Poster #168

Hyporheic Mixing as a Strong Controller of Riverbed Biogeochemistry in Low-Order River Networks

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Hyporheic mixing between river water and groundwater is hypothesized to exert a strong influence on riverbed biogeochemistry in low-order streams and rivers. Indeed, mixing zones near the sediment-water interface are thought to be hotspots of biogeochemical activity. In the semi-arid western US where river discharge is dominated by snow-melt, the seasonal expansion and contraction of the hyporheic zone likely exposes the riverbed to alternating oxic and anoxic conditions, with implications for reactions affecting metal mobilization and carbon processing. A greater understanding of these interdependent processes is critical for predicting the export of nutrients from upland watersheds, tracking metal mobilization in contaminated regions, and modeling the future behavior of river biogeochemistry in a changing climate.

Working around a representative meander feature of the East River (Crested Butte, CO), we used a series of vertically resolved temperature and redox probes to track the extent of hyporheic mixing, and the impact of mixing on riverbed biogeochemical processes. Pore water temperature data collected between August, 2016 and February, 2017 revealed a greater river water influence in the point bar location and a greater groundwater influence at the meander apex and cut bank locations. Groundwater upwelling increased at the cut bank location throughout the summer and fall. In winter, the onset of riverbed freezing occurred later at the groundwater-influenced locations, thus sustaining conditions necessary for microbial activity throughout more of the year. Further evidence for strong groundwater influence in shallow regions of the riverbed was obtained through depth-resolved pore water sampling at discrete time points. Characteristic of anaerobic microbial metabolism, aqueous metal (iron, manganese) concentrations increased with depth, while sulfate decreased over the same vertical profile. Furthermore, evidence of aerobic respiration (through oxygen consumption measurements) was mostly confined to the upper 20-cm of sediments. Ongoing 16S rRNA gene and metagenomic analyses will provide greater insight into the distribution of microbial metabolisms through the sampled zones.

In late-Spring 2017, complementary pore water samples will be collected during high river discharge to measure the effects of strong river water down-welling on riverbed biogeochemistry. Combined biogeochemical datasets will be used to develop coupled reactive transport and microbial population models in the riverbed. These models will be used to quantify reactive solute exchange across the riverbed and microbial population dynamics under various seasonal signals. In particular, we will explore potential impacts of future changes in precipitation, snowmelt, and river discharge on hyporheic mixing and associated biogeochemical processes.