NEUP Nuclear Energy University Programs
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Reducing Uncertainty in Radionuclide Transport Prediction Using Multiple Environmental Tracers

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Collaborators:

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ABSTRACT:

Objectives: In this project, we will use observations of multiple environmental tracers to improve predictions of radionuclide reactive-transport in a shallow alluvial aquifer discharge to the Little Wind River near Riverton, Wyoming. We hypothesize that incorporating environmental tracer concentrations directly into reactive transport models, we will significantly reduce predictive uncertainty since these tracers are subject to many of same transport processes as radionuclides over the correct spatial and temporal scales. Our goal is to develop a new methodology to characterize natural reactive flow and transport systems, reduce predictive uncertainty in radionuclide transport simulations, determine the maximum information content of the tracer suite, and optimize future groundwater characterization efforts.

Experimental Approach: We will utilize recent theoretical developments considering the use of environmental tracers, and advances in high-performance reactive flow and transport models, to obtain the maximum information on the transport system. We will sample multiple environmental tracers with transport information over a wide range of temporal scales. We will then calibrate reactive transport model of U migration directly to the observed tracer concentrations, contaminant concentrations as well as hydraulic data. Model calibration uses field observations to determine the optimal subsurface distribution of parameters controlling transport. The uncertainty of these parameter estimates will be calculated for calibration using different subsets of available data. Calibration-constrained predictive uncertainty of contaminant migration will then be quantified. The uncertainty reduction resulting from incorporating environmental tracer data, and the ability of environmental tracers to characterize field scale reactive flow and transport will be quantified. These results will be used to determine optimal tracer sampling strategies for future studies.

Expected Results: In order to build confidence in repository safety, optimize repository design and forecast repository performance, accurate forecasts of natural system transport are required. The best data to characterize transport are observations of long-term transport. Environmental tracers provide critical information on reactive transport at the correct spatial and temporal scales for long term transport prediction, and thus potentially provide a robust characterization of the transport system. We expect that the incorporation of observed tracer concentrations directly into reactive transport models as calibration targets will significantly reduce predictive uncertainty, and improve accuracy of repository performance assessment simulations. Finally, our project will be carried out using the code base currently being developed by Sandia for the DOE for future repository safety assessment, thus providing a robust test of model development workflow and simulation capabilities in a real-world transport setting.