InterPore2022

Monday 30 May 2022 - Thursday 02 June 2022

Book of Abstracts tmpWN06Cr.png

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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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Germany **References**:

Time Block Preference:

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

In person

Poster / 528

Simplified simulation of two-phase flow in karst conduits in carbonate rocks

Authors: Uebert Gonçalves Moreira[1] ; Franciane Fracalossi Rocha[2] ; Alfredo Jaramillo[1] ; Fabricio Simeoni de Sousa[1] ; Roberto Federico Ausas[1] ; Gustavo Carlos Buscaglia[1] ; Felipe Pereira[3]

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Oil reservoirs are composed of several combinations of matrices, fractures and cavity systems, which result in various properties of porosity, permeability and fluid transport behavior 1. Thus, the problem of flow through a reservoir in the presence of karsts is complex and the predictive capabilities related to the flow and transport processes remain severely limited.
In this work, we perform computer simulations of the five spot problem in a domain $\Omega \subset \mathbb{R}^2$ to numerically describe an incompressible two-phase flow in a karstified carbonate rock. The methodology is based on the geometric treatment and simulation data proposed in [2], and on the application of the Karst Index (KI) concept presented by [3]. The use of the KI follows a similar approach to the application of the Well Index presented in [4]. Given the lack of knowledge of the precise geometry of karst network shape, we consider a particular arrangement of the branchwork type in the sense of the shape defined in [5] and idealized by [2]. The mathematical model used basically consists of a system of equations that includes Darcy's Law, a mass conservation equation for each component and a transport equation. The domain is discretized by an uniform mesh, where the karst is embedded, with different configurations of homogeneous and high-contrast heterogeneous media. The equations are discretized by standard finite volume schemes.
As a way of validating the results, we verified that the masses are conserved in all elements. In addition, the behavior of the pressure, velocity and saturation fields are consistent with the expected physical behavior. The results were compared with simulations in domains without the presence of karsts and substantial differences were noted between them. Our results emphasize the need to include karst regions in reservoir simulations and have potential to be used in more complete treatments that make use of Multiscale Methods and parallel simulations.

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Brazil **References**:

1 C. Braester. Influence of block size on the transition curve for a drawdown test in a naturally fractured reservoir. SPE 10543-PA, 24(5), 1984.

[2] P. Ferraz, P. Pereira, E. Abreu, M. A. Murad. Recursive Mixed Multiscale Model Reduction for Karst Conduit-Flow in Carbonate Reservoirs. Transport in Porous Media. 139: 527–558, 2021.

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[4] C. Wolfsteiner, L. J. Durlofsky, K. Aziz. Calculation of well index for nonconventional wells on arbitrary grids. Comput. Geosci. 7(1), 61–82, 2003.

[5] A. N. Palmer. Origin and morphology of limestone caves. Geological Society of American Bulletin, 103: 1–21, 1991. **Time Block Preference**:

Time Block B (14:00-17:00 CET) **Participation**:

Online

MS03 / **98**

Simulation of CO2 mineral trapping and permeability alteration in fractured basalt: Implications for geologic carbon sequestration in mafic reservoirs

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