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Tracer Transport along a Vertical Fault Located in Welded Tuffs

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A near-vertical fault that intercepts the fractured welded tuff formation in the underground Exploratory Studies Facility (ESF) at Yucca Mountain, Nevada, has provided a unique opportunity to evaluate important hydrological parameters associated with faults (e.g., flow velocity, matrix diffusion, fault-fracture-matrix interactions). Alcove 8, which intersects the fault is located in the cross drift of the ESF, has been excavated for liquid releases through this fault and a network of fractures. Located ~20 m below Alcove 8 in the main drift of the ESF, Niche 3 which also intercepts the fault, serves as the site for monitoring the wetting front and for collecting seepage following liquid releases in Alcove 8.

To investigate the importance of matrix diffusion and the extent of area subject to fracture-matrix interactions, we released a mix of conservative tracers (pentafluorobenzoic acid [PFBA] and lithium bromide [LiBr]) along the fault. The ceiling of Niche 3 was blanketed with an array of trays to capture seepage, and seepage rates were continuously monitored by a water collection system connected to the trays. Additionally, a water sampling device, the passive-discreet water sampler (PDWS), was connected to three of the collections trays in Niche 3 into which water was seeping. The PDWS, designed to isolate continuous seepage from each tray into discreet samples for chemical analysis, remained connected to the trays over a period of three months. During

this time, all water that seeped into the three trays was captured sequentially into sampling bottles and analyzed for concentrations of PFBA and LiBr.

Water released along the fault initially traveled the 25 m vertical distance over a period of 36 days (at a velocity ~ 0.7 m/day). The seepage recovered in Niche 3 was less than 10% of the injected water with significant spatial and temporal fluctuations in seepage rates. Along a fast flow path, the benzoic tracer (PFBA) and LiBr were first detected ~ 12 days after they were released into the fault. Along slower flow paths the tracers appeared \sim two weeks later, with PFBA preceding the LiB. The differing travel times of the two conservative tracers suggests the impact of matrix diffusion in the transport process.

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