# Field-scale Modeling of Hydrologic and Biogeochemcial Dynamics in the Hyporheic Zone of the Columbia River along the Hanford Reach

PNNL SBR SFA (Laboratory Research Manager: Charlette Geffen)

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Hydrologic and biogeochemical processes in the hyporheic zone of Columbia River along the Hanford reach are controlled by water level fluctuations in the river as a result of seasonal snowmelt and upstream dam operations, as well as local geologic structures and aquifer heterogeneity. Biogeochemical hot spots exist within a layer of alluvium (the hyporheic zone) that is situated between the riverbed and the adjacent unconfined aquifer aquifer. Monitoring of the microbial community within this zone along with water elevation, specific conductance, temperature and dissolved oxygen (DO) at different depths from the river bed (see poster by Stegen et al.) demonstrated a sharp gradient of dissolved oxygen within the first 40cm of alluvium. Laboratory experiments were conducted on fresh alluvial materials to identify key biogeochemical reaction networks within this carbon-containing layer (see poster by Liu et al.), including respiration, denitrification and nitrification. A field-scale hydro-biogeochemical model was formulated within PFLOTRAN based on a 2-D cross-section perpendicular to the river. The biogeochemical reaction network was adopted from laboratory experiments performed on sediments from the cross section. In-situ specific conductance observations from hyporheic zone piezometers were converted to groundwater fraction using a linear mixing model with river water and groundwater end-members. These were then assimilated within PFLOTRAN to estimate alluvium and aquifer permeabilities. DO profiles at 10cm and 40cm below the riverbed were used to estimate rate parameters for the reaction network. Effective model-data integration across scales allowed satisfactory simulation of this complex system. However, various challenges were revealed in attempting to model this complex and dynamic system. Additionally the need for more robust field monitoring of dissolved salts as tracers of water movement and source, and redox active solutes and dissolved gases as markers of biogeochemical reaction was affirmed as a priority for future field research.