Hydrogen isotopic record of biomarkers in Ross Sea sediments for the reconstruction of West Antarctic Ice Sheet in the last 30 kyr

Michiko Toyoda[1]; Yusuke Yokoyama[2]; Hideki Miura[3]; Yoshito Chikaraishi[4]; Hidekazu Tokuyama[5]; Hiroshi Kitazato[6]; # Naohiko Ohkouchi[7]

[1] ORI, Tokyo Univ; [2] Dept. Earth & Planet. Sci., Univ. Tokyo; [3] NIPR; [4] JAMSTEC, IFREE; [5] ORI, Univ. Tokyo; [6] IFREE, JAMSTEC; [7] JAMSTEC

It has been pointed out that not only a melting of Northern Hemisphere Ice Sheets but also that of the Antarctic Ice Sheet may have been responsible for sea-level rise after the Last Glacial Maximum (LGM). The West Antarctic Ice Sheet (WAIS) is the one that has been anticipated its potential disintegration as a consequence of the global warming, since the major part of the ice sheet is grounded below sea-level. Several studies have also suggested the possibilities of partial collapse of the WAIS after the LGM, leading to abrupt sea-level rises. In this study, the fluctuations of the WAIS during the late Pleistocene have been reconstructed with hydrogen isotope compositions of lipid biomarkers including sterols and phytol from Ross Sea sediments. Because the sediments from Antarctic margin lack planktonic foraminifera, the hydrogen isotopic composition of sedimentary organic matter originated from the algae is an only proxy useful for tracing the isotopic composition of surface water in the past.

In the western margin of the Ross Sea, Antarctica, a sediment core (GC1604: 74.55S, 168.00E, 922m) was collected during R/V Hakurei-Maru TH95 Antarctic Cruise in 1996. Chronology of the core was established based on AMS radiocarbon dating of the acid-insoluble organic fractions from sediments. Correction for the reservoir effect as well as dilution effect from terrestrial old carbon was carried out with subtracting the core top radiocarbon date. Obtained radiocarbon ages were converted to the calendar years.

Dried sediments were extracted with organic solvents. The total extracts were separated into compound groups, using chemical methods such as silica gel column chromatography, urea adduction and silver nitrate-impregnated silica gel column chromatography. Each compound was identified and quantified by gas chromatography/mass spectrometry. The compound-specific hydrogen isotope analysis was carried out by gas chromatography/thermal conversion/isotope ratio mass spectrometry.

The hydrogen isotopic compositions were determined for phytol, archaeol, fatty acids (FAs), stanols, and sterols which were well separated on the chromatograms. In the Ross Sea, stanols, sterols, and FAs derive mainly from plankton including algae and zooplankton. Phytol and archaeol are produced as a side chain of chlorophylls by algae and archaea probably inhabited the water column, respectively. The dD values for the paleo-surface-water (dDwater) of Ross Sea was reconstructed with assuming the isotopic fractionations associated with the biosynthesis; -276 per mil for sterols and archaeol, -345 per mil for phytol (Sessions et al., 1999; Chikaraishi et al., 2005) and -173, -150 and -126 per mil for C14, C16 and C18 FAs (N. Ohkouchi and T. Eglinton, unpub. results). Throughout the last 30 kyr, the dwater values estimated by dDcholesterol, dDcholestanol, dDFAs and dDarchaeol are relatively constant around +50 per mil rather than 0 per mil. Such a D-enriched value suggested the  values overestimated by about 50 per mil. However, the dDwater values estimated by dDsitostanol and dDphytol exhibited remarkably low values (˜-350 per mil) intermittently during the last 11 kyr (10.5, 5.5, 2.5 and 0.5 ka). Furthermore, the surface water appears to have been ˜100 per mil depleted in D at around 18 ka compare to the other periods during the last deglaciation.

We ascribed these shifts in D as the result of massive ice-melting events could have occurred at least four times in the Holocene and 18ka. The meltwater from the WAIS (dDwater ˜-350 per mil) covered the sea surface due to its lower salinity and the phytol and sitosterol could have been produced mainly at the very surface layer of the water column where sea water was substantially depleted in D. Instead, the cholesterol, cholestanol, FAs, and archaeol are produced in the deeper portion of the water column where dDwater was around 0 per mil due to the mixing with seawater outside of Ross Sea.