Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MZZ42-P01 Room:Convention Hall Time:May 24 16:15-17:30

Biogenic magnetite prevails in oxic pelagic red clay core in the South Pacific Gyre

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Magnetotactic bacteria have been observed in wide variety of environments, including soils, freshwater lakes, and marine sediments, since Blakemore first described in 1975. Magnetotactic bacteria, which most commonly live within the oxic-anoxic transition zone (OATZ) of aquatic environments, produce intracellular crystals of magnetic minerals, specifically magnetite or greigite. It is considered that the magnetite/greigite crystals facilitate the bacteria's search for optimal conditions within the sharp chemical gradients of the OATZ. Petermann and Bleil (1993) reported living magnetotactic bacteria in pelagic and hemipelagic sediments near OATZ in the eastern South Atlantic at water depths to about 3,000 m, but they could not find actively swimming magnetotactic bacteria in sediments of deeper water depths.

The South Pacific Gyre (SPG) is far from continents and the lowest productivity region on Earth. IODP Site U1365 (water depth 5,696 m) cored pelagic red clay of 75.5 m thick above ˜100 Ma basement (except for chart layers from ˜42 to 61.5 m) in the western edge of the SPG. The core mainly consists of iron rich clay. The color is dark reddish and/or dark brown throughout the core. We conducted a paleomagnetic and environmental rock magnetic study of the pelagic clay core. The magnetostratigraphy revealed the top 5 m sediments cover the last 5 My, and sedimentation rate decreases downward from 1.7 to 0.6 m/m.y. Geochemical measurements of pore water indicate that dissolved oxygen was present throughout the core (>50 microM). Thus oxygen penetrates through the entire sediment column to the sediment/basalt interface, and there is no OATZ.

Magnetic mineral assemblage of this core is dominated by biogenic magnetite despite no OATZ. First-order reversal curve (FORC) diagrams of all specimens have a narrow central ridge along the Hc axis with very small vertical spread. This indicates very weak magnetostatic interaction (Roberts et al., 2000), and is the characteristic of biogenic magnetite (Egli et al., 2010; Roberts et al., 2011). Presence of biogenic magnetite was confirmed by TEM observation. Occurrence of biogenic magnetite was reported also in pelagic red clay of the North Pacific with TEM observations (Yamazaki and Ioka, 1997), and these samples also display the characteristic FORC diagrams. These observations suggest that biogenic magnetites commonly occur in oxic pelagic red clay without OATZ.

Keywords: Biogenic Magnetite, Pelagic Red Clay, Oxic Environment, Environmental Magnetism, South and North Pacific Gyre, IODP Exp.329

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Reconstructing the paleoenvironment of the Gulf of Aden and its surroundings lands using biomarkers

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Lands surrounding the Gulf of Aden are one of the most important sites when considering the history of *Homo sapiens*. The oldest known modern human's cranial, estimated to be *ca.* 195 ka, was found at Omo Kibish, Ethiopia (McDougall et al., 2005). Modern human expansion out of Africa, thought to have taken place at *ca.* 60 ka (Quintana-Murci et al., 1999), must have been greatly influenced by the environment of the Arabian peninsula. Mesopotamia has seen rises and collapses of many civilizations. The aim of this study is to reconstruct paleoenvironment of these areas at high time resolution. As a first step, I mainly focused on reconstructing paleoceanographic conditions since the ocean has strong interaction with the atmosphere and the land. Here I focused on three periods, 0.7-7.8 ka (Period I), 53-69.7 ka (Period II), and 195-207.4 ka (Period III). Reconstruction of the paleoenvironment was done by extracting lipids from the sediment and analyzing the biomarkers using GC-MS/FID.

The sampling site of the sediment core GOA4 is off the coast of Yemen, in the Gulf of Aden. The climate of the Gulf of Aden is primarily controlled by summer SW monsoon and winter NE monsoon. On a longer time scale, SW monsoon strengthens during the interglacial, and NE monsoon during the glacial (Rostek et al., 1997).

Biomarkers focused in this study are long-chain n-alkanes, alkenones, and highly branched isoprenoids (HBIs). Carbon preference index of the long-chain n-alkanes ranged from 5-8.5, strongly suggesting that they are mainly of terrestrial origin. The long-chain n-alkanes were the only terrestrial biomarker detected in this study. This may imply that the terrestrial environment surrounding the Gulf of Aden had scarce vegetation.

