Facies Delineation at Local and Reach Scales

PNNL SBR SFA (Laboratory Research Manager: Charlette Geffen)

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Facies are elements of a sediment classification scheme that groups complex geologic materials into a manageable set of discrete classes. Facies classifications are arbitrary to a degree; their usefulness hinges on being able to distinctly relate facies type to quantitative properties needed for flow and reactive transport modeling (e.g., hydraulic properties, microbiologic characteristics). In the PNNL SFA, facies are being defined at multiple scales, providing a hierarchical structure for assigning multiscale model properties. At both reach and local scales, facies definitions are based on readily measured quantities that have adequate spatial coverage (e.g., stratigraphic units, grain size distribution, bathymetric and hydrodynamic attributes). Separate facies classifications have been defined in 1) the subsurface aquifer adjacent to and beneath the Columbia River (*subsurface facies*); and 2) the recent riverbed alluvial sediment (*riverine facies*).

Subsurface facies definitions and maps were based on pre-existing Hanford Site geologic maps. Hydraulic properties were related to facies type based on statistics of borehole measurements and pumping/slug test experiments. Subsurface facies and property maps are being used for local and reach scale modeling of hyporheic exchange, and are being refined as new data become available (e.g. hyporheic exchange observations from airborne electromagnetic and boat-based thermistor surveys). Riverine facies are less commonly studied than subsurface facies. Our riverine facies classification scheme is based on new measurements performed on freeze cores collected along the Columbia River shoreline. These were analyzed to quantify associations among microbial activity parameters (e.g., abundance of nitrite and carbon oxidizers), geochemical attributes (e.g., TOC, percentages of N/C/H), and physical properties. Multivariate data analyses indicated a strong relationship between physical and biogeochemical properties in the alluvial sediments. Mud and sand content, for example, were found to have strong associations with the abundance of nitrite and carbon oxidizing bacteria. Riverine facies are being refined and spatially mapped using river bathymetric attributes (e.g., slope, aspect, and local variability) and simulated hydrodynamic attributes (e.g., shear stress, flow velocity, river depth). Shear stress determines sediment transport and deposition and is associated with river-bed texture and sediment thickness. The spatial distribution of riverine facies will be further constrained using thermal imagery data and 3D time-lapse electrical resistivity tomography. The completed 3D distributions of riverine and subsurface facies and the corresponding flow, transport and biogeochemical properties will support parameterization of multiscale models of

hyporheic exchange between groundwater and river water and associated biogeochemical transformations.