

The Role of Dissolved and Particulate Organic Carbon in Biostimulated Uranium Attenuation.

Linda Figueroa¹, Emily Leshner¹, James Ranville¹, Bruce Honeyman¹, Kate Campbell², Ken Williams³
Mike Wilkins⁴, Jim Davis², Phil Long⁵

¹Colorado School of Mines,

²USGS Menlo Park;

³Lawrence Berkeley National Lab;

⁴University of California, Berkeley;

⁵Pacific Northwest National Lab

The Integrated Field Challenge Site at Rifle, Colorado (RIFC) is home to a legacy of subsurface uranium contamination resulting from mill operations. Research at RIFC has shown that acetate amendment (as an electron donor and carbon source), and the consequential growth of iron-reducing microbial communities results in the bioreduction of uranium. As microbial communities metabolize the acetate, dissolved and particulate organic carbon (OC) concentration and composition changes. Subsurface OC affects the biogeochemistry of an aquifer through equilibrium metal complexation and microbially mediated electron transfer and metabolic reactions. Accordingly, an understanding of OC composition and evolution over the course of bioremediation is useful in modeling the fate and transport of uranium. Operationally defined fractions of organic carbon in both particulate and dissolved phase can give insight into the microbial and chemical reactivity of the organic carbon fractions.

Both oxic coarse-grained, and bioreduced fine-grained sediments, and groundwater from the RIFC were analyzed before and after acetate biostimulation for total and operationally defined fractions of uranium and organic carbon. Uranium in the sediment was fractionated using both anoxic and oxic bicarbonate and acid extractions. The DOC fractionation scheme involved XAD-8 and XAD-4 resins to isolate and measure hydrophobic, transphillic, and hydrophilic organic carbon. The POC fractionation scheme involved sequential extraction using alcohol, acid and base solutions. Research findings include: higher organic carbon content in bioreduced sediments and the enrichment of the transphillic organic carbon fraction in groundwater as a result of acetate stimulation. Additional data will be presented outlining the changes in uranium and OC composition from temporally and spatially varying Rifle groundwater and sediment samples. The evaluation of the composition of the sediment and groundwater before and after biostimulation allows for a direct comparison of the extent of natural U(VI) bioreduction to acetate-stimulated bioreduction. This information will facilitate the design of a more effective bioremediation strategy for the Rifle IFC.