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Presentation of the new ICARE 4 set-up: principle and first results on the reactive-percolation experiments and modelling

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Carbon dioxide Capture and Storage (CCS) in deep geological formations has emerged over the past ten years as an important component of the portfolio of options for reducing greenhouse emissions.

However, more knowledge needs to be aquired about the CO_2-brine-rock interactions induced by the supercritical CO_2-injection, notably potential dissolution/precipitation processes occurring in the host rock and their effects on the fluid-transport properties.

As the understanding and the quantification of such processes are of paramount importance to assess the feasibility and demonstrate the safety of the geological sequestration of CO_2, it is particularly relevant to have an experimental apparatus enabling to mimic the conditions occurring in the geological media, in terms of pressure, temperature, chemistry, flow rates and partial pressure of CO_2.

Therefore, a new experimental set-up, ICARE 4, has been built-up to perform reactive percolation experiments on rock specimens, in order to investigate the chemical reactions and modifications on the hydrodynamics properties, such as porosity and permeability, induced by the CO_2/brine/rock interactions.

The experimental protocol will be described, as well as the methodology and the analyses needed to quantify the effect of the CO_2 reactivity, i.e. the characterization of the rock specimen before and after the percolation.

First results, obtained on calcareous sandstone and on fluvial sandstones will be presented. A monitoring of the permeability/porosity changes linked to the precipitation/dissolution reactions as well as the chemical evolution of the outlet fluids was done. A test of isotopic tracing using the $\delta^{13}C$ (dissolved CO_2) fingerprints of the outlet fluids has also been performed; it demonstrates the interest of using isotopic tracers to complete the informations given by the reactive percolation experiment and to isotopically monitor the precipitation/dissolution processes.

A comparison between experimental and modelling results has also been performed using a reactive-transport numerical tool TOUGHREACT.

The modelling of the CO_2-saturated brine's injection through a rock specimen has highlighted a good matching between the measured and modelled poroperm properties changes in response to the CO_2 reactivity.