学 位 論 文 内 容 の 要 旨

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Study of archaeal and bacterial lipids in surface sediments from the western Arctic Ocean and the Bering Sea and their application to paleoenvironmental reconstruction

（西部北極海とベーリング海の表層堆積物中に含まれるアーキアおよびバクテリア起源脂質の研究とその古環境学的応用）

As global warming continues and the extent of Arctic sea ice decreases rapidly, the Arctic Ocean is experiencing a dramatic environmental change. Furthermore, strong positive feedbacks in the Arctic climate system may affect the global climate (Miller et al., 2010; Screen and Simmonds, 2010). Ongoing decrease of sea ice in the Arctic Ocean seems to be likely similar conditions occurred during the early and middle Holocene (Jakobsson et al., 2010). Paleoclimate studies are important to better understand ongoing change in the Arctic and to predict future Arctic conditions by reconstructing the past environments. In this study, glycerol dialkyl glycerol tetraethers (GDGTs), which are membrane lipids produced by archaea and bacteria, in surface and core sediments from the western Arctic Ocean including the Chukchi Sea and the northern Bering Sea are analyzed to understand their source and transportation in the Arctic region, to test the usability of GDGT-based paleoclimate proxies, and finally to reconstruct paleo-environmental changes in the western Arctic Ocean.

In surface sediments, isoprenoid GDGTs are abundant on the outer shelf and shelf edge of the Chukchi Sea and the upper slope of the Bering Sea. The higher abundances are attributed to a combination of higher production of marine Archaea (Thaumarchaeota) at sea ice margin, redeposition of GDGT-carrying fine particles, and the better preservation of GDGTs at sites with higher sedimentation rates at the outer and shelf edge of the Chukchi Sea. In the study area, the TEX_{86} and TEX_{86}^{L}-derived temperatures are not consistent with sea surface temperatures, with unrealistically high TEX_{86} and TEX_{86}^{L}-derived temperatures in samples north of 73 °N. It is probably biased by contribution of different source from Thaumarchaeota. Branched GDGTs are abundant on the Chukchi shelf and in the Yukon and Mackenzie River estuaries. High concentration of both branched and isoprenoid GDGTs in some study sites indicate a concentration processes such as sediment redeposition

and efficient preservation at sites with high sedimentation rates play important role. Sediments from the western Arctic Ocean north of 75 °N, the Yukon and Mackenzie River estuaries, and the Yukon River have higher cyclization ratio of branched tetraethers (CBT) than sediments from the Chukchi and Bering Seas, suggesting two different sources of branched GDGTs tentatively inferred as soil bacteria and the bacteria living in marine environments.

Based on the result of surface sediment, the GDGT-based proxies are applied to interpret paleo-environmental changes using three cores HOTRAX 05-01 JPC5 and JPC8, and ARA02B 01A-GC from the northern Chukchi Sea. All of the three cores showed a similar changing pattern in GDGT composition during the Holocene. In the early Holocene, both isoprenoid and branched GDGT concentrations were low, and BIT and CBT were relatively high. The similar composition is found in modern sediments from the western Arctic Ocean north of 75 °N, suggesting that the northern Chukchi Sea was covered by perennial sea ice. GDGT concentration increased, and BIT and CBT decreased in the end of early Holocene and reached the same level as those in modern sediments at 8 ka, suggesting existence of seasonal sea ice. TEX_{86}, TEX_{86}^{L} and MBT/CBT indices did not simply indicate temperatures but were affected by the relative contribution of different sediment sources. Remarkable millennial-scale variability in ARA02B 01-GC during late Holocene likely reflected changes in sediment transport in the northern Chukchi Sea.

In summary, resuspension and redeposition of fine particles on the Chukchi shelf and sea ice transportation in the slope and basin of the Chukchi Sea are major processes controlling GDGTs in the western Arctic Ocean including the Chukchi Sea and the northern Bering Sea. GDGT-based proxies are applicable as an environmental proxy in the Arctic Ocean and useful to reconstruct sea ice history but TEX_{86} and TEX_{86}^{L} need a more consideration for applicability of temperature proxy. The middle Holocene, was covered by seasonal sea ice, could be an analog of ongoing Arctic rather than the early Holocene covered by perennial sea ice.