the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Analysis of Potential Leakage Pathways and Mineralization in Caprocks for Geologic Storage of CO_2

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

DOE is partnering with Utah State University (USU) to conduct research and training to examine the nature and extent of caprock integrity on CO_2 sequestration. The effort will analyze the integrity of caprock in exhumed (unearthed) analogs of CO_2 flow systems in order to determine the extent of CO_2 flow in leakage scenarios resulting from the presence of fractures or faults. Suitable geologic storage formations typically possess the ability to retain injected CO_2 due to low-permeability confining layers (caprock) throughout more shallow formations that prevent upward CO_2 movement. Under normal circumstances, one molecule of CO_2 would require an extremely long time period (hundreds of thousands to a million years depending on caprock thickness) to travel through one caprock layer by diffusion alone. However, faulting or fracturing of the caprock layer could allow accelerated CO_2 transport to shallower formations, including drinking water sources.

The study will help constrain risk-based assessments and provide further insight into the design of sequestration projects. USU is examining a series of fractured and

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PARTNERS

None

faulted shales and mudrocks, some of which were taken from pilot CO_2 storage sites in the Colorado Plateau region of Utah. All field work will be conducted at four separate field sites at which USU has worked in the past.

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2012

COST

Total Project Value

$299,930

DOE/Non-DOE Share

$299,930/$0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

Goals/Objectives

The goal of the project is to educate and train students in the science and technology of carbon capture and storage, with a focus on geologic storage. The objective of the project is to investigate the integrity of caprock in exhumed analogs of CO_2 flow systems in order to determine the processes by which CO_2 may flow and bypass sealing rock. USU is focusing on the presence of fractures or faults in caprock, as they are one of the key features that may lead to seal failure.

Primary project objectives include:

- Determining the nature of the caprock formation and early-stage growth of fractures in low-permeability shales and mudstones.
- Determining and characterizing key conditions that affect CO_2 flow through fractures/faults in caprock formations at time scales relevant for CO_2 injection and migration.
- Assessing the mechanisms that diminish or improve sealing quality of fractures/faults in seals.
- Building simple geometric and geostatistical models to determine the distribution of fractures, faults, and their relationships to CO_2 flow and /or mineralization within the rocks.

Benefits

The overall results of the project will make a vital contribution to the scientific, technical, and institutional knowledge necessary to establish frameworks for the development of commercial-scale CCS. The project will provide an added benefit of improving scientific understanding of the impacts of natural or induced small and large-scale fractures or faults in mudstone, shale, and siltstone seals on CO_2 flow. Further, the project provides opportunities for students to learn methods used to conduct geologic analyses for determining the suitability of future carbon sequestration sites, gain experience with methods used to develop and run models to assess the fate of CO_2 in the subsurface, and investigate the key aspects of assessing the processes and risks of caprock breach and mitigation in a sequestration site.

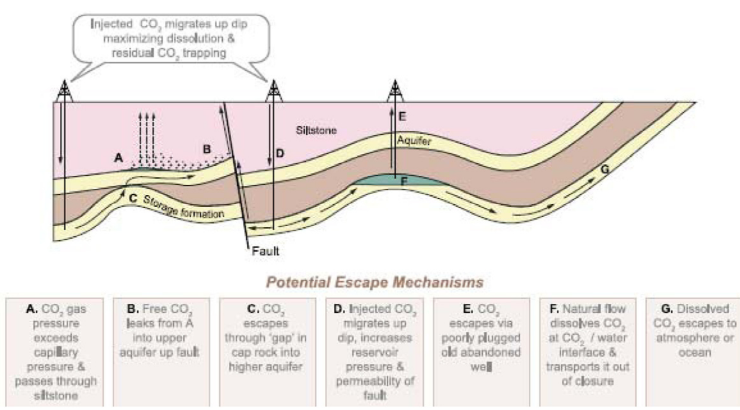

Figure 1. Potential leakage pathways envisioned by the Intergovernmental Panel on Climate Change (IPCC) neglect the effect of fracture networks in caprock.

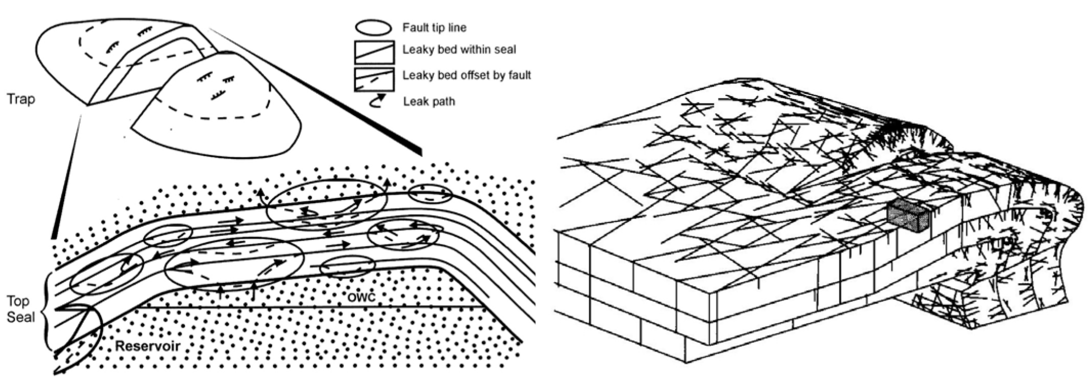

Figure 2: Schematic view of seal bypass systems envisioned for petroleum systems. Left frame shows fracture-linked leak path and complex fracture networks. The right frame shows fractures induced during different segment folding.