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Authors
Williams, Kenneth H.
Long, Philip E.
Shelobolina, Evgenya
et al.

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Kenneth H. Williams, Philip E. Long, Evgenya Shelobolina, Susan S. Hubbard, and Jillian F. Banfield

The importance of iron-bearing clay minerals as a source of bioavailable iron is well documented. Under conditions of biostimulation, consumption of such accessible ferric compounds by iron-reducing microorganisms can result in elevated rates of respiration and successful contaminant remediation. As these compounds are exhausted and more recalcitrant forms of ferric iron are accessed, competition by other microbial strains, such as sulfate-reducers, can result in metabolic processes less favorable to sustained remediation efficacy. Improved diagnostic methods are needed to elucidate the extent of microbe-induced mineral transformations over the large spatial scales encountered during field experiments. Geophysical monitoring methods have shown sensitivity to the mineralogical changes associated with iron-reduction at the lab and field scale and show promise for monitoring the progress of stimulated subsurface bioremediation. Alterations in the physiochemical properties of iron-bearing clays and clay-sized particles resulting from microbial respiration led to variations in the measured values of complex resistivity. The changes correlated with the exhaustion of bioavailable ferric compounds and suggest an approach for monitoring the sustainability of prolonged iron-reduction under stimulated conditions.