data set comprises current velocity and direction, seawater temperature, salinity and density, concentration of suspended particulate matter and bottom sediment samples. Because field work was conducted under fairweather conditions, water column currents were weak being more significant in the surface layer (maximum values around 0.1 m/s). A mixed surface layer approximately 5 m thick was identified; it was characterized by temperature and salinity between, respectively, 24.3 °C - 25.6 °C and 35.1 - 35.4. Nearbed currents were weaker (maximum values of 0.06 m/s) and a wider range of temperature and salinity values were documented (respectively, 15.8 °C – 25.2 °C and 35.2 - 36.6). Close to the surface, suspended sediment concentration varied between 0.33 and 18.8 mg/L; nearbed values oscillated between 0.32 and 29.9 mg/L. Carbonate content reached up to 80 % of the total weight of a few samples, mostly in the vicinity of the islands. Throughout the study area sediments are mostly fine to very fine sands, with local pockets of coarse silt and medium sands. Higher values of suspended sediments were associated with the presence of the finer-grained sediments and with flow constrictions due to the proximity of the coastal islands. Results obtained from the application of a Sediment Trend Analysis model (eCSedTrend, Poizot & Méar 2008) indicates that some of the islands play an important role in determining the pattern of sedimentation observed in areas shallower than 20-25 m.

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Origin of lamination in ancient microbialites: modern evidence for microbiocoenosis in precipitation and amalgamation of carbonate laminae

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The first appearance of microbially laminated stromatolites in sedimentary rocks as old as 3.5 billion year is generally accepted as evidence for the advent of the earliest advanced ecosystem, or microbiocoenosis denoting the microbial community within an ecosystem (Schopf *et al.*, 1983). In the early Archean, the interacting microorganisms lived together in a habitat under anaerobic conditions with organic matter supplied to the community by the earliest autotrophs. The simultaneous appearance of laminated stromatolites with the Earth's earliest ecosystem has long stimulated research to understand how the laminae formed and the processes leading to their accumulation and build-up to produce the stromatolite structures. The rock record, however, offers limited fossil biological evidence to evaluate the processes involved in the development of the ancient laminae. For this reason, the application of new methods and technologies to study the processes involved in the microbiocoenosis of microbial mats found in modern environments may provide important information to interpret and extrapolate geobiological data back into the geologic past. Recently, we have conducted extensive research into the ecosystem of modern lithifying microbial mats growing in Lagoa Vermelha, Brazil and their associated stromatolites. Furthermore, we have been able to cultivate the living stromatolites under controlled conditions in the Geomicrobiology Laboratory, ETHZ. The success of this long-running experiment has enabled us to follow the laminae development process within the microbiocoenosis of the metabolically active microbial mat. We can separate the distinct microbial levels of the mat on mm-scale and distinguish the in situ metabolic processes using microelectrode measurements. The microbial induced precipitation of carbonate layers within the biomass or extracellular polymeric substance (EPS) of the mat appears to be the first step in the process of laminae formation, eventually leading to an amalgamation of the discrete layers into a lithified stromatolite structure. To test this amalgamation model, we have applied Scanning Transmission X-ray Microscopy (STXM) and Near-Edge X-ray Absorption Fine Structure (NEXAFS) to obtain information on nano-scale variations of the molecular carbon K-absorption edge in the lithified stromatolitic laminae. This required that we calibrate the spectra of the major microbial constituents at three different micro-levels in the living microbial mat (cyanobacteria, aerobic sulfur oxidizing bacteria and sulfate reducing bacteria, including their respective EPS layers). Comparing these spectra with the spectrum for the lithified stromatolitic laminae demonstrates the importance of the metabolic activity associated with the overall microbial diversity of the microbiocoenosis. However, the dominant signal measured in the lithified stromatolitic laminae shows the best correlation with the zone of bacterial sulfate reduction and resultant carbonate precipitate, with a significant correlation also consistent with all measured EPS. This implies that the activity of sulfate reducing bacteria, metabolizing the organic matter (EPS) produced by (photo)autotrophs, is a critical factor promoting laminae formation. In other words, the zone of modern microbial laminae amalgamation, and hence laminae build-up, is associated with the anaerobic microenvironment, similar to the proposed conditions under which the very earliest stromatolites formed in the Archean (Schopf *et al.*, 1983). These observations may have important implications for understanding the distribution of stromatolites in space and time.

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The Intermontane Zapata basin, NW Argentina: Tectonostratigraphic evolution in the broken foreland

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The thick-skinned Sierras Pampeanas morphotectonic domain of W and NW Argentina (27°S–33°S) is characterized by a set of ~N-S basement ranges, which bound deep Neogene basins. These basins are known as intermontane basin systems and are common feature within the broken foreland of the Andes. However, although this region is the modern analogue for similar scenarios in the world, there are still many uncertainties about their origin and evolution. The Neogene stratigraphy of the broken foreland of Argentina suggests a clear event of deformation and exhumation of crystalline basement for the Late Miocene-Pliocene, traditionally associated to the arrival of the flat subduction. However, thick synorogenic sequences exposed in Famatina and Salar de Antofalla have revealed the presence of basement deformation as early as ~20-17 My (Early Miocene). In the NW end of the Sierras Pampeanas, immediately east of Famatina, the intermontane Zapata Basin (IZB) places within a transitional area between the early and late broken foreland stages. Although most studies have suggested the IZB is Late Miocene (or later) by correlations with the Fiambalá and Hualfin Basins, it preserves a volcanic marker recognized within the Lower Miocene successions of Famatina (in the “El Puesto” section, Tinogasta). The IZB is ~2.5km thick and dominated by playa-lake, aeolian, fluvial and alluvial deposits. The column is organized into two coarsening-upward sequences evidenced by two basal sections of distal alluvial strata overlaid by conglomeratic fluvial and alluvial beds. Provenance and paleocurrents indicate a source area and topographic relieves to the west. Yet, while the base of the basin preserved distal alluvial facies, proximal conglomerates derived from the Fiambalá basement dominate the upper sequence. On the base of sedimentology and stratigraphic descriptions, we propose the lower sequence is a lateral gradation of the coarser Famatina sections whereas the upper sequence has a very coarse and local provenance from basement highs exposed in the region. Thus, the lower sequence can be interpreted as a (a) distal foredeep filling occurred between the Lower-Middle Miocene (ca. 17-13 Ma) and the upper sequence as an (b) intermontane episode since the late Miocene to Quaternary. The boundary at ca. 13 Ma is based on an apatite fission- track age supplied by the Fiambalá basement (Carrapa *et al.*, 2006), which support a Middle Miocene basement exhumation, basinal fragmentation and development of the second sequence (clast compositions coming from the Fiambalá range). The volcaniclastic marker horizons in Famatina interfingering a coarser alluvial section, suggest an increase of the regional slopes in that direction within the lower megasequence, i.e., to the west, consistent with the regional paleocurrents and facies associations. This suggests the Famatina sections correspond to the proximal foredeep during the Early-Middle Miocene basin stage, associated to the exhumation of the Famatina basement (Cordon de la Cumbre belt). A later exhumation, intermontane folding and rotation of the upper sequence, controlled by the east- vergent basement thrusting along the Zapata range, evidence a tectonic activity occurred in the Late Pliocene - early Pleistocene, as suggested by Quaternary layers lapping onto the rotated basement blocks.

Holocene paleoenvironmental study of the Vellayani lake, Kerala, India

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Lakes preserve nearly continuous sediment record that holds signatures for understanding paleoenvironment and hydrological regime of the area. In this study the reconstruction of the palaeoenvironment of the lakes around Vellayani lake, Kerala, is presented. The area receives the south west monsoon. The bedrock exposed in the area are predominantly charnockites of Post Arcahean age and are overlain by the Quaternary ferruginous sediments. Two sediment cores of nearly 240 cm length were collected from the Vellayani lake site and the core sediments were analyzed for mineral magnetic study, loss of ignition, major oxide analysis, trace element and REE data to decipher the provenance and paleoenvironmental changes during the Holocene period. Textural analyses indicate that the silt percentage is high compared to the clay content and this corroborates well with high alumina content. The main source of Al_2O_3 is fine silt and clay. Occurrence of clay layers reveals quiescent, stagnant water condition. High organic content in the clay layers indicate reducing environment. Nickel is mobile under reducing conditions and between 50 and 170cm depth it shows an increasing trend. The decreasing trend of zinc in the core indicates that the mobility of zinc is less. REE data reveals negative Eu and Ho anomaly and a positive Eu anomaly. The LREE enriched pattern with negative Eu anomaly point towards sediment contribution by the weathering of the post Achaean rocks. Magnetic minerals like hematite and magnetite are formed due to the oxidation and reducing condition in the environment. Based on magnetic susceptibility data the sediment cores can be divided into three zones. The first (A) (upper part of the core thickness 50 cm) and third zone (C) (lower part of the sediment core 70 cm thick) reveals high hematite content. The X fd% of the sediments reclines between 5 and 10% which indicate large fine viscous magnetite component of SP range. The second zone has X fd% less than 10% points towards magnetite component of SP range. Low ARM/SIRM value indicates high magnetic component however in both the sediment cores the ARM/SIRM is very high in Zone A and zone C substantiating the X fd values and the occurrence of high hematite content. Occurrence of hematite implies oxidation which occurs when the iron minerals are exposed to the atmosphere in an semi-arid environment. Based on our data paleoenvironment of the region around the Vellayani Lake fluctuated between semi arid and semi humid conditions.

Lowstand compartmentalization of non-marine depositional systems: the case study of the Hauterivian Avilé Member in central Neuquén Basin, Argentina

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The Avilé Member of the Agrio Formation is a non-marine unit developed due to a major relative sea-level fall that almost desiccated the back-arc Neuquén Basin during Hauterivian times. It has a wedge shape ranging from a few meters in marginal areas to over 150 m in the central basin, and its lower boundary is a major regressive surface that puts non- marine deposits on top of deep-marine shales all across its extension. The upper limit of the Avilé Member is a transgressive surface that marks the re-establishment of the deep-marine accumulation in vast areas of the basin. Internally, the Avilé Member is dominated by a complex interaction among non-marine depositional systems. Five major associations were identified representing different settings, including bedload and mixed-load dominated fluvial systems, aeolian systems and lacustrine systems (normal and hypersaline). Two different non-marine palaeogeographic settings are defined from the regional distribution and the vertical evolution of sedimentary environments. The western sector is characterised by a northward flowing fluvial system that shows a longitudinal evolution from bedload dominated sandy systems down to mixed-load, high sinuosity systems. Downstream, the fluvial system evolved into an open, clastic lacustrine system, where coarsening upwards cycles are inferred to represent lacustrine deltaic progradation. Upstream, the unit records an alternation of bedload and mixed-load fluvial systems, reflecting high-frequency changes in the accommodation/supply relation. Eventually, the fluvial system evolves into a lacustrine system indicating a vertical evolution to conditions dominated by an increase in accommodation or a drastic decrease in sediment supply. In the eastern sector, a different lateral and vertical array of sedimentary environments is recorded. A hypersaline lacustrine system with reduced clastic input is developed in downstream areas, which evolved from fluvial deposits that indicate the complete desiccation of this part of the basin. This system is not fed by a well-developed fluvial network, but it laterally relates to a dry aeolian system. A vertical cyclicity is also defined in these deposits recorded as coarsening- upward cycles in the lacustrine system and super surface formation in the aeolian environment. On top, a fluvial system is developed represented by amalgamated channels upstream and isolated channels with preservation of floodplain deposits in downstream areas. The differences between the sedimentary environments developed in the eastern and western sectors of the study area reflect a strong compartmentalization of non-marine systems. Most of the water and clastic input was routed towards the western area, while in the east a shallow hypersaline system was developed with reduced clastic input and laterally related to an aeolian system. Both areas seem to react effectively to short-term changes in accommodation/supply conditions developing an internal cyclicity that can be associated with high- frequency changes in base level. Also these two sectors seem to evolve into wetter conditions associated with higher base levels that may indicate a gradual climate change or the influence of a transgressive trend that ends with the complete flooding of the non-marine system. However, while in the western sector the unit ends with the accumulation of lacustrine deposits, in the eastern area both the aeolian and the lacustrine system are truncated by the development of a fluvial system. This contrasting response it is likely to represent the re- routing of the main fluvial system into the eastern sector. The differences observed within this lowstand wedge indicate that facies and stratigraphic organization within lowstands can be more complicated than during highstand and transgressive periods. Therefore, models based on the distribution of marine deposits may not predict the variability of non-marine deposits observed during lowstand periods.

From hyperconcentrated to debris flows: basement controls on sedimentary styles in a Miocene alluvial fan (Teruel Basin, Spain)

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Recent research on alluvial fan settings has emphasised the prominent role played by catastrophic sediment-gravity flows and prevalently unconfined waterflows on alluvial fan construction. Tectonic and geomorphic constraints on fan development concur in triggering sedimentary events with elevated sediment/water ratios, in contrast to more typically "fluvial" systems. The direct coupling between fans and their areally restricted, poorly integrated catchments lies at the root of this distinction. Generalized models of fan architecture in relation to allogenic controls are still a subject of debate in the literature, but analyses of process sedimentology in fan deposits can shed light on other important factors driving fan development, such as the geology of catchment areas and their expansion through time. An example is discussed here from the Teruel Basin (Tertiary, central Spain), where exceptional 3D exposures provide the full stratigraphic record of an alluvial fan that developed along the western tectonic margin. The system developed as a fully aggradational clastic wedge without significant unconformities or local incision, due to forced positive alluvial accommodation in an endorheic setting. The evolution of sedimentation through time in the fan is therefore represented in its completeness by the exposed stratigraphy. The system is divided into two distinct clastic packages, presenting a sharp, areally traceable transition. The lower package is dominated by conglomeratic strata in sheets and shallow lenses, massive to crudely bedded, ungraded to normally graded, with poorly developed fabrics and frequent bi- to tripartition in divisions with moderate to good sorting but no evidence for traction structures. Such stratasets are attributed to mainly unconfined hyperconcentrated flows, dominant during early fan development. A stratigraphic interval with notably abundant sandstones marks the abrupt transition from lower to upper fan package, which consists of alternating coarse and fine clastic units stacking in sheets continuous at outcrop over hundreds of meters. Mud-rich conglomerates are structureless, clast- to matrix-supported, poorly to very poorly sorted and present outsized clasts and generally poorly erosive boundaries. They are attributed to rheologically plastic debrisflows with high strength and competence. Interbedded fine clastic packages are dominantly composed of massive, poorly pedogenized claystones and subordinate clay-rich sandstones. Transport processes probably ranged from bedload transport of mud aggregates to clay-rich slurries in poorly confined flows and networks of very shallow braided channels. The vertical succession of sedimentary units in the fan exactly corresponds to an inverted stratigraphy of adjacent basement outcrops along the basin margin. Thick Triassic claystones of distal alluvial origin are here overlain by a thin sand-rich stratigraphic interval representing paralic and shallow-marine deposition, and overlain by a regionally extensive angular unconformity which separates them from a thick Jurassic association of platform to basinal limestones, marlstones and dolostones. The rheological and temporal transition evident in fan deposits, from dominant hyperconcentrated flows to frequent cohesive debrisflows dispersed within high volumes of muddy alluvium, was dictated by progressive unroofing and expansion of the catchment. The sharp, unconformable contact between Mesozoic carbonates and clay-dominated clastics triggered a sudden shift in bedrock sources. Progressive yield of highly erodible clayey lithologies strongly influenced the rheology of catastrophic sediment transport. Two perfectly conformable clastic packages composing the fan record this transition in their distinct facies associations and architecture.

