Ec-009 会場：C401 時間：6月10日 11:00-11:15

海底堆積物中のバクテリア起源マグネタイトの形態と有機炭素フラックスの関係

Organic carbon flux controls the morphology of magnetofossils in marine sediments

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走磁性バクテリアは細胞内に鎖状に連なる磁鉄鉱結晶を作る．バクテリア起源磁鉄鉱は，その形成が生体によりコントロールされ，特徴的な形態とサイズを持つ．太平洋表層堆積物中に化石として残されている生物源磁鉄鉱の形態と有機炭素フラックスの関係を調べたところ，等方的形態の結晶の割合がより酸化的環境に多く，異方的形態の結晶がより還元的環境に多いことがわかった．この発見は，生鉱物形成過程に重要な意味を持つとともに，バクテリア起源磁鉄鉱形態が，古環境の指標になりえることを示す．

Magnetotactic bacteria have been discovered in a wide variety of environment, including marine and lacustrine sediments and land soils in aerobic to sulfate reducing conditions. Magnetotactic bacteria yield chains of magnetite or greigite crystals (magnetosomes) within a cell. The crystal sizes are under strictly biological control to yield particles of single-domain (SD) size. Bacterial magnetites have characteristic morphologies, those are, hexagonal prism, octahedron, and tear-drop shape, and they appear to be species-specific. Factors which control the morphology were, however, not understood.

The deep-sea surface sediments were collected at 13 sites in the Pacific using a box-corer or a multiple corer. At eight sites out of thirteen, organic carbon (Corg) fluxes were determined from particulates collected by sediment traps moored for about one year. Magnetofossil morphology was determined on 100 to 300 crystals in general for each site under a transmission electron microscope (TEM). Biogenic magnetites were identified based on the characteristic morphologies and SD sizes. We grouped the magnetofossils into isotropic (equant octahedron) and anisotropic based on their morphologies under TEM images. The latter group was subdivided into hexagonal prisms and tear-drops. Magnetofossil morphology in the surface (within the top 2 cm) sediments under the sediment traps clearly correlated with the Corg flux, although it is semi-quantitative. Isotropic crystals dominated sites with a low Corg flux, whereas the ratio of anisotropic crystals increases in the higher Corg flux sites. Geographically, the isotropic-dominant region corresponds to the low primary productivity province. The Corg control on magnetofossil morphology was observed also within cores. A 40 cm box-core of hemipelagic terrigenous mud from Western Caroline Basin showed a downcore increase of the ratio of anisotropic crystals with an increase of Corg content during the last glacial period. Variations in Corg content in sediments generally reflect changes in Corg flux in the equatorial Pacific.

In the deep sea, organic carbon flux controls the chemical environment of surface sediments. Our results indicate that species having isotropic magnetosomes prefer a relatively oxidized condition, and those with anisotropic magnetosomes favor a more reduced environment. Although only a few species of magnetotactic bacteria can be cultured and studied in detail, our observation is consistent with the known habitat. The bacterium Magnetospirillum magnetotacticum (MS-1) produces octahedral crystals under microaerobic conditions. On the other hand, the strain MV1, which was isolated from sulfide-rich marine sediments and can grow anaerobically, yields magnetosomes of hexagonal prisms. A possibility that magnetofossils are a paleooxygen indicator was once suggested when bacterial magnetites were considered to be produced only in aerobic sediments. This possibility was excluded by the discovery of anaerobic species. Hesse (1994) reported magnetofossil morphology variations within a sediment core, which revived the possibility as a paleoenvironmental indicator. Our finding demonstrates that magnetofossil morphology can be a new tool for recovering paleo-oxic/anoxic conditions, in particular for the sediments and sedimentary rocks which did not preserve original chemical compositions.