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Experimental study of the hydrogeochemical properties of the Hontomin cap rock under CO_2 supercritical conditions

Jordi Cama, Josep M. Soler, Gabriela Davila, and Linda Luquot
Institute of Environmental Assessment and Water Research, Barcelona, Catalonia, Spain (jordi.cama@idaea.csic.es)

Gabriela Dávila, Linda Luquot, Jordi Cama and Josep M. Soler

Departament de Geociències, Institut de Diagnosi Ambiental i Estudis de l'Aigua (IDAEA), CSIC, Barcelona 08034.

The main cap rock for CO_2 injection at the PDT Hontomin site (Spain) is a marly shale made up of calcite (56 %), quartz (21%), illite (17%) clinochlore (3%) and others (albite, gypsum, anhydrite, pyrite) (∼3%). Contact with CO_2-rich acid brines may induce the dissolution of these minerals. Since the brine contains sulfate, gypsum (or anhydrite at depth) may precipitate, which may coat the surface of the dissolving calcite grains and cause their passivation. These mineral reactions will also induce changes in porosity and permeability. Percolation laboratory experiments with Hontomin shale rock cores under controlled pCO_2 (8 MPa) are being performed to quantify these processes.

In mechanically fractured cores (7.5 mm in diameter and 18 mm in length), two synthetic brines (a sulfate-free solution and a version of the Hontomin formation brine (sulfate solution)) were injected into the rock at constant flow rates (0.2, 1 and 60 mL/h) under CO_2 supercritical conditions (pCO_2 = 8 MPa and T = 60 °C). As the pH of the injecting brines in equilibrium with a pCO_2 of 8 MPa is acidic (∼3), it was observed that in the case of the sulfate-free brine experiments, the main processes that yield variation in the hydrodynamic behavior of the fractured rock was the dissolution of calcite, Si-bearing minerals, clinochlore and pyrite. In the sulfate-rich brine experiments, the dissolution of calcite and Si-bearing minerals also occurred, together with gypsum precipitation in the experiments run at low flow rates. As a result, initial fracture permeability tends (i) to stabilize or increase when the cap rock interacts with the sulfate-free brine and (ii) to decrease as the rock interacts with the sulfate-rich brine.

The interpretation (reactive transport modeling) of the changes in mineralogy and solution composition, together with the analysis of the changes in physical properties (porosity and permeability), will provide valuable information (e.g., kinetic parameters such as mineral surface area) required in the performance assessment of a CO_2 sequestration plant.