The Biogeochemistry of Pu and U: Distribution of Radionuclides Affected by Microorganisms and their Siderophores, Reductants, and Exopolymers

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Radionuclide-contaminated environments are often oxic, including the Rocky Flats Environmental Technology Site (RFETS), and the contaminated groundwater at the NABIR Field Research Center (FRC). Radionuclide distribution within such environments is affected by indigenous biogeochemical processes, including the metabolic activities of aerobic microorganisms, key members being the ubiquitous *Pseudomonas* and *Bacillus* genera. Because of the chemical similarities between the actinides, uranium (U) and plutonium (Pu), and iron (Fe), the metabolic processes of these microorganisms that affect the biogeochemistry of Fe could also significantly affect Pu and U distribution. We propose to determine the extent to which metabolic processes involved in Fe acquisition and exopolymer production affect the distribution of Pu and U between the aqueous and solid phases. We will determine the equilibrium distribution of Pu and U between these phases, in the presence and absence of microorganisms, and in relation to Fe bioavailability.

We have continued our investigations of the redistribution of actinide species during aerobic dissolution of Fe=bearing minerals. For example, *Pseudomonas putida* and *P. mendocina* are common siderophore producing bacteria in soil and subsurface environments. Our research has produced unequivocal evidence that, driven by the process of aerobic Fe acquisition from minerals of high crystalline order (e.g., hematite), these species desorb and solubilize U(VI) that was sorbed previously to the mineral surface. Most striking about our results is not only that all of the U(VI) was removed from the solid phase but, more importantly, U(VI) remained in solution following centrifugation, under both oxic and circumneutral pH conditions. It did not adsorb onto the cells or surface of the reaction vessel, precipitate, or re-adsorb onto the mineral surface. The importance of this result to NABIR is that under specific nutrient conditions U can be mobilized (i.e., chelated) and thus becomes less likely to adsorb to solid phases. Such knowledge is essential for management and treatment strategies.

The results of the research program will contribute to NABIR's stated needs to understand both "the principal biogeochemical reactions that govern the concentration, chemical speciation, and distribution of metals and radionuclides between the aqueous and solid phases" and "what alterations to the environment would increase the long-term stability of radionuclides in the subsurface."