



Metal sorption and the bacterial membrane: implications for biomineralization and fossilization

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Dissimilatory metal reduction by bacteria in anaerobic settings is gaining recognition as a vital process in the global cycling of redox-active metals, Fe in particular. Metal respiration by bacteria found in subsurface environments potentially produces large amounts of reduced metal species. The fate of those metals is poorly understood. The bacterial surface is rich in reactive carboxyl and phosphoryl groups that have a demonstrated ability to sorb metals; this supports that the surface could become metal-saturated, a possible step on the pathway to fossilization. Extensive metal sorption or precipitation should, however, result in loss of membrane mobility and permeability. We have been investigating the interaction of Fe and other metals with the cell wall of *Shewanella putrefaciens*, a dissimilatory metal reducing bacterium, during respiration of mineral and soluble metals as well as during sorption of soluble metal species, using synchrotron-based x-ray absorption spectroscopy, electron microscopy, and fluorescence polarization methods.

In the case of Fe, it appears that the bacterial outer membrane excludes Fe^{2+} added in soluble form to a much greater extent than Fe^{2+} produced during respiration of mineral FeIII. In no case were minerals observed to nucleate at the bacterial surface, supporting active exclusion of metals from the immediate extracellular environment. Results when bacteria respire FeIII-citrate are comparable to results with hydrous ferric oxide (HFO). In the case of HFO, however, internal precipitates of fine-grained Fe are much more abundant, indicating that the source of FeIII impacts the formation of Fe biominerals. The ratio of FeII/FeIII in the intracellular granules, which are produced under anaerobic conditions, does not change after exposure to O_2 , providing

evidence that the granules are chemically stable.