CMWR XVI - Computational Methods in Water Resources
XVI International Conference, Copenhagen, Denmark, June 19-22 2006

Title: Modeling Coupled Processes of Multiphase Flow and Heat Transfer in the Unsaturated Fractured Rock

Yu-Shu Wu, S. Mukhopadhyay, K. Zhang, and G. S. Bodvarsson

Earth Sciences Division
Lawrence Berkeley National Laboratory
Berkeley CA 94720 USA

Abstract

A multidimensional, mountain-scale, thermal-hydrologic (TH) numerical model is developed for investigating unsaturated flow behavior in response to decay heat from the radioactive waste repository in the Yucca Mountain unsaturated zone, Nevada, USA. The TH model, consisting of both two-dimensional and three-dimensional representations of the unsaturated repository system, is based on the current repository design, drift layout, and thermal loading scenario under estimated current and future climate conditions. More specifically, the TH model implements the current geological framework and hydrogeological conceptual models, and incorporates the most updated, best-estimated input parameters. This mountain-scale TH model simulates the coupled TH processes related to mountain-scale multiphase fluid flow and evaluates the impact of radioactive waste heat release on the natural hydrogeological system, including thermally perturbed liquid saturation, gas- and liquid-phase fluxes, and water and rock temperature elevations, as well as the changes in water flux driven by evaporation/condensation processes and drainage between drifts. For a better description of the ambient geothermal condition of the UZ system, the TH model is first calibrated against measured borehole temperature data. The ambient temperature calibration provides the necessary surface and water table boundary as well as initial conditions. Then, the TH model is used to obtain scientific understanding of TH processes in the Yucca Mountain unsaturated zone under the designed schedule of repository thermal load.