MINERALOGIC TRANSFORMATIONS ASSOCIATED WITH MICROBIAL REDUCTION OF MAGNETITE

[1]FREDRICKSON, JAMES K., [1]ZACHARA, JOHN M., [1]GORBY, YURI A., and [2]DONG, HAILIANG. [1]Pacific Northwest National Laboratory, Richland Washington, USA and [2]Department of Geosciences, Princeton University, Princeton, New Jersey, USA

Dissimilatory iron reducing bacteria are capable of reducing Fe(III) in poorly-crystalline to crystalline Fe oxides including hydrous ferric oxide (HFO), goethite, and hematite. The mixed valence Fe oxide magnetite has been shown to be a common end product of bacterial dissimilatory reduction of HFO. The formation of magnetite in sediments can potentially sequester two-thirds of the oxidation capacity of sediments and may make a major contribution to their magnetic properties. A series of experiments were conducted with biogenic magnetite, generated by the reduction of HFO by Shewanella putrefaciens CN32, to investigate the conditions that promote the reduction of Fe(III) and the resulting Fe(II) minerals. Biogenic magnetite in solutions buffered with either bicarbonate (HCO3-) or PIPES, with or without PO4, was inoculated with CN32 and provided with lactate as an electron donor to promote Fe(III) reduction. The extent and rate of magnetite reduction in the bicarbonate-buffered medium was higher than that in the PIPES-buffered medium due to complexation of bioproduced Fe(II) with HCO3- (or PO43-) and formation of siderite (vivianite). In the HCO3--buffered solutions, Fe(III) in the biogenic magnetite was reduced to Fe(II), and siderite precipitated. In the PIPES-buffered medium, Fe(III) in biogenic magnetite was also reduced to Fe(II), but secondary mineral phases were generally absent. Vivianite formed in those solutions containing P. The ability of DIRB to utilize Fe(III) in crystalline magnetite is, in general, consistent with predicted behavior based on thermodynamics and is mainly a function of pH, pCO2, pe and the concentration of complexing ions such as phosphate. The ability of DIRB to reduce sedimentary magnetite has significant implications for sedimentary biogeochemical processes.