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バイオマーカーによるアデン湾周辺域の古環境復元
Reconstructing the paleoenvironment of the Gulf of Aden and its surroundings lands using biomarkers

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Lands surrounding the Gulf of Aden are one of the most important sites when considering the history of *Homo sapiens*. The oldest known modern human's cranial, estimated to be *ca.* 195 ka, was found at Omo Kibish, Ethiopia (McDougall et al., 2005). Modern human expansion out of Africa, thought to have taken place at *ca.* 60 ka (Quintana-Murci et al., 1999), must have been greatly influenced by the environment of the Arabian peninsula. Mesopotamia has seen rises and collapses of many civilizations. The aim of this study is to reconstruct paleoenvironment of these areas at high time resolution. As a first step, I mainly focused on reconstructing paleoceanographic conditions since the ocean has strong interaction with the atmosphere and the land. Here I focused on three periods, 0.7-7.8 ka (Period I), 53-69.7 ka (Period II), and 195-207.4 ka (Period III). Reconstruction of the paleoenvironment was done by extracting lipids from the sediment and analyzing the biomarkers using GC-MS/FID.

The sampling site of the sediment core GOA4 is off the coast of Yemen, in the Gulf of Aden. The climate of the Gulf of Aden is primarily controlled by summer SW monsoon and winter NE monsoon. On a longer time scale, SW monsoon strengthens during the interglacial, and NE monsoon during the glacial (Rostek et al., 1997).

Biomarkers focused in this study are long-chain n-alkanes, alkenones, and highly branched isoprenoids (HBIs). Carbon preference index of the long-chain n-alkanes ranged from 5-8.5, strongly suggesting that they are mainly of terrestrial origin. The long-chain n-alkanes were the only terrestrial biomarker detected in this study. This may imply that the terrestrial environment surrounding the Gulf of Aden had scarce vegetation.

SST reconstructed from core GOA4 was compared with that from core TY93-909/P recovered off eastern Yemen (Rostek et al., 1997). The fact that SST of GOA4 is about 2oC higher during the interglacial indicates that the Gulf of Aden is outside the trajectory of strong SW monsoon. The difference between the SST of GOA4 and TY93-909/P during the interglacial is expected to be larger than the glacial because SW monsoon and following upwelling is more strengthened at the site TY93-909/P. Despite that, fluctuations of SST on glacial-interglacial time scale at both sites show similar trends. Several hypotheses could be made, as follows (Rostek et al., 1997); (i) Global warming (cooling) during the interglacial (glacial) might have cancelled the effect of sea surface cooling (warming) associated with the upwelling strengthening (weakening) of the SW monsoon. (ii) Deepening of the mixed layer due to the enhancement of NE monsoon during the glacial could have counteracted the weakening of the SW monsoon.

The origin of HBIs detected in this study is probably the diatom genus *Rhizosolenia*. Since the size of the genus *Rhizosolenia* is considerably large, the concentration of HBI is used as a proxy for the productivity of diatoms. Sediment trap study taken place in the northwest Arabian Sea indicates that the blooming of diatoms is a month later than that of coccolithophores (Haake et al., 1993). This is because silicate-rich water lies deeper than that of nitrate and phosphate, and injection of silicate-rich water to the surface does not occur until late summer when SW monsoon is more enhanced.

Abundance of diatoms in Period I could be explained by the fact that diatoms prefer nutrient-rich environment. The reason that the coccolithophores were scarce may be because of earlier occurrence of the injection of silicate-rich water to the surface layer due to the enhanced upwelling. This hypothesis does not seem to fit for Period III which scarcity of diatoms can be observed. This may be due to other limiting factors such as Fe availability. Scarce diatoms and abundant coccolithophores in Period II is reasonable since the surface water during the glacial was probably oligotrophic.

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