

Direct observation of microbe-metal-mineral interaction by micro-XAFS-FISH technique

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Microorganisms in the environment critically impact global geochemical cycles and redox reactions of various elements. Many geochemically important redox reactions (e.g., sulfate reduction and Fe(II) oxidation) are largely associated with microbial activity. In addition, microbes can mediate mineral formation by a process called biomineralization. Recent studies suggest a significant relationship between Fe(II)-oxidizing bacteria and ancient Banded Iron Formation, one of the large geochemical events in Earth's history. The general ecological importance of environmental microbial reaction and biomineralization has been well recognized; however, the specific mechanisms of the reactions in the environments such as the reaction rate and spatial dynamics are poorly understood. In the environment such as soils, microbial reactions and habitability vary locally and form complicated geochemical networks, which makes it difficult to characterize the specific biogenic reactions in detail.

In the present study, we developed a novel method using synchrotron microprobe (micro-XAFS) combined with fluorescence in situ hybridization (FISH) to determine directly microbial communities and chemical species with high spatial resolution (XAFS-FISH), and applied it to bacteriogenic Fe oxidation in natural hot spring. We successfully conducted in situ visualization of potential Fe(II) oxidizers in Fe mats and characterization of Fe biominerals with 1-5 micrometer spatial resolution by the XAFS-FISH technique. The present study shows that coupled XAFS-FISH could be a potential technique to provide direct information on specific biogenic reaction mediated by target microorganism, even if the microbe is uncultivable species.

In my presentation, I'll talk about not only details of the XAFS-FISH technique but also its application into biogeochemical reactions of trace metal(loid)s such as arsenic in the natural environments.

Keywords: micro-XAFS, FISH, Iron-oxidizing bacteria, arsenic