Subsurface Bio-Immobilization of Plutonium: Experiment and Model Validation Study

Donald T. Reed

Earth and Environmental Sciences Division, Los Alamos National Laboratory
Carlsbad Environmental Monitoring and Research Center, Carlsbad NM

A concurrent experimental and modeling study centered on the interactions of *Shewanella alga BrY* with plutonium species and phases is proposed. The goal of this research is to investigate the long-term stability of bioprecipitated "immobilized" plutonium phases under changing redox conditions in biologically active systems. The longevity of the subsurface immobilization of plutonium (e.g., by bioreduction) is a key consideration in the effectiveness of remediation/containment approaches used, affects the design/choice of immobilization approaches, and defines issues regarding the closure of contaminated sites (e.g., natural attenuation). Plutonium is the key contaminant of concern at several DOE sites that are being addressed by the overall NABIR program.

This is a new project, which is being done in collaboration with Professor Bruce Rittmann at Arizona State University. Key elements of the research planned for this year include the following:

- Establish the radiotoxicity of plutonium complexes towards *S. alga*.
- Perform growth studies for *S. alga* under a range of environmental conditions in the absence and presence of plutonium, and as a function of plutonium speciation.
- Update the CCBATCH model to incorporate plutonium data relevant to these *S. alga* studies to model the experimental results.
- Confirm and establish the conditions under which bioreduction of plutonium by *S. alga* in the +5 and +6 oxidation states (i.e., as PuO_2^+ and PuO_2^{2+} aqueous species).
- Initiate studies to investigate the bioassociation of plutonium with *S. alga* at environmentally relevant concentrations.
- Initiate a CCBATCH model upgrade to include transport experiments.

The overall hypothesis for the proposed research is that stable recalcitrant plutonium phases will prevail in biologically active systems where bioreduction occurs. Understanding the relationship between aqueous speciation and composition, biological effects and interactions, and the fate and immobilization of the plutonium is the longer-term goal of this research.