FIRST PHASE OF SMALL DIAMETER HEATER EXPERIMENTS IN TUFF

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ABSTRACT

As part of the Nevada Nuclear Waste Storage Investigations (NNWSI) project, we have undertaken small diameter heater experiments in the G-Tunnel Underground Facility on the Nevada Test Site (NTS). These experiments are to evaluate the thermal and hydrothermal behavior which might be encountered if heat producing nuclear waste were disposed of in welded and nonwelded tuffs. The two Phase I experiments discussed have focused on vertical borehole emplacements.

In each experiment, temperatures were measured along the surface of the 10.2 cm diameter heater and the 12.7 cm diameter boreholes. For each experiment, measurements were compared with computer model representations. Maximum temperatures reached were: 196°C for the welded tuff after 21 days of operations at 800W and 173°C for the nonwelded tuff after 35 days of operations at 500W. Computed results indicate that the same heat transfer model (includes conduction and radiation only) can describe the behavior of both tuffs using empirical techniques to describe pore water vaporization.

Hydrothermal measurements revealed heat-induced water migration. Results indicated that small amounts of liquid water migrated into the welded tuff borehole early in the heating period. Once the rock-wall temperatures exceeded 94°C, in both tuffs, there was mass transport of water vapor as evidence indicated condensation cooler regions. Borehole pressures remained essentially ambient during the thermal periods.

CONCLUSIONS

These phenomenological evaluation experiments in welded and nonwelded tuffs have shown that:

1. The same heat transfer modeling technique can be used for tuffs having porosities of 0.15 and 0.45, and maximum temperature data/model comparisons were within 6%. Convection should be integrated into near field models if accuracies are to be improved.
2. Only small amounts of liquid water were detected in the bottom of the boreholes. Major water transport mechanisms appear to be the accumulation of vapor in the warmer air around the heater and later deposition as condensate in cooler regions away from the heater.
3. Borehole surfaces did not show structural degradation. While measurements were not taken in the rock outside of the borehole, results show that there is the potential for pore moisture vapor transport into the fractures and this could impact joint motion in the thermomechanical evaluations.