# Understanding Contaminant Migration within a Dynamic River Corridor through Integrated Field and Laboratory Experiments and Reactive Transport Modeling

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The behavior of a persistent uranium plume within an extended river corridor at the DOE Hanford site is dominantly controlled by river stage fluctuations in the adjacent Columbia River. The plume behavior is further complicated by substantial heterogeneity in physical and geochemical properties of the host aquifer sediments. Multi-scale field and laboratory experiments and reactive transport modeling were integrated to understand the complex plume behavior influenced by highly variable hydrologic and geochemical conditions in time and space. In this work, we (1) describe multiple data sets from field-scale uranium adsorption and desorption experiments performed at our experimental well-field, (2) develop a reactive transport model that incorporates hydrologic and geochemical heterogeneities characterized from multi-scale and multi-type datasets and a surface complexation reaction network based on laboratory studies, and (3) compare the modeling and observation results to provide insights on how to refine the conceptual model and reduce prediction uncertainties. The experimental results revealed significant spatial variability in uranium adsorption/desorption behavior, while modeling demonstrated that ambient hydrologic and geochemical conditions and heterogeneities in sediment physical and chemical properties both contributed to complex plume behavior and its persistence. This research underscores the great challenges in adequately characterizing this type of site to model the reactive transport processes over scales of 10 m or more. Our analysis provides important insights into the characterization, understanding, modeling, and remediation of groundwater contaminant plumes influenced by dynamic surface water and groundwater interactions.