Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

BPO003-09 Room:201B Time:May 26 10:45-11:00

A Holocene diatom oxygen isotopes record from the Indian Sector of the Southern Ocean

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The oxygen isotope ratio ($d^{18}O$) of diatom frustules are promising as a quantitative proxy of past seawater temperature and seawater $d^{18}O$, analogous to foraminifer $d^{18}O$. Therefore, diatom $d^{18}O$ is expected to be used for paleoceanographic studies in polar regions where foraminifer shells are hard to be preserved in sediments. However, conventional methods for measurements on diatom $d^{18}O$ have various limitations, including difficulty of processing and necessity for large amount of samples. Here we present diatom $d^{18}O$ records from the Southern Ocean in order to reconstruct paleoceanographic change in the Southern Ocean and the Antarctic Ice Sheet fluctuations during the Holocene. Our analytical system is composed of inductive high temperature carbon reduction and continuous-flow isotope mass spectrometry. In this system, silica is reduced by carbon at 1600 degree C to produce carbon monoxide for isotope analysis. The carbon monoxide gas is directly introduced into mass spectrometry by helium gas. Our system is capable to measure ˜100 microgram of diatom $d^{18}O$ safely without any cumbersome procedures. A piston core COR-1PC (54o16.04'S, 39o46.00'E; 2,864 m water depth; 408 cm core length) was collected from the Conrad Rise, Indian sector of Southern Ocean in January 2008 by R/V Hakuho-Maru. Sediments were mostly composed of diatom ooze. The age model was established using AMS 14C dating on planktonic foraminifera (*Neogloboquadrina pachyderma*, sinistral) with core top and bottom ages estimated as 813 cal BP and 10,192 cal BP, respectively. We measured diatom $d^{18}O$ from 43 samples. We found that; i) diatom $d^{18}O$ in the Conrad Rise fluctuates between 38 per mil and 43 per mil through the Holocene, ii) diatom $d^{18}O$ show periodic variation during early to middle Holocene, iii) fluctuations of diatom $d^{18}O$ are different from those of foraminifer $d^{18}O$. We interpret fluctuations in diatom $d^{18}O$ to be dominated by a sea water $d^{18}O$ signal because the diatom $d^{18}O$ fluctuations exhibit more volatility than is expected for sea surface temperature. The periodic variation of early to middle Holocene seen in the Conrad Rise is also seen in other parts of the Southern Ocean, which coincides with the Holocene Thermal Maximum. This suggests that the Antarctic Ice Sheet underwent periodic melting associated with warming since the end of the last ice age.

Keywords: diatom d18O, foraminifer d18O, Southern Ocean, Holocene, Holocene Thermal Maximum