Palynological studies on the western Arctic paleoenvironmental changes

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Abstract The Arctic environments have experienced dramatic and rapid changes. One of the most remarkable features can be observed in the Arctic sea ice coverage, which shows a rapid change in its extent and thickness during the last three decades. Recent rapid reduction in the sea ice extent is related to a major shift in the Arctic atmospheric and oceanic circulations, which plays a crucial role in regulating the global earth's climate. Of particular interest is the sea ice change in the western Arctic, which is considered as a key parameter in past climate changes in Arctic and subarctic regions controlling the intensity and direction of sea ice drifts in the Beaufort Gyre and Transpolar Drift area, and consequently regulating sea-ice and freshwater exports toward the North Atlantic. However, records of the past sea ice changes in the western Arctic especially on centennial to millennial scales have not been well-computed in climate models due to the rarity of suitable marine sedimentary records. Remnants of microscopic organisms in marine sediments such as spore, pollen and dinoflagellate cysts have been suggested as a useful tool for reconstructing palaeoceanographic conditions in the western Arctic, inferring the past terrestrial environment and sea surface conditions such as sea surface temperature, sea surface salinity and the sea ice extent. 2011 Arctic research expedition (ARA02B) to the western Arctic Ocean was carried out by the Korean Icebreaker 「ARAON」. In this study, we investigated spacial and temporal variations of organic microfossil records in sediments of the Chukchi shelf cross the Chukchi Plateau in order to reconstruct palaeoceanographic changes in the western Arctic Ocean.

1. Introduction

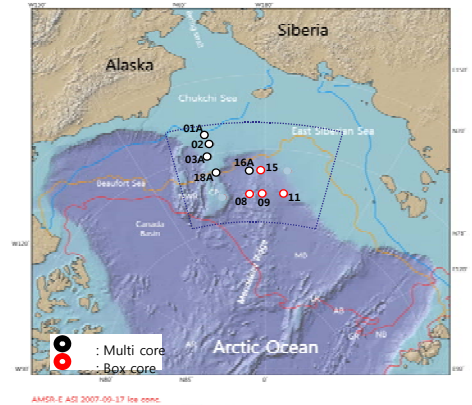

Figure 1. Locations of 9 geological stations at the Chukchi Borderland and the southern Mendeleev Ridge in the western Arctic Ocean.

- The Arctic Ocean is a key component of the global climate system characterized by the perennial ice cover, the relative importance of the continental shelves and shelf processes, and the complex interaction of water masses of the Atlantic, Pacific, and riverine sources.
- The sedimentary records in continental shelves and slopes of the Arctic Ocean show generally higher sedimentation rates and thus provide detailed sedimentary archives.
- However, integrated perspective for marine and terrestrial sequences in this region has been poorly investigated, although it is of primary importance to understand mechanisms transferring climatic variability between both domains.
- Microfossil assemblages such as dinoflagellate cysts and pollen provide a pivotal information of past oceanic condition, depositional settings and influence of palaeo-river discharge on the shelf environment.
- In this study, we present preliminary results of organic microfossil analysis on the Chukchi Borderland and the southern Mendeleev Ridge of the western Arctic Ocean.

2. Materials and methods

Figure 2. Sediment core collection during the ARA02B cruise onboard ARAON in the western Arctic Ocean.

Box-core (9 stations)and multi-core (station 01A) sediment samples were collected from the Chukchi Borderland and southern Mendeleev Ridge in the western Arctic Ocean. For palynological analysis, a known volume of the wet sediment was oven-dried and treated with 10% hydrochloric acid and 40% hydrofluoric acid to remove calcium carbonate and silicate materials. The samples were passed through a 10μm pore sized mesh sieve and the residue was preserved in a 10ml vessel. Where possible, 300 dinoflagellate cysts were counted from each sample with a microscope at 250 and 400 times magnification.

