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Paleoproductivity changes and mid-Brunhes event off Luzow-Holm Bay in the Antarctic Ocean during past 730 kyr

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1. Introduction

The Southern Ocean plays a very important role in the global climate system on the present and geologic past. It's clear that concentration of atmospheric CO_2varied by the amplitude of about 90 ppm during past 700 kyr. The causes and processes of atmospheric CO_2change are not clear, but biological pump and surface water stratification in the Southern Ocean are thought to be important phenomena. Several subsystems of the Southern Ocean such as sea surface temperature, surface water frontal system, sea-ice distribution influenced to the global climate change. The solution for these problems is an important task for recently paleoclimatology and paleoceanography. However, the paleoceanographic records have been limited in the south of modern Antarctic Polar Front (APF). Therefore we studied a change of biological productivity and of sea-ice distribution for the glacial-interglacial climate cycle in the Southern Ocean. Furthermore, we focused on a major paleoceanographic changes in the Southern Ocean related to the mid-Brunhes event (MBE), which is a climate transition that occurred between Marine Isotope Stage (MIS) 13 and MIS 11 about 430 ka.

2. Materials and Method

A sediment core LHB-3PC was used in this study. Core LHB-3PC was collected from off Luzow-Holm Bay in the Indian Sector of the Southern Ocean during the R/V Hakuho-maru cruise KH07-4 Leg3. Sediments are mainly composed of diatomaceous clay. The dried and powdered sediments were analyzed in elemental analyzer on-line mass spectrometer (DeltaPlus Advantage) to measure the total organic carbon (TOC) contents, total nitrogen (TN) contents, carbon isotope ratio of organic matter ($d^{13}C_{org}$), and nitrogen isotope ratio ($d^{15}N$). Oxygen isotope stratigraphy was not used in core LHB-3PC due to poor preservation of carbonate materials. Age model of LHB-3PC was established by diatom and radiolarian biostratigraphy and graphic correlation between grain size variation of magnetic minerals and a standard oxygen isotope variation (Suganuma et al., in prep.).

3. Results and Discussion

Concentration of TOC ranged from 0.1 to 0.3 wt.% at core LHB-3PC, except for each turbidite layers. The averaged value of TOC is very low (0.14 wt.%) and TOC dose not showed a periodical variation. In contrast, biogenic opal contents increased during the interglacials and decreased during glacials. Both TOC and biogenic opal are generally known as a proxy for paleoproductivity. However these proxies did not shown a similar pattern of variations. TOC values are relatively lower and sedimentation rates are also slow (0.9cm/ka), suggesting that the settled sediments were exposed with a long period in the oxygenated Antarctic Bottom Water (AABW) on the seafloor. Therefore, it is imply that the effect of organic matter decomposition was relatively strong.

The amplitude of $d^{13}C_{org}$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. In addition, the interglacial climate on the Antarctica was much warmer after than before the MBE (EPICA community member, 2004). 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.

Keywords: Antarctic Ocean, Luzow-Holm Bay, paleoproductivity, mid-Brunhes event, sea-ice