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Biosignature found in iron oxide mineralogy of iron-oxidizing microbe origin?

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Recently, many iron mats have been discovered at deep-sea hydrothermal fields in all over the world. It has been thought that microbes, especially iron-oxidizing microbes, are the key players for forming the iron mats. However, there was no direct evidence to this, due to cultivation difficulty of iron oxidizers. Recently, '*Mariprofundus ferrooxidans*' that belong to the Zetaproteobacteria was successfully isolated. From this isolation, it has been proved that this microbe can oxidize ferrous iron as the electron donor, and can widely be observed in various deep-sea low-temperature hydrothermal fields. Therefore we have investigated how these microbes contributed to the formation of the iron mat using mineralogical and culture independent approaches.

We tried to clarify mineralogical properties of natural or lab-prepared iron oxides of iron-oxidizing microbes by using XAFS, SEM and EDX. Natural samples were collected at 3 sampling sites: iron mats from deep-sea hydrothermal fields in the Mariana Volcanic Arc, Mariana Trough and the Okinawa Trough. Lab-prepared iron-oxide synthesis was carried out using chemoautotrophic bacterium Mariprofundus ferrooxydans PV-1 (ATCC BA-1020) and was cultured by diffusion cell's method (Kikuchi et al., 2011, 2014). SEM observation showed similar morphology to all samples, which have distinctive plait-like structure, and at where iron oxides precipitate around distinctive materials. Although each natural iron-oxide sample was precipitated at different environments and with different dominant microbial species within the natural samples, XAFS showed identical spectrum. Regardless of medium employed in the cultivation, lab-prepared iron oxides also showed similar spectrum to natural samples. XANES fitting suggested that iron mats consist of ferrihydrite and iron-organic complex being the same as the lab-prepared iron oxides. These results strongly supported the iron-oxidizing chemolithoautotrophs had significant ecological roles in producing the iron mat. These mineralogical analyses may help to find biosignature in the deep-sea environments.

Keywords: iron-oxidizing bacteria, Biosignature, Mineralogical property, deep-sea, hydrothermal fields