Discrete-Flow-Path Development in Unsaturated Fractures at Yucca Mountain

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Abstract

We have carried out numerical modeling studies to investigate the development of discrete-fracture flow paths and flow-focusing phenomena in the unsaturated rock of the potential repository horizon at Yucca Mountain, Nevada. These studies are based on two-and three-dimensional (2-D and 3-D) numerical models using site-specific parameters. The 2-D and 3-D models use high-resolution spatial discretization to explicitly include effects of discrete fractures with stochastically developed fracture permeabilities and a continuum approach. The permeability field is generated based on air-permeability measurements at various scales. For most of the cases considered, uniform infiltration with different average rates (1 to 500 mm/yr) is prescribed at the top of the model, while variability in outflow at the bottom of the model is used to evaluate the degree of flow focusing. In addition, scenarios involving nonuniform infiltration at the top boundary, different permeability correlation lengths, and different flow-allocation schemes were analyzed. The modeling results obtained from all of these cases showed a remarkably similar flow-focusing pattern at the repository horizon. Furthermore, tracer transport simulation results also revealed additional features of focused flow and transport through the fracture network.

Keywords: preferential flow, flow focusing, discrete flow paths, unsaturated flow and transport, fractured media

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