

Biotic and abiotic products of Mn(II) oxidation by spores of the marine *Bacillus* sp. strain SG-1

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ABSTRACT

Bacterial Mn(II) oxidization by spores of *Bacillus*, sp. strain SG-1 has been systematically probed over the time scale 0.22 to 77 days under in-situ conditions and at differing Mn(II) concentrations. Three complementary techniques, *K*-edge X-ray absorption near-edge spectroscopy (XANES), X-ray emission spectroscopy (XES), and in-situ synchrotron radiation-based X-ray diffraction (SR-XRD), have been utilized to examine time-dependent changes in Mn oxidation state, local-, and long-range structure in amorphous, crystalline, cell-bound, and solute Mn species. The primary solid biogenic product of Mn(II) oxidation is an X-ray amorphous oxide similar to δ -MnO₂, which has a Mn oxidation state between 3.7 and 4.0. Reaction of Mn(II) with the primary biogenic oxide results in the production of abiotic secondary products, feitknechtite or a 10 Å Na phyllomanganate. The identity of the secondary product depends upon the Mn(II) concentration as described by thermodynamic relations. A decrease in the dissolved Mn(II) concentration is followed by mineralogic transformation of the secondary products. Thus, Mn(II) appears to act as a reductant toward the biogenic oxide and to control the stability of secondary reaction products. Mineralogic changes similar to these are likely to be commonplace in natural settings where bacterial Mn(II) oxidation is occurring and may liberate sorbed metal ions or alter the rates of important Mn oxide surface-mediated processes such as the degradation of organic molecules. It is plausible that microbes may exploit such mineral transformation reactions to indirectly control specific chemical conditions in the vicinity of the cell.