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Experimental and modeling study of the hydrogeochemical properties of the Hontomin main reservoir rock under CO_2 subcritical conditions

J. Cama (1), M. Garcia-Rios (2), J.M. Soler (1), and G. Dávila (1)

(1) Institute of Environmental Assessment and Water Research (jordi.cama@idaea.csic.es), (2) Fundación Ciudad de la Energía

The main reservoir rock for CO_2 injection at the PDT Hontomin site (Spain) is a vuggy limestone made up of calcite ($\sim$97 %) and dolomite ($\sim$1%). Contact with CO_2-rich acid brines will induce the dissolution of carbonate minerals. Since the brine contains sulfate, gypsum (or anhydrite at depth) will precipitate, which may coat the surface of the dissolving carbonate grains and cause their passivation. These mineral reactions will also induce changes in porosity and permeability. Two types of laboratory experiments under controlled pCO_2 (initially up to 40 bar) are being performed to quantify these processes: columns filled with crushed carbonate grains of calcite or dolomite (size of 1-2 mm) and Hontomin limestone rock cores.

Under subcritical pCO_2 the experimental results of the column experiments indicate that calcite/dolomite dissolution and gypsum precipitation are the dominant processes involved. Dedolomitization (mole per mole replacement of dolomite by calcite) is a negligible process in these experiments.

In a core plug test, a synthetic version of the Hontomin formation brine was injected into the rock (35.15 mm in diameter and 66 mm in length). A constant hydraulic gradient of 0.5 MPa between both ends of the core (4 – 3.5 MPa) was used. Confining lateral and axial pressure was 10 MPa. Temperature was 40 C. As the pH of the injecting brine in equilibrium with a PCO_2 of 4 MPa is acidic ($\sim$3), it was observed that the main process that yields variation in the hydrodynamic behavior of the rock was the dissolution of mineral carbonates, yielding an increase in the flow rate and initial permeability.

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.