Mechanical characterization of Arctic marine sediments reveals the life cycle of vanished ice sheets

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Geological and geomorphological evidences from terrestrial environments in the Beringian region of Siberia had confused our ideas on the exstence of Arctic ice sheets during the Pleistocene glaciation, while no controversy has come from the other Arctic areas that were widely covered by ice sheets (Brigham-Grette, 2013). Recently the west Arctic sea floor opened up to seismic survey and sediment core sampling due to the withdrawal of summer sea ice. Seismic echos in the forms of bathymetric maps and seismic profiles identified marine glaciogenic records on the sea floor and subsurface along the East Siberian continental margin (Niessen et al., 2013). The controversy seems to be terminated by leaning toward the inference that the Siberian Shelf edge and parts of the Arctic Ocean were covered by ice sheets of about 1 km in thickness extending to the continental margin at depths of up to 1 km. Remaining tasks are to refine the life cycle of the glaciation in terms of the time-based position and scale of the vanished ice sheets for restoring the ancient climatological conditions. The recovery of climate change for the human-time scale is a fundamental process of predicting the future climate and marine conditions.

During sedimentation, marine sediments undergo progressive consolidation by gravitational loading as they are buried and interstitial fluids are expelled (Song et al., 2011). When a sample is recovered from depth, it undergoes elastic rebound as the overburden is removed. Reloading of the sample along the same stress path that it was subjected to results in elastic recompression followed by the virgin consolidation after passing the maximum effective stress that has acted on the sample in the past (Craig, 2004). The maximum past effective stress is called the preconsolidation pressure that could be determined from laboratory tests. If the vertical load is raised by glaciation on sedimentary formation, the preconsolidation pressure of rock samples from the formation may indicate the load of ice sheets that has vanished. The glaciation also increases the pore-fluid pressure by compressing the sedimentary formation. The diffusion of pore pressure occurs during and after the glaciation. The pore pressure variation by the diffusion is a function of time and position with a central parameter called the diffusion coefficient. The information on pore pressure and hydraulic properties of marine sediments may suggest the scale and history of vanished ice sheets. In this paper we suggest geotechnical experiments of core samples and in situ measurements of formatin pore pressure to refine the life cycle of vanished ice sheets.

Keywords: Arctic ice sheet, uniaxial consolidation, preconsolidation pressure, life cycle of glaciation.

References

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