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Mid-Brunhes event (MBE) in the Southern Ocean

Minoru Ikehara[1*], Shuko Okamoto[1], Boo-Keun Khim[2], Yusuke Suganuma[3], Kota Katsuki[1], Takuya Itaki[4]

[1]Kochi University, [2]Pusan National University, [3]National Institute of Polar Research,
[4]Geological Survey of Japan, AIST

A Pliocene climate was warm, and the Quaternary is a period of glaciation. Alternating growth and decay of polar ice sheets, regulated by orbital forcing, characterize Quaternary climate history. During the Pleistocene, there are several major climate shifts. The mid-Pleistocene transition (MPT) of the global climate system was initiated by a shift towards much larger northern hemisphere ice sheets during the spans from ca.1.2Ma to 0.8Ma. Orbital obliquity at 41-kyr cycles had dominated the earlier part of the Pleistocene. The MPT ending with predominance of 100-kyr cycles is one of the fundamental enigmas in Quaternary climate evolution. Another distinct climate change, the mid-Brunhes event (MBE) is roughly corresponds to the transition between Marine Isotope Stage (MIS) 12 and MIS 11 about 430 ka. The MBE is characterized by feature of ice-volume variations with large amplitude of 100-kyr dominated glacial-interglacial cycles.

The Antarctic Cryosphere is composed of several subsystems, such as cold surface water, active biological productivity, surface water frontal system, sea-ice distribution, and East Antarctic ice sheet. The Southern Ocean has played a significant role in the global climate system during the geologic past, even in the present-day. In order to resolve the causes and processes of atmospheric CO2 change, important is to understand mechanisms and processes of subsystems in the Antarctic Cryosphere during the major climate shifts. We collected a piston core LHB-3PC from off Lutzow-Holm Bay in the Indian Sector of the Southern Ocean during the R/V Hakuho-maru cruise KH07-4 Leg 3. Sediments of core LHB-3PC are mainly composed of diatomaceous clay. Age model of core LHB-3PC was established by diatom and radiolarian biostratigraphy and a graphic correlation between grain size variation of magnetic minerals and standard oxygen isotope curve.

High biogenic opal contents occurred during the interglacials, indicating that the marine productivity was enhanced at the interglacial periods in the high-latitudinal Southern Ocean. Carbon isotopes of bulk organic matters ranged from -26 to -22 permil, and isotope values increased during the interglacial stages. The high carbon isotope of sediment organic matter in core LHB-3PC suggests that the phytoplankton growth rate increased during the interglacial period in the Antarctic surface water. In contrast, marine productivity was significantly restricted during the glacials. The lowered glacial productivity was also supported by the decrease in amount of siliceous microfossils such as diatom and radiolarian at core LHB-3PC. In addition, the amplitudes of carbon isotope of organic matter and biogenic opal were significantly increased at the each interglacials after the MBE than those of before it. Therefore, it implies that biological productivity in the surface Antarctic Ocean during the interglacials was increased after the MBE. The solar radiation is most important in the high latitudinal Antarctic Ocean where the nutrients exist always abundantly in surface water. A core site is located at modern seasonal sea-ice coverage. Therefore the summer sea-ice distributions for the interglacials are completely different before and after the MBE, suggesting that the core site was covered with a perennial sea-ice before the MBE. Our findings linked closely with the air temperature change that reconstructed

from hydrogen isotope records of ice core EPICA Dome C, Antarctica (EPICA community members, 2004), suggesting that the northward shift of summer sea-ice edge in the Antarctic Ocean had related to the cold temperature of Antarctica for the interglacial periods before the MBE. The amplitude of each change of the Antarctic Cryosphere subsystem increased more after the MBE about 430 ka.

Keywords: Southern Ocean, mid-Brunhes event, paleoproductivity, sea-ice, climate transition