IMPLICATIONS OF THE DRIFT SCALE HEATER TEST AT YUCCA MOUNTAIN FOR
EPITHERMAL MINERALIZATION

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An 8-year long, drift scale heater test (DST) is currently underway at the underground Exploratory Studies Facility at Yucca Mountain in Nevada. The host rock for the DST is a highly fractured, welded tuff. The rock has ~10% matrix porosity 90% filled with water. After a little more than two years of heating, the temperature at the drift wall reached ~200°C and has been maintained at that temperature for the past ~1.5 years. Gas and water (both vapor and liquid) have been collected from monitoring boreholes since the test began. The CO₂ concentration of the gas and the isotopic compositions of the water and CO₂ are measured. These data are used to constrain numerical models of coupled thermal, hydrological, and chemical processes occurring in the system.

Despite obvious differences from epithermal systems (e.g., the DST is being conducted in an unsaturated system), the trends observed in the isotopic compositions of the water and CO₂ have interesting implications for natural systems. In areas below boiling, the isotope ratios of the water are near that of the ambient pore water ($\delta^{18}\text{O}$ about -12‰). Where significant amounts of vapor condensate occur (above the boiling front above the drift and in fracture zones to the sides of the drift), the $\delta^{18}\text{O}$ values of the water are lower than the pore water, reflecting addition of low- $\delta^{18}\text{O}$ steam condensate. Conversely, in boiling zones, the $\delta^{18}\text{O}$ values of the water become progressively higher, representing Rayleigh fractionation of the pore water as it is vaporized. As the temperature approaches boiling, the gas phase becomes dominated by water vapor. The remainder of the gas phase consists of air with elevated CO₂ (up to 15%). The source of the CO₂ is primarily dissolved inorganic carbon (DIC) in the pore water. As the temperature increases, the $\delta^{13}\text{C}$ values of the CO₂ shift from approximate equilibrium with the pore water DIC (-15‰) to much higher values (>0‰). Dissolution of calcite in fractures is also a significant source of CO₂ in regions with drainage of vapor condensate. Isotopic data from several Mexican epithermal vein systems will be discussed in light of these findings.