Introduction to CO_2 Storage

Carbon dioxide storage in subsurface geologic formations is one option to reduce significant levels of CO_2 emitted to the atmosphere. Fundamental science and engineering principles indicate that such systems should be feasible and safe: the energy cost of preparing CO_2 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 CO_2 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 CO_2 storage, from rock characterization in the presence of CO_2 to simulations, models and theory that predict and monitor fluid flow. The following three GCEP research activities are taking place in the area of CO_2 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 CO``` Injection to Geophysical Parameters”. This project aims to demonstrate techniques for quantitatively predicting the combined seismic signatures of CO_2 saturation, chemical changes to the rock face, and pore pressure. The team has developed “a new model of the relationship between complex valued P-wave modulus and water saturation by considering the scale of fluid distribution, from the viewpoint of the effect of mesoscopic wave-induced fluid flow on a rock saturated with multiple-phase fluids.”

Katharine Maher and co-investigators Dennis Bird and Gordon Brown from Stanford University are looking into the “Reactivity of CO_2 in the Subsurface”. They are investigating a range of homogeneous and heterogeneous reactions that occur as a result of the injection of CO_2 into several different underground environments. The goal of the research is to predict and manipulate reservoir reactivity and reaction products during emplacement of CO_2. Key findings from the experimental work 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. This year the group is studying natural analogues of mineral carbonation with field experiments in Red Mountain, California and Iceland.

Professor Sally Benson’s team continues to study the fundamental science behind the long-term fate and trapping of CO_2 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 six publications and submissions on CO_2 and brine flow simulations in porous media.