MEMORANDUM FOR: Ron Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

FROM: William Ford, Hydrogeologist
Technical Review Branch
Division of High-Level Waste Management

SUBJECT: MAY 20, 1987, TRIP REPORT TO THE AMERICAN GEOPHYSICAL UNION CONFERENCE IN BALTIMORE, MARYLAND

On May 20, 1987 I attended the American Geophysical Union Conference in Baltimore, Maryland. At this conference I attended all the talks on unsaturated flow and transport. On this day three talks were presented that were relevant to the Yucca Mountain High Level Repository. A brief description of these talks is presented below.

(1) Modeling Tracer Diffusion In Unsaturated Porous Media, Both Fractured And Unfractured

Kay H. Birdsell, Phillip G. Stringer, Lee F. Brown, Gail A. Cederberg, Bryan J. Travie, and A. Edward Norris (Los Alamos National Laboratory)

A proposed field diffusion test for the Nevada Nuclear Waste Storage Investigation Project was modeled. For the test, a solution containing nonsorbing tracers is introduced into a borehole in the geologic medium. The tracers diffuse and flow from the saturated source into the unsaturated matrix in the surrounding tuff. After some time, the borehole is overcored, and fluid tracer concentrations throughout the core are measured. The experimental data will be used to evaluate diffusive behavior and to derive diffusion coefficients for the tracers in the specific tuff.

The test will involve 5 meters of horizontal drifting in the Calico Hill and Topopah Springs Units. Then a 10 cm deep and 10 cm diameter hole will be drilled in the floor. Inside of this hole a 3 cm diameter hole will be drilled an additional 30 cm in depth. A liquid tracer will then be placed in the bottom of the hole.

Numerical simulations were used to study the effects of diffusion coefficient, porosity, saturation, and fracturing on tracer movement. Tests in the Topopah Spring Member and the tuff of Calico Hills, which have different porosities and saturations, were simulated. The simulations made the following predictions. The spread of tracer will be sensitive to the diffusion coefficient of the tracer in the water. The tracer will diffuse farther in the Topopah Spring Member than in the tuff of the Calico Hills because of the former's lower porosity and saturation. While advection will be a significant mechanism for tracer penetration into the Topopah Spring tuff, it will not be so for tracer penetration into the Calico Hills tuff. A horizontal fracture located below and near the source will have little effect on tracer transport in the Calico Hills tuff during a test. However, the fracture will alter the tracer behavior in the Topopah Spring tuff. especially at early times. Overcoring with a water cooled drill bit will not change the diffusion test results when the diffusion coefficient is low because the saturation front will not overlap the tracer profiles.

(2) Preliminary Capillary Hysteresis Simulations in Partially Saturated Fractured Rocks

Auli Niemi (Earth Sciences Division, LBL), Gudmundur S. Bodvarsson (LBL) and Parviz Montazer (USGS)

As part of a study to characterize the unsaturated zone at Yucca Mountain, Nevada, preliminary capillary hysteresis simulations were carried out. At present there are no measured hysteresis data for the tuffs at Yucca Mountain. The hysteresis model uses interpolation methods for determining appropriate scanning paths of the capillary pressure-liquid saturation relationship, based upon the wetting-drying history of the material. It was observed that for both a given total flux and a given total liquid saturation, the fracture flow was more dominant in the wetting cases than in the drying cases. In the drying cases, the effective permeability was determined by the matrix permeability at lower liquid saturations, and by the fracture permeability at higher saturations, whereas in the wetting cases it was determined by fracture permeability in the whole saturation range tested. This method assumes that 2nd and higher order curves can be approximated by 1st order curves. This report also observed that the effects of hystersis rapidly die out with depth where saturation is relatively constant.

(3) Chemical Evidence of Preferred Water Flow Paths in Unsaturated Fractured Tuffs, Yucca Mountain, Nevada

I.C. Yang, (USGS)

Pore fluids were extracted from cores of unsaturated tuff in a single borehole from Yucca Mountain, Nevada, using triaxial compression and high-speed centrifugation methods. Chemical analyses for major cations and anions indicated no substantial difference in pore-fluid chemistry extracted by these two methods. The tritium log in the borehole indicated a tritium activity of about 20 Tritium Units (T.U.) at a dept of 1 m; activity decreased to 0 T.U. at a depth of 12 m, increased to 20 T.U. in the depth interval from 35 to 45 m and increased to 40 T.U. at about a depth of 50 m. This profile inversion in the depth interval form 12 to 50 m may indicate that water at a depth of 50 m did not percolate vertically from the alluvium directly above, but rather may indicate a rapid flow of recent water through fracture or non-vertical, steep-angle to lateral flow paths or both. Such flow paths were predicted by Montazer and Wilson

(1984) in their conceptual model. This conclusion is further supported by major-ion concentrations of the pore fluids from this borehole that did not indicate progressive increases in concentrations with increasing depth in the upper 100m. Assuming uniform mineral compositions of the tuff, longer water-rock contact time may result in larger concentrations. The smaller chemical concentrations in water at greater depth compared with larger concentrations at a shallower depth would indicate a relatively fast travel time along a non-vertical flow path or a period of intense recharge events at the site in the past. The large tritium concentration at deeper depth would be the result of fast travel time instead of the result of intense recharge in the past.

(Original Signed by [redacted]

William Ford, Hydrogeologist
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cc: Roy Williams, WILLIAMS AND ASSOC., INC.
Lyle Davis, WATER, WASTE AND LAND, INC.
Mark Logston, NUCLEAR WASTE CON., INC.

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