Paleoceanographic changes reconstructed by biomarker analysis of the sediment core from the Gulf of Alaska of the northern North Pacific over the last 10 million years

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Accumulation records by biogenic silica analysis suggested that the main regions of biogenic silica sink have moved from Atlantic Ocean to Pacific Ocean during the middle Miocene (ca. 15Ma~), which has been called "Silica switch" or "Opal shift" event (Cortese et al., 2004). Neogene paleoceanography associated with marine primary production in the Pacific is important in the understanding long time-scale biogeochemical processes including carbon material cycling. However, there were few reports for the biogenic accumulation, that is, primary production, in Pacific than Atlantic Ocean. The Gulf of Alaska (GOA) is located in the high latitudinal Northeast (NE) Pacific, where is the largest high nutrient low chlorophyll (HNLC) region. In the coastal area of the northern NE Pacific, seasonal-specific high production occurs due to the spring to summer blooms that are composed mainly of diatoms (Addison et al., 2012). Siliceous phytoplankton including diatom is major primary producer in the high latitudinal North Pacific. In the present study, we analyzed biomarkers in sediment core samples from the Gulf of Alaska (IODP Exp. 341 Site U1417) to reconstruct the variations in paleoenvironments and primary productions in the sea surface layers since the late Miocene (ca. 13Ma~) in the northern NE Pacific by the preliminary results.

We used the sediment cores recovered at the distal Surveyor Fan in the Gulf of Alaska (Site U1417; 56° 57.5'N, 147° 6.5'W) by Integrated Ocean Drilling Program (IODP) Expedition 341. Freeze-dried sediments were extracted by solvents and then separated into fractions by silica-gel column These fractions were analyzed by GC-MS and GC-FID.

We identified various algal biomarkers including long-chain alkenones, long-chain alkyl diols, and steroids as well as terrigenous biomarkers such as perylene and degraded triterpenoids. Sea surface temperature was estimated by alkenone unsaturation indices (U^{K}_{37} and $U^{K'}_{37}$) and long-chain diol index (LDI). Both alkenone and diol based temperatures varied with global cooling since the late Miocene as previously reported $d^{18}O$ records, and also showed remarkable decrease during the cooling events such as the Northern hemisphere glaciation (NHG). The alkenone (U^{K}_{37}) and diol based SSTs were almost similar, indicating that both indices are likely to be reliable in paleoclimate reconstruction at the Gulf of Alaska. However, the biomarker concentrations were below detection limits in some samples, so we used both paleothermometers in a complimentary way. As algal biomarkers, in addition to long-chain alkenones (haptophyte) and long-chain alkyl diols (diatom and eustigmatophyte), we could identify C_{25} highly branched isoprenoids (HBI) alkane (diatom), dinosterol (dinoflagellate), brassicasterol (haptophyte and diatom), ostreasterol (diatom), and occelasterol (diatom). Using concentrations and mass accumulation rates (MARs) of these biomarkers, paleoproduction of marine algae were reconstructed. We also compared the results of algal biomarkers with those of terrigenous biomarkers to examine the relationship between the primary production and terrigenous input.

References

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