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Laboratory-scale interaction between CO_2-rich brine and carbonate reservoir rocks under supercritical conditions

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A test site for a prospective CO_2 reservoir, situated in Hontomín (northern Spain), is composed of limestones/dolostones (calcite and dolomite) and sandstones (66 wt-% calcite, 21 wt-% quartz and 6.5 wt-% of microcline). CO_2 injection at depth will cause formation of CO_2-rich acid brines, which will likely promote the dissolution of carbonate minerals (calcite and dolomite). Since the brine contains sulfate, gypsum (or anhydrite at depth) will precipitate, which may cover the surface of the dissolving carbonate causing its passivation. These reactions imply changes in porosity and in the structure of pores in the repository rocks. Therefore, changes in permeability and fluid flow are expected. Laboratory experiments at different pCO_2 (atmospheric to 80 bar) and temperature (25 to 60 °C) are carried out to measure the progress of these reactions and the effect exerted on the porosity and permeability of these rocks.

A preliminary set of percolation experiments with limestone and sandstone cores showed that permeabilities were extremely small (<1e-18 m2), not allowing the injection of the solutions through the cores. Therefore, it was decided to use fractured rock cores for the experiments. Synthetic fractures were created by sawing the rock cores.

A second set of experiments, using the fractured cores, was performed under CO_2 supercritical conditions (pCO_2 = 8 MPa and T = 60 °C). Two different synthetic brines (one sulphate-free and another one sulphate-rich nearly equilibrated with respect to gypsum) were injected at different flow rates (0.2 to 60 mL/h). In the fractured sandstone cores, initial fracture permeability was found to be 1e-12 m2. As the synthetic brines circulated through the fracture, the permeability increased rapidly. This increase suggests that significant calcite cement dissolution was taking place. X-ray microtomography (mCT) examinations of the reacted cores are under way and are expected to reveal if calcite dissolution (and gypsum/anhydrite precipitation) along the fracture could originate preferential paths (wormholes) responsible for the rapid increase in permeability.

In the fractured limestone cores, fracture permeability was also initially high and remained that way from the very beginning of brine injection. Calcite dissolution in this rock must be considerable. mCT examinations are also under way to investigate the changes in porosity and permeability.