Applications of Thermo-Hydro-Mechanical and Phase-Field Models in Radioactive Waste Disposal Research

Lecture of
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January 30, 2025, 4pm

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The safe and sustainable disposal of radioactive waste is a pressing challenge, requiring a comprehensive understanding of containment integrity in various geological settings. This work integrates thermo-hydro-mechanical (THM) as well as phase-field modeling to explore processes affecting the stability of potential host rocks, including salt and clay rocks. In salt rock repositories, temperature evolution and shrinkage behavior are analyzed to assess safety and stability strategies. For clay rock, hydro-mechanical modeling focuses on cracking phenomena, using experimental data from the Opalinus Clay of the Mont Terri rock laboratory. The phase-field approach is employed to simulate crack initiation and propagation influenced by environmental factors such as relative humidity changes. Numerical results show correlation with in-situ observations, such as desiccation cracking and seasonal effects, offering insights into the interactions between mechanical deformation and water content redistribution.This work highlights the role of computational modeling in advancing the understanding of coupled processes essential for the long-term containment of radioactive waste. Additionally, it addresses some challenges and opportunities of scaling these methods from laboratory experiments to field applications, contributing to the broader discussion on building trust in model predictions.

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