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Coupling Effects of Heat and Moisture on the Saturation Processes of Buffer Material in a Deep Geological Repository

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Clay barrier plays a major role for the isolation of radioactive wastes in a underground repository. This paper investigates the resaturation behavior of clay barrier, with emphasis on the coupling effects of heat and moisture of buffer material in the near-field of a repository during groundwater intrusion processes. A locally available clay named “Zhisin clay” and a standard bentotine material were adopted in the laboratory program. Water uptake tests were conducted on clay specimens compacted at various densities to simulate the intrusion of groundwater into the buffer material. Soil suction of clay specimens was measured by psychrometers embedded in clay specimens and by vapor equilibrium technique conducted at varying temperatures. Using the soil water characteristic curve, an integration scheme was introduced to estimate the hydraulic conductivity of unsaturated clay. The finite element program ABAQUS was then employed to carry out the numerical simulation of the saturation process in the near field of a repository. Results of the numerical simulation were validated using the degree of saturation profile obtained from the water uptake tests on Zhisin clay. The numerical scheme was then extended to establish a model simulating the resaturation process after the closure of a repository. It was found that, due to the variation in suction and thermal conductivity with temperature of clay barrier material, the calculated temperature field shows a reduction as a result of incorporating the hydro-properties in the calculations.