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Utilizing GPR and Solute Tracer Experiments to Determine the Extent of the Hyporheic Zone

The objective of this study is to test geophysical imaging of salt tracers in the hyporheic zone of mountain streams, then using the measured hyporheic zone geometry to test and constrain flow models. Geophysical imaging has three primary benefits in hyporheic zone characterization: 1) geophysical imaging can provide laterally continuous images whereas direct sampling provides only point measurements, 2) surface geophysical methods are non-invasive, and 3) geophysical methods provide a target depth range of several meters or more, which may not be feasible with piezometer installations. When constrained with piezometer measurements, geophysical imaging may significantly improve hyporheic zone characterization. Introducing a salt tracer into a stream increases the conductivity of the water. We are investigating are variety of electrical and electromagnetic geophysical methods to detect the conductivity increase in the hyporheic zone with a primary focus on ground-penetrating radar, but including electrical resistivity, and time-domain electrogmagnetics. In July, 2005, we conducted a salt tracer experiment on an inflow stream to Bulltrout Lake, in the Sawtooth Mountains, Idaho. This site provided an excellent test location with well developed bedforms, sand dominated sediments conducive to GPR investigation, and characterization information from a number of previous tracer experiments. Geophysical data consists of; 1) four, multi-fold, surface GPR transects distributed along the study reach, 2) two GPR crosswell tomography panels, and 3) vertical electrical resistivity profiles measured along three subsurface electrode strings. Hydrological data include 1) tracer concentration monitored at 4 piezometer nests with piezometers installed at 20 and 40 cm at each nest and surface water concentration monitored at 2 locations. The surface GPR measurements provided clear stratigraphic images and velocity analysis provided laterally and vertically continuous porosity measurements. Our initial analysis suggests that crosswell GPR attenuation tomography imaged the tracer in the subsurface. Analysis is ongoing, but our early results are promising.

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