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The Role of Bacteria in Iron Biomineralization

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Bacteria contribute significantly to the development of extremely fine-grained iron mineral precipitates, including oxyhydroxides, carbonates, silicates, phosphates, and sulphides. They influence biomineralization in two significant ways. First, bacteria possess a negative surface charge at pH values characteristic of most natural environments, and in doing so, will become reactive towards metal cations. Once bound, those cations react with more ions, potentially leading to mineral precipitation if a state of supersaturation is achieved. Second, during metabolism, the bacterium affects the redox and saturation states of the fluids around the living cells. In this regard, the microenvironment surrounding each cell can be quite different from the bulk aqueous environment, and as a result, mineral phases form that would not normally be predicted from the geochemistry of the bulk fluid. The impact that iron biomineralization has on elemental cycling in aqueous and sedimentary environments cannot be overstated because many major elemental cycles are strongly linked to iron biomineralizing processes. Although individual 'biomineral' grains are micrometer in scale, if one adds the total amount of biomineralizing biomass, it is not difficult to imagine how they can be significant in partitioning metals from the hydrosphere into the sedimentary system. Indeed, the extensive record of banded iron formation (BIF), from 3.8 to 0.5 billion years ago, testifies to the enormous magnitude of ferric iron sequestration into the sediments throughout much of Earth's history.