

Introduction to CO₂ Storage

Carbon dioxide storage in subsurface geologic formations is one option to reduce significant levels of CO₂ emitted to the atmosphere. Fundamental science and engineering principles indicate that such systems should be feasible and safe: the energy cost of preparing CO₂ for injection can be as low as a few percent of the heating value of the original fuel; and the very existence of oil and gas reservoirs is proof that buoyant fluids can be contained in the subsurface for millions of years. Carbon dioxide has been injected safely into subsurface reservoirs for many years for enhanced oil recovery. However, long-term CO₂ storage does carry a risk of possible leaks to the atmosphere. The costs and risks are not insurmountable, but research is required to make these concepts economically and technologically feasible.

GCEP-funded scientists are investigating a range of research concepts in CO₂ storage, from rock characterization in the presence of CO₂ to simulations, models and theory that predict and monitor fluid flow. The following three GCEP research activities are taking place in the area of CO₂ Storage.

Professors Gary Mavko of Stanford University and Andreas Luttge of Rice University are leading a research effort on “Linking Chemical and Physical Effects of CO₂ Injection to Geophysical Parameters”. This project aims to demonstrate techniques for quantitatively predicting the combined seismic signatures of CO₂ saturation, chemical changes to the rock face, and pore pressure. The Stanford team reported on the laboratory measurements for ultrasonic monitoring of rock changes associated with CO₂. Future work on rock physics modeling will provide better understanding of the seismic signatures of CO₂ saturation, as well as chemical changes to the rock frame. Meanwhile the team at Rice University is using measurement and simulation to develop models that can help to bridge the gap between laboratory and field geochemical observations.

Katharine Maher and co-investigators Dennis Bird and Gordon Brown from Stanford University are looking into the “Reactivity of CO₂ in the Subsurface”. They are investigating a range of homogeneous and heterogeneous reactions that occur as a result of the injection of CO₂ into several different underground environments. The goal of the research is to predict and manipulate reservoir reactivity and reaction products during emplacement of CO₂. Key findings from the experimental work in their progress report suggest that carbonate precipitation may not be rate-limiting as recent studies suggest, and they have been able to manipulate the reactivity in the subsurface to significantly increase the rate of carbonate formation. The next step is to work on mineral carbonation experiments, natural analogues for carbonation, mineral and carbon transformations, and synthesis and modeling.

Professor Sally Benson’s team continues to study the fundamental science behind the long-term fate and trapping of CO₂ storage in saline aquifers. They conduct experimental investigations and numerical simulations to address important questions about multiphase flow theory needed to reliably predict field-scale performance. Their progress so far this year has led to five publications and progress on CO₂ and brine flow

simulations in systems with strong capillary heterogeneity.