Evidence from benthic foraminifera and radiolarian assemblages of intermediate water ventilation in the glacial North Pacific

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The modern North Pacific Ocean is the terminus for global thermohaline circulation. Here, no deep water mass is formed today, and the North Pacific Intermediate Water is formed primarily in the Okhtotsk Sea. However, the source and strength of intermediate water in the glacial North Pacific may have been very different from the present North Pacific Intermediate Water.

We have analyzed benthic foraminiferal and radiolarian assemblages in two piston cores collected from the subarctic area of the northwestern Pacific to clarify ventilation changes in the glacial North Pacific intermediate water. We have investigated benthic foraminifera of core ST-21 (water depth; 1,083 m) and radiolarian assemblages of core ST-5 (water depth; 2,083 m), collected from bathyal depths in the subarctic Oyashio current area. Foraminiferal oxygen isotope and 14C dates show that these two cores record climate oscillations from the last glacial maximum to the late Holocene.

Benthic foraminifera are divided into four assemblages that correspond to four periods: the last glacial, and the early, middle, and late Holocene. Distinct assemblage changes can be identified during deglaciation. The glacial assemblages are dominated by Epistominella pacifica, Uvigerina akitaensis, Cassidulina reniforme, and Nonionellina labradorica. E. pacifica is a species characteristic of the intermediate water in the North Pacific, north of Japan. This implies a southward advance of intermediate water that originated north of the Oyashio area during the last glacial period. On the other hand, Holocene assemblages are mainly composed of low oxygen indicative species (Bolivina spissa, Brizalina spp., Globobulimina spp.) similar to the assemblage found in this area today.

Radiolarian assemblages show that C. davisiana, which is an intermediate to deep-water dewelling species, was dominant during the last glacial. This species increased significantly during the last glacial period, constituting about 30 % of the total radiolarian populations, but decreased during the Holocene.

Glacial benthic foraminiferal and radiolarian assemblages indicate that there was the relatively strong ventilation of intermediate water, and the glacial subarctic Pacific Intermediate Water seems to have been cold well-oxygenated water similar to that produced by brine rejection during the formation of sea ice. On the basis of the glacial distribution of radiolarian species Cycladophora davisiana in the North Pacific, we hypothesize that the glacial subarctic Pacific Intermediate Water is derived from the Bering Sea, not the Okhotsk Sea. Intermediate water ventilation decreased drastically during deglaciation and switched to the modern North Pacific Intermediate Water circulation system during the Holocene. Similar ventilation changes have been seen in the northeastern Pacific, suggesting that these changes were widespread and synchronous in the North Pacific.