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In situ study of 3D fluid fingering in porous media using X-ray Computed Tomography

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Carbon capture and storage (CCS) is recognized as one of the most effective technologies for reducing CO2 emissions in the short to medium term. This three-phase process that includes: (i) capture of CO2, (ii) transportation, and (iii) underground injection of CO2 into the geological formations for storage, has highlighted that subsurface energy technologies will play a central role in the transition towards a lower-carbon future. Carbone dioxide geo-sequestration into underground reservoirs is a promising solution to mitigate irregularities in energy production and consumption cycles. Thus, the knowledge of the CO2-induced interactions for CO2-brine-rock systems at elevated temperatures and pressures, as well as the hydro-mechanical properties of the reservoir, is a requirement for any secure operation of a storage site.
The interactions between the invading and the resident fluid can, under favorable conditions, induce local instabilities in the fluid migration patterns. In particular, inside a porous medium, multi-phase flow is controlled by several factors, including the characteristics of the porous medium and the fluid properties. Studies for such a complex three-dimensional phenomenon have predominantly been performed in two-dimensional laboratory settings. However, to understand and possibly control the micro-scale migration of fluid fingering in porous media, a set of 4D experiments is necessary.

In this context, a series of experiments are performed, focusing on the migration of two immiscible fluids, characterizing percolation modes, and fingering effects developing at different flow conditions. During this process, x-ray tomographies are acquired. The 3D tomographic reconstructed images provide unprecedented insight into the nature and complexity of hydro-mechanical processes happening within the rock mass. In particular, when considering the material's microstructure and the labyrinthine pore network, X-ray CT emerges as the most powerful NDT technique allowing real-time 3D characterization of the fingering patterns. The fast image acquisition and the high spatial resolution provided by the X-ray CT enable capturing the time-resolved volumes of the developing fluid interface in the pore space.

Time Block Preference

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

References

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