Poster #222

Real Rivers Have Curves: Meander-Scale Field Investigation of Linkages Between Fluvial Geomorphology, Dynamic Hydrology, and Patterns of Hyporheic Exchange

H.F. Malenda[1], G. Guyran, K. Singha[1], S. Stauffer, J. Rowland, and N. Suftin

[1] Colorado School of Mines

Contact: Helen Malenda [hfmalenda@mymail.mines.edu] and Susan Hubbard [sshubbard@lbl.gov]

Hyporheic exchange is an essential component of stream and aquifer health worldwide. The exchange of waters controls biogeochemical reactions linked to nutrient cycling and regulates thermal properties necessary for hydrologic health and species diversity. Although the ecological significance of hyporheic exchange is well understood, an active area of research involves estimating biogeochemical potential of hyporheic exchange across river networks. However, current river-network scale models simplify fluvial sedimentology and discharge conditions and do not completely capture complex surface-groundwater interactions scaled across natural fluvial environments. Simplifications are rooted in a paucity of available hydrogeomorphic data and field observations in higher-order or unaltered settings, leading to the inherent exclusion or oversimplification of fluvial geomorphology in subsequent models. The absence of field observations of hyporheic exchange in diverse geomorphic settings and dynamic hydrologic conditions weakens the link between small-scale mechanistic observations and large-scale implicative studies of hyporheic exchange. This knowledge gap also precludes comprehensive estimates of how the effect of climate change on watershed hydrology will influence hyporheic exchange. In the East River WF-SFA we are conducting a field investigation focused on controls of fluvial geomorphology and discharge on hyporheic exchange in a natural sub-alpine setting. We are interested in quantifying how buried geomorphic features (fluvial sediment packages) affect the length of hyporheic flow paths and hyporheic residence times under changing surface- and ground-water conditions. The East River site provides an ideal natural laboratory for this research, because the river is actively meandering, allowing for observable connections between floodplain evolution and sedimentology. The hydrology is snowmelt dominated, providing end-member conditions of surface and baseflow hydrologic contributions. This research has three key components:

1. The introduction of a novel approach to mapping fluvial stratigraphy across multiple scales that combines point descriptions of floodplain sediments, ground penetrating radar (GPR) surveys, and remote sensing techniques to improve estimates of fluvial complexity in watershed-scale hyporheic models;
2. The implementation of continuous, meander-scale tracer tests under varying hydrologic conditions (peak snowmelt and baseflow) to observe changes in the magnitude and location of hyporheic exchange; and
3. The integration of floodplain sedimentology, tracer data, and hydrologic data into a flexible 3-D model of hyporheic exchange, and coupled with larger modeling efforts at the SFA.

Current interpretations of the field site’s floodplain sedimentology and geomorphic evolution combine sediment descriptions, GPR surveys, and remote-sensing maps of former river channels. Two 24-hr continuous tracer tests are planned for the 2017 field season, with in-stream and intra-meander instrumentation. Combining the 3-D sedimentology, tracer data, and continuous hydrologic data will allow us to better observe the interactions between floodplain stratigraphy, groundwater gradients, and surface water discharge, and assess their interaction’s effect on the magnitude and location of hyporheic exchange. The desired impact of this study is to 1) meaningfully integrate fluvial geomorphology into watershed-scale models of hyporheic exchange and 2) manipulate model hydrology to simulate various snowmelt scenarios and evaluate the impact on hyporheic exchange within the system.