Morphological and Microclimatic Slope Controls on Differential Mass-wasting Processes and Architectures (Atacama Coast, Northern Chile)

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Colluvial depositional systems are widespread components of subaerial landscapes, especially in tectonically active regions, and have recently attracted research attention as a new “frontier” in clastic sedimentology. Main emphasis is in general on periglacial and alpine settings, and on relationships between Quaternary slope stratigraphy and climate change. The Pacific coast south of Antofagasta (northern Chile) highlights the role of variable piedmont morphology, surface hydrology and microclimate as direct controls on local colluvial sedimentation in a hyperarid region. Complete surface accessibility of slopes is accompanied by continuous stratigraphic exposures at their base, following abandoned road works that cut laterally into footslope depositional sequences. This consents systematic and direct comparisons between active surface dynamics and the resulting sedimentary record. Five active morphological domains have been identified along the studied piedmont tract, with distinctive surface processes and sedimentary signatures, ranging from steep talus cones to debris-flow- and aeolian-dominated colluvial ramps to alluvial fan. In all domains, variable associations of mass-flow processes dominate in transferring clastic debris downslope. Slope morphology (height, gradient, and incision of bedrock walls), lithology, variable exposure to dominant winds, and the potential to concentrate and transfer surface runoff interact in complex ways in controlling sediment gravity flows and their interactions. The two steepest domains to the south are characterized by extreme gradients, an absence of catchments, maximum exposure to longshore winds and therefore scarcity of fines. Consequently, debris fall and grainflow processes dominate talus construction, with only minor resedimentation by talus creep and possibly incipient debris flow processes. Northwards, slope domains present a gradual reduction in gradient, development of confined catchments upslope, and a location in the lee of the highest local relief, with consequent widespread aeolian deposition. These factors result in abundant fines entrained with coarser debris during exceptional precipitations, giving higher cohesion to sediment-water mixtures and making debris flows the locally dominant process of sediment mobilization. Slope morphology prevents almost all debris-fall and grainflow events from directly reaching low heights along the distal piedmont and the coast, forming proximal, perched talus ramps that act as feeding reservoirs for debris flows when significant hydrological events take place. Spatial distribution, runout pathways and depositional architectures of debris flows along northern slope sectors are well differentiated and predictable, depending on interactions with local depositional styles of aeolian fines along slopes, and on the nature and location of runoff sources upslope. Our sedimentological study of the colluvial successions in this hyperarid setting illustrates the prominent influence of local piedmont geomorphology and microclimate variability on the spatial distribution and rheologic nature of mass-flow processes. This shows that changes in time-dependent allogenic controls, such as tectonics and climate, are not needed in all cases to explain variability in colluvial processes and architecture. In-depth facies analysis of presently active slope systems offers a valuable contribution to geohazard prediction and mitigation, allowing to spatially characterize and predict subaerial mass transport in terms of flow mechanics and event frequency.

Fluid-sediment interaction in open channel flows and turbidity currents moving over soft muddy beds

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The fact that the substrate of many environments consists of soft, muddy sediment has largely been ignored in many process-based sedimentological models, despite the fact that this is expected to have a significant impact on the flow properties and the ability of the flow to erode, transport and deposit sediments. This in turn is believed to affect the sedimentary facies, spatial distribution and architecture of sediment deposits. Therefore, it is timely to establish the differences between flows over hard, sandy substrates and soft, muddy substrates and to determine how this is expressed in sedimentary successions. Laboratory flume experiments, carried out at Bangor University, have been used to study flow characteristics of river-type flows and turbidity currents over muddy beds. For these experiments the degree of consolidation of the substrate, the flow velocity and the flow density have been varied to investigate the criteria for bed erosion versus coherent deformation without erosion and suspension collapse (*c.f.* Winterwerp, 2001) versus continuity of the flow, with possible acceleration. The specific aims of the experiments were to determine i) what happens to open-channel flows and turbidity currents when they move over a soft, muddy bed, both in terms of their velocity profile and turbulence structure; ii) what happens to the muddy substrates in terms of deformation and erosion, when they are subjected to open-channel flows and turbidity currents; iii) whether the conditions and physical threshold for suspension collapse for open-channel flows and turbidity currents can be quantified. To formulate diagnostic criteria for flow over muddy substrates, the laboratory work has been combined with field data. Observations of the continuity of single turbidity current events, erosional features and deposit geometry have been used to determine the interaction of the current with the underlying soft, muddy substrate.

Winterwerp, J.C. (2001) Stratification effects by cohesive and noncohesive sediment. Journal of Geophysical Research-Oceans, 106, 22559-22574

The isotopic composition of environmental elements and $\delta^{18}O$ - $\delta^{13}C$ in the four significant Neogene outcrops of the Santa Maria-Hualfín Basin (Cerro Pampa-Corral Quemado, El Cajón Valley and Santa Maria Valley), Argentina

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Four stratigraphic sections of the Santa María Hualfín Neogene Basin (Pampean Ranges of NW Argentina) were analyzed using $\delta^{13}C$ and $\delta^{18}O$ data taken from phreatic and edaphic concretions and fossil organic matter. The $\delta^{13}C$ and $\delta^{18}O$ compositions of phreatic concretional materials sampled with 20 to 30 m intervals in the Cerro Pampa, Corral Quemado, Cajón Valley and Santa María Valley stratigraphic sections, were determined in the Isotope Lab of the UFPe (Recife, Brazil). Most concretions are located in tabular bodies of siltstones and fine sandstones assigned to floodplain facies. The concretions are irregular to mammilary bodies a few centimeters long, isolated or grouped along an ill-defined level. In some cases it is possible to see mottled structures (with few root marks) located over the concretion level. Some concretions were collected in channel and crevasse splay facies. In this case, the concretions are elongated irregular bodies or vertical rhizoliths, occasionally related with root marks. Few paleosols horizons were logged in the Neogene successions and are defined by mottled structures, and rhizoliths, forming thin horizons (20-30 cm) with low lateral continuity indicating low maturity. The Cerling (1999) model defines an expression for the pCO_2 of the ancient atmosphere. The model is based in the isotopic composition of the organic matter contained in the sedimentary rocks and also calcretes (carbonate phreatic concretions). The global values for the 3-14 Myr interval were taken from the Ekart *et al.* (1999) tables. A model of the of Santa María-Hualfín Basin in the Miocene-Pliocene time span was calculated using the Cerling expression. The expression uses the mean pedogenic carbonate (δ^{13}Ccc) and/or organic matter (δ^{13}C OM), and estimates of the oceanic composition (δ^{13}Coce) for the 2-14 Ma span. The fraction of the carbonate evapotranspirated by the soil was estimated at 5.000 ppmv (Cerling value for similar paleoclimates). The carbon fractionation between the air and the ocean was estimated in 8 ‰ and the carbon fractionation between the organic matter and the carbonate concretions at 15 ‰. Using the Santa María- Hualfín Basin data for organic matter and Cerling estimates, the expression yields values of 765 ppmv of CO_2 for the 3-7 Myr and 898 ppmv for the 8-14 Myr interval. These values are close to the Ekart *et al.* (1999) data. The mean values of the δ^{13}Ccc in phreatic concretions are lower than in the organic matter yielding estimates completely out of the published range. It is possible that the concretions grew during a short time interval of soil development and were buried immediately, suffering modifications in isotope composition in the transition between the phreatic diagenesis into epidiagenesis. The values of the estimates with organic matter indicate a high carbon dioxide atmosphere during the Basin filling in the 3-14 Myr span. These atmospheric conditions point to extreme weather conditions associated with very hot summers with torrential precipitation coming from the southern Atlantic Ocean, alternating with long dry and cold winters. These aggressive weather conditions applied to low altitude plain located at the foot of the Puna and a much lower Andes Cordillera, created a savannah-like landscape that sustained a big and varied vertebrate fauna dominated by herbivorous forms.

Storm deposits in deep-water system: a Devonian example of Argentine Precordillera (Punta Negra Formation)

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The processes that control the sediment distribution from the shelf to the deep-water basin and their influence in the sedimentary deposition still generate debates. The sedimentary environments influenced by hybrid processes, controlled by storm and gravitational flows, are complex and poorly described in the literature. Instead, the tendency is to describe these systems in a simplistic way, without consider the relationship between the different processes. The Punta Negra Formation (PNF), generated in a foreland basin during the Devonian in the Argentine Precordillera, represents a mixed system composed by the intercalation of two distinct deposits: 1) Gravitational deposits formed by concentrated and turbulent flows; and 2) Storm deposits formed by high energy oscillatory flow. The gravitational deposits are composed by sandy sheet and channelized stacked beds. The sandy sheets are characterized by laterally continuous sandstone beds that in a large scale consist of elongate lobes with a convex-up geometry. Individual beds consist of massive ungraded to laminated (planar and ripple cross lamination), fine-grained sandstone beds. The stacked succession forms broad sand-sheets that can reach up to 7 km wide and 70 m thick. The sandy sheet deposits are interbedded with channelized and storm sandstones. The channelized deposits are characterized by thick, medium- to fine-grained sandstone beds laterally bounded by sandy siltstone overbank deposits. The unique channel-fill complex observed is composed by stacked succession approximately 50m thick and 100 to 150 m wide. It is composed by ten distinct channel-fill stages charactering beds with channelized geometry, plane on the top and concave on the bottom. Internally, beds may be ungraded throughout or laminated on the top. These deposits are caused by concentrated to bipartite gravitational confined flows. The storm deposits occur as discrete beds within sandy sheet deposits. Usually, the storm records are represented by individual beds, up to 2m thick, with Hummocky Cross Stratification (HCS). The external shape of these beds can be lenticular or plane at the bottom with a concave-convex geometry on the top. Internally, the beds are fine grained and may present either parallel or wavy lamination with thickness ranging from few millimeters to 2 cm. This lamines are characterized by a coarsening upward pattern, with very fine sand on the bottom and coarse, up to 1.5 cm in diameter, tabular grains (mica and/or vegetal fossil grains) on the top. The lamination may grade laterally and vertically to cross stratification that could be tabular, tangential or concave. The wavelengths of HCS can reach 5m. Eventually, the beds with HCS present unidirectional ripples and climbing ripples on the top. The deposition of HCS is related to oscillatory flows generated during storm events.in which the sand is carried from the proximal shelf area to the more distal area. During this process preexistent sediments are reworked generating high concentration of sediments available for the generation of the HCS structures. The PNF deposits represent a progradation of a shelf system (represented by Talacasto Formation) into a deeper gravitational dominated system. The presence of storm derivated structures and beds interbedded with purely gravitational generated beds indicates that the sedimentation occurred in between the fair weather and storm wave base. The understanding of the sediment distribution and the alternation of the depositional processes in PNF are very useful to comprehend actual and ancient deposits generated in such an hybrid environment, once the deposits generated in mixed system are very complex, the prediction of storms and gravitational events are almost impractical and the occurrence of these processes are very spaced for actual monitoring.

Paleoenvironment, mineralogy and geochemistry of Neoproterozoic aragonite crystal-fans from the Bambuí Group (Central Brazil)

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Neoproterozoic carbonate sequences are characterized by “anomalous” sedimentary structures, including sea-floor precipitates, represented by cement crusts and aragonite-pseudomorph crystal fans. These structures are interpreted as a result of post-glacial calcium carbonate oversaturation, which, on its turn, would be responsible for the negative carbon isotope signature of cap carbonates. Here we report new sedimentary and geochemical results on very well-preserved Neoproterozoic deposits of aragonite pseudomorph crystal fans at the base of the Sete Lagoas Formation (Bambuí Group, central Brazil). Aragonite-pseudomorph crystals occur in three different facies, including calm-water micrite-settling dominated facies, wave-influenced facies, and tide-influenced facies. The micrite-settling facies shows the highest abundance of crystal fans, arranged in centimeter-scale layers interfingered with the micrite matrix. Crystals and matrix show significantly different accessory mineralogy, the crystals presenting barite, iron-oxides and a higher amount of celestite and strontianite, considered to be diagenetic phases formed during the conversion of aragonite to calcite. Geochemical results, namely the Ce anomalies, are consistent with contrasted redox conditions for crystals, formed in more oxidized conditions, and micrite formation. The iron isotope results confirm such differences in redox conditions, crystal samples show more negative $\delta^{56}Fe$ values (-0.3‰ a -0.4‰) compared to matrix samples, with $\delta^{56}Fe$ values always higher than -0.2‰ Here we use geochemical, mineralogical and isotopic results to propose a biochemical model for crystals and micrite formation. In this model sulfidic waters occur in the pore space due to bacterial activity, generating an oxic-anoxic chemocline near the sediment-water surface. In the lower reducing zone, incomplete consumption of organic matter delivers excess alkalinity favoring precipitation of micrite with a light carbon enriched signature, and of sulfides as pirrotite and pirite. In such reducing conditions, Ba is soluble and no barite will form. Above the anoxic-oxic chemocline, a strong sulfate gradient may form favoring aragonite precipitation prior to calcite, and allows barite nucleation, as well as magnetite and hematite precipitation due to dissimilatory iron reducing bacteria. The bicarbonate ion source does not change significantly through the chemocline, producing similar $\delta^{13}C$ values for micrite (average –4.37 ‰) and crystals (average –4.08 ‰). Changes in redox conditions, however, were recorded by the Ce anomalies. Bacterial activity was probably the main mechanism of iron isotope fractionation at the base of the Sete Lagoas Formation during crystal/matrix pair formation. Dissimilatory iron reducing bacteria tend to deplete ^{54}Fe more than the sulfate reducing bacteria, leading to more negative values of $\delta^{56}Fe$. The typical magnetic minerals found in the crystal/matrix pair suggest that: 1) dissimilatory reducing bacteria activity induced magnetite and hematite precipitation associated with crystals, where we found more negative $\delta^{56}Fe$ values, probably above the chemocline; 2) micrite dominated layers less depleted in ^{54}Fe, forming mainly pirite and pirrotite below the chemocline, under sulfate reducing bacteria predominance.

Post-Glacial tephrochronology of Nahuel Huapi National Park, Northern Patagonia

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Nahuel Huapi National Park (41°S, 71°40'W) is under the strong influence of the numerous active volcanoes from the Central Southern Volcanic Zone (CSVZ). This portion of the volcanic arc extends from latitudes 37° to 41.5° S, following the Liquiñe–Ofqui fault zone. Strong westerly winds drive volcanic plumes to the east, depositing tephras in Nahuel Huapi area. Sedimentary records from lakes, exposures and archaeological sites preserve evidence of several explosive Late Glacial to Holocene eruptions from multiple sources. Mascardi (41° 20'S, 71°30'W) and El Trébol (41°04'S, 71°29'W) lakes, have been selected as reference records because of their continuity, time span (*ca.* 18,000 years) and good chronological control. Eleven tephras from Mascardi cores and fourteen from El Trébol record were fingerprinted according to petrography, shard morphology and major element composition. Trace and REE analyses were performed for Mascardi tephras. Results were compared with published data of lavas from Cordón-Caulle Complex, Osorno and Calbuco volcanoes. Bayesian methods have been applied to obtain chronological models for both cores, based on AMS dating and taking into consideration sedimentological and paleoenvironmental information of the sequences. Resulting age-depth models allowed precise dating of tephras. Additionally, a thick sequence exposed in the northern Nahuel Huapi area was studied, consisting of several tephras intercalated with paleosols overlying glacial deposits. Two radiocarbon ages from charcoal (7632 ± 228 BP) and fossil wood (7,400 ± 650 BP) date the base of the sequence. Four tephras were identified as good markers in Mascardi cores. A thick white dacitic coarse ash, dated between 15,915 and 15,463 cal yr BP has a distinctive composition and shard morphology. Two tephras mark the beginning and the end of the Huelmo/Mascardi Cold Reversal: a black basaltic andesite ash dated between 13,096 and 12,971 cal yr BP and a dark bimodal tephra (andesitic and dacitic glass) dated between 11,640 and 11,345 cal yr BP. Another marker, a basaltic andesite deposited during the HMCR, dates a seismovolcanic event occurred between 12,432 and 12,061 cal yr BP. A conspicuous thick white rhyolite-dacite hornblende bearing pumice overlain by brown basaltic-andesite scoria exposed in the northern area was correlated with its equivalent tephra in Trébol record. It is considered an excellent marker according to its distribution, thickness and chemistry and it is associated to a medium to large size explosive eruption of the Cordón-Caulle Complex dated between 2,070 and 2,325 cal yr BP. Mascardi record shows evidence of a period of explosive activity of Osorno volcano during the late Pleistocene-mid Holocene, after which it adopted the effusive style known for historic times.

