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Transport and Transformation of Particulate Organic Matter in Permeable Riverbed Sediments

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Rivers and other inland water systems are key sites of biogeochemical transformation and storage; they are also distinct ecosystems, geomorphological agents and conduits for material transport across continents to the oceans. Biogeochemical activity in rivers is often conceptualized as occurring predominantly in the water column. However, by far the largest amount of biogeochemical activity takes place within the riverbed, either at or just below the surface. This occurs because the concentration of organic matter (OM) and associated microorganisms is several orders of magnitude higher than the concentration in the water column. Such dynamics have fundamental implications for CO_2 and/or CH_4 production and efflux as well as retention and/or release and transport flux of other nutrients (e.g. N, P) associated with POM decomposition.

Our project is initiating a program of research to examine riverbed Particulate Organic Matter (POM) transport and biogeochemistry in Columbia River (CR) sediments, leveraging knowledge developed as part of the PNNL Science Focus Area (SFA). In particular, we are characterizing POM transport and transformation in simulated, near-shore CR sediments through a series of column experiments. This research is designed to lay the foundation for future experiments and in situ observations characterizing biogeochemical processes associated with POM accumulation and transformation in actual permeable riverbed sediments. The primary goals of this limited set of experiments are to (1) determine the physiochemical processes controlling the POM transport and accumulation within simulated riverine sediments, (2) quantify microbial respiratory metabolism and POM mineralization driven by this accumulation. In addition, we will develop a 1-dimensional transport-reaction model of POM accumulation and metabolism that can be utilized in future experimental studies and could eventually be incorporated into ongoing simulations of hydrological transport and biogeochemical activity in the Hanford 300 Area SIZ.

Current research efforts are focused on quantifying the short-term (< 0.5 day) accumulation of POM in simulated, permeable riverbed sediment. We have examined the transport and accumulation of fresh algal POM in column reactors packed with Hanford sand and fine-grained silt and clay. Parallel experiments are being conducted with latex spheres with an equivalent diameter to the POM. By examining the comparative behavior of the POM and non-living latex spheres will have determined that surface properties of particles and sediment play a critical role in POM transport behavior. The next phase of our research will investigate longer-term (2-4 week) decomposition dynamics of POM in permeable sediments.