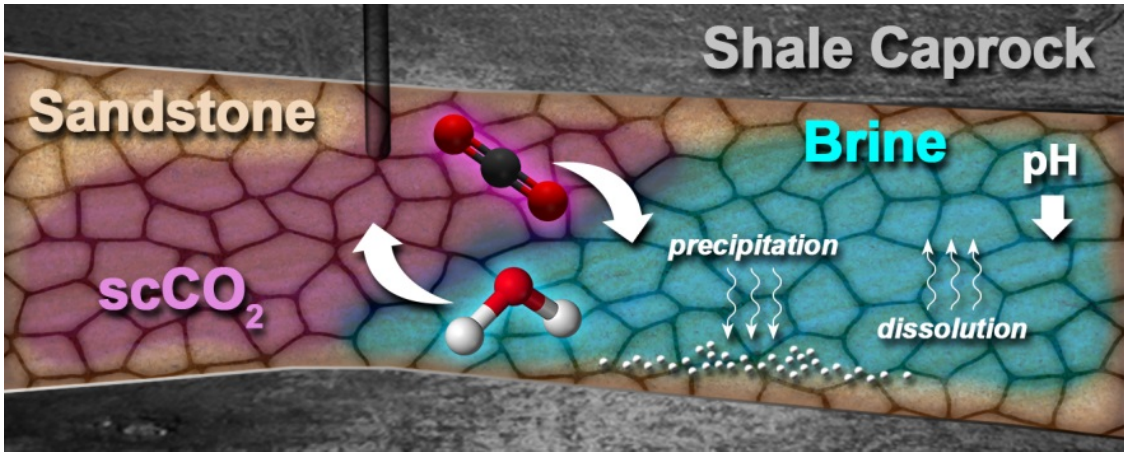

More on carbon dioxide injection at the Frio-I Brine Pilot

Ilgen A. G. and Cygan R.T. (2016) Mineral Dissolution and Precipitation during CO2 Injection at the Frio-I Brine Pilot: Geochemical modeling and Uncertainty Analysis. International Journal of Greenhouse Gas Control, 44, pp. 166-174. DOI: 10.1016/j.ijggc.2015.11.022

The Science

During the Frio-I Brine Pilot CO_2 injection experiment in Texas, in 2004, distinct geochemical changes in response to the injection of 1600 tons of carbon dioxide were recorded in brine samples collected from the monitoring well. We used geochemical modeling to quantify mineral dissolution and precipitation on the time scale of the field test (10 days) and long-term storage (1000 years). The relatively low reactivity of the Frio "C" mineral assemblage causes geochemical reactions in this system to have minimal impact on total porosity, and therefore should have a minimal impact on injectivity and long-term trapping.

The Impact

This study provides insight on the impact of geochemical reactions on injectivity and long-term trapping, and can guide potential site selection based on the geochemistry of the site.

Summary

Capture and geological carbon storage, particularly in deep permeable saline formations, is a potential method for decreasing atmospheric carbon dioxide (CO_2). Natural CO_2 gas fields can retain CO_2 on geologic time scales. So what does it take to store CO_2 in the subsurface? Crucial features of these reservoirs are sufficient porosity to accommodate the required volumes of CO_2, and continuous impermeable cap rock. Deep saline reservoirs are therefore among the top candidate formations considered for the geological storage of CO_2.

The injection of CO_2 into a reservoir stimulates a geochemical response mostly driven by acidification of the parent brine due to CO_2 dissolution. For some potential CO_2 storage reservoirs, dissolution and secondary mineral precipitation triggered by the injection of CO_2 would control the long-term changes in porosity and permeability, and could potentially impact the integrity of cap rock and the security of CO_2 storage.

Scientists from the Center for Frontiers of Subsurface Energy Security, an Energy Frontier Research Center, used geochemical data collected during the Frio-I Pilot CO_2 injection field test to quantify the extent of geochemical reactions during the test, and construct a predictive model for 1000 years after the injection.

Based on the geochemical models and data, the short-term effect of the CO_2 injection was dissolution of calcite and iron oxide minerals, amounting to ~ 0.02 wt. % loss of the reservoir rock mass; however; since the Frio C sandstone has a relatively unreactive mineral assemblage, only minor mineralogical changes are predicted during the first 1000 years of storage. In particular, minor carbonate and clay mineral precipitation in the Frio Formation "C" sandstone is expected as the system progresses towards chemical equilibrium during a 1000 year period, with no significant effects on the overall reservoir porosity.

This geochemical modeling study highlights potential sources of ions mobilized due to injection of CO_2 in a subsurface reservoir, and includes an analysis of uncertainties in mineral dissolution rates and their impact on CO_2 sequestration in saline reservoirs. Geochemical models can provide insight on the impact of geochemical reactions on injectivity and long-term trapping, and can guide potential site selection based on the geochemistry of the site.

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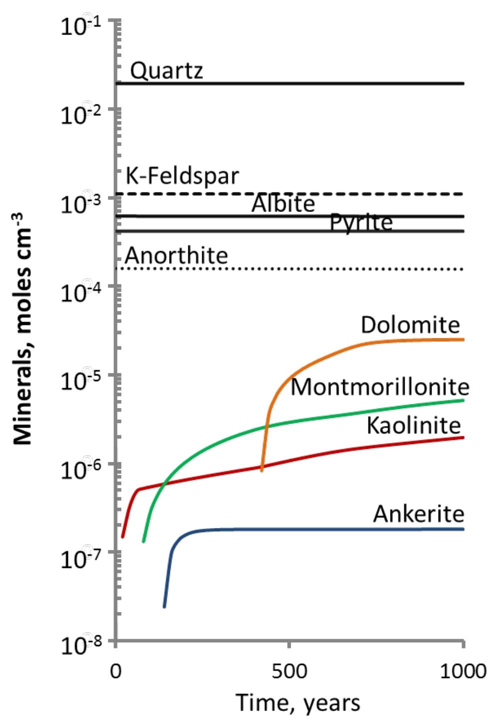

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Reactive flow model for Frio "C" reservoir predicts that during 1000 years of CO_2 storage clay minerals kaolinite and montmorillonite, and carbonates dolomite and ankerite will precipitate.