Morphosedimentary characteristics and evolution of the Mar del Plata Submarine Canyon, Northern Argentina Continental Margin

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Geological-geophysical surveys performed in 2009 at the northern Argentina Continental Margin (Cruises LBIV R/V Puerto Deseado -Argentina Hydrographic Survey- and M78/3 R/V Meteor -Universities of Kiel and Bremen, Germany), obtained information on the morphology, sedimentology, structure and stratigraphy of the Mar del Plata Submarine Canyon (MPSC), which allow to advance further on the previous knowledge of the canyon origin and evolution. The MPSC dissects the continental slope at 38°S. It starts on the middle slope over the Ewing Terrace, which represents a contourite terraced feature. The canyon´s main channel extends for 100 km with a WNW-ESE direction at water depths between 1500-3900 m. The channel cross-section has a V-shape, is 700/1000 m deep, 15-25 km wide, has a longitudinal mean slope of 1:60 and very steep lateral walls with a mean slope exceeding 1:10 (even dipping more that 45º). Secondary features are shallow channels at the southern side of the upper canyon, and a large semicircular-shaped terrace at the northern side in the middle canyon at 2500/3000 m water depth. The secondary channels in the canyon's head area constitute a tributary network flowing in two directions, from the NW and SE. The tributaries flowing from the NW extend upslope reaching water depths of 700/800 m, whereas those from the SE are sub-parallel to the isobaths, the largest one located at the middle Ewing Terrace at 1000/1200 m water depth. The channels network develops inside a broad and topographically very subtle amphitheater-like feature (which surrounds the canyon´s head) that extends upslope reaching the 500 m isobath. Surface sediments around the MPSC are mainly olive gray muddy sands enriched in biogenic components and bioturbated. Gravels and coarse sand as well as large blocks of rocks of varied composition are common at the canyon´s head and uppermost canyon, whereas muds are present in the middle and lower canyon. Seismic stratigraphy as well as the regional disposition and internal configuration of major seismic reflections –in particular Reflector "N" (base of the upper Pliocene) which is concordant with the canyon topography and overlies in discordance the older reflectors-, suggest that the present MPSC was formed in the upper Pliocene and evolved during the Quaternary. However, stratigraphic evidences of incisions or paleo-channels show that oldest, presently buried canyons have also formed probably since the Eocene and then filled with sediments and definitively deactivated before the Pliocene. Sedimentary megastructures identified in the seismic records show the importance of turbiditic processes as major conditioning factors in the MPSC origin and evolution. Cores obtained near and inside the canyon contain records of turbiditic layers and debris flows. Specific analysis performed on cores samples reveal sediment instabilities indicating gravitational downslope sediment transport. The disconnection of the canyon´s head from the adjacent shelf suggests a MPSC origin mainly related to deep marine processes without any significant participation of fluvial or shelf processes. Bathymetric surveys carried out with the Parasound echo-sounder along the 70 m isobath were unable to find any incised (or even buried) valley connecting the shelf and the canyon. It is considered that submarine slides at the upper slope, as well as active dynamic processes related to interaction between longitudinal (contouritic) and transverse (gravitational) processes were significant in the MPSC formation and evolution. These processes could have been enhanced during sea-level lowstands when the high-energy nearshore environments were located closer to the upper slope, and therefore a larger direct sediment transfer to the canyon´s head was favored. On the other hand, highstands are considered as relatively quiet times for the canyon evolution. No evidences have been found of any relevant tectonic conditioning in the MPSC origin.

Triassic braidplain deposits and their potential as reservoir rocks. Examples from Spain and Morocco

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We have studied sandstones originating from the development of braidplain systems identified near the intermediate section of the two Triassic red bed successions located in the Tabular Cover of the Iberian Meseta (Spain) and the High Atlas (Morocco). Both examples are of great interest as outcrop analogues for active hydrocarbon reservoirs such as the TAGI in Algeria. Facies architecture in both settings, the braidplain sandstones have a common pattern of facies architecture. On a macroscale, the sedimentary dynamics gave rise to large tabular bodies with flat, well-delineated tops and bottoms, thicknesses ranging from 15 to 20 meters, and lateral continuity of tens of kilometers. Three environments can be differentiated within them: (A) channel, (B) sand flat, and (C) sand flat tail. (A) In the channel area, the flat bed of an upper flow regime is the base for dunes and megaripples that stack to form a series of thinning-upward sequences. (B) 80 % of these layers comprise huge sandy bodies interpreted as sand flats. On the macroscale, these sand flats form geometric bodies up to 1,000 m long and 500 m wide, producing geometries identifiable as tiered bars containing four building phases. The base shows a thick set of planar cross-stratification corresponding to a transverse bar on top of which the sand flat formed. Above that, there is a series of thinning-upward sets of planar and trough cross-bedding, suggesting that the subaerial accomodation space over the sand flat progressively decreased to become an island with rippled sands intercalating with ever-thicker layers of clay and silt. At the top, the succession seems to be cut by a slough channel. (C) Finally, a small proportion of these tabular beds corresponds to the transition between the two aforementioned settings. It is a zone characterized by significant shifts in the scale of cross-stratification, where a megaripple 30–40 cm thick can grade into mega cross-bedding several metres high. This structure is a delta foreset located on the sand flat tail. It is a response to the sand flat progression towards the channel, where the bedforms encounter an abrupt increase in subaerial accomodation space. Potential as resevoir rocks The lateral migration and constant growth of the sand flats also leads to constant changes in channel positions, which process almost entirely eliminates the flood-plain fines. The slough channel visible in the final development phase of the sand flats at their roof, and changeable with each flood event, is responsible for most of the erosion of the fines deposited during abandonment of the sand flat. These dynamics produced quite a thick layer of kilometric lateral continuity, no lateral barriers to fluid movement, and in which reservoir estimate is very accurate. The identification of these types of deposits in boreholes can also allow extrapolation of the discovery to sites several kilometres away, given the dimensions of the examples studied in Spain and Morocco.

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Mechanisms of biomineralization in hypersaline and open marine microbial mats

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Microbial mats are organosedimentary biofilm communities that greatly impacted the geochemical and physicochemical conditions on Earth through geological time. These laminated ecosystems are formed by a combination of processed, including biomass production, binding and trapping of sediments, and mineral precipitation. The lithified mats, or microbialites, date back possibly as much as 3.8 billion years, and are characterized by extremely high metabolic rates. Coupled to this, rapid cycling of major elements occurs, perhaps most prominently that of carbon, on scales that span micrometers to millimeters. On a microscopic scale, the biological activity of mat communities has changed the geochemical conditions through the formation of resilient biofilms that stabilize sediments though binding and trapping and in situ precipitation. The interpretation of fossil microbial mats in the rock record and, consecutively, assessment of their potential role in the alteration of Earth's geochemical environment through time is hampered by the poor preservation of these organic-rich structures. The preservation potential, however, can be enhanced through microbially-mediated lithification. The three key components of microbially-mediated mineral precipitation are: 1) the "alkalinity" engine (i.e., microbial community metabolism and environmental conditions impacting the calcium (or magnesium) carbonate saturation index); 2) the complex organic matrix comprised of exopolymeric substances (EPS); and 3) the coordination of community physiologies and sensing of environmental conditions (e.g., pH, oxygen concentration) through chemical communication, or quorum sensing. These combined geochemical-microbial activities provide conditions that allow specific microbialites to form, both on a macroscale as well as on a microscale (i.e., shape and composition of minerals). While mineral shape and composition may be a function of the EPS properties and therefore has the potential to reflect a specific signature of the microbial community, it is unresolved how, for example, a continuous lamina vs. clotted fabrics form. The cyanobacterial community, situated near the surface according to the ambient light conditions, provides the organic carbon for heterotrophs. All these respiring organisms (including "strict" anaerobes, such as sulfate- reducing bacteria and methanogens) display their maximum metabolic activity along a surface horizon that may lithify. Some ideas emerge how chemical communication may play a role in this, and how microbial signaling compounds may be used to detect specific environmental conditions and may allow synchronizing of intra- and interspecies metabolic activities. These recent observations and ideas are, however, merely a first step in the understanding of microbialite formation, and their potential to weather the diagenetic processes so that some of the biological signatures are preserved.

Geometric characteristics and evolution of a tidal channel network in experimental setting

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This work reports on a laboratory study that aims to reproduce a tidal channel network, in order to enhance the understanding of the morphodynamic evolution of the channel characteristics as the network expands and when it finally reaches equilibrium. A high-resolution laser system scanned the bed topography at different time steps creating multiple digital elevation models of the channel network. 270 individual channel segments are analyzed and cross-correlated in terms of their width, depth and length. The laboratory results show positive correlations between depth and width as well as between length and width of channel segments of the network configuration at final equilibrium. In a downstream direction, channels appear to widen more than they deepen, indirectly a sign that discharge has a stronger control on channel width than on depth. In contrast to fluvial drainage networks that commonly display fractal and scale-invariant behaviour, the geometric properties of the experimental tidal creek network shows scale dependence. Channel attributes exhibit consistent patterns of exponentially decreasing abundance, with increasing creek length, depth and width. The nature of the observed exponential distributions within creek attributes (width, depth, length) allows for statistical predictability of relative creek attribute dimensions downstream and through time.

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SCOPSCO – Scientific collaboration on past speciation conditions in Lake Ohrid

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Lake Ohrid is a transboundary lake shared between the Republics of Macedonia and Albania. With more than 210 endemic species, the lake is a unique aquatic ecosystem and a hotspot of biodiversity. The origin and the age of Lake Ohrid are not under debate to date. Both marine and limnic origin is proposed, and age estimations, which concentrate around 2 to 5 Myr, suppose that the lake is the oldest, continuously existing lake in Europe. This importance was emphasized, when the lake was declared a UNESCO World Heritage Site in 1979, and included as a target area of the International Continental Scientific Drilling Program (ICDP) already in 1993. Modern hydrology and sedimentation in the Lake Ohrid basin is controlled by a complex interaction of multiple processes, including counter-clockwise surface currents. However, Lake Ohrid appears to have reacted uniformly to climatic forcing on changes in catchment configuration, limnology and hydrology in the past as evidenced by contemporaneous changes in sediment successions from different parts of the lake basin. Extant sedimentary records cover the last glacial/interglacial cycle and reveal that Lake Ohrid is a valuable archive of volcanic ash dispersal and climate change in the northern Mediterranean region. A total of 12 tephra layers and cryptotephras spanning from the end of the Middle Pleistocene to the present were recognised so far. Interglacial sediments commonly appear as calcareous mud and glacial sediments are dominated by clastic material. Short-term climatic fluctuations are also recorded in the sediment successions and can be well correlated to other paleoclimate records in the Mediterranean. Initial quantitative inferences of past lake surface temperatures using the TEX86 paleothermometer revealed c. 5-6°C lower temperatures in the glacial compared with the interglacial periods. Seismic and sedimentological studies from subaquatic terrace levels at 32 and 55 m water depth point to significant lake level low stands and thus a significantly drier climate during MIS 6, MIS 5.5, and during the last glacial inception. These existing sedimentary records, however, are too short to provide information about the age and origin of the lake and to unravel the mechanisms controlling the evolutionary development leading to the extraordinary high degree of endemism. Concurrent genetic brakes in several invertebrate groups suppose that major geological and/or environmental events have shaped the evolutionary history of endemic faunal elements in Lake Ohrid. High-resolution hydroacoustic profiles (INNOMAR SES-96 light and INNOMAR SES-2000 compact) taken between 2004 and 2008, and multichannel seismic (Mini-GI-Gun) studies in 2007 and 2008 demonstrate well the interplay between sedimentation and active tectonics and impressively prove the potential of Lake Ohrid for an ICDP drilling campaign. The maximal sediment thickness is c. 680 m in the central basin, where unconformities or erosional features are absent. A deep drilling in Lake Ohrid is envisaged for 2011 and would help (i) to obtain more precise information about the age and origin of the lake, (ii) to unravel the seismotectonic history of the lake area including effects of major earthquakes and associated mass wasting events, (iii) to obtain a continuous record containing information on volcanic activities and climate changes in the central northern Mediterranean region, and (iv) to better understand the impact of major geological/environmental events on general evolutionary patterns and shaping an extraordinary degree of endemic biodiversity as a matter of global significance. For this purpose, five primary drill sites were selected based on the results obtained from sedimentological studies, tectonic mapping in the catchment and detailed seismic surveys conducted between 2004 and 2008. For the recovery of c. 680 m long sediment sequences at up to 260 m water depth a newly developed platform operated by DOSECC shall be used.

Coal occurrence in salt sediments, Carpathian Foredeep, Poland

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Badenian (Middle Miocene) salt series in Polish part of the Carpathian Foredeep are 30-100 m thick and contain intercalations of claystones and mudstones with anhydrite, rarely sandstone and conglomerate interbeds and they are referred as Wieliczka Fm. Carbonized plant fragments (e.g. cones, leaves) are known from numerous underground excavations in the Wieliczka salt mine. Their study lead to distinguishing 136 taxa of trees and shrubs (Lancucka-Srodoniowa, 1984). This paper presents new results of petrological investigation of coal substance deriving from the Wieliczka and Bochnia salt mines. Two forms of coal material from the profile of salt rocks have been distinguished after petrographical study: - coal layers and coal pockets in salt, - coal debris of xylitic coal and detritic coal in sandstone and conglomerate occurring within the salt series. Coal layers in both locations are of at least several centimeters in thickness and can be easily distinguished by blackish color and cubic cleavage. They are mainly made of rare type of lignite – gelific coal with abundant fine xylite. The gelific coal is composed mostly of gelinite maceral (eugelinite – 74%), whereas xylite is made of textinite (22%) and rarely of fusinite (3%). Pyrite (1%) is also found to be one of its ingredients. Coal layers and coal pockets in conglomerates are about several millimeters thick. They mainly consist of gelinite (81%) but its important components are also macerals of liptinite group (up to 15 %): cutinite (12%) descended from leaves, resinite (1%) that is fossil resin from gymnosperms trees and liptodetrinite (2%). Interesting form of gelinite is its striation that arose as a result of progressive filling of primary rock pockets and insect holes and burrows by organic gel. The petrographic composition of xylite fragments in sandstone in the Wieliczka mine and xylites from the Bochnia deposit are very diverse. They occur as chips, gravels and sand grains of up to 0,25 meter in diameter. There are also debris of detritic and gelinite coal (up to 20%). Xylites from the Wieliczka mine are gelified to different degree, however, from the Bochnia deposits are strongly gelified and have a zonal structure. Additionally the latter may contain abundant textoulminite and euulminite as well as ulminite. Semifusinite and fusinite continually converting into textinite are also their typical constituents. Xylite fragments are often impregnated with pyrite. Lithoclasts of detritic coal are composed of densinite (85%) with a small amount of gelinite grains (up to 5%) as well as macerals of liptinite group – cutinite and resinite (up to 6%). Additionally, they consist of fine grain pyrite and quartz. Coal material in both salt deposits is humic and it has a low rank of coalification. It consists of 61 to 65 % C – elemental carbon content, recalculated to dry and ash-free basis. The coefficient of random reflectivity of euulminite B is 0.22 to 0.26 %. That is typical for coal that is described as ortho-lignite C (ECE-UN 2003, ISO 11760: 2004). Coal in the Wieliczka and Bochnia mines are visibly allochtonous, coming from peat deposits that formed around marine salinas. The petrographical composition suggests salinized moores of fen type, generally forest swamp and open marsh. It is plausible that there were also raised bogs, evidently related to rheotropic, riverine zone. Organic material was washed off and then transported in the organic sol form by the streams and settled in water of salted water reservoir (coal layers) or it was transported to the reservoir in the form of lithoclasts of peat and organic detritus.

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Stratigraphic correlation between Corumbá (Brasil) and Itapucumi (Paraguay) groups

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The study of South American Neoproterozoic successions has improved the comprehension of the bioevolutionary, climatic and geotectonic phenomena occurred contemporaneously with the Rodinia supercontinent rifting. During this time interval, important subsidence cycles took place at the margins of Amazonian, Pampia and Rio de La Plata Cratons, leading to the deposition of carbonate and siliciclastic sequences in the newly formed basins. Units, as the Corumbá (in Brazil), Puncoviscana (in Argentina) and Arroyo del Soldado Groups (in Uruguay), contain important Ediacaran fossils represented by microfossils and skeletal organisms as *Cloudina* sp. and *Corumbella* sp. In this context, the Itapucumi Group is the less known Neoproterozoic unit and constitutes a gap in the knowledge of the geologic evolution of SW Gondwana. The Itapucumi Group occurs in northeastern Paraguay as a marginal belt and a sedimentary cover of the Rio Apa Block, a promontory of the Amazonian Craton. The Rio Apa Block is delimited at its eastern portion by the Paraguay Belt, a W- vergent thrust-and-fold belt, which is composed by the Ediacaran successions of the Corumbá Group. The Itapucumi Group is about 400 meters thick and comprises siliciclast rocks of the Vallemi Formation at the base, followed by limestones and dolomites of the Camba Jhopo and Tagatiya Guazu Formations, and capped by marls and pelites of the Cerro Curuzu Formation. Close to-the Paraguay River, this unit is metamorphosed at the chlorite zone of greenschist facies and intensely deformed, showing E-vergent thrusts and folds, opposite to those of the Paraguay Belt, located in the other margin of the block. This Western Domain of the Itapucumí Group is characterized by shelf successions of ooid-grainstones of the Camba Jhopo Formation, deposited as beach spits and proximal coastal facies. East to these outcrops, rocks of the Tagatiya Guazu Formation are not deformed and constitute an extensive cratonic cover comprised by lagoonal facies deposited in inter- to supratidal context, associated with microbialites and thrombolites containing *Cloudina* sp. fossils. Covering these successions there are pelites, marls and grainstones of the Cerro Curuzu Formation representing deep shelf depositional systems with siliciclastic contribution. The stratigraphic architecture of Itapucumi Group successions is similar to that described for the Corumbá Group which is formed by siliciclastic deposits of the Cerradinho, Cadiueus and Puga Formations at the base, superimposed by carbonate rocks of the Bocaina and Tamengo Formations, and the pelitic sediments of the Guaicurus Formation at the top. Sedimentologically, the carbonate units of the Corumbá Group are representative of shallow water shelf deposits grading into deep water successions in a transgressive environment, in the same way that lagoonal depositional systems grade to oolitic spits in the Itapucumi Group. Towards the top of both units, the presence of deeper deposits with siliciclastic contribution would be representative of retrogradational conditions, which characterizes a regional sea level rise. The presence of *Cloudina* sp. fossils in Tagatiya Guazu Formation reinforce the paleoecological and cronostratigraphic correlation with Tamengo Formation. Carbon isotope data from Itapucumi and Corumbá Groups gave positive values between +3 and +5 ‰ δ^{13} VCP-DB, corroborating the stratigraphic correlation between these units. In this way, the paleontological, stratigraphical and isotopic data support the correlation between Itapucumi and Corumbá Groups and suggest a contemporary sedimentary evolution. The opposite patterns of tectonic vergence between both fold-and-thrust belts could be explained by the Rio Apa Block acting as a rigid barrier during the Cambrian orogenetic event.

