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Paleoceanographic variations in the Sea of Okhotsk based on biomarker analyses

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http://www.kochi-u.ac.jp/marine-core/index.html

1. INTRODUCTION

The Okhotsk Sea is a marginal sea, located in the northwestern Pacific rim. The Okhotsk Sea is characterized by an extended seasonal sea-ice cover and is considered as a possible source area of the North Pacific Intermediate Water (NPIW) (Tally, 1991; Freeland et al., 1998). The formation of the Okhotsk Intermediate Water (OIW) during the summer season may be associated with the inflow of the saline Tsushima Current (so-called Soya Warm Water) from the Japan Sea through the Soya Strait (Watanabe and Wakatsuchi, 1998). Therefore, the reconstruction of past sea surface temperature (SST) and salinity (SSS) in the Okhotsk Sea is indispensable for study of the past variations in the NPIW formation and of the detailed climate changes in the northwest Pacific.

A deep-sea sediment core (XP98-PC1; 51N, 152E, 1107m water depth) was collected from the slope off Kamchatka Peninsula in the Sea of Okhotsk. Oxygen isotopes in planktonic (Globigerina bulloides and Neogloboquadrina pachyderma) and alkenone were analyzed to reconstruct the variations in paleo SST and SSS in the southeast Okhotsk Sea. Flux changes in marine biomarkers, such as alkenone, phytol, brassicasterol, and dinosterol, were also reconstructed to discuss variations of paleo productivity in the surface ocean.

2. RESULTS AND DISCUSSION

(1) Sea surface temperature at the early deglaciation (~15 kyr) lowered by 2 degrees C than that in modern Okhotsk Sea. However, an amplitude in SST drop was reached to 5 degrees C in the southern Okhotsk Sea (northern Kuril Basin) (Ternois et al., 2000). Thus the amplitude of the change in SST between the last glacial and the Holocene was regional different in the Okhotsk Sea.

(2) The alkenone records indicated that summer to autumn SST during the Holocene (past 10 kyrs) were fairly constant at about 8-9 degrees C, being similar to the modern summer SST. Oxygen isotopes of planktonic foraminifera, however, showed the short-term variations during the last glacial to the Holocene. Paleo SSS estimated from oxygen isotopic values of planktonic foraminfiera and alkenone SST suggested that the local excess-salinity, after removal of the long-term trend caused by changes in global sea level changes, is lowered during the early deglaciation by 3-4 psu in comparison with a modern surface salinity. The results also indicate that the millennial scale oscillations in SSS were periodically occurred in the southeast Okhotsk Sea.

(3) The decreased SSS in the Okhotsk Sea may correspond to the warmer climate signals in the Greenland ice core (GISP2), whereas increased SSS may occurred during the colder conditions (Renssen et al., 2000; Mayewski et al., 1997). Similar fluctuations of warm water species in diatom assemblages were observed in the southwest Okhotsk Sea (Shimada et al., 2000) and Japan Sea (Koizumi, 1994). These results suggest that the millennial scale variations in surface current systems and paleoceanographic conditions occurred in the Okhotsk Sea and the surrounding areas. Reconstructed salinity changes may have been caused by the time-series variation of fresh water supply into the southeast Okhotsk Sea, due to precipitation change in the surrounding environment of the Okhotsk Sea.

(4) Downcore profiles of marine biomarker accumulation rates in the Okhotsk Sea (Core PC1) suggest that the marine productivity was extremely low during the last glacial period (25-16.5 kyr), whereas they were increased during the last deglaciation and early Holocene. Several increase peaks were observed in the enhanced period of marine biomarker flux during the last deglaciation. These results indicate that the biological productivity decreased extremely in the surface water in the Okhotsk Sea at the last glacial, and it is suggested that the surface productivity had been intermittently propagated during the last deglaciation.