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Biomineralization associated with microbial reduction of Fe^{3+} and oxidation of Fe^{2+} in solid minerals

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Abstract

Iron-reducing and oxidizing microorganisms gain energy through reduction or oxidation of iron, and by doing so play an important role in the geochemical cycling of iron. This study was undertaken to investigate mineral transformations associated with microbial reduction of Fe^{3+} and oxidation of Fe^{2+} in solid minerals. A fluid sample from the 2450 m depth of the Chinese Continental Scientific Drilling project was collected, and Fe^{3+}-reducing and Fe^{2+}-oxidizing microorganisms were enriched. The enrichment cultures displayed reduction of Fe^{3+} in nontronite and ferric citrate, and oxidation of Fe^{2+} in vivianite, siderite, and monosulfide (FeS). Additional experiments verified that the iron reduction and oxidation was biological. Oxidation of FeS resulted in the formation of goethite, lepidocrocite, and ferrihydrite as products. Although our molecular microbiological analyses detected *Thermoanaerobacter ethanolicus* as a predominant organism in the enrichment culture, Fe^{3+} reduction and Fe^{2+} oxidation may be accomplished by a consortia of organisms. Our results have important environmental and ecological implications for iron redox cycling in solid minerals in natural environments, where iron mineral transformations may be related to the mobility and solubility of inorganic and organic contaminants.

Keywords: CCSD, iron redox cycling, nontronite, subsurface, *Thermoanaerobacter ethanolicus*