BUSTED BUTTE PHASE 2: INTRODUCTION AND ANALYTICAL MODELING OF NONREACTIVE TRACER AND LITHIUM BREAKTHROUGH

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The Busted Butte Unsaturated-Zone Transport Test Facility is located approximately 8 km southeast of Yucca Mountain, and was designed to address uncertainties associated with flow and transport in the UZ site-process models for Yucca Mountain. Busted Butte Phase 2 consisted of a 10m x 10m x 7m test block. From July 1988 through October 2000, complex tracer mixtures were injected continuously at 77 discrete points located along eight parallel 10-m boreholes arranged in two horizontal planes. In August 1999, iodide was added to the tracer mixture to explore the effects of initial hydraulic transients.

During the course of the experiment, porewater samples were collected at regular intervals using sorbing-paper collection pads, emplaced into fifteen horizontal and inclined 10-m collection boreholes, oriented perpendicular to the injection boreholes. Potential travel distances ranged from 20 cm to over 500 cm. Nonreactive tracer and weakly sorbing lithium breakthrough was observed at most of the collection points during the injection period. Following termination of injection, approximately 800 rock samples were collected using overcore and mineback techniques, and analyzed for tracer concentration. Rock analyses are discussed in a subsequent paper.

To complement complex 3-dimensional finite-element modeling of the entire block, bromide, iodide, and lithium breakthrough onto the collection pads has been modeled with CXTFIT. This simple 1-dimensional analytical code uses a non-linear curve-fitting routine to estimate transport parameters including apparent velocity, dispersivity, and field retardation factors. Preliminary results show that: (1) Bromide and iodide behaved similarly, despite the fact that bromide was injected in a strongly transient flow field, while iodide injection began after flow had approached steady state conditions. (2) With the exception of the closest collection points, tracer velocities remained relatively constant, indicating that transport was effectively 1-dimensional. (3) Scale-dependent dispersion was observed, with dispersivities increasing from less than 1 cm for the shortest travel distances, to approximately 10 cm over longer distances. (4) Field lithium velocities were consistently faster than predicted using laboratory batch-sorption results.