Flow and Transport Through a Fault Embedded in Fractured Rock

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RESEARCH OBJECTIVES

The overall objective of this investigation is to study flow and transport through a 20 m vertical section of a fault located in the fractured welded tuff of the Topopah Spring welded tuff unit at Yucca Mountain, Nevada (Figure 1), the proposed site for a high-level nuclear waste geologic repository.

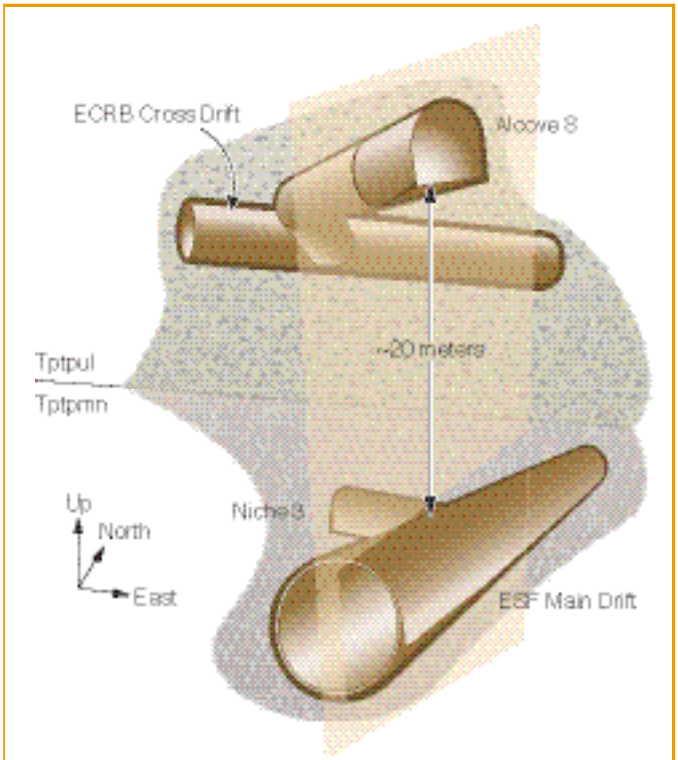

Figure 1. Location of the test bed between the Cross Drift and Main Drift in the Exploratory Studies facility. Shaded plane is located along presumed location of fault.

APPROACH

This investigation involved the release of approximately 82,000 liters of water along a horizontal section of the fault, under ponded conditions over a period of thirteen months and then under reduced fluxes for another six months. When quasi-steady-state seepage was observed at the lower end of the test bed, two tracers with different molecular diffusion coefficients were introduced into the ponded water infiltrating the fault. After tracer-laced water had been released into the fault, more tracer-free water was released. As water was released into the fault, changes in moisture content were monitored in the formation, while a large cavity excavated below the test bed was visually inspected for seepage. Water percolating through the fault and into the excavated cavity was continuously monitored with an automated, remotely accessed water collection system.

ACCOMPLISHMENTS

We observed that water (introduced along the fault) followed the fault as the primary vertical flow path, while the adjacent fractured matrix served to move water laterally and vertically. Unlike primary flow paths along the fault, flow was not persistent along the secondary flow paths under similar boundary conditions. The field experiment showed the existence of a capillary barrier and confirmed the dynamic nature of flow through the fault. Further, observations of bromide concentrations in seepage water during the early stages of the experiment, and of bromide and pentafluoride benzoic acid (PFBA) concentrations in the seepage water, indicate the significant influence of matrix diffusion on transport through a fault embedded in fractured, nonwelded rock.

SIGNIFICANCE OF FINDINGS

Field tests involving both flow and transport within a fault under unsaturated conditions are rare. This test has provided insights into mechanisms that come into play when water with tracers is introduced into a fault located in this unsaturated environment. This information is being used to develop conceptual models of flow and transport through Yucca Mountain.

RELATED PUBLICATIONS

Salve, R., D. Hudson, H. H. Liu, and J. S. Y. Wang, Development of a wet plume following liquid release along a fault. Water Resources Research, 2003 (submitted); Berkeley Lab Report LBNL-52711, 2003.

Liu, H. H., R. Salve, J. S. Y. Wang , G. S. Bodvarsson, and D. Hudson, Field investigation into unsaturated flow and transport in a fault: Model analysis. Journal of Contaminant Hydrology, 2003 (submitted); Berkeley Lab Report LBNL-52823, 2003.

Salve, R., A passive-discrete water sampler for monitoring seepage. Groundwater, 2003 (in press); Berkeley Lab Report LBNL-51203, 2002.

ACKNOWLEDGMENTS

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