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Validating Thermohydrologic Models Using the Drift Scale Test of the Proposed Repository at Yucca Mountain: Impact of Capillary-Pressure Cap

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The MultiScale ThermoHydrologic Model (MSTHM) supports the total system performance assessment (TSPA) for the proposed nuclear-waste repository at Yucca Mountain. The MSTHM uses the Nonisothermal Unsaturated Flow and Transport (NUFT) code to represent thermal-hydrologic (TH) processes occurring at scales from a few tens of centimeters around individual waste packages and emplacement drifts (tunnels) all the way to the kilometer scale for heat flow through the mountain. The TH model involves two-phase (liquid and gas) nonisothermal flow and transport in an unsaturated fractured rock system, using a dual-permeability model of overlapping fracture and matrix continua. The TH model depends on calibrated system parameters, including the van Genuchten α and m parameters for the capillary pressure versus saturation relationship. Because those parameters were calibrated under isothermal conditions, they may not fully address nonisothermal conditions driven by waste-package heat generation that drives liquid saturation below residual saturation. Various extension methods are considered for the van Genuchten capillary-pressure function as applied to a 3-D nested-mesh TH model of the Drift Scale Test (DST), as well as a corresponding 2-D drift-scale TH submodel, which supports the MSTHM. Simulated temperatures and liquid saturations are compared with field measurements from the DST. Compared to past DST model-validation studies, agreement between the simulated results and field measurements is improved, partially due to implementing a capillary-pressure cap. Because the same hydrologic properties and capillary-pressure cap are applied in the TH submodels supporting the MSTHM, this model-validation study builds confidence in the MSTHM as it is applied to Yucca Mountain TSPA.

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