

The Argonne National Laboratory Subsurface Biogeochemical Research Program SFA: Fe and S Biogeochemistry in Redox Dynamic Environments

SBR - ANL SFA (Laboratory Research Manager: Robin Graham)

K. M. Kemner¹ (kemner@anl.gov), D. A. Antonopoulos¹, T. M. Flynn¹, B. Mishra², M. I. Boyanov³, D. E. Latta⁴, M. M. Scherer⁴, C. Liu⁵, J. K. Fredrickson⁵, K. M. Rosso⁵, J. M. Zachara⁵, E. J. O'Loughlin¹

1. Argonne National Laboratory; 2. Illinois Institute of Technology; 3. Bulgarian Academy of Sciences; 4. University of Iowa; 5. Pacific Northwest National Laboratory

Understanding the interplay of the Fe and S biogeochemical cycles with the hydrologic cycle is essential to accurately predict the mobility of contaminants; atmospheric greenhouse gas emissions; carbon cycling and sequestration in subsurface environments; and nutrient mobility in near-surface and subsurface polar, temperate, or tropical systems. The objective of the Argonne Subsurface Biogeochemical Research Program (SBR) Scientific Focus Area (SFA) is *to identify and understand the coupled biotic-abiotic transformations of Fe and S within redox-dynamic environments at the molecular- to core-scale, as well as to understand the effects of Fe and S biogeochemistry on the transformation and mobility of major/minor elements and contaminants.* To accomplish this objective, the Argonne SBR SFA integrates two key analytical strengths at Argonne — the Advanced Photon Source (APS) for synchrotron-based interrogation of systems and next-generation DNA sequencing and bioinformatics approaches for microbial community and metabolic pathway analysis — with biogeochemistry and microbial ecology. Addressing this objective contributes directly to the goal of the United States Department of Energy (DOE), Office of Biological and Environmental Research (BER), Climate and Environmental Sciences Division (CESD) to “advance fundamental understanding of coupled biogeochemical processes in complex subsurface environments to enable system-level environmental prediction and decision support.”

Argonne SBR SFA research addresses four critical knowledge gaps: *(1) an in-depth understanding of the molecular processes affecting Fe, S, and contaminant speciation in dynamic redox environments; (2) an understanding of the role of biogenic and abiotic redox-active products and intermediates in Fe, S, and contaminant transformations; (3) a mechanistic understanding of the factors controlling the mass transfer of Fe, S, and contaminants in heterogeneous media; and (4) an in-depth understanding of the relationship between microbial community dynamics/function and coupled biotic-abiotic controls, and their effects on major/minor element cycling and contaminant transformations.*

The long-term vision of the Argonne SBR SFA envisions ultimately integrating the new mechanistic knowledge generated by the SFA into multiscale Earth system models to enhance their predictive power for relevant environmental processes. The ten year vision also includes (1) an ever-increasing emphasis on integrating metagenomic-based analysis approaches for understanding ecological and functional controls on the biogeochemistry of Fe and S, (2) an increasing emphasis on model development to predict the transformations and mobility of nutrients and contaminants in many subsurface and near-surface environments, and (3) expansion of these studies with a greater emphasis on using minerals and microbial communities from a network of field sites encompassing many types of redox-dynamic environments.