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A Mountain-Scale 3-D Numerical Model for Characterizing Unsaturated Flow and Transport in Fractured Volcanic Rock at Yucca Mountain

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Abstract

A three-dimensional site-scale numerical model has been developed to simulate water and gas flow, heat transfer, and radionuclide transport in the unsaturated zone of Yucca Mountain, Nevada, the American underground repository site for high level radioactive waste. The modeling approach is based on a mathematical formulation of coupled multiphase fluid and heat flow and tracer transport through porous and fractured rock. This model is intended for use in predicting current and future conditions in the unsaturated zone, so as to aid in assessing the system performance of the repository. In particular, an integrated modeling methodology is discussed for integrating a wide variety of moisture, pneumatic, thermal, and isotopic geochemical data into comprehensive modeling analyses. The reliability and accuracy of the model predictions were the subject of a comprehensive model calibration study, in which the model was calibrated against measured data, including liquid saturation, water potential, and temperature. This study indicates that the model is able to reproduce the overall system behavior at Yucca Mountain with respect to moisture profiles, pneumatic pressure and chloride concentration variations in different geological units, and ambient geothermal conditions.