SST reconstructed from core GOA4 was compared with that from core TY93-909/P recovered off eastern Yemen (Rostek et al., 1997). The fact that SST of GOA4 is about 2oC higher during the interglacial indicates that the Gulf of Aden is outside the trajectory of strong SW monsoon. The difference between the SST of GOA4 and TY93-909/P during the interglacial is expected to be larger than the glacial because SW monsoon and following upwelling is more strengthened at the site TY93-909/P. Despite that, fluctuations of SST on glacial-interglacial time scale at both sites show similar trends. Several hypotheses could be made, as follows (Rostek et al., 1997); (i) Global warming (cooling) during the interglacial (glacial) might have cancelled the effect of sea surface cooling (warming) associated with the upwelling strengthening (weakening) of the SW monsoon. (ii) Deepening of the mixed layer due to the enhancement of NE monsoon during the glacial could have counteracted the weakening of the SW monsoon.

The origin of HBIs detected in this study is probably the diatom genus *Rhizosolenia*. Since the size of the genus *Rhizosolenia* is considerably large, the concentration of HBI is used as a proxy for the productivity of diatoms. Sediment trap study taken place in the northwest Arabian Sea indicates that the blooming of diatoms is a month later than that of coccolithophores (Haake et al., 1993). This is because silicate-rich water lies deeper than that of nitrate and phosphate, and injection of silicate-rich water to the surface does not occur until late summer when SW monsoon is more enhanced.

Abundance of diatoms in Period I could be explained by the fact that diatoms prefer nutrient-rich environment. The reason that the coccolithophores were scarce may be because of earlier occurrence of the injection of silicate-rich water to the surface layer due to the enhanced upwelling. This hypothesis does not seem to fit for Period III which scarcity of diatoms can be observed. This may be due to other limiting factors such as Fe availability. Scarce diatoms and abundant coccolithophores in Period II is reasonable since the surface water during the glacial was probably oligotrophic.

Keywords: the Gulf of Aden, human history, biomarker, paleoenvironment, Indian monsoon

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Evaluation of the desertification in Tarim Basin based on provenance study of size-separated fluvial sediment since 8Ma

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Tarim Basin is located to the north of Tibetan Plateau. Tarim Basin is characiterized by very dry climate and the Taklimakan desert is developed in the central part of Tarim Basin. In previous studies, the desertification of Tarim basin was considered as having been triggered by the uplift of Tibetan Plateau (e.g. Zheng et al., 2000, DH Sun et al., 2011). However, the timing of desertification has been dated only roughly by eolian sediments, and there is a possibility that Tarim Basin was arid but eolian sediments are not generated.

In this study, we tried to evaluate the timing of aridification based on the dust contribution to the fine fraction in the fluvial sequence which is evaluated by examining provenance of size-separated samples. We conducted the provenance study of quartz, which is common mineral in sediments resistant to weathering.

For the provenance study of quartz, we used Electron Spin Resonance (ESR) signal intensity of quartz and crystallinity index (CI) of quartz. ESR signal intensity of quartz reflects the age of mother rock (Toyoda and Naruse, 2002), whereas CI of quartz reflects physical condition of its formation such as temperature and rate of crystallization (Murata and Norman, 1976). In her study of modern river sediments in the Tarim basin, Isozaki (2009 MS) suggested that quartz in coarse fraction (>63um) of river sediments reflects bedrock geology of the catchment area based on ESR signal intensity and CI of quartz. On the other hand, fine fraction (<16um) of river sediments may reflects geology of the river catchment area and eolian dust.

We applied this method for the fluvial sequence. Firstly, we revealed the size-separated provenance change of fluvial sediments. Secondly, we found the provenance separation of size-separated fluvial sediments, and we evaluated the contribution of eolian dust in the fine fraction of the fluvial sequence.

We conducgted field survey at the Yecheng section in the southwestern Tarim Basin. Fluvial to alluvial deposits with occasional intercalations of eolian sediments deposited between 7.6Ma to 1.8 Ma are continuously exposed along the Yecheng section (Zheng et al., 2010; Tada et al., 2010). We selected 27 river sediments (9 sandstones and 18 conglomerate matrix) in 0-16um and 63-500um, and measured ESR signal intensity and CI of quartz.

