

Hydrological and Geological Features Contributing to a Seepage Event at Yucca Mountain

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The occurrence of an unusual seepage event in the Exploratory Studies Facility (ESF) tunnel at Yucca Mountain (YM) in 2005 provides an opportunity to further understand the hydrological system associated with flow in fractured rocks and seepage into tunnels. Understanding the contributing factors for this seepage occurrence in the ventilated tunnel will assist U.S. Nuclear Regulatory Commission in its assessment of Department of Energy flow models. The seepage event began in the later portion of an El Niño winter (February 2005) predominantly along a 40-m [130-ft] section of the south ramp of the ESF tunnel. The stratigraphic section at this location is comprised of a portion of the Tiva Canyon Tuff, which is a rhyolitic ignimbrite. The effect of El Niño conditions in the semi-arid climate of southern Nevada near YM is greatly increased winter precipitation. Based on the ~50 years of record at a nearby meteorological station, the winter of 2004-2005 was the wettest winter on record. The previous largest winter precipitation amounts were recorded in the El Niño years of 1992-1993 and 1997-1998. During the 1997 El Niño year, a monitored set of boreholes in nearby Pagany Wash indicated that a saturated front traversed the entire Tiva Canyon Tuff section during a single event (Le Cain and Kurmack, 2002, USGS Water Resources Investigations Report 02-4035). It is unclear if the fracture system in the south ramp location was saturated in the February 2005 event; no data were available to estimate the saturated state of the fracture system. With heavy precipitation occurring throughout the winter, however, the matrix and fracture systems were likely primed (i.e., saturation levels were likely significantly higher than normal) for a significant percolation event. Ponding caused by focusing of runoff at the ground surface above seepage location in the south ramp of the ESF tunnel likely did not occur based on topographical and catchment considerations (no significant depressions or gullies). Analyses of the geological characteristics associated with the seepage location suggest the contributing factors that constrained seepage to this particular portion of the tunnel include (i) distance to the surface (i.e., ~60 m [200 ft]), (ii) gently dipping strata with distinct lithological contacts that may have laterally diverted water, (iii) faults and fractures, and (iv) downslope capping by rock units with different hydrological characteristics. This is an independent product of the CNWRA and does not necessarily reflect the views of regulatory positions of the NRC. The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or of the acceptability of a license application for a geologic repository at Yucca Mountain.