Calcite – aragonite transitions in speleothems from Morocco, controlling factors and palaeo-climatic significance

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Aragonite and calcite carbonate mineralogies co-precipitate in continental cave deposits (speleothems). As speleothems may provide excellent archives for paleo-climate reconstruction (e.g. Finch *et al.*, 2003), the environmental controls leading to either aragonite or calcite or a calcite-aragonite co-precipitation are of significance. At present it is assumed that the main factor driving aragonite precipitation is a high Mg/Ca ratio in the dripwater. Therefore, the presence of aragonite in speleothems has been assigned to increased evaporation and lower drip rates (Railsback *et al.*, 1994, Frisia *et al.*, 2002, Wurth *et al.* 2002) and consequently drier climatic conditions. In speleothems from southern France (Grotte de Clamouse) and Morocco (this study; Grotte de Chien Perdu and Grotte de Piste) calcite-aragonite transitions occur stratigraphically and laterally (Morocco). The speleothems from Grotte de Clamouse in France (McMillan *et al.*, 2005) show (stratigraphically) an increasing Mg/Ca ratio and $\delta^{13}C$ in the calcite towards the aragonite. Calcite-aragonite transitions were studied in detail in Moroccan speleothems. Geochemical transects involving $\delta^{13}C$ and $\delta^{18}O$ and trace elemental values are analyzed on a 0.1 mm resolution. From this, a well pronounced decreasing trend in $\delta^{13}C$ value within the calcite towards the aragonite is observed in stalagmite GP2. This pattern is normally in agreement with more humid conditions, and therefore difficult to explain. One explanation is an increase of secondary calcite towards the aragonite. In order to shed light on this rather complex issue, thin sections of aragonite-calcite transitions are investigated under a polarization microscope as well as under cathode luminescence. However, results from stalagmite GP2 indicate a primary radiaxial fibrous calcite (Neuser and Richter 2007). Observations on Moroccan speleothems obtained so far, are in direct contrast to data presented by McMillan *et al.* (2005). This suggests that oversimplifying interpretations must be avoided.

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Correlation between sedimentary and diagenetic environments, microfacies types and thermal properties of Calcalpine dolomites of the Vienna Basin (Austria)

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Triassic dolomites from the Alpine floor under the Miocene Vienna Basin were investigated. Like in their outcropping part the Calcareous Alps are subdivided by a series of nappes. From the Triassic successions of the "Goeller" and "Higher Calcareous Alpine" nappes predominantly Wettersteindolomite (Ladinian to Lower Carnian) and Hauptdolomite (Norian) were analysed, with the purpose to gain a relationship between different types of dolomites and their thermal properties for feasible geothermal characteristics, taking into account the dolomitization processes, facies differentiation and petrophysical aspects. The selected samples, covering different dolomite types of the Wetterstein- and Hauptdolomite formation, derive from deep wells of the hydrocarbon exploration and production. To evaluate depositional environments and diagenetic processes microfacies analyses took place by means of thin sections from dolomites of core samples. The different types of dolomites were distinguished by size and habitus of the crystals, intensity of dolomitization, sedimentary and diagenetic structures and the occurrence of microorganisms. X-ray diffractometry revealed the mineral composition, the coexistence with other mineralizations and the Mg^{2+}/Ca^{2+} ratios of the various phases of dolomitization. To determine the essential thermal properties, laboratory measurements of the following parameters took place: porosity, density, thermal conductivity and thermal capacity. Thermal conductivity measurements were conducted under several different conditions: in a natural state after collection, in a dry state and under saturation by high saline water. Additionally, in order to identify and quantify the effects of anisotropy, the measurement orientation of the samples relative to their coordinate system was changed to take care of bedding or cleavage planes. The sedimentary and diagenetic environments of Wetterstein dolomites are the reef and lagoonal areas of the Wetterstein carbonate platform with supratidal to subtidal depositional conditions. The early to late diagenetic environments resulted in dolomicrites, fine grained bedded dololaminites and massive dolomites without lamination or internal structure. At equal chemical composition the higher thermal conductivity of the massive dolomite with an amount of about 5,4 W/(K*m) can be predominantly associated with the increase of grain size and the lower porosity of this dolomite type in contrary to the laminated dolomite. Regarding the relationship between tectonical and sedimentary dolomite breccias of the Wetterstein formation, the analysed calcite cemented tectonical breccia had a 10 to 30 percent lower amount of thermal conductivity. The microtextural types of the investigated Norian Hauptdolomite consist of stromatolitic dolomites, often with fenestral texture, microcrystalline and crystalline dolomites without sedimentary structures and the brecciated dolomites. Intercalations of claystone and the presence of evaporites have to be taken into account. The variation of thermal conductivity of the analysed Hauptdolomite types related to different sedimentary and diagenetic environments ranges from an amount of 2,9 W/(K*m) to 4,7 W/(K*m). The thermal properties of the selected samples give additional information at the first time about the thermal potential of the mostly rather thick dolomites within the carbonate platforms of the different tectonic units of the Calcareous Alps and may be used as a guideline for future geothermal utilization.

Carbon isotope stratigraphy: positive excursions and negative spikes – lessons from the Mesozoic

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The use of carbon-isotope records in marine carbonate and organic matter as a paleoenvironmental and stratigraphic tool has been proven in numerous studies over the last 30 years. The Phanerozoic C-isotope curve is punctuated by several negative carbon isotope spikes often related to sudden addition of light carbon to oceans and atmosphere. The spikes at the Permo-Triassic Boundary, the Smithian-Spathian boundary, the Triassic-Jurassic Boundary, the Toarcian, the Early Aptian or at the Cretaceous-Paleogene and Paleocene-Eocene transition have been recognized in different sections on a global scale. They are interpreted as short-term perturbations of the global carbon cycle and sudden addition of light carbon from volcanic and/or methane sources are considered as the major cause of these anomalies. Negative spikes can be used as prominent stratigraphic markers and they can be traced from pelagic settings into coastal environments. They often coincide with pronounced changes in coastal and pelagic sedimentation. Changes include biocalcification crises, extinction of marine biota and changes in sea level and in climate patterns. The synchronous change in sedimentation and in carbon cycling suggests that sudden addition of light carbon had an impact on climate and on oceanography. A further negative spike dated as mid-Oxfordian in age and considered as a “methane spike” triggered controversial discussions. This negative spike has been documented in several sections from the Tethys realm, while it seems missing in other sections of Oxfordian age. A close look at Oxfordian chemostratigraphy shows that the negative spike follows a well-documented and precisely dated positive excursion in the Transversarium ammonite zone, which can be used as a stratigraphic marker. If the debated negative spike in the Oxfordian carbon isotope curve is of global extent or if is related to diagenesis and hydrocarbon seepage remains open. Local negative spikes in the carbon isotope curve can be caused by transient enhanced precipitation of carbonate depleted in C-13 and mediated by anaerobic oxidation of methane as documented from local methane seeps in the Jurassic Tethys Ocean.

Pelagic sediments – archives of unstable mid-Cretaceous oceanography and climate

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Mid-Cretaceous pelagic sediments deposited in the Tethys Ocean provide a record of profound change in oceanography and climate. Alternating black, green and red pelagic sediments were deposited in the deep western Tethys Seaway during the Aptian and Albian. They were replaced by white pelagic foraminiferal limestone of Late Albian-Cenomanian age. Black-green-red pelagic sediments of the Aptian-Albian manifest orbitally driven changes in oceanography. Superimposed on these cyclic changes are several Oceanic Anoxic Events (OAE 1a-1d). OAE's coincide with high-amplitude positive carbon isotope excursions and with the formation of "Large Igneous Provinces". Volcanism is therefore considered as a trigger of C-cycle perturbation. Resulting greenhouse climate forced Cretaceous Oceans repeatedly into an "OAE mode". A detailed isotope geochemical investigation of the beginning of Oceanic Anoxic Event 1a demonstrates how a prominent negative spike at the very base of OAE1a was caused by rapid increase of atmospheric pCO_2 derived from a volcanic source. A change of up to 8 permil in C-isotope fractionation between marine a terrestrial biomarkers and marine carbonate within a few kyr records a rapid increase of atmospheric CO_2 concentrations. The Aptian greenhouse pulses had an impact on hydrological cycling, on weathering and erosion patterns. A coastal low-latitude section of the Central Atlantic outcropping in S. Portugal records how increased weathering during the Early Aptian OAE1a resulted in the deposition of quartz-rich sandstone and of early diagenetic kaolinite. During Aptian to Albian times, the studied coast was located near the boundary between the tropical-equatorial hot arid belt and the northern mid-latitude warm humid belt, which roughly correspond to the Southern Laurasian and Northern Gondwana floral Provinces. Episodes of increased accumulation of siliciclastics are recorded all along the low-latitude Tethyan seaway during the Aptian and they can be linked to intensified chemical weathering and hydrological cycling triggered by warm and humid conditions. Shifting of humid and arid climate belts can be traced into the Asian continent (Mongolia – NE China - Korea), where a humid pulse with lacustrine sediments of Aptian-Albian age seems to coincide with the time of most extreme greenhouse conditions. Change in Aptian carbon cycle and pCO_2 was accompanied by a widespread biocalcification crisis affecting both open marine and coastal biocalcifiers in mid-latitude environments. The synchronicity of neritic and pelagic calcification crises suggests that widespread choking of biocalcification was triggered by ocean acidification. High temperatures could have outcompeted the acidification effect in warm low latitude oceans.

Provenance changes in Ediacaran sedimentary successions in the eastern border of the Río de La Plata craton, south Brazil

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This abstract reports the application of major, trace, and rare earth element geochemistry to twenty sedimentary samples of the "Camaquã Basin" of south Brazil, in order to recognize possible changes in provenance pattern in the Ediacaran Maricá (~630 to 600 Ma) and Bom Jardim (600 to 570 Ma) successions. These units record the transition between a marine scenario of isolated landmasses and a continental panorama within the context of the amalgamation of western Gondwana, during the evolution of the Brasiliano/Pan-african orogenic cycle. The studied sections crop out in the Sul-rio-grandense Shield of south Brazil, near the eastern border of the Archean/Paleoproterozoic Río de La Plata craton. Samples representing the Ediacaran, coastal-marine Maricá succession plot between the island-arc and active continental margin fields in the K_2O/Na_2O vs. SiO_2 tectonic discrimination diagram, and in the island-arc field of the diagrams involving TiO_2, Fe_2O_3(T) and MgO contents. Ternary La-Th-Sc and Th-Sc-Zr/10 diagrams show that the samples of the Maricá unit have a continental island-arc character. Moreover, the Maricá samples are situated around the baseline of the upper continental crust field in the Th/Sc vs. Zr/Sc diagram. All these geochemical features, and the absence of negative Eu anomalies, suggest the source areas of the Maricá sediments evolved in arc-related settings. Integration with Sm-Nd TDM ages up to 2.3 Ga allows to propose the arc-related Paleoproterozoic TTG rocks of the eastern border of the Río de La Plata craton as the dominant sediment sources. Two sectors of the alluvial, continental Bom Jardim succession show opposite geochemical behavior. In the western Irapuá outcrop sector, located near Neoproterozoic ophiolitic sources (the São Gabriel belt, 800 to 700 Ma in age), samples plot inside the ocean island arc field of all tectonic setting diagrams. Moreover, Th/Sc ratios are systematically below 0.6, and Cr/Th is above 20. These values, together with MgO contents higher than 2.5%, point to a significant influence of mantle-derived rocks. In the La-Th-Sc and Th-Sc-Zr/10 ternary plots, Irapuá samples plot also in the vicinity of the ocean island-arc fields, directly linked with oceanic plateau samples of the São Gabriel belt. In the opposite basin margin, the eastern Piquiri outcrop sector has sedimentary samples with a mixed character between the passive and continental active margins in tectonic diagrams, suggesting more evolved source areas. Contents of Cr and MgO are very low, and Th/Sc ratios (around 2,0) are clearly positioned in the upper continental crust field of the Th/Sc vs. Zr/Sc diagram. Trace elements and REE also display continental signature, with negative Eu anomalies and near the passive margin fields of tectonic diagrams. This evinces the depositional basin (or basins), during the deposition of the Bom Jardim succession, was (or were) located between two very distinctive Neoproterozoic terranes, the western one formed by ophiolitic rocks of the São Gabriel oceanic belt and the eastern counterpart characterized by more evolved supracrustal successions recorded in the continental Porongos belt. Thus, considering the results and conclusions stated above, it was possible to clearly identify distinct geochemical behaviors in the studied sedimentary samples. The complex tectonic evolution of the Sul-rio-grandense Shield region during the Neoproterozoic, with Paleoproterozoic and Neoproterozoic terranes juxtaposed, is perfectly recorded in the geochemical composition of the "Camaquã Basin" successions. Geochemical analyses are, as seen here, a powerful tool for provenance studies in sedimentary basins of all ages, especially when integrated to petrography, detrital geochronology, and Sm-Nd isotope geology.

Gyrolithes in Holocene estuarine incised-valley fill sediments, offshore southern Vietnam

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Open *Gyrolithes* burrows occurring in Holocene firm mud deposited in ancient river valleys appear to be linked to fluctuating salinity in confined, incised valleys during the final stages of sea-level rise. Marine transgression resulted in the interaction of fluvial and tidal currents in a mesotidal setting leading to estuarine circulation. *Gyrolithes* were found only in confined valleys; they were not observed in wide valleys and tidal flat settings where thin transgressive deposits directly rest on very stiff paleosols. *Gyrolithes* traces post-date burrows with diffuse outlines, which implies soft sediment consistencies, but they pre-date burrows of the *Glossifungites* suite that are ascribed to fully marine conditions, while some of the latter have been actively filled by marine deposits. The pore-water composition of the *Gyrolithes*-bearing host sediment supports these findings, while exhibiting only 75%–95% of the marine chloride value. *Gyrolithes* are restricted to low-gradient parts of the shelf, implying that the estuarine conditions were stable for a time span sufficient for the *Gyrolithes* producers to establish themselves. Estuarine circulation provided an omission surface for a considerable length of time, while ebb tidal currents, especially during spring tide, provided increased current strength in narrow, confined valleys. The absence of *Gyrolithes* in other parts of the study can be explained by morphology, especially in wide valleys that are nearly unconfined or have a steep gradient. Alternatively, paleogeographical changes have been of importance, because the ancient Mekong River mouth shifted, and high sediment supply prevented the formation of an appropriate omission surface. The *Gyrolithes* observed off the southern coast of Vietnam were likely produced by the same type of organism as they are very similar with respect to size and geometry. The ornamentation of the burrow wall suggests thalassinidean shrimp as the burrow producers. *Gyrolithes* burrows are very abundant, because they have been encountered in similar settings in many small-diameter cores. In modern settings, *Gyrolithes* burrows are common in habitats subjected to strongly fluctuating conditions.

