Effect of Mineral Surface Transformations during Biogeochemical Iron Cycling on the Fate of Contaminants and Micronutrients

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The biogeochemical cycling of iron in soils, sediments, and marine and lacustrine aquatic systems involves primarily the alternation of iron between oxidized and reduced forms. Such cycling is connected to the carbon, oxygen, phosphorus, and sulfur cycles through microbial and abiotic processes and plays an important role in controlling the fate of water contaminants in modern aquatic systems. Recent work has shown that when microorganisms initiate biogeochemical iron cycling a cascade of secondary abiotic processes occur involving reactions between aqueous Fe(II) and solid Fe(III) oxide minerals. Our work has shown that these reactions produce subtle changes in iron chemistry but have substantial effects on the distribution and fate of other elements. Aqueous Fe(II) activates nanoscale growth and dissolution processes on iron oxide mineral surfaces. This dynamic surface behavior is modified by common constituents of natural waters and affects the fate of select trace elements and inorganic contaminants by repartitioning these species between the solid and aqueous phase. This element redistribution during biogeochemical iron cycling entraps contaminants in mineral structures but also causes their rerelease, alters the bioavailability of micronutrients, and affects the interpretation of proxies for ocean composition on the early Earth.

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