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# Testing and Modeling of the Unsaturated Zone at Yucca Mountain

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## Abstract

The unsaturated zone at Yucca Mountain has been under investigation for over two decades as a possible location for a high-level nuclear waste repository. Testing of the unsaturated zone has been performed in multiple boreholes and two long underground tunnels. The testing involves evaluations of geological, geochemical, geophysical, and hydrogeological characteristics of the unsaturated fractured rocks. This paper provides an overview of the testing and the modeling done to date and our current understanding.

The testing performed to date evaluates the amount of water that enters the mountain, how this water moves through the mountain, and how radionuclides dissolved in the water will migrate from the repository to the water table. Various tests have been conducted, including a large array of infiltration tests, seepage tests in niches, fractured matrix interaction tests, and flow and transport tests between tunnels. In addition, a series of heater tests has and is being conducted to evaluate the effects of heat on fluid flow, seepage, and radionuclide transport. Along with all of these tests, computer modeling is used to design the tests, predict the results, and then calibrate to actual test data after the test is completed.

In this paper, we show a virtual tour of the various hydrological and thermal test beds in the tunnels at Yucca Mountain. Then we will describe the major tests, results obtained, and modeling of these tests. Emphasis is placed upon current understanding of large-scale water flow through the mountain, potential water seepage into drifts, and radionuclide transport processes. Finally, we discuss uncertainties in process understanding, testing results, and modeling.

*Keywords:* unsaturated flow, seepage, coupled processes, radionuclide transport, fracture flow