SLAC Groundwater Quality SFA Program Overview

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Project: SLAC Groundwater Quality SFA (John Bargar)
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Project Abstract: Alluvial groundwater is a critical and overdrawn resource in the Western U.S. that supplies water for ecosystem functions and human use. The composition of groundwater is modified by myriad biotic and abiotic sediment-water reactions as it flows through alluvium. Biogeochemical reactivity is concentrated at interfaces between interbedded coarse- and fine- grained sediments, producing sharp redox gradients and biogeochemical (BGC) hot spots and hot moments, *i.e.,* where intensified BGC activity and productivity substantially modify groundwater composition. These subsurface inferfaces may be very large, spanning 10s of square km across a watershed, and thus have major impacts on water quality. Yet in spite of their apparent importance, the mechanisms by which hydrological tiggers such as ET-driven flow or inundation events interact with subsurface interfaces to create BGC hot moments and hot spots, and the resulting impacts on groundwater quality, remain poorly understood and therefore difficult to predict.

The SLAC Groundwater Quality SFA addresses the fundamental question, "How do subsurface interfaces mediate molecular-scale processes and groundwater quality in floodplains and watersheds?" We will systematically investigate molecular to meter scale processes that couple hydrology to BGC and influence groundwater quality using geochemical, microbiological, and hydrological measurements, integrated through reactive transport modeling. We focus on two types of interfaces that are profoundly important to water quality and floodplain BGC function, but which have received little research attention at the molecular-to-system level: (1) Interfaces between coarse (gravel/cobble) basal alluvium and overlying fine-grained organic-rich sediments, which are ubiquitous and extends over large areas in mountain and intermountain West riparian corridors, as exemplified by two uranium- and metals-contaminated field sites at Slate River, CO and Riverton, WY. These interfaces appear to be 'hot spots' for the generation of colloids carrying Fe, S, Mn, organic carbon, and trace metals, indicating their importance as sources for colloidal transport and associated implications for water quality. (2) Fine-grained, reducing sediment lenses and layers embedded within coarse-grained aquifer material with low groundwater oxygen concentrations (but not anoxic), which promote the establishment of 'reducing halos' in the aquifer material and profoundly alters groundwater composition. We are developing quantitative process representations that will contribute directly to the IDEAS-Watershed ESS software ecosystem. This work will provide new and deeper mechanistic process knowledge of hydrological-BGC coupling within floodplains and watersheds, their impact on water quality, and their response to changing weather patterns and other perturbations.