

Reactive Iron Mineral Coatings in Redox Transition Zones

H. HUA¹, X. YIN^{2*}, L. AXE³

New Jersey Institute of Technology, University Heights
Newark, NJ 071021, USA

¹hh99@njit.edu ^{2*}correspondence: xy239@njit.edu

³lisa.b.axe@njit.edu

Method:

In this research, we are studying reactive Fe mineral coatings in redox transition zones from a site with subsurface contamination. An anaerobic 60 foot core was collected from the Chambers Works Site in Deepwater, NJ. Working in a glovebox, two inch subsamples were used to evaluate redox transition zones using bulk composition, redox potential, pH, VOCs in the headspace, as well as abundant bacteria. Four redox transition zones were identified for further study with a suite of complementary analyses to characterize the surface chemistry. Analyses included sequential extraction (phases and speciation), x-ray diffraction (mineralogy), x-ray fluorescence (composition), field-emission scanning electron microscopy (surface morphology down to the nm scale) with energy dispersive analysis (surface composition), and bench-scale experiments.

Discussion of Results:

Evidence from multiple lines suggest a clear trend in bulk minerals and reactive iron (II)/(III) mineral coatings throughout transition zones. Identified iron (II) mineral coatings include pyrite, mackinawite, siderite, and pyrrhotite. While ferrihydrite, goethite, and lepidocrocite were the dominant iron (III), greigite and magnetite were observed as iron (II)/(III) minerals. In the shallowest transition zone running through an aquitard layer, spherical and sub-spherical packed framboidal pyrite and framboidal greigite were abundant. Flaky mackinawite, individual grains of cubic pyrite, and pyrrhotite were dominant iron sulfides in a deeper aquitard transition zone. Siderite and magnetite were rich in two deeper transition zones found in aquifer layers that may be less reactive to targeted contaminants than aquitard zones. Overall, the most significant reactive mineral coatings were observed in redox transition zones located in aquitards where there is a strong indicator of Fe²⁺/Fe³⁺ cycling. Iron speciation, mineral coatings, and mineral morphology observed in the redox transition zones contribute to contaminant attenuation and degradation pathways. Therefore, ongoing studies are focused on abiotic degradation pathways for halogenated solvents present in the system.