Contribution ID: **36** Type: **Oral Presentation**

Shrinkage-induced cracking in Opalinus Clay: investigation of crack modeling parameters and response in the CD-A experiment

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The long-term storage of heat-generating radioactive waste requires enhanced material and process understanding of potential host rocks such as clay. Opalinus Clay formations are intensely researched in the laboratory- and field-scale experiments. In the Mont Terri Rock Laboratory in Switzerland, the strongly coupled hydro-mechanical behavior of Opalinus Clay is investigated in the field-scale Cyclic Deformation (CD-A) experiment whose measurements started in October 2019. The experiment consists of two twin niches, which are compared with the help of (i) long-term direct and indirect measurements e.g., resistivity, water content, suction and crack development and (ii) numerical simulations. The niches have identical dimensions but differ in their environmental conditions. While one niche is closed to retain high humidity conditions, the so-called "open niche"is exposed to the influence of the neighboring gallery and subjected to the effects of seasonal air humidity changes. One of these effects is shrinkage-induced cracking, which we observe in periods when the relative air humidity decreases.

We model the cyclic deformation behavior of Opalinus Clay with a macroscopic poromechanic approach by considering partial saturation under the Richards assumption. The formulation consists of the balance equations of the solid and liquid phases with displacements and pore pressure as independent variables. Hydromechanical coupling is achieved via the effective stress concept. The deformation behavior, e.g. swelling, shrinkage, is mainly driven by the pressure gradients. These exert a strong influence on the effective stress field, which may lead to cracking. To account for such shrinkage-induced cracking, we couple the hydro-mechanical model with the phase-field fracture model. The coupled equations are numerically implemented within the open-source finite element software OpenGeoSys (OGS-6).

Using a set of material parameters obtained from field measurements and literature, we compare the hydro-mechanical response of a laboratory scale and of a local in-situ scale model, which represents the open niche. The size and setup of the local in-situ model are determined accordingly to the desaturated and/or damage zone interpreted from field observations. We investigate the sensitivity of certain fracture mechanical parameters and attempt to reproduce in-situ observations of crack opening variations in response to humidity fluctuations in the open niche. Finally, we propose a preliminary methodology for applying the phase-field modeling approach at the spatial and temporal scales of the CD-A experiment.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

In person

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