Microbial community trajectories in response to accelerated remediation of subsurface metal contaminants

University-Led Research

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The objectives of our project are to: (1) Determine if the trajectories of microbial community structure, composition, and function following organic carbon (OC) amendment can be related to, and ultimately predicted through evaluation of key determinants. (2) Assess the relative importance of the characteristics of the indigenous microbial community, sediment, groundwater, and OC supply rate as major determinants of microbial community functional response and bioremediation capacity. We are using sediments from three DOE sites: Oak Ridge, TN; Rifle, CO; and Ringold formation, Hanford, WA; in a full-factorial reciprocal transplant experiment that includes sterile controls. Each sterilized sediment/inoculum combination receives OC supplied as sodium-acetate at two concentrations in synthetic groundwater that approximates the *in situ* conditions at each site. Sediments from the three sites were sieved, homogenized and a portion sterilized by gamma-irradiation. Sterilized sediments were inoculated with a small mass (2.0 g) of "live" sediment, thoroughly mixed and packed into flow-cells. The 2.0 g mass of inocula was selected following a gene-sampling-effort relationship experiment using PhyloChip and GeoChip arrays to determine the minimum mass required to provide inocula with reproducible phylogenetic content and functional capacity.

The 174 flow-cells constructed for this experiment are operating in an anaerobic chamber with synthetic anaerobic groundwater. All cells received groundwater without OC for approximately 6 weeks. The first destructive sampling of flow-cells (T0) occurred prior to OC addition to establish a baseline for the subsequent trajectory analysis. The remaining flow-cells are supplied with two OC supply rates: 0.1 and 1.0 mmol OC/kg/day. The OC supply rates were chosen based on prior experiments using Oak Ridge, TN sediment. Early results suggest inoculum and sediment-specific functional responses. Trajectory analysis will be performed as communities evolve over several months of biostimulation.

Remediation of subsurface metal contaminants at DOE sites involves microbial mechanisms of oxidation/reduction or complexation; which is controlled in large part by the ecology of the microbial community. Recognizing and quantifying the relationships between community structure, function, and key environmental factors may yield quantitative understanding that can inform future decisions on remediation strategies.