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Coupled numerical modeling of the China Mock-Up experiment for swelling clay barriers

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A notable part of active research on engineered barrier systems for the safe disposal of nuclear waste involves finding and understanding appropriate buffer materials. A buffer material which acts as a barrier between a nuclear waste canister and the surrounding host rock must possess certain properties, some as low-permeability, resistance to contaminant transport, ability to withstand high temperatures and pressures for extended periods of time etc. Bentonite is one such suitable candidate for a buffer material. Predicting the long-term behavior of bentonite under coupled THMC conditions remains a challenge. The behaviour of the Chinese GMZ-Na bentonite was investigated on a technical scale in the China Mock-Up experiment which yielded a significant amount of data on this material. The analysis of this experiment requires numerical models taking into account the coupled thermal, hydraulic and mechanical processes occuring in the bentonite.
We performed such numerical modeling of the China Mock-Up experiment using a monolithically coupled thermo-hydro-mechanical model for partially saturated swelling porous media with vapour diffusion and phase change phenomena implemented in the open-source numerical code OpenGeoSys-6 (OGS-6). The aim of this analysis is manifold. Firstly, to study thermal desaturation due to the waste-induced heating process as well as the subsequent resaturation by formation fluids. Secondly, to look at different representations of the boundary conditions for temperature, pore pressure as well as displacement and their impact on the results. To better represent the interaction of porous and non-porous materials, a recently implemented feature in OGS-6 allows for partial assembly of the matrices and thus, enables the user to deactivate a subset of the processes for some certain sub-domains. We tested the functionality of this feature and utilize it to represent the steel tank and insulation layer surrounding the bentonite blocks in the experimental setup which proved beneficial for the representation of the measurements.

Participation

In-Person

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