Poster #21-50

The Influence of Microbial Exudate s on Actinide Fate and Transport: Pond B, Savannah River Site

Nancy Merino[1], Connor Parker[2], Daniel I. Kaplan[3], Mavrik Zavarin[1], Annie B. Kersting[1], Yongqin Jiao[1], and Brian A. Powell[2,3*]

[1] Lawrence Livermore National Laboratory, Livermore, CA
[2] Clemson University, Clemson, SC
[3] Savannah River National Laboratory, Aiken, SC

Contact: bpowell@clemson.edu

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To examine the role of microbial exudates in the biogeochemical cycling of actinides, the LLNL BioGeoChemistry of Actinides SFA is performing a combination of field and laboratory studies at Pond B of the Savannah River Site (SRS, South Carolina). Pond B received SRS R reactor cooling water from 1961–1964 that contained trace amounts of Pu (33 MBq ^{238}Pu and 430 MBq ^{239,240}Pu), ^{241}Am, and ^{137}Cs (1). Microorganisms are known to interact with actinides through various mechanisms including bioaccumulation, biosorption, bioreduction, and biomineralization. However, little is understood about the influence of extracellular microbial metabolites (exudates) beyond a few complexing and solubilizing agents (e.g., siderophores, citrate and oxalate) and extracellular electron carriers (e.g., flavins). Microbial exudates play an important role in shaping microbial community structure and function and are likely to impact actinide biogeochemical cycles at Pond B.

Pond B naturally stratifies in the summer and is ideally suited to examining the effects of seasonal anoxia. Previous measurements suggest that during stratification, Pu in the particulate and dissolved fraction of the water column will increase in the anoxic zone, but the mechanism(s) causing mobilization are uncertain (1). Our study will focus on characterizing pond and sediment biogeochemical profiles (including microbial community analyses) to determine the long-term migration behavior of ^{239}Pu, ^{241}Am, and ^{137}Cs. With these data, we will test the hypothesis that seasonal anoxia leads to remobilization of Pu from shallow sediments into overlying water due to Fe-oxide reductive dissolution and release of microbial exudates. The microbial community and geochemical parameters will be sampled at select locations with depth and time. Laboratory microcosm experiments will be undertaken, mimicking conditions that enrich for specific metabolic activity, such as iron oxidizers, iron reducers, denitrifiers, and sulfate reducers, and correspond to each layer of the stratified pond: epilimnion, thermocline, and hypolimnion (e.g., light/dark cycles, microaerophilic conditions, and anoxic conditions, respectively). Microbial exudates collected from the microcosms will be exposed to Pu to probe for Pu-exudate complexation and specific exudates of interest will be further characterized. Through the combined field and laboratory studies, we will provide insight into how microbial communities can influence Pu fate and transport via extracellular metabolites.

Reference:

1. F. W. Whicker, J. E. Pinder, J. W. Bowling, J. J. Alberts, I. L. Brisbin, Ecological Monographs 60, 471 (1990).