Coupled Biological and Micro-XAS/XRF Analysis of *In Situ* Uranium Biogeochemical Processes

University-Led Research

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Biogeochemical processes play a critical role in reductive uranium immobilization in groundwater found at former uranium mining and processing locations throughout the United States and other parts of the world. While microbiological and molecular studies have brought insights regarding enzymes and candidate microbes involved in bioimmobilization in contaminated aquifers, we have not yet correlated the identity and distribution of organisms associated with metal redox transformations, functionality of extracellular proteins in these systems, and complex mineral-microbe processes influencing uranium immobilization at the micrometer scale. The objective of our newly funded exploratory two-year project is to merge existing toolsets to query microbial location and distribution in conjunction with geochemical alterations in sediments. Our work is currently exploring methodologies for labeling subsurface microorganisms in the presence of sediments using fluorescent dyes and nanomaterials coupled to visualization using microprobe x-ray absorption and fluorescence spectroscopy (micro-XAS/XRF) analysis. We are also bridging efforts with other currently funded DOE projects and the Rifle IFRC (PI's Mailloux, Ranville, and Williams) with the goal of extending our research scope to include arsenic biogeochemistry. This merged approach will enable the co-visualization of microbe-metal processes in sediments and provide a mechanism to increase our understanding of heterogeneities, redox state, mineral form, and targeted biostimulation. The work has implications both for fundamental field-scale biogeochemical science as well as engineering applications and monitoring tools targeting low-cost, minimally invasive remediation of contaminated aquifers.