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SILICA DEPOSITION IN FIELD AND LABORATORY THERMAL TESTS OF YUCCA MOUNTAIN TUFF

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A field thermal test was conducted by the Yucca Mountain Site Characterization Project to observe changes in the Topopah Spring Tuff middle nonlithophysal zone geohydrologic system due to thermal loading. A laboratory-scale crushed-tuff hydrothermal column test was used to investigate the tuff as a potential construction material within a nuclear-waste repository. Results of similar column tests have been cited as indications that silica deposition would plug the rock fractures above a repository and create unfavorable drainage conditions. Data from field and laboratory tests are used here to predict the magnitude of fracture sealing.

For the crushed-tuff column test, a one-meter-high column was packed with crushed tuff to a porosity of about 50%. Water filling the lowermost 10 cm of the column was boiled and the vapor condensed at the top of the column, percolating down to the boiling zone. After 100 days, intergranular pore space in the saturated portion of the column was almost filled with amorphous silica.

The Drift Scale Test at Yucca Mountain is a heating test in the unsaturated zone. It consists of a four-year heating phase, now complete, followed by a four-year cooling phase. Heaters in a 60-m-long drift and in the adjacent rock have heated the drift walls to 200°C. As the rock was heated, fluids naturally present in the rock migrated away from the heat sources. A boiling zone now separates an inner dry-out zone from an outer condensation zone. A heat-pipe region exists in the outer margin of the boiling zone above the heated drift. Amorphous silica coatings up to a few micrometers thick were deposited in this region. Deposits were observed in less than 10% of the fractures in the heat pipe region.

Drift-scale test results yield a silica deposition rate of about 250 μm/1000 years in 10% of the fractures in the heat-pipe region. We did not calculate deposition rates from our column test, but a rate of 9.1 mm/1000 years in all fractures of the heat-pipe region is predicted by Sun and Rimstidt (2002) from the results of a similar test. We believe the rate based on field-test observations is a better prediction because the field test more closely resembles the expected environment in a repository. Rates based on column-test results may be reasonable for local zones of preferred fluid flow.