the ENERGY lab

PROJECT FACTS

Carbon Sequestration

# Numerical Modeling of Geomechanical Processes Related to $CO_2$ Injection within Generic Reservoirs

## 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

NETL is partnering with the Missouri University of Science and Technology to conduct research and training to model potential $CO_2$ leakage through caprock (seal) and well penetrations by developing multi-scale models of different geological settings for sequestration sites and comparing the results with geomechanical processes. Successful CCS depends on minimizing the risk of $CO_2$ leakage through caprock and fracture networks in formations above the target $CO_2$ storage formation. Low-permeability formations located above the target $CO_2$ injection formation can act as a seal and prevent the upward migration of $CO_2$ into other formations or its escape into the atmosphere. The effort will focus on how fluid pressure induces rock deformation, how faults and fractures affect fluid migration, as well as on critical wellbore placement and wellbore integrity.

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## PARTNERS

None



U.S. DEPARTMENT OF ENERGY

## PROJECT DURATION

**Start Date**
12/01/2009

**End Date**
11/30/2012

## COST

**Total Project Value**
$317,938

**DOE/Non-DOE Share**
$299,114/$18,824

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

The project will provide graduate and undergraduate students with the skills needed to develop generic, two-dimensional (2-D) and three-dimensional (3-D) finite element (FE) models of sequestration sites based on different geological settings and boundary conditions. Students will be trained to analyze the influence of different geological settings under varying boundary conditions on induced fractures and to analyze the influence of these fractures on fluid migration. Further, 3-D models of wellbore scale size will be used to address problems related to optimal drilling sites, directions, and wellbore integrity.

## Goals/Objectives

The main objective of the project is to train graduate students to develop multi-scale FE models of different geological settings and study the effects of $CO_2$ injection related pore pressure increases on geomechanical processes. The results will demonstrate how fracture and fluid flow, as well as wellbore integrity, are dependent on a variety of changing input parameters such as geometry, loading conditions, and material properties.

## Benefits

The overall result 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 help to develop a well-trained future generation of geologists, scientists, and engineers that have the skills needed to implement commercial-scale CCS technologies. Further, it will provide a more thorough understanding of how reservoir geometry affects wellbore, formation, and caprock stability, thus facilitating future site selection efforts.

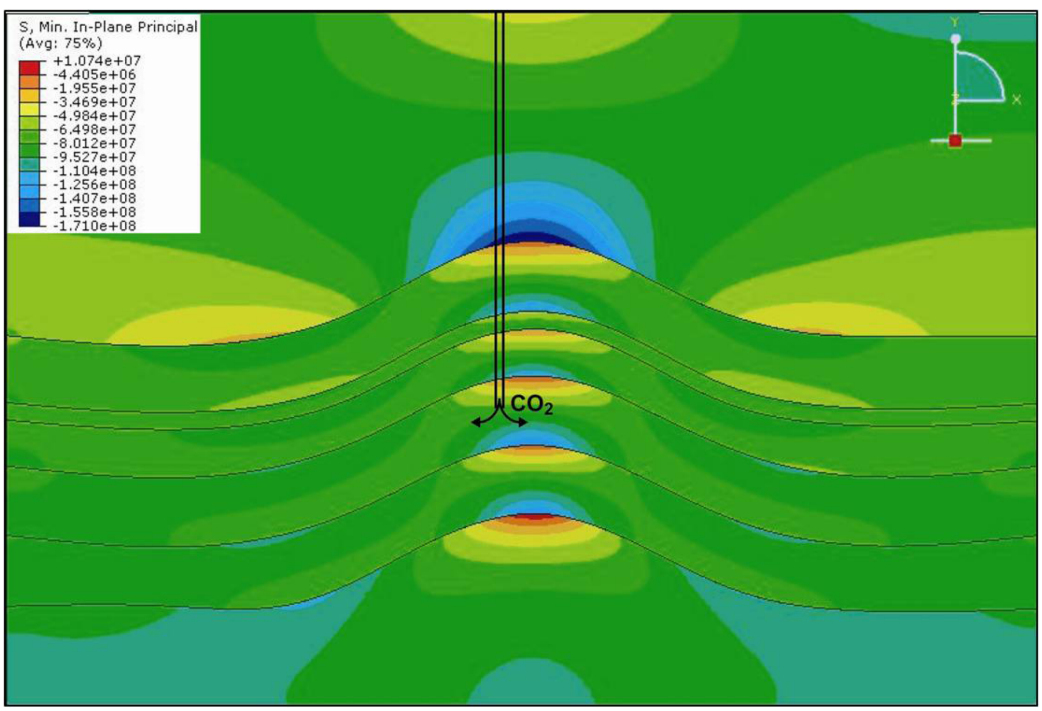


*Figure 1. Principal stresses associated to an anticline structure change from compressional stresses (blue contours) to tensional stresses (red contours) within each layer. The $CO_2$ injection related pore pressure increase will result in different failure types for the various regions of the anticline structure.*