Paleosol-based paleoclimate reconstructions of Late Paleocene through Middle Eocene Argentina

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In the Salta Basin, northwest Argentina, the Maiz Gordo Formation has long been known to contain the Paleocene-Eocene (PE) boundary although the boundary's precise stratigraphic position has not been well constrained. Here we refine the position of the PE boundary in the basin using carbon isotope chemostratigraphy of paleosol organic matter and carbonate nodules: an amalgamated-paleosols marker zone is distinct from the calcic aridisols above and below it and is widespread in the basin across at least 200 kilometers in well-exposed sections. The paleosol zone also corresponds to coeval lacustrine highstand facies in the middle of the basin. A comparison is made to similar, well studied, and in many cases well dated, sections throughout North America and parts of Europe, and on a detailed literature compilation that includes sections on all continents except Antarctica. We present a conceptual paleoclimatologically-based model for the development of a geosol (widespread coeval paleosol): the late Paleocene-early Eocene represents the warmest event during the past at least 70 million years of Earth history during which time tropical soil-forming conditions expanded poleward in both hemispheres. Results from field measurements of depth to and thickness of calcic horizons, average diameter of calcic concretions, and an estimate of stage of calcic zone development are described for strata above and below the boundary geosol. Transfer functions (Retallack, Geology, 33 (4), 333-336) relating depth to and thickness of the calcic horizon to mean annual precipitation and mean annual range of precipitation are applied, respectively to quantify changes in Paleogene atmospheric hydrology in northwest Argentina. The results of major oxide analyses and the related Chemical Index of Alteration minus potash (CIA-K) climofunction (Sheldon *et al.*, Journal of Geology, 110 (6), 687-696) as an additional measure of paleoprecipitation rates are also presented. The records indicate an overall drying and decrease in seasonality leading up to the PE boundary, when maximum warmth and precipitation occurred, followed by fluctuating dry to seasonally wetter conditions in the Eocene. The Eocene record is punctuated by much wetter conditions high in our section which we preliminarily hypothesize is a record of the Early Eocene Climatic Optimum. In a very general sense our records appear to correspond to similar records generated from western North America (Retallack, see above), although our data indicate that Paleogene northwest Argentina was subjected to overall and episodically wetter conditions.

Giant submarine landslides offshore NW-Africa

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The passive continental margin off Northwest Africa is dominated by high terrigenous sediment input (fluvial and aeolian) and high primary production in upwelling areas. The redeposition of these sediments is controlled by both gravitational and bottom current induced along slope sediment transport. Some sections of the margin show repeated instabilities, while other regions are stable for a long time. Two prominent examples for large scale landslides are the Dakar Slide offshore Senegal and Sahara Slide offshore West-Sahara. Seismic data from cruise M58/1 in 2003 and new bathymetric data of the headwall area of the Sahara Slide collected during Cruise MSM11/2 show a megaslide with a length of 700km and an estimated volume of 600 km^3. The distal part of this slide complex is well studied, while data in the source-area are sparse. The age of the main slide event was dated on distal deposits to 50-60 ka. Available data of the source area indicate vertically stacked slide deposits and a relatively recent reactivation of the headwall. To investigate this observation in more detail additional data was acquired during the Poseidon P395 Cruise in February 2010. The headwalls of Sahara Slide were surveyed by several hydro-acoustic methods including high-resolution seismic reflection system, SWATH bathymetry and a deep-towed side-scan sonar system. Our investigation were complemented by gravity coring of the slide sediments. First results indicate that the headwalls and adjacent debris display several facies, but are all apparently young. The debris is overlain by a thin drape (4 to 10 cm) of modern sediments. Considering the average regional sedimentation rate of approximately 4 cm per millennium, the latest failure occurred about roughly 1 – 2 ka ago. Hydro-acoustic including high-resolution seismic data acquired during Cruise MSM11/2 in spring 2009 in addition to data from cruise M65/2 in 2005 reveal a giant submarine slide offshore Senegal named Dakar Slide. The slide exhibits headwalls of at least 90 km length along slope in water depths between 3.100 and 3.400 m. The northern sidewall runs for 90 km into the deep-sea where it reaches the distal part of the Dakar Canyon. Seismic data show that the distal part of the Canyon was repeatedly destroyed and filled by slide deposits. Erosion of these canyon fills indicates reactivation of the Canyon in the past. The area above the slide is not characterized by mass-wasting events although the slope (3°) is steeper than the slide´s slope (0.5-1°). A large scale "wavy" sediment structure is imaged beneath the northern head- and sidewall of the Dakar Slide in the seismic data. It covers at least 400 km^2 and is up to 1 km thick. The crests of the "waves" run parallel along the slope. We interpret this feature as rotated blocks separated by listric faults that root in a deeper detachment. They either represent pre-failure slow deformation or the laterally pushed deformation facies of the Dakar Slide. Upslope of this area between 1.300 and 2.000 meters, bathymetric and high resolution seismic data show additional signs for creeping in the form of down slope orientated bulges. The Dakar and the Diola Canyon border the slide and seem to restrict the failure´s along- slope propagation. Mass-wasting events prior to Dakar Slide were common as indicated by the repeated slide deposits filling the Dakar Canyon and the abundance of deeper lying acoustically chaotic to transparent units in the seismic data.

Large-scale submarine mass-wasting offshore Uruguay

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New geophysical data acquired during cruise M78/3 with RV "Meteor" in 2009 reveal large-scale mass-wasting along the passive continental slope offshore Uruguay. The slope failure is hosted in contouritic deposits between 1800 and 3300 m water depth, affecting an area of at least 1200 km². Two escarpments up to 100 m high run along the slope. Echo-sounding data indicate that they are headwalls of individual failures with associated acoustically transparent sediment bodies. Sediment cores recovered from 3 transects across the failure complex confirm that the acoustic transparent units are debrites. Structure and geometry of the failure complex is indicative for a retrogressive submarine slide. Sedimentological evidence in accordance with hydro-acoustic data indicate that debrites deposited downslope of this failure complex are recent (Holocene) features on the slope. The morphology of the headwalls is underlain by a deeper reflector which we interpret as detachment. The detachment probably correlates with a regional BSR (c.f. Tomasini *et al.*, 2010). Listric faults positioned upslope of these headwalls root into this detachment and are precursor of future failure at the location.

Tomasini, J., De Santa Ana, H., Johnson, A.H., 2010, Identification of New Seismic Evidence Regarding Gas Hydrate Occurrence and Gas Migration Pathways Offshore Uruguay, Extended Abstract for the AAPG 2010 Annual Convention & Exhibition, 11 – 14 April 2010, New Orleans, Luisiana, USA.

Holocene flood history of the Central Alps reconstructed from terrigenous layers in lacustrine sediments (FloodAlp project)

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Floods caused by extreme precipitation events represent a major natural hazard in the Alpine realm, involving enormous financial and social damage. In order to assess this hazard, knowledge about the natural variability of extreme flood events is required. Lacustrine sediments allow the reconstruction of flood recurrence rates in the past, with the great advantage that their records reach beyond the time span covered by instrumental and historic data series. The FloodAlp project aims to reconstruct the Holocene flood history of the Central Alps. We investigate 18 small lakes (0.01 to 3 km^2) along a North-South Alpine transect from northeastern Switzerland to northern Italy covering a wide range in altitude. This multi-archive approach eliminates only locally occurring events like spatially limited thunderstorms from the overall signal and gives evidence on the geographical distribution of the flood events. Sedimentologically, our approach is based on the mobilisation of sediment material in the catchment during intense precipitation events and the subsequent transport of this material in the river waters to the next downstream lake. The high density of the water-sediment mixture reaching the lake leads to the formation of underflows and finally to the deposition of flood-turbidite layers on the flat basin floor. Fundamental is the selection of appropriate lakes recording these flood events. The most important criteria are (i) a well-defined morphobathymetric depocentre where turbidity currents deposit their material; (ii) a certain relief around the lake in order to mobilise and transport large amounts of sediment material; (iii) the presence of geomorphological structures giving evidence for persistent detrital input in the past. Flood layers can ideally be identified and distinguished from the regular background sediments by visual observations on the split core surface and high-resolution image analysis. Additional chemical, mineralogical and physical methods such as analysis of bulk density, XRD patterns, grain-size distributions, as well as XRF core-scanning complete the characterisation of the sediments. For the Southern Alps, sediment cores from Lake Ledro, Ghirla, Endine (all N-Italy) and Cadagno (Switzerland) have been recovered. Flood records have been established for Lake Ledro (Trento province) and Lake Ghirla (Varese province) identifying in each lacustrine basin over 400 event layers. The age-depth models for Lake Ledro and Lake Ghirla are based on thirteen and eight radiocarbon ages, respectively. The thickness of the flood deposits varies between 0.1 and 37 cm and their coarsest grain-size fraction ranges from fine silt to coarse sand, providing additional information on the intensity of the flood events. Both flood records indicate distinctly increased flood activity during the Little Ice Age (100-400 cal yr BP) and between 2400 and 3600 cal yr BP. In contrast, the records show differing patterns of flood events in the early and mid-Holocene. Flood frequency in Lake Ledro is elevated between 6000 and 8000 cal yr BP, while Lake Ghirla shows periods with intense flooding between 4900 and 6000 cal yr BP and 8000 and 9800 cal yr BP. Enhanced flood activity in Lake Ghirla correlates with elevated aerosol concentrations in the GISP2 ice-core record and increased storminess reconstructed from lakes in the NE United States, giving evidence for interrelations between flood frequency and large-scale atmospheric processes. In Lake Ledro, flood activity can be reproduced by lake-level fluctuations reconstructed from littoral sediments, while the above- mentioned large-scale processes only show positive correlations in the late Holocene. Additional flood records from the Southern Alps and the comparison with records from north of the Alps will give further evidence on the regional and large-scale climatic processes controlling the variability of Alpine precipitation patterns.

Middle Cambrian microbial-metazoan reef, Zhangxia Formation, Shandong Province, North China

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Middle and Upper Cambrian reefs were constructed mostly by stromatolite and thrombolite because the previously flourished archaeocyaths went extinct at the end of the Early Cambrian, and new reefal metazoans did not evolve until the Ordovician. Although some sponges were reported from middle Cambrian reefs, their diversity was very low (mostly single taxon) and their role in the reef was limited. Here, we report relatively diverse reefal metazoan community from the Middle Cambrian Zhangxia Formation (Changhian Stage) and discuss their paleoenvironmental implications. The Zhangxia Formation in central Shandong Province consists mainly of oolite, bioturbated wackestone and microbial carbonates of thrombolite, dendrolite and stromatolites. Microbial bioherms in the lowermost part of the formation (*Crepicephalina* Zone) are characterized by metazoan community of sponges and octagonal cone-shaped organisms (OCOs, uncertain affinity). The reefs were built by stacks of several layers (about 20 cm in thickness) of microbial and metazoan buildups. Most of the layers formed by lateral train of small thrombolite and stromatolite bioherms containing calcimicrobes such as *Epiphyton*, *Renalcis*, *Angulocelluria* and *Girvanella*. Metazoan- rich bioherms usually occur along certain layers. The base of the metazoan-rich bioherm consists of coalescent small bioherms of thrombolite containing few sponges or OCOs. Large tube-shaped anthaspidellid sponges usually started growing on the top of the stabilized surface of this thrombolite aggregates. Attachment of smaller sponges and OCOs on the large sponges resulted in framework of reef body. OCOs usually showed pendent-style growth mode attaching to the lower surface or side wall of the large sponges. Large masses of *Epiphyton*, most likely, developed on the thrombolitic surface, coexisting with other metazoans. *Epiphyton* masses usually formed finger-like body with layered texture by arrayed short branches. Theses metazoan and *Epiphyton* masses have downward tufts of thrombolite and stromatolite. Stromatolite commonly encrusted large body of metazoan and microbial complex. Metazoans in this reef were members of the constructors and made a loose framework of the bioherm with solitary or rarely branching body, which was strengthened by microbial binders. The resulting framework with bush-like *Epiphyton* acted as a baffler to trap fine- and coarse-grained sediments. The reef abutted on bioturbated wackestone and intervening oolitic, oncolitic and skeletal packstone to grainstone in the southern end. Inter- filling sediment in the northern end is characterized by oolitic and oncolitic packstone to grainstone. The whole reef is overlain by oncolitic bioturbated wackestone. Common skeletal grains are articulate brachiopods and polymeroid trilobites which are frequently encrusted by microbial masses. These sedimentary facies around the reef suggest that it was located in the lagoonal environments which had enhanced energy regime around the reef. The reef community of Middle Cambrian Zhangxia Formation is relatively diverse compared to their time- equivalent reef communities. This is the earliest metazoan reef of the North China Platform and may represent an ecological stepping-stone between archaeocyath-rich Early Cambrian reef and sponge-rich Early Ordovician reef.

Reconstructing the palaeo-coastline of North Africa during the Early Cretaceous: new data from Libya and Tunisia

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The location and evolution of the palaeo-coastline of North Africa during the Early Cretaceous is, for the large part, poorly constrained. In Libya, most published literature indicates that the palaeo-coastline remained relatively stable and in close proximity to the present day shoreline throughout the Early Cretaceous. The southern region of Libya, which includes the Murzuq Basin, has been considered to be dominated entirely by non-marine continental facies. The more northerly Ghadames-Illizi Basin has also long been considered to be mostly dominated by continental sedimentation throughout the Neocomian–Early Albian, before a switch to carbonate dominated marine sedimentation during the Late Albian. New sedimentological data has been collected from outcrops of the Messak, Kabaw/Kiklah and the Sidi Aïch Formations (in southern and northern Libya and central Tunisia respectively). This work has identified numerous marginal-marine indicators within the Early Cretaceous suite, with potential marine influence extending many 100 kms into southern Libya. A previously unidentified marine transgressive facies association has been identified in the Messak Fm that correlates with coeval transgressive events recorded in Tunisia, N Libya and Egypt. This infers a much more widespread Early Aptian transgression across North Africa that extended in southern Libya to a similar palaeo- latitude to published interpretations of maximum transgression across southern Egypt. The data presented here represent the preliminary results from four field campaigns covering Libya and Tunisia. This poster questions the widely accepted interpretation of depositional environment of the widespread 'Nubian' sandstone lithofacies and provides evidence for a significantly more complex palaeo-coastline for the Early Cretaceous North African margin. Within this framework we also illustrate the difficulties in identifying continental fluvial from clastic dominated marginal-marine deposits in the rock record.

Carbon and oxygen isotopes of matrix from borehole 1317E of IODP 307, SW off Ireland: Indications to paleoceanography and paleoclimate of the coral mound development

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Carbon and oxygen isotopes of over 500 matrix samples from a 155-m- long section of the borehole U1317E, IODP Exp. 307, Porcupine Seabight, SW off Ireland, were measured to explore the changes in paleoceanography and paleoclimate for the Challenger Mound carbonate associated with cold-water corals. The $\delta^{13}C$ values vary in two stages: –0.6 to –5.0‰ in the lower mound (2.36 ~ 1.90 Ma), and –1.0 to 1.0‰ in the upper mound younger than 1.1 Ma; $\delta^{18}O$ values generally range from 1.0 to 2.5‰. Totally, these results indicate that $\delta^{18}O$ values are positive and $\delta^{13}C$ negative through the lower mound, which are consistent with the paleoceanography of the North Hemisphere since the 'Mid-Pliocene global warmth' event, and they are coincident with the initiation of the Challenger Mound above the base, demonstrating carbonate mound initiation and growth in a glacial climate. In the upper mound, the positive $\delta^{13}C$ regression suggests a possible linkage to the intensified mid- Pleistocene climate shift in northern North Atlantic. We try to interpret in detail as following. Lying in oxygen minimum layer, low bioproductivity and relatively cold water related to glaciation paleoclimate, could lead to the featured isotope values. Glacial sea level rising and falling are suggested to be responsible for the fluctuation of the isotope changes, which would have changed the temperature and salinity of oceanic current. However, in the upper mound, the $\delta^{13}C$ profile shows a positive shift across the disconformity between the upper and lower mound. The mid- Pleistocene climate shift in northern North Atlantic might be responsible for the $\delta^{13}C$ regression. More intensified glaciation in mid-Pleistocene climate shift generally felt sea level down and shallow the water depth of the mound summit, at which Mediterranean Upper Core Water could be one of the key factors to boost the carbonate mound and caused increasing $\delta^{13}C$ values in oxygen minimum layer. The profile of $\delta^{18}O$ values of the matrix is similar to that of planktonic foraminiferal test, partly in opposition during the glacial. The reverse $\delta^{18}O$ values seem conflicting with that cold sea-water causes the calcite $\delta^{18}O$ to increase. As we know, North Atlantic Deep Water production was reduced by lowest sea level when drift-ice increased in peak. The Labrador Sea Water withdrawal by North Atlantic Deep Water reduction left space for either Mediterranean Upper Core Water or Eastern North Atlantic (Central) Water upon the amplitude of the falling sea level. The Mediterranean Upper Core Water would have emerged the mound summit when sea level went down in 500-700 m, or Eastern North Atlantic (Central) Water replaced Mediterranean Upper Core Water when was above 500 m. Either Mediterranean Upper Core Water or Eastern North Atlantic (Central) Water, or both would have resulted in the relatively warmer and more saline water temperature in intermediate layering of North Atlantic, consequently, low $\delta^{18}O$ values are obtained and much more negative than these of planktonic foraminiferal.