From the result of analyses, we found the provenance separation of size-separated fluvial sediments (difference in provenance between fine and coarse fractions) at 6.6Ma, 6.0Ma, and after 4.5Ma. Assuming the provenance separation was caused exclusively by eolian contribution, Tarim Basin was arid after at least 6.6Ma.

By comparing with the provenance changes at the Yecheng section in coarse fraction (63-500um)(presented in H-CG33), the ages of uplift activity in the leading edge of Kunlun mountains are approximately the same as the timing of eolian dust contribution increase and desert formation in the Tarim Basin. So, there is possibility that the uplift activity in the leading edge of Kunlun mountains contributed dust production and sand desert formation in the Tarim Basin after 8Ma.

Keywords: Tarim Basin, Desertification, Taklimakan Desert, Provenance study, Eolian dust, Uplift

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Estimation of the growth-rate influences on the oxygen isotope and Sr/Ca ratios in the Porites at high latitudes

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The skeletal oxygen isotope in the coral is used as a good proxy to reconstruct sea surface temperature (SST). On the other hand, some studies showed that coral growth rates may affect the oxygen isotope in coral (McConnaughey 1989a; Felis et al., 2003; Suzuki et al., 2005; Hayashi et al., 2013). Here we reanalyzed the same Porites coral in Omata et al. (2006), which was collected in the eastern of Ushibuka in the Amakusa area, Japan, which is located at slightly lower latitude than the northern limit of the hermatypic corals. We measured Sr/Ca ratio and reconstructed SST. Compared to the oxygen isotope ratio measured by Omata et al. (2006), our results showed that Sr/Ca ratio is the robust SST proxy which is independent of its growth rate. We suggest that Sr/Ca ratio is more suitable for reconstruction of SST using the small growth-rate Porites corals, especially in high latitudes.

Keywords: skeletal oxygen isotope in the coral, Sr/Ca ratio, high latitudes, coral growth rates

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Provenance and mixing ratio of the sediments discharged from Yangtze River based on ESR signal intensity and Crystallini

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The Yangtze, the largest river in east Asia, is 6300km long and its drainage is 1.94x106km2. Since its drainage has over 400 million habitats, the flood of the Yangtze can damage human activities seriously. According to the observation, floods in the middle-lower reaches of the Yangtze are affected by the ENSO. However, floods in the upper reaches are affected by the South Asia Monsoon. So, to investigate floods, not only temporal but also spatial fluctuation is important.

To reconstruct the flood history before the observation records, it is possible to estimate the provenance of flood sediments. For that purpose, it is necessary to establish the proxy to distinguish sediments from each tributaries of Yangtze.

The suspended particle matter, SPM, occupy over 98% of the sediments discharged from Yangtze. Its mean diameter of SPM during normal weather at lower reaches is around 10um. In the flood deposits from the Yangtze estuary, however, the median diameter is 25-35um, which is much larger than that of SPM.

Yang et al., (2007) and Mao et al. (2011) analyzed Sr and Nd isotope in SPM of the Yangtze. CIA is also analyzed by Shao et al. (2012). Their results suggest that it is possible to distinguish sediments from the upper reaches from that in the middle-lower reaches. However, Sr-isotope and CIA can be altered by chemical weathering, and they didn't evaluate qualitative differences depending on particle diameters.

The objective of this study are 1) to distinguish the particles of different tributaries by using ESR(Electron Spin Resonance), CI(Crystallinity Index) and 2) to confirm whether these parameters can estimate the provenance of sediments, which are separated into three fractions.

The result revealed that the ESR values are lower than 2 in the tributaries of the upper reaches, which are gradually rising to 7-10 in the tributaries of the middle reaches. The combination of ESR and CI values can be used to distinguish particles from each tributaries. It is important to select appropriate fractions to analyze, since the ESR values of different fractions are not necessarily the same.

The ESR and CI values at lower reaches are estimated from ESR and CI values of each tributaries and the median sediment budget based on observation. The analyzed values of the lower-reach sediments are slightly different from the estimated values. The sediment budget of each fractions are needed to be improved.

Assuming the sediment flux of tributaries in the upper or middle reaches increases, the magnitudes of changed in ESR and CI values of the sediment from the lower reaches are estimated. These parameters turned out to be more sensitive to the flood of the middle-lower reaches than that of the upper reaches.