3. Results and discussion

❖ Box-core surface sediments

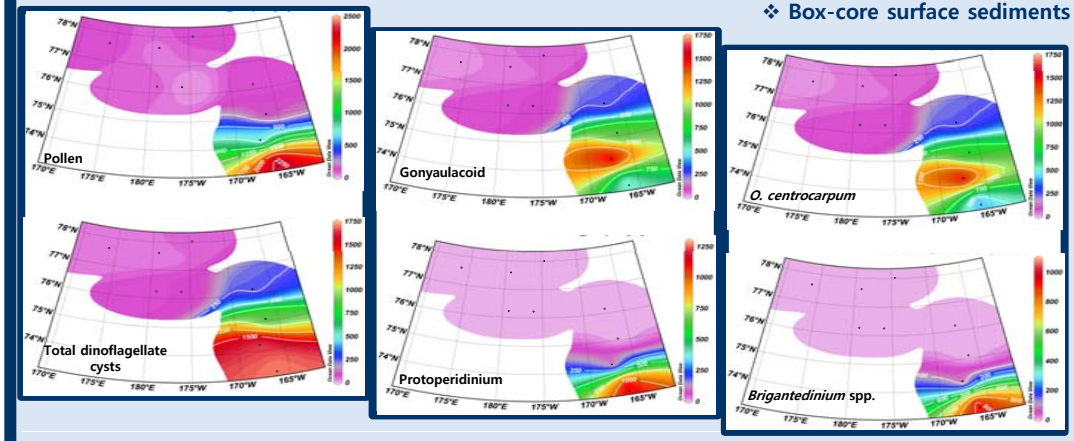

Figure 3. Distributions of major microfossil concentrations in the Chukchi Borderland and the southern Mendeleev Ridge, the western Arctic Ocean.

- A total of 9 genera and 14 dinoflagellate cyst taxa identified. Dominant species include *O. centrocarpum*, *Brigantedinium* spp. and *Spiniferites elongatus*.
- Dinoflagellate cyst and pollen concentrations sharply decrease from the inner to the outer shelf areas.
- Protoperidinioid group (e.g. *Brigantedinium* spp. and *Polykrikos swartzii*) pre-dominates at station 01A near the coast.
- Gonyaulacoid group (e.g. *Operculodinium centrocarpum* and *Spiniferites elongates*) pre-dominates at station 02.

❖ 01A multi-core sediment

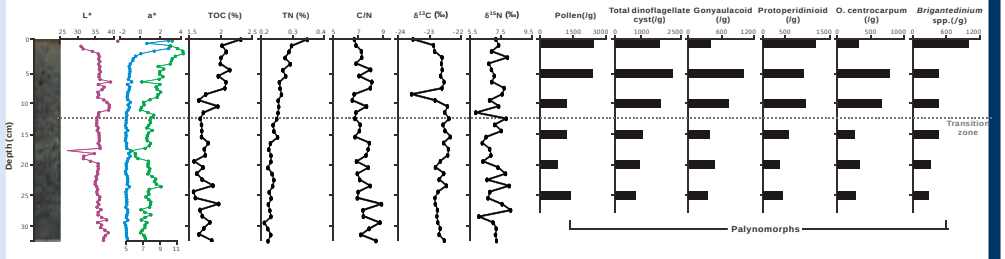

Figure 4. Vertical variations of sediment color parameters (L*, a*, b*), total organic carbon and nitrogen contents, C/N ratios, isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) and organic microfossil records in core 01A.

- A total of 14 genera and 23 dinoflagellate cyst taxa identified. Dominant species include *O. centrocarpum*, *Brigantedinium* spp., *Spiniferites elongatus*, *Dubridinium* spp., *Echinidinium* spp. and *P. dalei*.
- Dinoflagellate cyst and pollen concentrations show a gradual increase from the bottom to the top of the core.
- In the lower part of the core (from the bottom to 15cm), lower values of total organic carbon and nitrogen contents correspond to lower concentrations of dinoflagellate cyst and pollen.
- A prominent increase in dinoflagellate cyst and pollen concentrations accompanied by total organic carbon and nitrogen contents in the upper part of the core (from 15cm to the top) suggest increased nutrient inputs and marine productivity in the study area.
- The C/N ratios range between ca. 9 and 7 and represent marine organic matter. Comparison of TOC and C/N ratios indicates that the increase in organic matter deposition in the upper section of the core is due to increased accumulation of marine organic matter, as supported by $\delta^{13}C$ and $\delta^{15}N$ values.

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