Carbon isotopes of pedogenic carbonates from SE China: application to atmosphere pCO_2 changes in the mid-Cretaceous

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The anthropogenical modern industrialization greatly rising the concentration of atmosphere carbon dioxide (pCO_2) is an incontrovertible truth. However, it is not assured that its contribution to greenhouse is the key contribution, and its effect on future climate is less certain. The state of arts makes people appeal the counterpart in geological time, so that the reconstruction of ancient pCO_2 has been developing by different techniques and methods such as modeling, fossil stomata and plant, paleosol proxy, etc. The problem is that fewer causes leading to the higher pCO_2 in the Paleozoic and Mesozoic than in the Quaternary have been discussed since reconstruction techniques and result reports of pCO_2 have been the main tasks in paleoclimatology until present. By CO_2 paleobarometer of pedogenic carbonate, two big problems in the Paleozoic and Mesozoic: (1) the pCO_2 are much higher than estimates by fossil stomata (Royer, 2006); (2) the ages of ancient pCO_2 results are inaccurate and conjectural due to lack of dating materials within continental lithofacies, which may result in mistaking correlation, perhaps except for those in the latest Cretaceous by paleomagnetic chrons. The first problem seems solved by using the parameter S(z) 2500 ppmV (Breecker *et al.*, 2010), and the second one needs to be overcome by precise dating. So is in the Cretaceous. There is almost no pCO_2 reconstruction in China except for a report on two horizons of the mid-Cretaceous from the Lhasa terrane in Tibet (Leier *et al.*, 2009) although lots of the middle-late Mesozoic continental sediments are widespread all over the mainland of China. In recent work we use new carbon isotope data of the pedogenic carbonates from Zhejiang and Jiangxi, SE China to estimate the pCO_2 in the late Early Cretaceous with a finer age confine by U-Pb isotope measurements on single zircons taken from intercalated volcanic rocks, and try to explore the linkages of changes to geological events. The equation of the Cerling model (Cerlin, 1999) was used to calculate the pCO_2 in this study, and 2500 ppmV was used to the S(z) parameter as Breecker *et al.* (2010) newly suggested. The carbon-isotope proxy of these carbonates suggests pCO_2 mostly ranging from 1000 to 2000 ppmV during the Hauterivian–Albian interval (ca. 30 Ma duration). Such high values support the concept of a mid-Cretaceous greenhouse climate. These results for pCO_2 are on average higher than those established by studies of stomatal indices and by biogeochemical modeling. Major changes from lower to higher pCO_2 were recognized as three distinct events during the early Aptian, early Albian and late Albian respectively. These events may be broadly correlated with extrusion of Large Igneous Provinces such as the Ontong Java Plateau and the Kerguelen Plateau, potentially involving expulsion of large volumes of volcanogenic CO.2 into the atmosphere. The Oceanic Anoxic Events 1a (early Aptian), 1b (early Albian), and 1c-1d (late Albian), characterized by widespread marine organic-carbon burial, must have moderated these effects by drawing down the levels of atmospheric carbon dioxide.

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Deposits of deep-water oscillatory flow generated by internal waves in the Xujiajuan Formation (Middle Ordovician), Xiangshan Group, Ningxia Autonomous Region, China

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The Xiangshan Group (Middle to Upper Ordovician; 1600–10000 m thick) consists predominantly of deep-water turbidity current deposits and can be divided into three formations: the lower Xujiajuan Formation, middle Liangzuizi Formation and upper Mopanjng Formation. The deposits have been described as flyschoid or "Qingtongxia" flysch for its very fine- grained sandstone and the relative lack of Bouma sequence. The Xujiajuan Formation (the lower part of Xiangshan Group; Middle Ordovician; 500–2800 m thick) mainly consist of very fine-grained sandstone, grayish green, medium- to thick-bedded, low-grade metamorphic, interbedded with yellowish to grayish green shale (slate), and at the top, with some thin beds of dark gray limestone alternating with shale or very fine-grained calcareous sandstone. Recently, it has been proposed that internal-wave and internal-tide deposits as well as deep-water combined-flow deposits are developed in the upper part of Xujiajuan Formation, according to the bi-directional cross-beddings and combined-flow-ripple laminations in deep-water environment respectively (Li *et al.*, 2009, 2010). Some wave-generated structures, such as undulatory laminations, offshooting laminations (in terms of Raaf *et al.*, 1977) and cross-laminated lenses, which associated with bi-directional cross-beddings or combined-flow-ripple laminations were discovered based on careful field observations. There are two host lithologies, one is grayish white, yellowish green, thin- to medium–bedded, fine-grained calcareous siltstones, and the other is light gray thin-bedded silty limestone enclosed in grayish green, medium- bedded shale, with irregular base contact and long lens shape. Here we focus on the origin of these wave-generated structures, and interpreted as the interactions, near the wave base, between submarine topography and deep-water oscillatory flow generated by internal waves and internal tides. The evidence is as follows: 1) these deep-water sedimentary structures share the same characteristics with some wave-ripple beddings generated by oscillatory flow in the nearshore marine settings; 2) the environment where these deep-water sedimentary structures form is well influenced by internal waves and internal tides; 3) the grain size in host lithologies suggests that the capacity of deep-water oscillatory flow for translation and deposition coincides with the energy of internal waves and internal tides. The internal-wave and internal-tide deposition is a new research field in the deep-water deposition. Bi-directional cross-beddings, which were generated by alternating bi-directional currents, have been documented clearly for the typical sedimentary structure of internal-wave and internal-tide deposits. The undulatory laminations, offshooting laminations and cross-laminated lenses in deep-water environment documented here, perhaps proposed a new perspective in the mechanism of internal-wave and internal-tide deposition.

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Oxygen isotope ratios of tridacnid shells as archives of daily SST variations

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Tridacnid shells have following advantages as a proxy for paleoenvironmental changes: 1) Tridacnids have symbiotic algae in their tissues and the clams grow fast in shallow water environments. Thus, solar radiation affects symbiotic activity, and its intensity and variations are reflected as daily growth rates in the shells, 2) The shells have fine growth bandings (several to dozens µm in width), each corresponding to a daily growth increment. Thus, daily records of their growth environments, such as not only solar radiation but also water temperature, salinity, and rainfall, can be retrieved, 3) The rapid growth rates and the finer growth bandings allow us to detect geochemical records with high temporal resolution and reliable chronology from the shells, 4) Since the shells form in oxygen-isotopic equilibrium with ambient seawater, changes in water temperature and salinity can be easily calculated without considering modification of the isotopic composition due to vital effects, 5) Their dense shell structures are less susceptible to diagenetic alternations. In order to evaluate the availability of their oxygen isotopic ratios as a proxy for water temperature and salinity, we examined growth bands and oxygen isotopic profiles of two specimens of tridacnid. One (*Tridacna derasa*) was cultivated at the Ishigaki-jima Branch of Okinawa Prefectural Fisheries and Ocean Research Center, Ishigaki-jima, southwestern Japan. This specimen was cultured in a coral reef near the center and sometimes in a water tank. Another specimen (*Hippopus hippopus*) was cultured in a water tank at the ''Aquarium des Lagons'', Noumea, New Caledonia. The tank was placed outside and environmental variables such as water temperature, salinity, photon density flux, and isotopic composition of seawater were measured. Each shell was cut along its growth axis. First, we examined whether $\delta^{18}O$ values of carbonates deposited onto shell surface at a given time was different by location in a shell or not. Oxygen isotopic ratios of the specimen of *Tridacna derasa* along five different growth axes, one line in the extrapallial shell near the umbo, three in the inner shell and one in the outer shell, were analyzed and were compared with each other. The isotopic profiles show a regular cyclic pattern and average values of the profiles are similar. This result indicates that $\delta^{18}O$ values of shell carbonates will be uniform in a transverse direction. Then we tried to remove shell carbonate of a daily growth increment using a micro-dissector and measured its $\delta^{18}O$ value by conventional acid-decomposition method. Although this equipment allowed us to remove a daily growth increment of faster growing specimen, we removed shell carbonate deposited in several days because growth rate of the shell used in this experiment (*Hippopus hippopus*) was slow. Each date of the carbonate deposition was estimated by sclerochronological method and oxygen isotopic composition of the carbonate was compared with that of aragonite deposited in equilibrium with seawater. Our results confirm that tridacnids precipitate their shells close to equilibrium with seawater. Thus tridacnid shell is an excellent recorder of its growth environment. It will be possible that daily records of water temperature and salinity are reconstructed from tridacnid shells using the method proposed here and some new techniques such as “clumped isotope geochemistry”.

Decadal-scale climatic oscillation recorded in a stalagmite from Okinoerabu-jima, southwestern Japan

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Speleothems are an important archive for studying climate change in the Late Quaternary. Many researchers have studied speleothem records in various regions, but a few paleoclimatic studies have been conducted on Japanese speleothems. We started a comprehensive study of paleoclimatic records and signals of human-induced environmental perturbations from Japanese speleothems in several years ago. This is one of the recent results of our paleoclimatic studies using a Japanese stalagmite. Stalagmite K-T2 was collected in Kurinjyofuki, a 245 m long cave located in Okinoerabu-jima, southwestern Japan (27°22′34.5″N, 128°36′10.7″E). The climate is subtropical humid, with a mean annual temperature of 22.3°C and a mean annual precipitation of 1983 mm. K-T2 is a 17 cm long stalagmite and it was active when collected. The stalagmite was sawed into halves along growth axis, polished and visually inspected. K-T2 is composed of white, fibrous calcite crystals and no sign of recrystallization is apparent. The age model for K-T2 is based on growth rates estimated by annual banding measurements. It is known that some speleothems emit visible light when irradiates by ultraviolet light (Shopov *et al.*, 1994). In this study, we used the dating method using a microscope spectrophotometer designed to measure fluorescence intensities of speleothems (Kurisaki and Yoshimura, 2008). The mean growth rate of K-T2 was estimated to be 225 µm/yr throughout its growth history (AD 1250 to present). Subsamples for stable isotopic analysis were taken at 0.5 mm intervals along the growth axis of K-T2. These powdered samples were analyzed using an automated carbonate preparation device (Keil III), linked to a Finnigan MAT Delta S mass spectrometer at Tohoku University. The reproducibility of the system was 0.03 ‰ for $\delta^{13}C$ and $\delta^{18}O$, based on daily replicate measurements of an internal laboratory calcite standard. Isotopic profiles of K-T2 show following distinctive features: 1) The relationship between both isotope ratios is changed around AD 1720. Although the first-order (decades-long scale) variations in $\delta^{13}C$ are negatively correlated with those variations in $\delta^{18}O$ before AD 1720, positive correlation is apparent after AD 1720, 2) No clear correlation is observed between the variations in both isotopes at the second-order (several-years long) scale, 3) Both isotope variations have apparent periodicities of 18-60 yrs. The shift of correlation between both isotopes around AD 1720 might reflect changes in vegetation. Area of sugarcane field has been extended in this island since the 17th century. Variations in both isotopes at the periodicities of 18-60 yrs will be related to decadal-scale climatic oscillation such as PDO (Pacific Decadal Oscillation).

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Sediment transport pathways on the modern microtidal sand flat reconstructed by the new method of sediment trend analysis (P-GSTA): Case studies of Kushida River and Obitsu River deltas, Japan

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A new method to reconstruct the sediment transport pathways, which is based on the sediment grain-size distribution and using principal component analysis, (P-GSTA) is proposed here. In this method, a linearly-combined value of six parameters of grain-size distribution (mean, coefficient of variance, skewness, kurtosis and log-ratios of mud and gravel contents) with different weighting factors is used as a proxy of sediment transport processes, while the previous grain-size trend analysis (GSTA) models have considered only three parameters (mean-grain size, sorting and skewness) with equal weight. For automated determination of the weighting factor of each grain-size parameter, the principal component analysis (PCA) of grain-size parameters is conducted, assuming that the magnitude of the weight is proportional to the degree of spatial variation of each parameter. The resultant linear combination of grain-size parameters obtained as the first principal component (PC1) represents the predominant spatial change of grain-size distribution curves in the sampling area. Then, the sediment transport pathways in the depositional systems are estimated from the spatial variation of the PC1 scores. This method was applied in two modern sandy tidal-flat systems in the Kushida River and the Obitsu River deltas. The Kushida River flows into Ise Bay, and forms bayhead delta. The the tidal range of Ise Bay is about 2m during spring tide (microtidal). Tidal flat is about 0.4 km^2, and sediment is mainly composed of medium to coarse sand. The sandy tidal flat is characterized by sand bars and shallow braided channels, and it is interpreted that sediment transport is dominated by fluvial and wave activities. The Obitsu Delta is progresses into Tokyo Bay, and associated tidal flat spreads about 8 km2. The tidal range is about 2m during spring tide (microtidal). The sediment in the tidal flat is mainly composed of fine to medium sand. Primary geomorphologic features are sand bars and shallow channels. It is interpreted that sediment transport is dominated by wave and littoral currents. We investigated the entire area of the tidal-flat in the Kushida River (0.4 km^2), and a part of the tidal-flat in the Obitsu River (0.4 km^2). Bottom surface sediment (<10 cm) was obtained and granulometric parameters were calculated by settling tube method. PCA was conducted and spatial variation of principal components was visualized by kriging interpolation. P-GSTA was conducted using this interpolated data. At the tidal-flat system in the Kushida River Delta, P-GSTA successfully reconstructed sediment transport pathways on the microtidal sand flat. PC1 of statistic parameters indicated that the grain-size distribution of sediments on the surface of microtidal sand flat becomes finer, better sorted, less gravelly and more negatively skewed downcurrent through the sediment-transport processes by fluvial and wave activities. Then, we employed the eigenvector of PC1 as weighting factors of grain-size parameters to calculate the linearly-combined value, and estimated the sediment transport pathways in the system. In contrast to the result of our method, results of other GSTA models previously proposed were inconsistent with actual sediment transport processes, suggesting effectiveness of our method throughout a microtidal sand-flat system. In the tidal-flat system in the Obitsu River Delta, however, the sediment transport pathways were not adequately reconstructed by all the existing GSTA models including our method. The characteristics of grain-size parameters represented in the PC1 were that the grain-size distribution of sediments becomes better sorted, positively skewed, and shows smaller kurtosis accompanied with fining of mean grain size. In this case, the PC1 did not exhibit the degree of sediment transport properly, so that the spatial variation of the PC1 scores had no correlation with the direction of sediment transport pathways inferred from the downstream directions of wave, littoral and fluvial currents. This was probably because the sampling area of this study was too small considering the entire size of the depositional system, and therefore the granulometric change through sediment transport could not be detected sufficiently. This result suggests that the GSTA methods require an appropriate size of the sampling area in which effects of sediment transport processes predominate in determining the spatial variation of sediment grain-size distributions.

The prediction of a hydrocarbon reservoir in a regressive systems tract in a lacustrine basin from the Paleogene Qaidam Basin in Western China

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There are three common systems tract defined in classical sequence stratigraphy: Highstand Systems Tract (HST), Lowstand Systems Tract (LST), and Transgressive Systems Tract (TST). They are closely related to shoreline shifts caused by base level changes, whether relative sea level or relative lake level. Regressive Systems Tract (RST) is a theoretical systems tract, which could develop during two rapidly rising periods of relative lake level separated by a pulse of increasing sediment supply, or during a continuous rise in relative lake level. That is to say, the RST would include all sediments except for those of the TST; RST includes the HST and LST of classical sequence stratigraphy. The lower boundary of the RST is defined as the Maximum Flooding Surface (MFS) with the upper boundary as the Maximum Regressive Surface (MRS). The internal stacking pattern of the RST would include aggradation as well as progradation and aggradation. In a nonmarine basin, the systems tract boundaries can be traced from lake level changes in most lacustrine basins. Without clear regional unconformities, only transgressive and regressive systems tracts can be distinguished. RST may develop best in foreland basins. The Paleogene Qaidam Basin, located at western China, is a foreland basin with an area of 12.1×104 km2 with a maximum thickness of sedimentary rocks at 17.2km. The main studied block from the basin has 3-D data covering 600km2 with the major interval identified as the Lower Gangchaigou Formation. This formation exhibits only RST and TST, as characterized by outcrops, well profiles, and seismic sections. The reduced lacustrine areas of deposition, progradational sand bodies, and well-developed reservoirs are features of RST. Two key techniques in sequence sedimentology were used in the investigation of reservoirs here: (1) regional sequence sedimentology to understand potential facies distribution and (2) target sequence sedimentology to determine potential reservoir sandstone bodies distribution of petroliferous belts through the study of parasequence and parasequence sets. Also some seismic reservoir prediction techniques (seismic inversion and seismic phase) were used. The distribution of sandstones and traps can be predicted after studying facies, stratigraphic architecture, and the combination of source-reservoir-seal from the identification of system tracts. The sand body distribution map in a sequence is mainly qualitative or semi-quantitative data, though the prediction of reservoirs is enhanced by sequence stratigraphic analysis. The depositional evolution of the Paleogene Qaidam Basin is interpreted as involving a continuously increasing subsidence, thus increasing accommodation space, leading to a more broad lake area. RST and TST are well-developed and they contain multiple sets of reservoir-seal combinations. The statistics of Well D3 in the study block show that the percentage of sandstones in RST is from 20 to 40%, resulting in a good prediction of seismic reservoir potential. Clearly, the use of regressive systems tracts is important in identifying hydrocarbon reservoirs in a lacustrine foreland basin. Finding commercial oil exploration targets through seismic slice technology is certainly enhanced with the use of sequence stratigraphy.

