

Framboidal pyrite as a biomarker in geological samples

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Size distribution of framboidal pyrite is often used as an indicator of ancient ocean anoxia. It is hypothesized that combined information among size distribution of framboids, grain-level morphology, sulfur isotopes and trace elements can be used as a biomarker for ancient microbial activities. Shale samples were collected from the Hokuroku district in order to examine this hypothesis. The age of samples are ranging from ca. 15 Ma to 10 Ma. Kuroko, well-known submarine hydrothermal deposits, were formed at ca. 13Ma and its influence to environmental changes are also expected. Size distribution of framboidal pyrite suggests that bottom of Japan sea became anoxic and most likely euxinic during the Kuroko formation period. Sulfur isotope compositions indicate that microbial sulfate reduction, sulfur oxidation and sulfur disproportionation during this period. After 13Ma, size distribution of framboidal pyrite does not show any ocean anoxia. Morphology of nano-sized pyrite in framboids is found to be changed from octahedron to cubo-octahedron dominant types. This systematic change corresponded well to oceanic environmental changes. In addition, abnormal Mn enrichment was found in framboids formed in later diagenetic stage. This suggests sulfate reduction coupled with MnO₂ dissolution, probably caused by sulfate reducers in ancient deep biosphere.