Millennial-Scale Variations of Intermediate Water Intensity in the Bering Sea during the Last Glacial-Interglacial Cycle?

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Knowledge on the past deep and intermediate water circulations in the North Pacific is important to understand the dynamics of global climate changes and feedback processes. Yet, ventilation changes in the North Pacific basin during the last glacial-interglacial cycle are still poorly understood.

It is widely accepted that at present North Pacific Intermediate Water (NPIW) forms in the Okhotsk Sea at present. However, according to studies on radiolarian assemblage, the Bering Sea is suggested to have been the dominant site of NPIW production during the glacial period. It is therefore critical to identify intermediate water flow and reconstruct its variations in the Bering Sea.

During Mirai cruise MR06-04 Leg2, three pairs of piston cores, each is approximately 18m in length, have been recovered along a depth transect at the northeastern part of the Bering Sea continental slope. Studies on lithology and age model (based on last occurrences of radiolarian species) suggest that the two deeper cores (1002m and 1158m water depth) preserve continuous climatic records covering deglaciation and MIS 2-4, while the shallowest core (852m water depth) seems to preserve a record back into the last interglacial.

We conducted lithological observation utilizing soft-X ray radiographs and high resolution major element analysis by XRF micro-scanner (supported by 102 samples measured by conventional XRF) to reconstruct changes in intermediate water circulation in the Bering Sea during the last glacial-interglacial cycle. The results advocate for a possible relationship between grain size and compositional variation of the detrital component, for example in Ti/Al or Si/Al ratios. Although changes in these elemental ratios could reflect millennial-scale variation in bottom current velocity, changes in riverine and ice rafted debris input are also alternative possibilities. To solve this problem, we examined redox sensitive elements such as S and Mn. We assumed S/Fe ratio and Mn/Al ratio to represent the degree of pyritization, which is commonly employed as a proxy for the bottom water oxygenation level. Mn/Al peaks coincide with prominent peaks of calcium carbonate and loss of ignition (preliminarily regarded as proxy for organic carbon) in the lower part of the core. These peaks could indicate a deepening of the oxygen minimum zone towards the depth of core recovery, thereby allowing enhanced preservation of CaCO3 and organic matter. S/Fe increases on the other hand also seem associated with these periods of low bottom water oxygenation. The geochemical evidence of the cores points to millennial-scale variations in bottom water oxygenation level during the last glacial to deglaciation period, possibly also associated with ventilation changes due to changes in NPIW intensity.