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Coupled Geochemical-geomechanical Processes in CO2 Storage Reservoirs

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Geologic CO2 sequestration is a promising means of reducing atmospheric CO2 emissions. At the interface between the scCO2 and formation brine, CO2 will dissolve into formation brine, lowering formation pH and creating conditions favorable for mineral reactions. These reactions may alter the porosity, permeability, and stiffness of the formation, impacting injectivity and reservoir security. However, the rate, extent, and impacts of mineral trapping on formation properties is not well understood. The objectives of this work are to experimentally measure mineral dissolution rates and changes in porosity, permeability, and stiffness in core samples mimicking CO2 sequestration systems. We conducted core flood experiments in a custom-built triaxial core holder with in-situ acoustic measurement capabilities at temperature of 50˚C and pressure of 100 bar. Representative reservoir rocks, here sandstone samples with high porosity and permeability, were tested in this study. During the experiments, the aqueous effluent samples were periodically collected, and their composition were measured using ICP-MS. Ion concentrations were used to infer column scale mineral dissolution rates and the evolution of mineral volume fractions. The pressure at the core inlet and outlet were continuously monitored and used to infer changes in the permeability of the core sample as reactions progress. Changes in the material stiffness was measured using acoustic wave velocities. These changes in stiffness can be correlated to changes in the mineral volume fractions and degradation of sample cementation. Before and after the experiments, 3D images of the core samples were captured via X-ray Computed Tomography to determine the changes in porosity. Reactive transport and geomechanical simulations were developed based on the experimental system. Reactive transport simulations were performed to seek to match the observed ion concentrations. Geomechanical simulations were performed to examine the effects of changes in the mineral volume fractions on the material stiffness and compare these with the measured changes from the experiments.

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References

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Participation

Online

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