the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Geologic Sequestration Training and Research

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 University of Alabama at Birmingham (UAB) to conduct research and education in geologic carbon sequestration, in an effort to expand the number of engineering graduates trained in both the theory and practice of CCS. UAB will conduct research on determination of the minimum capillary displacement pressure of seal layer samples obtained from the Southeast Regional Carbon Sequestration Partnership (SECARB) Phase II CO_2 Storage Pilot Test Program, the SECARB Phase III Anthropogenic CO_2 Test Program at the Citronelle Dome, north of Mobile, Alabama (Figure 1), and the Site Characterization project at Alabama Power Company's Plant Gorgas. The seal layers of interest are the Selma Chalk, the Washita-Fredericksburg Formation, and the Marine Shale of the Tuscaloosa Formation, located at depths ranging from 4,550 to 7,250 ft. The students' research will focus on the capacity and integrity of the seal layers using a triaxial core holder, nitrogen gas and supercritical CO_2, and brine samples collected from Citronelle Dome or prepared using existing composition data. The objective of the students' research will be to identify the most effective seals against potential upward migration of CO_2.

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U.S. DEPARTMENT OF ENERGY

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$344,940

DOE/Non-DOE Share
$299,940/$45,000

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

The students will expose the seal layer samples to CO_2-saturated brine and water-vapor saturated CO_2 for periods of a month or more. Changes in pH, concentrations of metal ions, carbonate ions, and bicarbonate ions will be monitored to determine the rates of rock matrix dissolution and the rates at which pores are filled by precipitation of ions from solution. Changes in absolute and relative permeability will be monitored. The students will examine the treated samples under a scanning electron microscope to determine the types of minerals dissolved, the solids precipitated, and the spatial distribution of changes in porosity.

Existing numerical models will be adapted by the students to simulate CO_2 injection into the candidate target formations. The models will have the capacity to determine CO_2 flow, diffusion, and chemical reactions in the subsurface. UAB will use site specific data (absolute permeability, effective permeability, displacement pressure, and brine chemistry) in developing the models, to better refine present estimates of the storage capacity of the candidate formations and determine the optimal spacing of injection wells required to accept CO_2 at various rates from a nearby coal-fired power plant. Sensitivity analyses will be performed to determine how the variation of input parameters affects the models' results.

UAB will also develop a new lecture course on coal combustion and gasification, climate change, and carbon sequestration. The first offering of this course will be Fall 2010. Based upon feedback from the students, the course will be refined and offered again in the fall of 2012.

Goals/Objectives

The primary objectives of the project are to engage engineering students in the process of evaluation of reservoirs for geologic carbon sequestration by a major electric utility, develop research protocols for assessment of confining layer integrity, and refine estimates of target formation storage capacity.

Benefits

The participation of students in the research and formal course work in the advanced undergraduate/graduate level course on coal combustion and gasification, climate change, and carbon sequestration will produce graduates well-versed in the many facets of fossil fuel utilization and its possible effects, and prepared to work on the implementation of carbon capture and sequestration at commercial scale. Overall, the project will make a vital contribution to the scientific, technical, and institutional knowledge necessary to establish frame-works for the development of commercial-scale CCS. The results from this research can be used to refine estimates of CO_2 pressures, storage capacity, CO_2 migration, and potential for CO_2 seepage, in the absence and presence of CO_2-brine-mineral reactions.

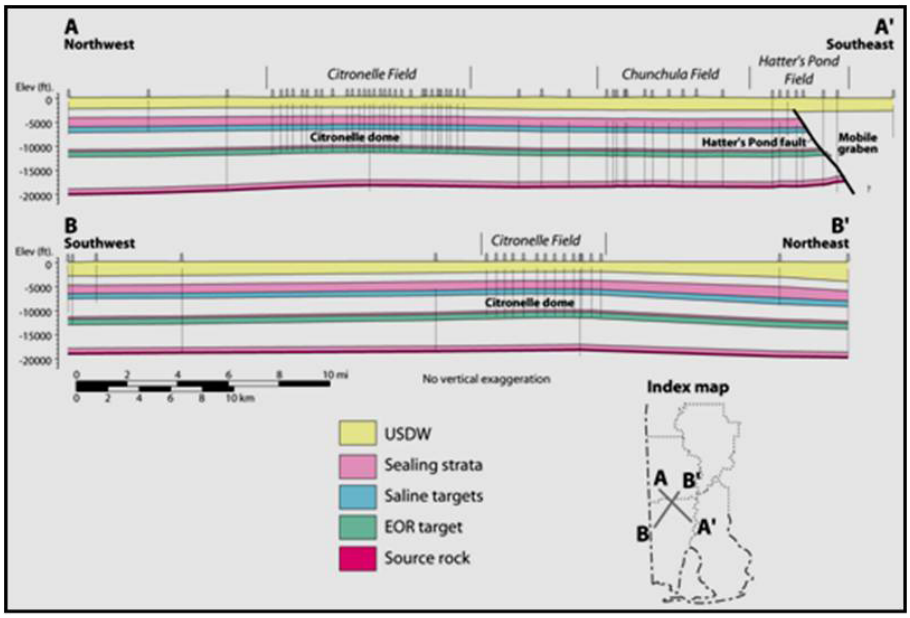

Figure 1. Cross sections of Citronelle Dome north of Mobile, Alabama, showing potential CO_2 storage formations ("Saline targets," in blue) and seal layers ("Sealing strata," in pink).