Oxidative Remobilization of Uranium Following Biostimulated Reduction

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A key issue to the success of biostimulation-based remediation of uranium (U) contamination in aquifers is the long-term stability of the sequestered U following cessation of biostimulation and the return to ambient groundwater conditions. Because substantial levels of groundwater dissolved U(VI) can remain following U ore extraction by *in situ* leaching and recovery (ISR), remediation of ISR sites using biostimulated reduction is being evaluated. Column experiments with sediments from a deep aquifer previously mined by ISR showed that biostimulation of the indigenous microbes with lactate was effective in lowering the 20 μM U(VI) influent to <0.1 μM through reduction and precipitation of U(IV). Near complete U uptake continued through 82 days (77 pore volumes, PV) well after the onset of sulfate reduction. Effluent [U] remained low (<0.1 μM) for over 30 PV after electron donor and U(VI) were removed from the influent. Increasing dissolved oxygen to suboxic levels similar to pre-ISR conditions (6 μM) resulted in remobilization of sequestered U, with effluent [U] increasing to 0.6 μM after 33 PV. Subsequently, the rate of U remobilization increased rapidly with [U] reaching 13 μM after 87 days (82 PV). In contrast, effluent [U] remained low (<0.8 μM) through 140 PV of oxic elution (250 μM dissolved oxygen) following biostimulated reduction using acetate in column experiments with shallow aquifer sediments from the Old Rifle site. Solid-phase speciation, distribution and extent of reduced U, Fe and S are compared as possible indicators of the difference in remobilization of bioreduced U observed in the two experiments. Our findings indicate that biostimulation may be effective for lowering [U] following ISR but that maintaining reducing conditions will be necessary to limit remobilization of sequestered U.