The influence of plant and microbial exudates on radionuclide mobility in subsurface environments

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Brian A. Powell[1] (PI), Kyle Barber[1], Taiwo Biotidara[2], Timothy A. DeVol[1], Christophe Darnault[1], Musa Danjaji[2], Rebecca Dozier[1], Nimisha Edayilam[1], Christopher Eley[2], Kevin Finneran[1], Autumn Gathers[2], Jazz Geter[2], Sarah Hennesey[1], Nicole Martinez[1], Fabio Matta[3], Dawn Montgomery[1], Stephen Moysey[1], Maryah Nwadeyi[2], Kindsly Ogujiuba[2], Nishanth Tharayil[1], Carlie Williams[2], Ernest M. Wylie[1], Shaniqua Young[2],
[1]Clemson University, [2]University of South Carolina, [3]South Carolina State University

This project is part of Department of Energy, Experimental Program to Stimulate Competitive Research (EPSCoR) Implementation Grant *"Radionuclide Waste Disposal: Development of Multi-scale Experimental and Modeling Capabilities"*. The key issues to be addressed include identifying source terms for contaminants in geologic disposal scenarios, determining the chemical speciation of risk-driving radionuclides (*e.g.*, Np, Tc, Cs, U, I) within engineered waste forms and natural subsurface environments, delineating the biogeochemical and physical processes through which contaminant transport is manifested, and predicting contaminant mobility across wide temporal and spatial scales.

This presentation specifically addresses the influence of microbial and plant exudates on radionuclide mobility. The risk driving radionuclides ^{99}Tc, ^{237}Np, ^{137}Cs, and ^{238}U were selected to represent a wide range of geochemical behavior. We have examined the influence of a variety of factors on radionuclide mobility including ionic strength, pH, and the presence of microbial or plant exudates. Comparison of baseline distribution coefficients to distribution coefficients in the presence of ligands such as oxalate, citrate, riboflavin, and catechol showed that high ligand to nuclide concentration ratios produced enhanced mobility, dissolution of native uranium, increased sorption of neptunium and to a lesser extent technetium and minimal effects of cesium behavior. Ionic strength had the greatest influence on Cs partitioning which is consistent with Cs sorption via ion exchange.

Further experiments have examined the influence of plant activity on radionuclide uptake in hydroponic systems. We studied the changes in composition and rate of exudation of metabolites from roots of *Andropogon spp*. exposed to different forms of phosphorous (P) fertilization. Plants were initially grown with available forms of nutrients and were transferred to different nutrient treatments of varying P bioavailability. There were significant and consistent shifts in the metabolic profiles in roots within 36 hours after exposure to various nutrient treatments.

These studies provide insight into the potential effects of plant and microbial exudates on radionuclide mobility and provide necessary data for further miscible displacement experiments and numerical values for modeling efforts which will utilize a unique set of imaging tools to monitor radionuclide transport through soils in 2D and 3D.

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