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Using Pore-Water Chloride Data to Calibrate the Yucca Mountain Unsaturated Zone Flow and Transport Model

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Abstract

In this study, porewater chloride data from Yucca Mountain, Nevada, are analyzed and modeled by 3-D chemical transport simulations and analytical methods. The simulation modeling approach is based on a continuum formulation of coupled multiphase fluid flow and tracer transport processes through fractured porous rock, using a dual-continuum concept. Infiltration-rate calibrations were performed using pore-water chloride data. Model results of chloride distributions were improved in matching the observed data with the calibrated infiltration rates. Statistical analyses of the frequency distribution for overall percolation fluxes and chloride concentration in the unsaturated zone system demonstrate that the use of the calibrated infiltration rates had an insignificant effect on the distribution of simulated percolation fluxes, but significantly changed the predicted distribution of simulated chloride concentrations. An analytical method was also applied to model transient chloride transport. The method was verified by 3-D simulation results as able to capture major chemical transient behavior and trends. Effects of lateral flow on percolation fluxes and chloride distribution in the Paintbrush nonwelded unit were studied by 3-D simulations, with increased horizontal permeability. The combined results from these model calibrations furnish important information for the UZ model studies, contributing to performance assessment of the potential repository.

Keywords: chloride, unsaturated zone, Yucca Mountain, geochemistry, infiltration map, percolation