Sandstone petrography of the Cretaceous Izumi Group, Izumi Mountains, southwestern Japan and its tectonic implications

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The Upper Cretaceous lzumi Group is the infilling of an EW-trending, elongated basin, some 300 km long and 15 km wide, developed due to the left-lateral strike-slip movements along the Median Tectonic Line of southwestern Japan. The depocenter progressively shifted to the east with migration of the basin margin. The lzumi Group has been classified into three geographic facies: the northern marginal facies; the main facies; and the southern facies. The deposits of the northern marginal facies consist of basin-margin conglomerates and slope mudstones. The deposits of the main facies comprise turbidites and associated coarse clastic deposits, which represent the deep-water basin-fill. Paleocurrent analysis indicates that sediments derived from the northern terrains were dominantly dispersed westward along the basin axis. The southern facies deposits are of terrestrial and shallow-water origin and are attributed to the final filling of the basin behind the eastward-migrating depocenter. Petrographic characteristics of the sandstones for each geographic facies were studied and compared. The techniques used include standard modal analysis and petrography of lithic fragments. In every facies sandstones, monocrystalline quartz is quite dominant quartz variety and plagioclase is more abundant than K-feldspar. The composition of lithic fragments is also almost same among the sandstones of three geographic facies: felsic volcanic rocks are most abundant followed by granitic rocks and sedimentary rocks, in decreasing order. The mineral composition and lithology of lithic fragments strongly suggest that the provenance was chiefly composed of felsic volcanic rocks and granitic rocks, both of which are widely distributed in the area adjacent to the north of the basin. Plotting of the data on a QFL diagram, however, the southern facies sandstones show some differences in modal composition with the sandstones of northern marginal and main facies. On QFL and QFLt diagrams, the field of the sandstones of the northern marginal facies almost overlaps with that of the main facies sandstones and the sandstones of these two facies show little differences in modal composition. On the contrary, the sandstones of the southern facies occupy the field separated from those of the other two facies. i.e. southern facies sandstones contain more abundant quartz and less amount of lithic fragments than the other two facies. Accordingly the sandstones of the southern facies show higher value (av. 0.58) of maturity index compared with the northern marginal (av. 0.37) and main (av. 0.34) facies sandstones. Taking account of same source rocks adjacent to the basin and no significant difference in the distance between the source terrain and depositional site for the deposits of three geographic facies, the higher compositional maturity of the southern facies sandstones is suggestive of recycling of older sediments previously deposited within the basin. With the eastward shift of the depocenter of the basin, the previous depositional site of the main facies turbidites possibly turned to uplift rapidly and the uplifted deposits of the northern marginal and main facies, which were still in the unconsolidated or semi-consolidated state, acted as a sediment source for the deposits of the southern facies.

The genesis and sedimentary records of a large tidal channel in South Yellow Sea Coast, East China

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A characteristic radial tidal sand ridge system (RTSRS) has developed under a complex tidal current field along the eastern coast of China between the Yangtze River delta to the south and the abandoned Yellow River (Huanghe) delta to the north. The radial tidal sand ridge system, composed of 70 more sandy ridges and tidal channels, covers an area of 22,470 km^2. A large tidal channel named XiYang lies on the north of RTSRS. It has a north opened trumpet shape, with width of 12-25 km and length of 80 km. The maximum water depth reaches to 20 m. A core, 36.1 m long was drilled (33°15.84′ N， 120°53.761′ E) in the XiYang tidal channel, aimed to revel the history of sedimentary environment and predict the genesis of it. Five sedimentary facies have been distinguished on the basis of lithology, sedimentary structures, grain size, and fossils: 1) tidal channel. The top 10cm of the core comprise this facies. It consists of silty fine sand, intercalated with thin clay layer and shows flaser bedding; 2) inter-subtidal. The core between 0.1m and 15.77 m comprises this facies. Rhythmic couplets between silt/fine sand and clay/silty clay dominated the facies. Wavy beddings and lenticular beddings as well as small ripple beddings are common. The average grain size fluctuates from 4Φ to 5.5Φ; 3) lagoon. This facies occur between15.77~20.5 m down core depth. It consists of olive grey and dark grey clay, intercalated with shell fragments and peat. No bedding has been found in this facies. The average grain size changes between 4.5~6.5Φ, with average value of 5.66Φ; 4) flooding plain. This facies, composed of silty clay intercalated with clay silt occurs between 20.5 and 28.4 m down core depth. Horizontal laminations and small ripple beddings are common in this interval. Caliche nodules indicate probable exposure during deposition. The average grain size changes from 4Φto 5Φ, with average value of 4.89Φ; 5) delta front. This facies occurs between 28.4~35.81 m. The deposits are mainly composed of massive olive grey sandy silt. Subtle horizontal beddings have been found in the middle of this interval. The average grain size is 3.86Φ. During the late Pleistocene period (after 40ka B.P.), the study area experienced delta front, flooding plain and lagoon environment, showing a long-time regression process. The XiYang tidal channel gradually formed under strong tidal erosion during the Holocene transgression. When the Yellow River delivered to South Yellow Sea coast in 1128 bringing a great amount of deposits, the channel was filled. After the Yellow River switched to Bohai Bay in 1885, the entering sediments was cut and the channel encountered tidal erosion a lot. As a result, the channel bottom became relief.

Impact of Typhoon Morakot on modern sedimentary environment in the mud depocenter off the Zhejiang-Fujian coast, China

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The mud belt off the Zhejiang-Fujian coast, with the thickness more than 40 m in its depocenter, is one of the larger fine-grain sediment sinks in the East China Sea Shelf. The sediment of the mud belt was mainly discharged from Changjiang (Yangtze) River, which almost accounted for 32 percent of total sediment from Changjiang (Yangtze) River since the High Sea Surface Period (B.P. 7000y). The formation of this mud belt was mainly controlled by the East China Sea Shelf hydrodynamic circulations besides the materials supplies. Both of the materials supplies and the circulations have seasonal variations due to the Asia Monsoon. The sediment in the mud belt was mainly deposited in winter, while the typhoon processes in the summer had evidently impacts to the sedimentary process. Typhoon Morakot, making landfall firstly in Taiwan on Aug. 8th and then in Fujian on Aug. 9th after crossing through the Taiwan Strait, was the strongest typhoon to impact the East China Sea (ECS) in 2009. Two surveys were conducted on Aug. 1st and 12th, respectively, in the mud depocenter off the Zhejiang-Fujian coast in the ECS inner shelf to studying the impact of Typhoon Morakot on the marine environment and sediment transport. Continuous in-situ hydrographic data (water temperature, salinity, depth, turbidity and particle size) and ship-based hydrodynamic data (flow velocity and direction) were recorded by a CTD, a LISSIT-ST and an ADCP, respectively, at 29 stations (in 5 sections) in the first survey and 23 stations (in 4 sections), selected from the 29 stations, in the second survey, respectively, the water and surface sediment samples were collected at the same time. The impact of typhoon process on the modern sedimentary environment was discussed by contrasting the distributions of water temperature, salinity and turbidity at surface and bottom layers and on the sections in two surveys. Significant variations, which mainly occurred in the upper and bottom water layers, of these distributions were shown after typhoon. The water in the upper layer, which temperature and salinity dropped generally around 0.2-1.4 degree centigrade and 0.3-3.3 salinity, and turbidity increased significantly from around 1 to 1-30 FTU, respectively, mixed sufficiently after typhoon. The thermo-halocline disappeared in the completely mixed upper 30 meters after typhoon, however, in the first survey the maximum gradients of water temperature and salinity (the thermo-halocline) existed in water depth from 5 to 20 meters. The ranges of water temperature and salinity both reduced in the whole water column after typhoon due to the mixing processes. In the bottom layer, the water temperature and salinity dropped around 2-7 degree centigrade and 0.2-0.6 salinity, respectively, and the water turbidity (mostly higher than 50 FTU) increased evidently and attained its extremum (more than 150 FTU) in the bottom nepheloid layers, which several times to several tenfold higher than that in the first survey (generally between 10 to 60 FTU). The integrated weather and dynamic processes accompanied with typhoon, including the strong cyclonic wind stress and huge heat (energy) exchange in the marine-atmosphere boundary, strong precipitation (increasing the supply of terrignous materials and freshwater), stirring directly the surface sediment, enhancing the external seawater intrusion and river runoff input, and increasing the shear stress and periodic load amplitude in the water-sediment boundary, etc, were directly responded to the variations of water structure, sediment transport and deposit process after typhoon.

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Stratigraphic analysis of the mass flow complexes of Maracangalha Formation (Cretaceous of Recôncavo basin), at Maré Island, Brazil

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The Maracangalha Formation is characterized by thick and internally deformed sand bodies (Pitanga Members) interpreted as mass flow deposits, intercalated with turbidite deposits (Caruaçu Member), accumulated in the rift phase of the Recôncavo Basin. These sand bodies can be important landmarks within a sedimentary basin, helping the delimitation of slope and basin margins, as well as the documentation of syn-sedimentary tectonic movements. The work aimed at: a) identifying the constituent facies, both depositional and deformational, and discriminating structures generated by slumping and fluidization; b) defining the geometry of the mass flow complexes and distinguishing individual mass flow sand bodies; c) recognizing the movement direction of each mass flow sand body in the complex, using syn-depositional kinematic indicators. Field work provided data for the preparation of photo-mosaics and columnar sections of the outcrops where the lithofacies and the deformation structures were described. The structural data were represented in stereograms in order to identify and delineate the different bodies within a mass flow complex. The analysis of outcrop data allowed the identification of three depositional and four deformational facies: Fa, Fb and Fc, formed by processes arising from the action of turbidity currents, and D1, D2, D3 and D4, which represent the deformed structures generated by the processes of fluidization, overload and gravitational instability in unconsolidated sediments. These facies were grouped into four different facies associations: the first, representative of the Caruaçu Member, is composed of interbedded sandstone and mudstone layers, interpreted as turbidite lobes with paleocurrent toward southeast. The facies associations II, III and IV are characteristic of the Pitanga Member and represent seven slumps bodies under different stages of deformation, with flow direction varying from south to southwest. These bodies can: preserve their primary bedding, having internal deformation that obscures the primary structures (facies association II); be massive, with asymmetrical folds and reverse faults (facies association III); or massive with imbricated blocks preserving primary bedding (facies association IV). The main mechanism responsible for the generation of these mass flow deposits is seismic activity, related to rift tectonics. As the interval studied (Maracangalha Formation) is part of the rift climax phase in the Recôncavo Basin, it is very likely that earthquakes associated with tectonic pulses have played an important role as trigger mechanisms of mass movements in the area. The high local rates of sedimentation may also have been an important trigger mechanism of mass flows in the study area. The deltaic progradation from source areas at the northern portion of the basin, with high sedimentation rates, may have led to instability in delta front regions. The structural framework of the Recôncavo rift must also have had an important role in the movement direction of the mass flows. Normal faults parallel to the basin border fault (NE-SW), together with associated antithetic faults, formed paths for preferential sediment flow toward the depocenter. It is expected that the obtained results will serve as reference for future work, allowing the understanding of sedimentological, stratigraphic and structural factors that define the reservoir quality in mass flow complexes.

A megafan depositional system in northern Amazonia based on integration of remote sensing and sedimentology

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Large-scale and smoothly deepening, fan-shaped depositional systems containing sedimentary strata formed by channelized and unconfined flows have been increasingly documented in the literature, with the most well documented and spectacular examples being the megafans of Okavango in South Africa, the Kosi, Gandak and Tista in the Gangetic–Brahmaputra plains, and the Taquari in the Brazilian Pantanal wetlands. This type of still dynamic depositional system, typical of intracontinental sedimentary basins usually with active tectonics, initiated to develop in the Quaternary or even earlier geological times. Analogues have been rarely documented in the geological record, with the Luna System in the Ebro Basin in Spain and Pennsylvanian deposits in the Paradox Basin in USA cited as few exceptions. The widespread identification of ancient analogues for this depositional system is highly dependent on comparisons with recent counterparts. Identification of present day megafans is not straightforward, being based on geomorphological characterization, greatly supplied by remote sensing techniques. Innovative remote sensing advances, including digital elevation model (DEM) derived from the Shuttle Radar Topography Mission (SRTM) and ALOS (Advanced Land Observing Satellite)-PALSAR (Phased Array type L-band Synthetic Aperture Radar) provide an unprecedented opportunity to undertake large-scale geomorphological studies in areas where optical sensors had limited success. The goals of the present work are two-folded: to describe the remote sensing techniques applied for revealing a large megafan depositional system in an area of the Brazilian Amazonia; and 2. to integrate these data with preliminary shallow sub-surface sedimentological information of this fan system. Remote sensing products included both optical and radar images. The optical image comprehended a single Landsat-TM5, acquired on September 2006. The radar image was acquired from ALOS-PALSAR sensor on September 2009, which operates in L-band. Our remote sensing approach can be divided into three steps: 1 digital image processing; 2. multisensor data integration; and 3. visual interpretation. In step (1) the optical and radar image was corrected for geometry and radiometry. In step (2) we enhanced the optical dataset using the selective principal components technique, reducing all spectral bands in three channels containing the maximum of information. Those were combined in a RGB color composition and latter transformed to IHS color space. The I vector was changed to PALSAR image, generating a multisensor product. In step (3) we performed visual analysis on this hybrid image, to extract the main units and general morphology. These data were combined with topographic information derived from the DEM-SRTM, as well as sedimentological descriptions of 16 cores up to 5 m in depth. The investigation revealed two fan-shaped coalescing lobes up to 45 km in extension and 25 km in diameter in lowland areas in the left margin of Branco River, one of the main tributaries of the Amazonas drainage basin. The bulk of the deposits consist of moderately to well-sorted sands, in general ranging from very fine- to medium-grained, though coarse-grained sands are locally significant. Muddy sands, pelites and mudstones are subordinate in these deposits. The lithologies are chiefly arranged in vertically superposed sharp bounded coarsening, and less frequently, fining upward successions up to 2 to 3 m thick. Preliminary AMS dating revealed ages up to 20,000 yr B.P. The presence of this megafan depositional system has large implications to discuss regional tectonics and climate fluctuations during the latest Pleistocene-Holocene of Amazonia.

A genetic facies tract for the analysis of coarse-grained hyperpycnal flow deposits

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Understanding of hyperpycnal flow deposits represents a deep challenge for sedimentologist since facies types associated to river- generated turbidites could be very different with respect to those related to conventional (re-sedimented surge-like) turbidity flows. Direct fluvial discharges result in subaqueous flows with associated deposits having characteristics often considered typical of alluvial sedimentation. A hyperpycnal flow is a land-derived, relatively slow moving, and fully turbulent sediment gravity flow having the ability of carrying basinward interstitial freshwater and plant material. In contrast with surge like ("classical") turbidites, hyperpycnal flows have a slow moving and more diluted leading head which will be very sensitive to the subaqueous topography. The moving of a hyperpycnal flow will not necessarily require steep slopes since the flow could be maintained as long as the high-density fluvial discharge continues . Therefore, the distance reached by a hyperpycnal flow will be more dependent on the duration of the related flood event. In contrast with surge-like flows where deposition is dominated by the head, in hyperpycnal flows deposition mainly occurs along the flow body. These characteristics allow the preservation in the hyperpycnal deposit of evidences of flow fluctuations that occurred during the passing-by discharge resulting in the accumulation of composite beds. In contrary with classical models of turbidity sedimentation, coarse grained materials are not transported at the flow head, but are dragged at the flow base as bedload related to shear forces provided by the overpassing long-lived turbulent flow. Facies analysis performed during more than ten years in a number of lacustrine and marine units dominated by hyperpycnal flows allowed the distilling of a genetic and predictive facies tract of general application to the analysis of long-lived and coarse-grained hyperpycnal deposits. This facies tract is composed of three main genetically-related facies groups termed B, S and L, corresponding to bedload, suspended load and lofting transport processes respectively. Type B (bedload) facies are the coarsest grained and relate to shear and frictional drag forces provided by the overpassing long-lived turbulent flow. Three main facies types are recognized, termed B1 (massive or crude bedding conglomerates), B2 (pebbly sandstones with low angle asymptotic cross-stratification) and B3 (pebbly sandstones with diffuse planar lamination and aligned clasts). Type S facies are almost fine grained and relate to the gravitational collapse of sand-size materials transported as suspended load. Four facies types are recognized, denominated S1 (massive sandstones), S2 (parallel laminated sandstones), S3 (sandstones with climbing ripples) and S4 (massive siltstones and mudstones). Facies L (lofting) relates to the buoyancy reversal of the hyperpycnal flow provoked by the lift-up of a less dense fluid (in this case freshwater) typically in marine and other saline basins. Finest materials suspended in the flow (very fine grained sand, silt, plant debris and mica) are lifted from the substrate and settle down forming silt/sand couplets of great lateral extension (lofting rhythmites). Facies L develops only in marine/saline environments while facies S3 and S4 are more common in lacustrine environments. Hyperpycnites are often very complex showing internal erosional surfaces and gradual facies recurrences related to deposition from long-lived and highly dynamic (fluctuating) flows. This complex behavior results in the accumulation of composite beds, having an internal facies arrangement which strongly departs from conventional facies models built-up from surge-like flows. Facies B characterize transfer zones and its occurrence allows predicting sandstone deposits (facies S) basinward. Facies L mostly accumulates in flow margin areas.

