Diffusion/Deposition/Remobilization of Uranium in Bioreduced Zones

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It is common practice to inject substrates and other reactants to reduce the mobility and/or toxicity of subsurface contaminants through bioreduction and other remediation techniques. These injections result in manipulated zones that are in a state of chemical disequilibrium. For example, bioreduction can significantly reduce the concentration of contaminants (like U) and other inorganics in groundwater but increase the concentration on the solid phase. Due to preferential transport through subsurface heterogeneities, there will be abrupt aqueous concentration gradients between well connected high permeability zones that receive a high concentration of treatment media (low U zone) and adjacent lower permeability zones that do not receive treatment media (high U zone). The objective of this study is to assess the diffusion of U into bioreduced zones from adjacent unreduced zones, deposition of the U in the bioreduced zone and remobilization of U after the bioreduction has stopped.

Laboratory bottle tests, field observations at the U.S. DOE Oak Ridge Integrated Field Research Challenge site during U bioreduction experiments and numerical modelling were employed to meet these objectives. U contaminated soils encapsulated in polyacrylamide hydrogels (Spalding et. al., 2010) were used in the lab and the field to determine U release and diffusion rates. A two site kinetic model was used to predict release and diffusion of U from unreduced zones to adjacent reduced zones.

The results of our study suggest that U will migrate from unreduced zones into reduced zones when bioreduction is active resulting in “extra” U being deposited in high permeability transport pathways. However, if bioreduction conditions are not maintained, an unintended consequence may be an increase in the U flux (relative to pre-bioreduced conditions) as the “extra” U is released as a result of oxygenated groundwater entering the previously reduced zone.

Spalding, B. P., S.C. Brooks and D. B. Watson. Hydrogel-Encapsulated Soil: A Tool to Measure Contaminant Attenuation In Situ. 2010. *Environ. Sci. Technol.* 44(8):3047-3051.