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PRODUCTS OF AN ARTIFICIALLY INDUCED HYDROTHERMAL SYSTEM AT YUCCA MOUNTAIN

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Studies of mineral deposition in the recent geologic past at Yucca Mountain, Nevada, address competing hypotheses of hydrothermal alteration and deposition from percolating groundwater. The secondary minerals being studied are calcite-opal deposits in fractures and lithophysal cavities of ash-flow tuffs exposed in the Exploratory Studies Facility (ESF), a 7.7-km tunnel excavated by the Yucca Mountain Site Characterization Project within Yucca Mountain. An underground field test in the ESF provided information about the minerals deposited by a short-lived artificial hydrothermal system and an opportunity for comparison of test products with the natural secondary minerals.

The heating phase lasted nine months, followed by a nine-month cooling period. Natural pore fluids were the only source of water during the thermal test. Condensation and reflux of water driven away from the heater produced fluid flow in certain fractures and intersecting boreholes. The mineralogic products of the thermal test are calcite-gypsum aggregates of less than 4-micrometer crystals and amorphous silica as glassy scale less than 0.2 mm thick and as mounds of tubules with diameters less than 0.7 micrometers. The minute crystal sizes of calcite and gypsum from the field test are very different from the predominantly coarser calcite crystals (up to cm scale) in natural secondary-mineral deposits at the site. The complex micrometer-scale textures of the amorphous silica differ from the simple forms of opal spherules and coatings in the natural deposits, even though some natural spherules are as small as 1 micrometer. These differences suggest that the natural minerals, especially if they were of hydrothermal origin, may have developed coarser or simpler forms during subsequent episodes of dissolution and redeposition. The presence of gypsum among the test products and its absence from the natural secondary-mineral assemblage may indicate a higher degree of evaporation during the test than during the deposition of natural calcite-opal deposits.