Contribution ID: **381** Type: **Poster Presentation**

On the CO2/caprock interaction based on quantitative image analysis from in-situ x-ray tomography

Monday, 30 May 2022 15:10 (1h 10m)

Previous studies have highlighted the great potential of shales as geological barriers thanks to their favourable properties (very low permeability, high capillary entry pressure, swelling properties). However, the response of shales is governed by Thermo-Hydro-Chemo-Mechanical (THMC) couplings of high complexity, often making their study challenging. The difficulty arises mainly from the fact that the undergoing phenomena take place in a much longer time period compared to the time-scale of experimental campaigns and thus, most measurable responses have been observed only at the application of extreme, often non-representative, boundary conditions. Taking into consideration limitations related to boundary conditions, sample size and mineralogy the proposed work aims to investigate the CO2/caprock interaction at the microscale level using for the first time live x-ray tomography.
X-ray tomography is a non destructive imaging tool that can provide precious insight into the 3D kinematics of heterogeneous materials and reveal localised response which otherwise is not depicted in the overall recorded measurements of typical hydromechanical testing methods. In order to improve both spatial (pixel size) and temporal (transport-related) resolution, very small cylindrical shale samples (d=h=5mm) are tested in a high resistance x-ray compatible cell. First, a better understanding of the contribution of the different mechanisms is demonstrated with simple isotropic CO2 exposure on the sample, where the chemo-mechanical and thermo-mechanical impact of supercritical CO2 on the material's microstructure is evaluated. A second series of tests follows where CO2 injection under isotropic confinement is performed.
3D image analysis revealed that even at that small scale, pre-existing micro-fissures in shales cannot necessarily be avoided. Pre-existing cracks are more prone than intact matrix to opening/closing (increased localised strain activity) upon THM loading which here is imposed both by thermal loading and water evaporation in the anhydrous CO2, they thus have a crucial role for the integrity of the entire storage system. Application of confinement closes pre-existing fissures (at least at a given resolution) but their contribution to the overall flow is yet to be quantified. CO2 breakthrough has been identified from the volumetric response of the sample which locally expands in locations around pre-existing fissures. The current work shows that even at resolutions lower than the average pore size of the material, 3D image analysis can reveal important insight on the localised behaviour which in the context of CO2 storage can be related to potential leakage paths.

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References

Boulin, P. F., Bretonnier, P., Vassil, V., Samouillet, A., Fleury, M., & Lombard, J. M. (2013). Sealing efficiency of caprocks: Experimental investigation of entry pressure measurement methods. Marine and Petroleum Geology, 48, 20-30.

Stavropoulou, E., Andò, E., Roubin, E., Lenoir, N., Tengattini, A., Briffaut, M., & Bésuelle, P. (2020). Dynamics of water absorption in callovo-oxfordian claystone revealed with multimodal x-ray and neutron tomography. Frontiers in Earth Science, 8, 6.

Minardi, A., Stavropoulou, E., Kim, T., Ferrari, A., & Laloui, L. (2021). Experimental assessment of the hydro-mechanical behaviour of a shale caprock during CO2 injection. International Journal of Greenhouse Gas Control, 106, 103225.

Stavropoulou, E. & Laloui, L. (2022). Evaluating CO2 breakthrough in a shaly a caprock material: a multi-scale experimental approach. Marine and Petroleum Geology (under submission)

Time Block Preference

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

Participation

Online

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