Geoscience Perspectives in Carbon Sequestration: Educational Training and Research through Classroom, Field, and Laboratory Investigations

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 (MU) to enhance its existing CCS training and research program, which offers courses in fundamental CCS topics related to the behavior of geologic systems for future application in the field of CCS (e.g., mineralogy, petrology, geochemistry, climate change, structural geology, sedimentology, and hydrology). MU appreciates the fact that the complexities of various physio-chemical reactions may affect the geologic storage of CO_2, and that a future work force of adequately trained environmental scientists and engineers is required to understand the various aspects of water-

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PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$360,796

DOE/Non-DOE Share
$299,590 / $61,206

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

CO_2-rock interactions. This project will fund a minimum of two graduate and two undergraduate students to research potential sequestration targets in the Midwest. Three geologic systems will be targeted as part of this study:

- **The Midcontinent Rift (MCR)-Western Arm** — A highly developed, but long inactive area of continental rifting in the central U.S.; it underlies sections of Indiana, Kansas, Minnesota, Nebraska, New Mexico, Oklahoma, and Texas. It is a classic triple-point rupture centered near present-day western Lake Superior.
- **The MCR-Eastern Arm** — Underlies sections of Kentucky, Michigan, and Ohio and contains a 157 foot thick sequence of poorly cemented and permeable sandstone.
- **The shallow Lamotte Sandstone** — Laterally equivalent to the Mt. Simon Formation of the Illinois Basin. The Lamotte grades laterally and vertically from an arkosic sandstone and conglomerate to a quartz arenite.

The project will include undergraduate student field trips with "hands-on" involvement, such as calibrating field instruments, recording field measurements, and collecting samples for follow-up laboratory work. The instruments include portable devices for measuring (1) pH-Eh-temperature, (2) conductivity, (3) water turbidity, (4) alkalinity, (5) Ca- and Mg-hardness, and (6) CO_2 gas flux. During the project, students will collect rock samples from field outcrops of the MCR sequence and the Lamotte Formation sandstones and overlying units. Drilled core samples from the MCR will be collected from core libraries of the Iowa, Kansas, and Kentucky State Geologic Surveys. These samples will be used to (1) conduct long-term carbon trapping and carbonate mineral formation experiments, (2) serve as the basis for dissolution process experiments to evaluate enhanced porosity and permeability, and (3) perform self-sealing repository fracture tests to evaluate reduced porosity and permeability.

Goals/Objectives

The objectives of the project include:

- Enhancing the undergraduate curriculum in geology and geochemistry through field trips that will expose undergraduate students to field studies so that they can investigate first-hand the behavior of CO_2 in natural settings and its influence on the environment.
- Supporting the fundamental research activities of a minimum of two graduate plus two undergraduate students who will develop expertise in water-CO_2-rock interactions.
- Acquiring both laboratory and portable field-based research equipment that will be utilized to achieve the previous listed objectives.

Benefits

Overall the project will make a vital contribution to the scientific, technical, and institutional knowledge needed to establish frameworks for the development of commercial-scale CCS. More specifically, the project will provide high-quality data to the scientific and engineering community that can be used to evaluate unique stratigraphic packages for CCS, carbon trapping in carbonate minerals, corrosion processes that may enhance porosity-permeability reactions at CO_2 gas injection sites, and self-induced or human-induced fracture sealing dynamics. Additionally, the project will identify unique repository horizons that have been discredited due to low porosity-permeability, identify minerals capable of trapping CO_2 for periods of geologic time, and evaluate potential self-sealing mechanisms for repository fractures.