Quantitative Characterization of Impacts of Coupled Geomechanics and Flow on Safe Permanent Geological Storage of Carbon Dioxide (CO_2) in Fractured Reservoirs

Award Number: DE-FE0023305

Project Summary:

The primary objective of this project was to develop a quantitative approach for understanding and predicting geomechanical effects on large-scale carbon dioxide (CO_2) injection, flow, and long-term storage in the subsurface. The project studied injection pressure-induced rock deformation and fracturing processes by combining laboratory studies and coupled flow-geomechanics modeling. The findings were incorporated into the high-performance TOUGH2-CSM simulator and other specialized coupled geomechanics modeling tools to develop tools for modeling CO_2 injection-induced rock mechanical processes associated with CO_2 storage in reservoirs to quantify flow, storage, and potential leakage pathways as well as remediation measures.

Prime Performer:
Colorado School of Mines

Principal Investigator:
Dr. Yu-Shu Wu

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

Performer Location:
Golden, Colorado

Program:
Carbon Storage

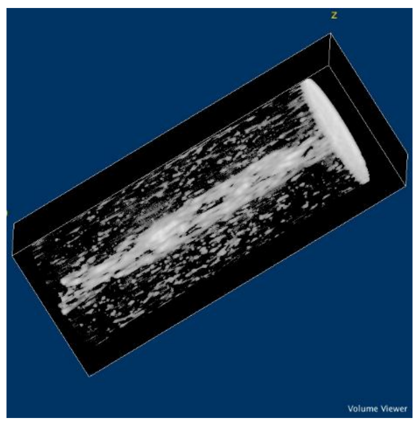

Figure 1: X-ray CT scan of a rock sample.

Project Outcomes:

Researchers conducted laboratory testing on the effects of geomechanics on CO_2 flow and transport properties in fractured rocks and on CO_2 and brine injection-induced fracturing. These studies found that the breakdown pressure for CO_2-induced fracturing was generally around the minimum horizontal stress, i.e., tensile strength was not important; the breakdown pressure for brine induced fracturing was generally greater than that for CO_2; and fracture orientation is mostly dominated by confining stress. Researchers also developed and validated CO_2 flow and geomechanics-coupled models for modeling fracture growth by implementing approaches for modeling fracture propagation into the existing multiphase flow and geomechanics simulators, TOUGH2-CSM and TOUGH-FLAC. This work represents a significant advance in modeling fracture propagation in porous and fractured media. Finally, researchers developed an inverse model to determine leakage location when an induced leakage occurs in a reservoir. While not the major emphasis of the project, the model was also successful in determining leakage location, which was based on changes in the pressure field resulting from this leakage. An opportunity exists for further research in this area.

Presentations, Papers, and Publications

Final Report: Quantitative Characterization of Impacts of Coupled Geomechanics and Flow on Safe and Permanent Geological Storage of CO_2 in Fractured Aquifers (December 2018) – Philip Winterfeld, Yu-Shu Wu, Timothy Kneafsey