Understanding Uranium Plume Persistence Processes at a Former Uranium Mill Tailings Area through the Use of Laboratory and Field Methods

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Background/Objectives. The Grand Junction, Colorado, Site is representative of several U.S. Department of Energy Office of Legacy Management (LM) sites where former uranium mills in the desert southwest of the United States were located on river floodplains. Uranium pilot mills were located at the Grand Junction site, and the associated mill tailings have been removed. However, slow dissolution of uranium from the solid phase below the tailings removal depths has resulted in ongoing groundwater contamination. Understanding uranium plume persistence issues at the Grand Junction site and other LM sites requires more detailed information on the processes that control the slow release of uranium from solid phase to groundwater.

Approach/Activities. Cores were collected in the shallow (<25 ft) sand and gravel alluvial aquifer beneath an area where uranium mill tailings were deposited and subsequently removed. These cores were used to create thin sections and examine the pore-scale location of uranium with fission-track radiography compared to the mineralogy. A column test was also performed on the same material using influent water that was similar to the current groundwater (without uranium) to determine uranium mobilization rates and concentrations. A reactive transport model was calibrated to the column results where a sequential addition of physical and geochemical processes helped evaluate the most important processes. Tracer testing will be completed in the spring of 2018 in the same area with multiple tracers and continuous geochemical sampling. This field-scale test data will also be evaluated with a reactive transport model and compared to the column test results with a focus on understanding the most important physical and geochemical process for uranium transport at multiple scales.

Results/Lessons Learned. The thin-section mineralogy combined with the fission-track radiography confirmed the presence of uranium sorbed on mineral coatings and granular cements (likely iron hydroxides). The column test data indicated an initial spike in the release of uranium, with slowly declining concentrations. The reactive transport modeling confirmed that sorption, dual porosity, and gypsum dissolution are all major processes in controlling uranium release. The column modeling effort also concluded that dual-porosity influences, seen with uranium concentration rebound during stop-flow tests, were likely due to high flow velocities in the column that are not representative of field conditions. Tracer testing will help confirm whether the major processes determined from the column tests are still the most important processes at a field scale. This presentation will summarize and compare all the laboratory and field data, along with modeling results, from the Grand Junction site to better understand the major processes that lead to uranium plume persistence at this site and, potentially, other LM sites.