Resolving Aquifer Controls on Larger River-Groundwater Exchanges of Mass and Energy

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Streams and rivers exchange water with surrounding aquifers preferentially through permeable geologic units. These exchanges of water between the surface and subsurface are important vectors of energy, biota, and solutes. They support fisheries and the removal of some pollutants from rivers. When submerged they are invisible to the naked eye, and to date, we have a poor understanding of the geologic controls on these exchanges in large river settings, hampering the development of predictive models. The overarching goal of this research project is to determine whether the dominant controls on groundwater inflows to rivers lie at the bed of the river or underneath the riverbed. Riverbeds are rarely smooth, regardless of their make-up (fine sediment versus gravel). Bedforms are generated in patterns that reflect the energy of the moving water in the channel. Across these bedforms, moving river water experiences shear stress, which can "pump" water into and out of the riverbed. Beyond the riverbed and its shorelines, the geologic setting of a river strongly dictates the river form (sinuosity and slope for example), as well as the potential patterns of water movement between the surface and subsurface. Current work along the Columbia River corridor being completed by scientists at the Pacific Northwest National Laboratory includes modeling convective exchange of river water through the bed and banks, broader groundwater flow modeling, and the collection of shallow geophysics data to characterize the distribution of near-surface geologic deposits that might influence river-groundwater exchange. In this research, we seek to identify groundwater inflows to the Columbia River using established and emerging field techniques adopted for large channels, and determine whether they are associated with the geologic structure around the river or the convective exchange along the riverbed. We will collect deep geophysical data using a FloaTEM system, which is a new cutting-edge tool for towed investigations.

This research will significantly complement the PNNL Scientific Focus Area research project on river corridors. Our findings will help put into context the processes occurring immediately adjacent to river channels, and help discriminate between proximal and distal controls. Our findings will also be useful for informing and calibrating reactive transport models being developed by other science groups working along the Hanford Reach of the Columbia River. The findings will also advance our fundamental understanding of the connections of landscapes to large river systems, which has potentially significant implications for water and fisheries management practices.