Model for the Evolution of Thermohydrology and Its Effects on Chemistry and Corrosion of Engineered Barrier Materials

C. Manepally[1], R. Green[2], D. Dunn[3], R. T. Pabalan[1], and Y. Pan[1]
Center for Nuclear Waste Regulatory Analyses (CNWRA)[1]
Department of Earth, Material, and Planetary Sciences[2]
Southwest Research Institute®[3]
San Antonio, Texas 78238

The evolution of the environment within the emplacement drifts of a potential high-level waste repository at Yucca Mountain, Nevada, may be influenced by several factors, including quantity and chemistry of seepage water, temperature, and relative humidity. Understanding the evolution of these environmental conditions is important, as it determines the duration and period of initiation of aggressive conditions that could cause early degradation of the waste package or the drip shield. This task is challenging as a result of the heterogeneity of the natural system, interactions between the engineered and natural components, the unsaturated conditions at the repository horizon, and the potential for natural drift degradation in a thermally perturbed environment. In this study, experimental and numerical models are designed to (a) simulate the in-drift conditions by controlling the heat load, infiltration flux and initial water compositions, and (b) measure the changes in temperature, relative humidity, and chemistry of the water contacting the surfaces of the engineered barrier materials. This study is a collaborative effort that integrates the unsaturated flow processes occurring during the thermal period with geochemical and corrosion processes. Relationships between evolution of the water chemistry as a function of temperature, relative humidity, infiltration flux, and corrosion of the waste package and drip shield materials are evaluated. The first phase of the experiment uses an inert medium such as quartz (sand) to avoid modification of the water chemistry by rock water interactions. Other tests use crushed tuff for the rock media. Numerical models are used to (a) determine the dimensions of the experimental setup, suitable heat flux, and appropriate infiltration flux rates, and (b) compare the results (temperature, relative humidity) with the measured data. Multiple tests are conducted with variable infiltration rates, initial water compositions, and heat loads. Results from the numerical model and ongoing laboratory experiments will be discussed.