

Development of a new method to observe the biomineralization using FISH combined with micro-XAFS

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Ubiquitous presence of microbes in aquatic systems and their inherent ability of biomineralization make them extremely important agents in the geochemical cycling of inorganic elements. However, the detailed mechanisms in environments are largely unknown, because there are few adequate analytical techniques to observe in situ the biogenic reactions. Here, we report a novel technical approach to characterize specific biomineral associated with a target microbe on high spatial resolution. The technique was developed by combining directly in situ phylogenetic analysis, fluorescence in situ hybridization (FISH), with a synchrotron microprobe method, micro X-ray absorption fine structure spectroscopy (micro-XAFS), and was applied to iron deposition by iron-oxidizing bacteria (IOB). In situ visualization of microbes revealed that in natural iron mats, Betaproteobacteria dominated by IOB were dominantly localized within 10 micrometer of the surface. Furthermore, in situ chemical speciation by the synchrotron microprobe suggested that the Fe local structure at the IOB accumulating parts was dominantly composed of short-ordered Fe-O₆ linkage, which is not observed in bulk iron mat samples. The present study demonstrated that coupled XAFS-FISH technique could provide direct information on specific biogenic reaction mediated by target microorganism.

Keywords: XAFS, biomineral, FISH, micro-XAFS