The Upper Jurassic - Lower Cretaceous formations in the Neuquén Basin – an accommodation controlled mixed carbonate – siliciclastic system

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The Quintuco - Vaca Muerta formation in the Neuquén Basin in Argentina is a mixed carbonate-siliciclastic system with a high degree of lateral and vertical heterogeneities. Integration of outcrop and core-based subsurface high-resolution sequence stratigraphy with the analysis of outcrop and seismic architecture offers new insights into the controlling parameters on carbonate-siliciclastic sedimentation. The system is an interplay between shore-parallel transported clastics and fluctuating accommodation space that control both the transport of clastics and the onset of carbonates. Seismic data of the Quintuco Formation in the Loma La Lata Field and outcrops of the time-equivalent Picún Leufú Formation in southern Neuquén Basin document a similar stratal architecture consisting of 1) a lower prograding clinoform unit dominantly composed of siliciclastics with upwards-increasing carbonate content, 2) an aggrading middle unit that can be subdivided into a lower siliciclastic dominated interval capped by a clean carbonate package, and 3) an aggrading upper unit in which siltstones and sandstones alternate with minor carbonates. In outcrop the low-angle clinoforms of the lower unit contain facies transitions from quartz sandstone in the topsets with high- energy bidirectional bedded sandstones along the shelf edge to siltstone and shale in the bottomsets. The time equivalent clinoforms in the subsurface are imaged on seismic time-slices and characterized by shelf breaks that are paleo-shoreline parallel over hundreds of kilometers. In the middle and the upper unit the carbonates are represented by ooid-skeletal grainstone intervals and oyster to coral floatstone beds. In each unit, transitions between siliciclastic and carbonate sedimentation occur rapidly at every scale. At a meter-scale clastic sandstones alternate rapidly with clean ooid- skeletal grainstones while on a decameter scale siliciclastic silt- and sandstone dominated packages alternate with pure carbonate intervals. The similarities of the stratigraphic architecture of the two areas, which are about 150 kilometers apart, indicate a basin-wide eustatic sea-level control on sedimentation and stacking of sequences rather than a local sediment supply driven process. The consistent clinoform breaks in the subsurface point towards longshore currents as the main mechanism for siliciclastic input. This interpretation is supported by the general fining trend of the clastic grainsize from south to north, which is in a more distal position from the continental input in the south as corroborated by provenance studies. Moreover the rapid transitions between siliciclastic and carbonate sedimentation are largely controlled by the available accommodation space on the shelf. High accommodation allows the development of strong longshore currents, which can carry sand and silt material for hundreds of kilometers across the shelf and thereby shut off the carbonate factory. During times of low accommodation, the current cannot reach across the shelf environment and high carbonate production leads to mixed and pure carbonate deposits.

Chemical weathering history since the late Pliocene in the Western Bohai Bay and implications

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Chemical and physical denudation of silicates can potentially affect global climate change through influencing global carbon cycle (Raymo and Ruddiaman, 1992). Therefore, much attention has been paid to researches on silicate weathering (Kump *et al.*, 2000). The North China Plain is under the influence of East Asian monsoon in the semiarid to humid zone. Up to date, studies on chemical weathering in the North China Plain are scarce because of a lack of long-term records with well- constrained chronology, and thus the relation between chemical weathering and climate remains poorly understood. In this study, a 203.6 m core was recovered from the North China Plain with a recovery of 89.3%. The textures of the sequence mainly consist of silty and silty-clay sediments. Paleomagnetic results defined a basal age of ~3.2 Ma. A total of 314 samples were taken for geochemical analysis. In order to minimize the grain size and carbonates effects on the chemical compositions, the samples were treated with acetic acid to remove the carbonates and the fine-grained fraction (<30 ìm) was used for geochemical analysis. The geochemical results show that a gradual decrease in chemical weathering intensity can be observed based on the ratios of Al/K, Ti/Na and CIA since ~3.2 Ma. The elemental ratios in detrital sediments may be influenced by several factors, such as chemistry weathering in the source regions, hydraulic sorting and changes of provenance (Fralick & Kronberg, 1997). However, the elements we select here to reconstruct the chemical weathering are Al, Ti, Na, Ca and K. The behaviors of these elements during chemical weathering have well been defined, and they are dominantly hosted in fine grain size fractions in sediments. Moreover, the textures of the BZ2 core sequence mainly consist of fine silty and silty-clay sediments, and we have used the fine fraction (<30 ìm) for geochemical analysis to minimize the potential effect of grain size on the chemical weathering. Although floods and shifts in course of the Huanghe River happened frequently, the provenance changes resulted from its shifts may not influence the whole weakening trend of the geochemical weathering intensity on the tectonic timescale, because of the characteristics of frequent flooding and shifting within short-time period. Therefore, the CIA and other geochemical proxies from the sediments in the core primarily reflect the chemical weathering intensity of the Huanghe drainage basins. Chemical weathering intensity is largely controlled by temperature and precipitation (White and Blum, 1995). The overall decreasing trends of the chemical weathering intensity indicated by CIA values and other elemental ratios are in parallel with the global cooling (Mix *et al.*, 1995; Shackleton *et al.*, 1995), suggesting that the gradual lowering of the temperature may be responsible for the observed weakening chemical weathering intensity since the late Pliocene.

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Mesozoic-Cenozoic detrital heavy mineral provenance records and basin-range evolution in Luxi and its adjacent area, eastern North China block

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Focusing the Luxi Uplift and its adjacent intracontinental basins, eastern North China block, this paper study the Mesozoic-Cenozoic depositional records and their implications for tectonic regimes in basin-range scale and further explore their sedimentary geodynamic settings and related lithospheric evolution over North China block since late Mesozoic. Main research contents of this paper include: (1) late Mesozoic-Cenozoic basin-fill framework and sequences, (2) detrital composition and high- resolution detrital heavy mineral (garnet, zircon, glaucophane) provenance tracing, (3) provenance change implications for uplift and subsidence of basin-range, and (4) geodynamic process of the Luxi Uplift and adjacent basin tectonic-sedimentary evolution. The research indicates that evident topography in west high to east low once occurred over the Luxi Uplift-Sulu orogenic belt during Late Mesozoic- early Paleogene, and, however, gradually reversed since 45Ma (corresponding to age of top layer of the No.4 segment of Shahejie Formation). In other words, the Luxi Uplift basically obstruct provenances directly derived from the Sulu orogenic belt since 45Ma. Through a research on depositional records and tectonic-lithological attributes in the studied area, this paper basically reveal erosional- sedimentary coupling processes between the Luxi Uplift and its adjacent intracontinental basins, and elucidate basin-fill and structure evolutional mechanisms dominatingly restricted by the Luxi intracontinental uplift and Sulu post-orogenesis, which may provide more sedimentary basis for understanding late Mesozoic-Cenozoic basin-range geodynamics over eastern North China block.

Diagenetic fluids evolution, genesis mechanism of tight sandstone reservoirs and evaluation method of diagenetic facies

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Tight sandstone gas reservoirs are characterized by low porosity (<12%), low permeability (0.1×10-3μm2), low gas saturation (<60%) and high water saturation (40%). These reservoirs have been widly discovered in China , such as Sichuan, Ordos, Turpan-Hami, Songliao, Junggar , Tarim basin. These reservoirs have complex genetic mechanism and large exploration difficulties. The reservoirs of the Upper Triassic Xujiahe Formation in Sichuan Basin have the characteristics of low compositional maturity, low contents of cements and medium textural maturity. The general physical properties of the reservoirs are poor, with low porosity and low permeability, and there are only a few reservoirs with medium porosity and low permeability in local areas. Firstly, Based on the diagenetic mineral association, a diagenetic sequence of cements is established: early calcites (or micrite siderites) →first quartz overgrowth→chlorite coatings→dissolution of feldspars and debris→chlorite linings→second quartz overgrowth (quartzes widen or filled in remain intergranular pores and solution pores)→dissolution→third quartz overgrowth (quartzes filled in intergranular and intragranular solution pores)→ intergrowth (ferro) calcites→dolomites→ ferro (calcites) dolomites → later dissolution→veins of quartzes and calcites formation. Mechanical compaction is the main factor in making the reservoirs tight in the basin, followed by the second and third quartz overgrowth. In a long-term closed system,only feldspars and some lithic fragments are dissolved by diagenetic fluids, while intergranular cements such as quartz and calcit are not dissolved and thus have little influence on the porosity of the Xujiahe Formation. This is the third factor that may have kept the sandstones of Xujiahe Formation tightfinally. The hydrocarbon was extensively generated from organic materials after the second quartz overgrowth, and selectively entered favorable reservoirs to form tight sandstone gas reservoirs. Secondly, based on a series of diagenetic parameters such as the rate of compaction, cementation and dissolution, the authors have divided into 8 types diagenetic facies : dissolution facies, cementation -dissolution facies, dissolution-cementation facies, cementation facies, dissolution-compaction facies, cementation -compaction facies, compaction facies, and fissure facies. Thirdly, the authors have built single well diagenetic facies composite profile and extract seismic attribute information according to calibrate typical well with different diagenetic features, combining with log datum and different diagenetic typical log parameters (such as element log, gamma log, density log etc.). Fourthly, combining with diagenetic facies genesis and distribution, seismic attribute information, and reservoirs physical properties , the authors have finally pointed out that the center and south of Sichuan are the most favorable reservoir distribution areas.

Lithology and dating of long lacustrine sediment records from the southern hemispheric mid-latitudes: ICDP deep drilling at Laguna Potrok Aike (southern Patagonia, Argentina) provides insights into late Pleistocene environmental dynamics

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Laguna Potrok Aike, located in the southern Patagonian Province of Santa Cruz (52°58'S, 70°23'W, 112 m a.s.l.), was formed by a volcanic maar eruption during the mid Pleistocene in the Pali Aike Volcanic Field. This archive holds a unique record of paleoclimatic and paleoecological variability from a region sensitive to variations in southern hemispheric wind and pressure systems, which provide a significant cornerstone for the understanding of the global climate system. Moreover, Laguna Potrok Aike is close to many active volcanoes allowing a better understanding of the history of regional volcanism. Patagonia also is the source region of eolian dust blown from the South American continent into the South Atlantic Ocean and onto the Antarctic ice sheet. Ongoing global climate change, the thread of volcanic hazards as well as of regional dust storms are of increasing socio-economic relevance and thus challenging scientific themes that are tackled for southernmost South America with an interdisciplinary research approach in the framework of the "Potrok Aike Maar Lake Sediment Archive Drilling Project" (PASADO) which is a contribution to the "International Continental Scientific Drilling Program" (ICDP). Using the hydraulic piston coring system from the GLAD800 drilling platform, a total of 510 m of overlapping sediment cores from two sites in the central 100 m deep basin of Laguna Potrok Aike was recovered during September to November of 2008. The excellent core recovery rate of 94.4% enables to develop an almost complete reference profile with a composite length of 106 m. This record consists of undisturbed laminated and sand-layered lacustrine silts at top with an increasing number of coarse gravel layers, turbidites and homogenites at depth. Below 80 m composite depth two mass-movement deposits (10 m and 5 m in thickness) are recorded with tilted and distorted layers as well as nodules of fine-grained sediments and randomly distributed gravel. Such features either indicate an increased seismicity that cannot be completely excluded for this late Quaternary backarc volcanic field or they are the result of hydrologically induced lake level variations and hence relate to changes in hydrological conditions in the catchment area. Intercalated throughout the record are 24 macroscopically visible volcanic ash layers that document the regional volcanic history. Moreover, these isochrones potentially act as links to southern hemispheric marine sediment and ice core records. For the upper part of the profile the chronology published by Haberzettl *et al.* (2007) was adapted and assigns a Holocene to Lateglacial age. It consists of 19 AMS radiocarbon and 3 tephra dates. 18 additional radiocarbon ages obtained from aquatic plant macrofossils provide ages back to 55,000 cal. BP for the lower glacial part of the record indicating a mean sedimentation rate of 0.9 mm/a. To obtain this age/depth relationship it was indispensable to subtract all volcanic ashes and re-deposited sediment units (almost 50% of the entire record) as they are linked to instant events contributing to sediment thickness but not to sediment age. Re-deposition also leads to one third of radiocarbon ages being out of sequence. The highly dynamic environmental conditions during the last glacial thus caused chronological complications that we envisage to overcome with 33 samples analysed for optically stimulated luminescence (OSL) dating and in combination with stratigraphic correlation techniques (e.g. paleomagnetism). This approach will provide a robust time frame for ongoing interdisciplinary paleoenvironmental and climatic reconstructions.

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Patterns and processes of current ripples at Netarts Bay, Oregon, USA

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Subaqueous oscillation ripple marks were studied in the nineteenth century. Bucher described unidirectional current, linguoid ripples with their short curving crests. Allen later classified current ripples on the shapes of ripple crests alone. Ripples were further classified as two dimensional ripples, in which flow was downstream with vertical components, and three dimensional ripples, in which flow was additionally transverse to the principal direction. Since all ripples exist in three dimensions, we prefer to call them two dimensional flow (2Df) and three dimensional flow (3Df) ripples. Processes that account for the change from 2Df to 3Df ripples remain unexplained. Observations of ripple patterns and flow processes at Netarts Bay, Oregon indicate to us that three dimensional flow is initiated by transverse forces in ripple lee side vortices, that in turn determine the patterns of both ripple crests and troughs. Netarts Bay is mesotidal and protected by a spit. Within it are tidal channels separated by broad, medium-grained sandflats covered by large-scale dunes and smaller-scale ripples. Shapes of ripple crests and troughs were exposed and described at low tide. Lee side vortices and flow paths were inferred and further supported by underwater video. Unidirectional 2Df ripples have long, straight crests and troughs, and their lee side vortices are also long and continuous. Where straight continuous ripple crests and troughs terminate laterally into flat surfaces, ripple scour pits and crests at the ends of the troughs reflect transverse flow into the centers of trough axes. Continuous sinuous ripples, with out-of-phase crests and troughs, are inferred to record spaced swelling and constriction of the diameters of lee side vortices and initiation of weak three dimensional flow. Increased flow velocity appears to further swell the broader vortices and segment them into individual cells, forming discrete ripple crests and scour pits, hallmarks of three dimensional flow. The mechanics of 3Df vortices appear similar to those of centrifugal air blowers, in which centrifugal forces at the perimeters of the vortices accompany low pressure along vortex centers. Hence flow is pulled along vortex axes, producing the transverse flow of 3Df ripples. At apparent low current velocities, a distinctive pattern of 3Df crests and troughs develops, in which the troughs are bilaterally symmetrical, pod-shaped scour pits. Downstream-adjacent crests curve around the scour pits with their centers pointed downstream. The scour pits and crests align in offset, checkerboard patterns downstream. With inferred increasing flow velocity, pod-shaped scour pits and lee side vortices become more boomerang-shaped with the tips pointing down flow. This curve focuses transported sand into the tongue-shaped crests of classic linguoid ripples. Around their lee slopes or resulting from their divergence, forms a second style of scour pits and crests, oriented at higher angles to flow. These commonly curve to the right or left, and pairs often converge or diverge. Bilateral and elongate ripple crests and troughs are recognized as the two principal styles of 3Df ripples at Netarts Bay. However, during flow the two intergrade, forming a continuum of forms. At Netarts Bay, ripple crests, troughs and lee vortices together reflect flow paths that appear to be crucial in modeling flow over rippled sand.

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