How do Fe-oxidizing microbes influence biogeochemical cycles? Perspectives from kinetics and metagenomics/transcriptomics

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Recent decades have seen significant progress on Fe-oxidizing microbial physiology and genomics, allowing us a window into how these microbes might function in nature. Fe-oxiding bacteria (FeOB) have been found in a wide variety of environments: from classical terrestrial Fe seeps to marine hydrothermal vents, aquifer and coastal sediments, burrows, and lake and estuary chemoclines. But, what are Fe-oxidizers doing there? That is, what roles do FeOB play in ecology and biogeochemical cycling?

To quantify effects on Fe cycling, we first need to know how fast microbes oxidize Fe(II) (vs. abiotic oxidation), and under what geochemical conditions FeOB. To this end, we have been performing kinetics studies to determine the rates at which autotrophic and heterotrophic FeOB oxidize Fe(II) under environmentally-relevant conditions. These results show how Fe oxidation rate depends on oxygen concentration, and that both inorganic and organic carbon can fuel Fe oxidation. To further determine how FeOB connect Fe and other cycles (e.g. C, N, S, P), we have been performing field biogeochemical/metagenomic studies in a coastal aquifer in Delaware, as well as metatranscriptomics studies on Fe mats from hydrothermal vents at the Loihi Seamount, Hawaii. The metatranscriptomic studies show us how mixed communities of uncultured Zetaproteobacteria function in the environment and in shipboard incubation experiments. Preliminary results show that Loihi mat microbes are expressing genes for carbon fixation, denitrification, N and sulfate assimilation, and Fe oxidation (putative). Because phosphate sorbs strongly to Fe oxyhydroxides, P is expected to be limiting in Fe mats; as a consequence, the community appears to be employing multiple strategies to access P, including recycling from organic molecules. Continuing analysis is giving us insights into how FeOB interact with other microorganisms and abiotic geochemical processes to influence biogeochemical cycles.