Bioremediation to plume persistence: Uranium biogeochemistry in naturally and artificially bioreduced aquifer sediments

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Manipulating the subsurface redox status of uranium has been proposed as an *in-situ* bioremediation strategy. Recent evidence suggests that biologically driven redox reactions in organic-rich sediments play major roles in maintaining uranium groundwater plumes in the upper Colorado River basin (U.S.A.). The speciation of uranium in these systems is poorly constrained but critical to predicting uranium fate and transport. Moreover, it is necessary to understand how biogeochemical cycles of other elements, including C, N, Fe, and S couple to those of uranium.

The SLAC SFA program has investigated reduced uranium, carbon, sulfur, and iron species at molecular to pore scales *in-situ* in the biostimulated aquifer and in sediments from organic-rich naturally-reduced zones (NRZs) at the U.S. Department of Enery's Rifle, CO field site. The purposes of this work are to constrain uranium speciation, understand the coupling of C, N, Fe, S and U redox cycles, and to characterize biogeochemical interactions between NRZs and the surrounding aquifer.

This talk will compare and contrast artificially and naturally bioreduced sediment systems. The rate and extent of uranium reduction appears to be closely tied to sulfur reduction. A coupled biological-abiotic process model will be discussed to account for the relative abundance of non-crystalline forms of U(IV) in both systems. It will be shown that aquifer-NRZ interfaces are biogeochemical hot spots that likely facilitate uranium resupply to aquifers.