Biostimulation of Uranium Reduction In Situ and Coupled Ex Situ Groundwater Treatment at the NABIR Field Research Center

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Previously, we characterized site hydrogeology, geochemistry, and microbiology in Area 3 of the NABIR Field Research Center in Oak Ridge, Tennessee. This site is adjacent to the S-3 pond cap, and contains high levels of uranium (~30 mg/L in the water, with 300–400 mg/kg on the soil), nitrate (8–10 g/L), aluminum (~0.5 g/L), and low pH (~3.6), plus a range of other metals and volatile organics. In preparation for planned biostimulation experiments, we have installed two injection and extraction well pairs. One well pair defines an outer flow cell. The second well pair defines an inner flow cell nested within the outer cell. We intend to stimulate U(VI) reduction within the inner cell by intermittent addition of an electron donor. Prior to this, we will neutralize acid within the outer and inner cells, and remove the aluminum and nitrate. This will be accomplished by pumping water from the outer extraction cell to an aboveground treatment train where it will be treated before reinjection. The treatment train includes vacuum strippers to remove volatile organics, a two-step precipitation process to remove metals, and a fluidized bed bioreactor to remove nitrate.

We have also evaluated the connectivity of the injection/extraction well pairs in a tracer study using bromide. Breakthrough profiles indicate that water is efficiently transported between the injection and extraction wells, with short breakthrough times. Simulations of the tracer study are being used to better define the leakage between the inner and outer cells, and to simulate the proposed field-scale experiments. The objective of the proposed experiments is to determine the rate and extent of uranium reduction in the field environment under controlled conditions. To prepare for these studies, we are performing batch and column microcosm studies, and we have evaluated uranium removal rates with different electron donors. Ethanol was the most efficient electron donor tested for stimulation of uranium removal. Experiments are ongoing to identify the microorganisms involved, and to elucidate interactions between the kinetics of U removal and desorption of U(VI) from the sediment.