

Chemical States of Iron in the Deep Sea Sediments; in case of the Antarctic Ocean

Katsumi SHOZUGAWA*¹, Motoyuki MATSUO¹, Akihito KUNO¹, Hideki MIURA².

¹Graduate School of Arts and Sciences, The University of Tokyo, 3-8-1 Komaba, Meguro-ku, Tokyo 153-8902, Japan

²National Institute of Polar Research, 1-9-10 Kaga, Itabashi-ku, Tokyo 173-8515, Japan

Introduction

Sea sediments provide a unique probe of the environment of the paleocean at the time of sedimentation. A massive fluctuation is not seen in the content of the whole sediment unless local event, like chimney, occurs even if we determinate quantity of a heavy metal element included in the sediment. It is difficult to identify the sea-event that happened on the ocean from the viewpoint of the elemental determination. Provided that the element is in the sediment abundantly, the chemical states of element change depending on sea environment. Specifically we paid attention to pelagic sea sediment of the Antarctic Ocean where we estimated that the environment would change greatly after Pleistocene age. Therefore, measuring the chemical states of iron with XANES spectra, we expect the reconstruction of the oxidation-reduction state of bottom water of sea at the time of sedimentation.

Experiment

JOGMEC (Japan Oil, Gas and Metals National Corporation) collected sample cores at the deep sea offing Antarctic Peninsula, located 60°11'08"S, 55°30'27"W in 1997. The water depth of collecting station is 3531m. All collected core samples were cut at every 1cm (~150mg) immediately, and were kept at 4 degrees until the measurement. Samples were also kept in N₂ atmosphere to prevent from being oxidized with air. The XAFS measurement was performed using synchrotron radiation ring at BL-9A/12C, Photon Factory, KEK[1]. A Si (111) double-crystal monochromator was used. The iron K-edge XANES spectra of the samples were measured in a fluorescence mode using a Lytle-type detector. As standard materials, Hematite, Olivine, Pyrite, Pyrrhotite were also measured. Hematite and Olivine are for a class of Fe(III) and Fe(II).

Results and Discussion

Sample core has been no influence of human activities, taking account of the sedimentation age and water depth. Besides, we applied the depth of core to sedimentation age with the dating value using ¹⁴C by JOGMEC. This core has about 32000y.B.P. sedimentation age at the bottom. Figure1 shows the normalized iron XANES spectra of the sediments by depth and standard materials. The measurement performed 18 samples according to the sedimentation age. All spectra passed the middle of

Hematite and Olivine near the K-edge. Contents of Fe(III) that is a characteristic of clay minerals tend to be abundant apparently.

Note that the K-edge. In the neighbourhood of K-edge, with an expansion in Fig.1, it is evident that state of oxidation-reduction of iron changed with the increasing the sedimentation age. The spectrum of 22000y. B.P. tends to be oxic relatively, in contrast, that of 10000y. B.P. tends to be anoxic. The surface of core (5500y. B.P.) passed middle of both. This trend was observed continuously with all samples from pre-edge to K-edge. Simultaneously we determined the quantity of iron with INAA (Instrumental Neutron Activation Analysis) over the entire core; the content of iron was constant, around ~1.8%, from the core-top to the bottom. Consequently, it was noticeable that the chemical states of iron fluctuated by the sedimentation age in spite of the constant iron content. This behaviour suggests the possibility that sea sediment logged events of the oxidation-reduction state of the AABW, Antarctic Bottom Water, which occurred after Pleistocene age[2]. However, we cannot rule out a possibility that the sample includes the degeneration of iron compounds after sedimentation. The further discussion will be required about the effect of the sediment diagenesis.

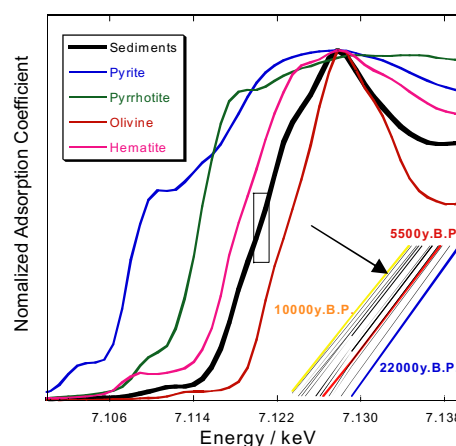


Figure1. Normalized iron K-edge XANES spectra of the sediments from various sedimentation age and standard materials.

References

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*shozum@dolphin.c.u-tokyo.ac.jp