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Lab-scale characterization of a shaly caprock for CO2 storage: advancements and limitations

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The potential of CO2 underground storage relies on the sealing efficiency of the overlaying caprock that acts as a geological barrier. Shales are extensively studied as potential caprock formations thanks to their favourable hydro-mechanical properties and their sealing capacity: low permeability, high sorption capacity, high swelling ability and high capillary entry pressure. The sealing capacity of a geomaterial is usually quantified based on its measured capillary entry-pressure, i.e. the max. pressure difference that may exist across the interface that separates two immiscible fluids before the non-wetting fluid penetrated the pore space.

The water retention properties of shales have been previously studied in either gas-water or oil-water systems, however, no results for CO2-water systems are reported to this day. In this work, the capillarity of a shaly caprock geometerial is investigated with a series of break-through tests (meso-scale). Based on these results, the capillary pressure (Pc) - saturation (Sw) relations of CO2 displacing water (drainage) and water rewetting (imbibition) are explored and modelled based on the basic principles of unsaturated soil mechanics. The final goal is to project the main findings of the work to possible implications for caprock integrity (entry-pressure) and sealing properties (permeability) for safe CO2 storage. To this end, the transport properties of the material before and after CO2 injection are assessed and compared to previous results. The impact of the boundary conditions (pressure and temperature) to the retention, transport and sealing properties of the caprock material are evaluated. The interpretation of the obtained results is supported by an additional series of injection tests, this time in the micro-scale, the kinematics of which are observed and measured locally with in-situ x-ray tomogrpahy.

Time Block Preference

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

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Primary authors: STAVROPOULOU, Eleni (EPFL); Prof. LALOUI, Lyesse (EPFL)

Presenter: STAVROPOULOU, Eleni (EPFL)

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