the ENERGY lab

PROJECT FACTS

Carbon Sequestration

# Training Graduate and Undergraduate Students in Simulation and Risk Assessment for Carbon Sequestration

## 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 poten-tial 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 Colorado School of Mines to conduct research and training in the area of "Simulation and Risk Assessment" associated with geologic carbon sequestration (GCS) to advance state-of-the-art CCS science. CCS simulation and risk assessment is used to develop advanced numerical simulation models of the subsurface to forecast $CO_2$ behavior and transport; optimize site operational practices; ensure site safety; and refine site monitoring, verification, and accounting efforts. Results can be integrated to provide an assessment of site technical and programmatic risks. As the simulation models are refined with new data, the uncertainty surrounding the identified risks decreases, thereby providing a more reliable risk assessment.

This laboratory project will focus on the risks associated with potential leakage of injected $CO_2$ and the pore-scale geochemical process associated with injectivity of $CO_2$, such as mineral reactivity and multiphase flow. Model simulations will identify high and low risk leakage scenarios by linking (Figure 1):

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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**

$414,948

**DOE/Non-DOE Share**

$299,997/$114,951

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

- Heterogeneous subsurface flow and contaminant transport.
- Possible capture in one or more downgradient receptors (wells).
- Water delivery system to many different households.
- Potential household exposure and health risk via multiple pathways.

Laboratory experiments will focus on the geochemical processes that occur as $CO_2$ is injected into saline reservoir sequestration targets. These processes include decreases in pH, changes in ionic strength, and changes in permeability and porosity of the reservoir and caprock. A quantitative model will be developed to better understand fundamental processes and will lead to a more robust conceptual model and tools useful for design and risk mitigation of CCS projects.

## Goals/Objectives

The goal of this project is to train graduate and undergraduate students and advance the science in two critical areas of risk assessment:

- Multi-process, reservoir-scale characterization and model simulation of health risks associated with leakage into overlying aquifers.
- Pore-scale geochemical processes in $CO_2$ sequestration related to injectivity and storage, including mineral reactivity and multiphase fluid reactions, needed to assess the likelihood of a successful sequestration effort.

## Benefits

Overall 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. Results from this project will lead to better informed risk assessments associated with geologic carbon storage and advance the scientific understanding of hydrogeochemical processes at multiple scales. The benefits to the DOE include advancing technological options to reduce greenhouse gas emissions and, in turn, to address climate-change mitigation; enabling two university professors to develop sustainable research programs in CCS science; enabling one post-doctoral research scientist to begin a career in CCS science; and producing two highly trained graduate scientists/engineers. These engineers, in turn, will be available to work in areas relevant to DOE goals for CCS projects, and to provide introductory classroom training to approximately 50 graduate and undergraduate students who will gain a firm grasp of the principles related to GCS.

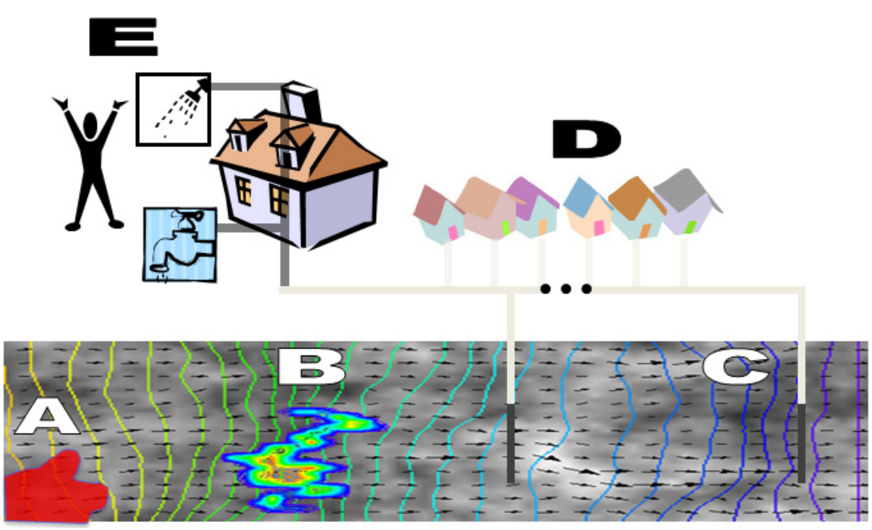


*Figure 1. Risk assessment model will link (A) $CO_2$ leakage and dissolution of metals; (B) heterogeneous subsurface flow and transport of metals; (C) capture in one or more down gradient wells; (D) water delivery system to many different households; and (E) household exposure and health risk to varying individuals. (Modified from Maxwell et al. WRR34 (4),1998; Maxwell and Kastenberg, SERRA13 (1-2), 1999).*