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A Progress Report on the Large Block Test

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Introduction

The Yucca Mountain Site Characterization Project is investigating Yucca Mountain, Nevada, for its suitability as a potential repository for high-level nuclear waste. When emplaced in a repository, the radioactive decay heat of the waste may cause coupled thermal-mechanical-hydrological-chemical (TMHC) processes in the near field. These processes must be understood before model calculations can be performed to confidently predict the near-field environment.

The Large Block Test (LBT) is designed to permit the conduct of experiments with controlled boundary conditions so that they will be more useful for testing some of the concepts of the coupled TMHC processes. Specifically, the LBT will study the dominant heat transfer mechanism, condensate refluxing, binary diffusion, rewetting of the dryout zone following the cool-down of the block, displacement in fractures, and rock-water interaction. The LBT will also evaluate test methodologies and instruments that may be used in future tests at the Exploratory Studies Facility and will evaluate the corrosion/oxidation potential of coupons of candidate waste package materials. This is a progress report on the LBT.

Description of the LBT

The LBT consists of two parts: tests of individual processes in small blocks in the laboratory, and integrated tests for the macroscopic coupled processes in the large block. An outcrop area at Fran Ridge was selected because of its suitable rock type and accessibility.

Test on the Large Block

A $3 \times 3 \times 4.5$ m block of nonlithophysal Topopah Spring tuff was isolated at Fran Ridge. The block will be heated from within to reach a steady state of 140°C at the heater horizon and about 60°C at its top for at least two months, then cooled down naturally, which may take six months. Zero-moisture-flux and zero-heat-flux boundary conditions will be maintained on the sides of the block throughout

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heating and cool-down. Vapor that leaves the top of the block will be collected and measured. The block will be restrained by straps to keep it from falling apart during the test.

Instruments will be installed in boreholes (which will be sealed) and on the block surfaces to monitor the responses of the block in three dimensions. The following parameters will be measured continuously: temperature, displacement, moisture content, thermal conductivity and diffusivity, pore gas pressure, acoustic emission, and acoustic velocities. Air permeability will be measured before and after the heating. Coupons of candidate waste package materials will be placed in strategic locations, and will be examined before and after the test for evidence of corrosion. After the test, the block will be dismantled to examine for evidence of rock-water interactions.

Small Block Tests in the Laboratory

Small blocks of the rock adjacent to the large block have been collected for tests to be conducted in the laboratory. The tests include thermal-mechanical deformations, fracture flow and matrix imbibition, drying and imbibition of intact and fractured blocks, vapor diffusion in the rock matrix, and condensation along a fracture. The water that flows through the test samples will be analyzed for chemical changes. Samples will be examined before and after each test for direct observation of rock-water interactions.

Progress and Status

Fractures on the four vertical sides and the top of the block have been carefully mapped. All horizontal boreholes have been drilled. Figure 1 shows a schematic of all the boreholes in the block. Video images were taken in each hole. The fracture distribution in those holes will be used to determine instrument placement. Grooves were machined on the block surfaces to accommodate surface instruments and cables from instruments in boreholes.

Some of the instruments have been procured and calibrated. These include RTD, Humicaps, pressure transducers, packers, main heaters, guard heaters and insulation material, liners for some of the neutron and observation holes, hardware for a data acquisition system, heat exchanger, and hardware for the ERT measurements.

Small block laboratory tests are in progress. These include measuring matrix permeability, studying fracture healing, investigating fracture flow and matrix imbibition, measuring relative humidity as a function of water saturation, and investigating vapor condensation along a fracture.

Three scoping 2-dimensional model calculations have been conducted: homogeneous porous medium, horizontal permeable layers, and vertical permeable zones. In addition, a three-dimensional finite element model has been set up to run NUFT codes for thermal-hydrological calculations.

The LBT was stopped just before instruments were to be installed in the block. The large block is mothballed with plastic wraps and insulation material. All holes are plugged. All instruments are shelved.

Acknowledgment

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Figure 1. Schematic diagram of the block with all of the instrument and heater holes.

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