Hydro-Biogeochemical Process Dynamics in the Groundwater-Surface Water Interaction Zone: Fundamental Mechanisms and Mechanism-based Models

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This presentation will describe our research plan on the mechanistic part of the new PNNL SFA research plan: Hydro-Biogeochemical Process Dynamics in the Groundwater-Surface Water Interaction Zone (abbreviated as SIZ hereafter). The research is to fill the knowledge gaps including fundamental biogeochemical processes governing coupled organic carbon, nitrate, and contaminant (Tc and Cr) transformation and gaseous species production (CO_2, N2O, and CH4) in SIZ sediments; key metabolic pathways, enzymes, and functions regulating biogeochemical processes and their applications in constructing biogeochemical reaction network and dynamic models; and subgrid heterogeneity, fine-scale facies and distribution, and their effect on the manifestation and scaling of biogeochemical reaction network and dynamic models. Research will be driven by large, field scale observations and evolving science questions from other elements in the PNNL SFA plan, and will provide:1) a biogeochemical reaction network and dynamic metabolic models that incorporate key metabolic pathways, enzymes, and functions regulating C, N, and contaminant transformation; and 2) biogeochemical reactive transport models incorporating the effect of subgrid heterogeneity on biogeochemical reaction network and dynamic metabolic models for the applications at large scales.

Flow-through laboratory experiments using the sediment cores from the SIZ will be used for identifying redox active fine-scale facies where organic carbon metabolizes in coupling with the reduction of contaminants (NO3, Tc, and Cr) and gaseous species production (CO_2, N2O, and CH4). The redox active materials will then be isolated for mechanistic studies of biogeochemical reactions, functional genes, and key metabolic pathways and enzymes, which will be used for development of biogeochemical reaction network and dynamic metabolic models to describe organic carbon metabolism and contamination transformation. The effect of subgrid heterogeneity and redox active facies distribution on the manifestation and scaling of biogeochemical reaction network and dynamic metabolic model will be rigorously evaluated in reactive transport systems. The derived knowledge and biogeochemical models will be used for large scale applications in other elements of the SFA.

This presentation is part of SBR/PNNL_SFA