Saprolite cores collected from around the former S-3 Ponds waste disposal site on the Oak Ridge Reservation in east Tennessee, USA, exhibit low pH and high concentrations of Al, Ca, Mg, Mn, various trace metals (e.g., Ni and Co) and radionuclides (e.g., U, and Tc). Because uranium is one of the major contaminants of concern at the site, its behavior was of particular interest. The mobility of uranium depends highly on pH. Groundwater titration experiments showed that when pH was increased from 3.87 to 5.45 with addition of dissolved sodium hydroxide, concentration of aqueous uranium decreased from 50 ppm to less than 5 ppm. Pretreatment of groundwater such as base titration was also found to be necessary to increase the groundwater pH and reduce the levels of some toxic metals for bioremediation. However, base additions to the sediments to increase pH are strongly buffered by various precipitation and sorption reactions. Therefore, batch, column, and field experiments have been carried out to investigate the geochemical processes that control contaminant mobility and bioremediation. Multi-process and multi-scale modeling and data analysis has been performed to develop a practical model to predict uranium immobilization for remediation of geochemically complex sites.

**References**


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**Field Scale Modeling**

A travel-time based reactive transport model was developed to simulate an in-situ bioremediation experiment at Area 3 for demonstrating enhanced bioreduction of U(VI) considering microbial reduction of nitrate, sulfate and U(VI).

**Batch Experiment Simulation**

The method of Spalding and Spalding (2001) was used to model soil buffer capacity by treating aquifer solids as an insoluble polyprotic acid. An equilibrium reaction model was developed considering aqueous complexation, precipitation, ion-exchange and soil buffering with pH-dependent ion exchange. Comparison of model results with experimental titration curves for contaminated soils indicated close agreement.

**Local Area 3 Model**

A local scale model was developed for Area 3 to facilitate interpretation of flow and tracer studies in the vicinity of well FW106. Pumping test calibration was performed to estimate hydraulic parameters. Reaction models developed through simulation of batch, columns, and field experiments will be incorporated into the local-area 3 model to help design future site investigation.