A Coupled Geomechanical, Acoustic, Transport, and Sorption Study of Caprock

Award Number: DE-FE0023223

Project Summary:

This project worked to develop a further understanding of how shales respond to carbon dioxide (CO_2)-induced deformation and reactions. Research was conducted to quantify CO_2 transmissivity and the development of acoustic methods for detecting damage to CO_2-saturated caprock through in-situ experimental studies of shale. This project provided tools to identify damaged shale caprock and a means of determining if CO_2 has migrated through the caprock.

Figure 1: A diagram of the triaxial coreflood test system. The system allows for caprock samples to be analyzed under simulated real-world pressures and temperatures. The system has integrated X-ray tomography and acoustics to allow for direct measurement of the conditions of mechanical failure and permeability of damage to shale resulting from brine and CO_2.

Prime Performer:
Colorado School of Mines

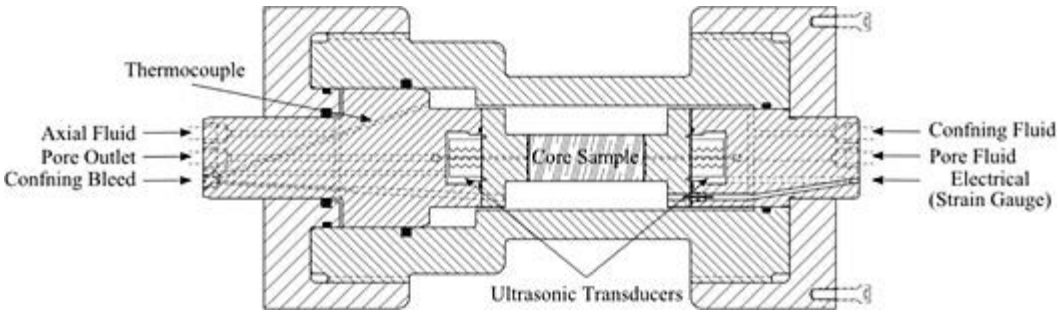
Key Performers:
Los Alamos National Laboratory

Principal Investigator:
Dr. Manika Prasad

Project Duration:
10/1/2014 – 9/30/2018

Performer Location:
Golden, Colorado

Program:
Carbon Storage



Project Outcomes:

This project carried out laboratory studies, including sorption capacity measurements, nuclear magnetic resonance (NMR) measurements during CO_2 injection, and permeability measurements on fractured shale cores from the Utica Shale, to improve understanding of the factors affecting the ability of shales to provide protection against leakage. Results can be used to quantify the potential for mitigation of CO_2 leakage by sorption in shale caprocks, detect CO_2 infiltration into shales, and assess the potential for leakage due to fracture of shale caprocks. Other laboratory experiments measured pore size distribution and specific surface area by injecting three types of vapor gases (nitrogen, hexane, and water) into dry and wet types of clay-rich shales and organic-rich shales. Results imply that the same type of shale can, at low pressure, develop permeable fracture systems while, at high pressure, can show substantial resilience to deformation. Thus, caprock behavior can depend critically on depth. The project studied the ability of seismic technology to understand and detect caprock damage, integrated the findings to develop protocols for shale characterization and developed guidelines for assessing sealing capacity of damaged caprock.

Presentations, Papers, and Publications

Final Report: A Coupled Geomechanical, Acoustic, Transport and Sorption Study of Caprock Integrity in CO_2 Sequestration (November 2014) – Manika Prasad and Bill Carey