the ENERGY lab

PROJECT FACTS

Carbon Storage - GSRA

The Potential Risks of Freshwater Aquifer Contamination with Geosequestration Simulation and Risk Assessment of Carbon Capture and Storage

Background

Fundamental and applied research on carbon capture, utilization and storage (CCUS) technologies is necessary in preparation for future commercial deployment. These technologies offer great potential for mitigating carbon dioxide (CO_2) emissions into the atmosphere without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCUS technical and non-technical disciplines 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 CCUS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL), through funding provided by the American Recovery and Reinvestment Act (ARRA) of 2009, manages 43 projects that received more than $12.7 million in funding. The focus of these projects has been to conduct geologic storage training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects 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 Duke University (Duke) to conduct research and training to advance CCUS in the area of simulation and risk assessment. Simulation and risk assessment for CCUS are used to forecast CO_2 behavior and transport; optimize site operational practices and ensure site safety; and refine site monitoring, verification, and accounting (MVA) efforts. This project will include collecting lithologic (rock/sediment) samples from shallow freshwater aquifers, situated above proposed CO_2 storage reservoirs, that produce water with high heavy metal content (defined as having greater than 10 percent of the Environmental Protection Agency (EPA) maximum recommended contaminant levels (MCLs) (Figure 1). Site-specific field data for the targeted aquifers will also be collected. This data could include hydraulic conductivity; storativity; hydraulic

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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

$299,918

DOE/Non-DOE Share

$299,918/$0

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

head of surrounding wells, lakes, and rivers; transmissivity; saturated thickness; aquitard properties; local precipitation; location, construction, and yield of any pumping and monitoring wells; and groundwater samples. Duke will simulate the impact of introducing CO_2 into a shallow freshwater aquifer and evaluate its effect on the heavy metal content of the aquifer. Bench tests will bubble CO_2 laden water through the lithologic samples and analyze the percolated water for heavy metals after different contact periods (Figure 2). This data will be used with industrystandard software and the field readings, to predict the extent of the impacted area if a CO_2 reservoir might leak.

Goals/Objectives

The primary objective of the DOE's Carbon Storage Program is to develop technologies to safely and permanently store CO_2 and reduce Greenhouse Gas (GHG) emissions without adversely affecting energy use or hindering economic growth. The Programmatic goals of Carbon Storage research are: (1) estimating CO_2 storage capacity in geologic formations; (2) demonstrating that 99 percent of injected CO_2 remains in the injection zone(s); (3) improving efficiency of storage operations; and (4) developing Best Practices Manuals (BPMs). The goal of the project is to understand how a potential CO_2 leak will affect waterrock interactions in freshwater aquifers in order to ensure better CO_2 storage permanence. Project objectives include:

- Estimating the subset of locations where relatively high levels of heavy metals may be most prevalent
- Identifying geochemical signatures in affected water which can be used as detection criteria.
- Determining the potential impact of CO2 which might not be contained in the target reservoir on water-rock interactions.
- Understanding the geographic, petrologic, and exposure-time dependence on these interactions.

Accomplishments

- As of March 2012, eight students had accumulated 2,416 training related hours under the program.
- Based on the initial year-long incubation, Duke has identified manganese, iron, and calcium (along with pH) as potential geochemical markers of a CO_2 leak. The concentrations of these elements increased within two weeks of exposure to CO_2.
- The project approached the one-year mark for the second set of incubations, continuing to monitor metals and other elements. Future plans include the altering of the reduction oxidation conditions of the incubations in the coming quarter.

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 CCUS. This research will result in a better understanding of how potential CO_2 leaks will influence water/rock interactions and groundwater chemistry outside of the CO_2 target reservoir and further demonstrate the value of CO_2 storage permanence within the subsurface. Additionally, the project will provide students an opportunity to develop vital skills relating to MVA technologies and aqueous chemistry that are required for the implementation of CCUS technologies on a commercial-scale.

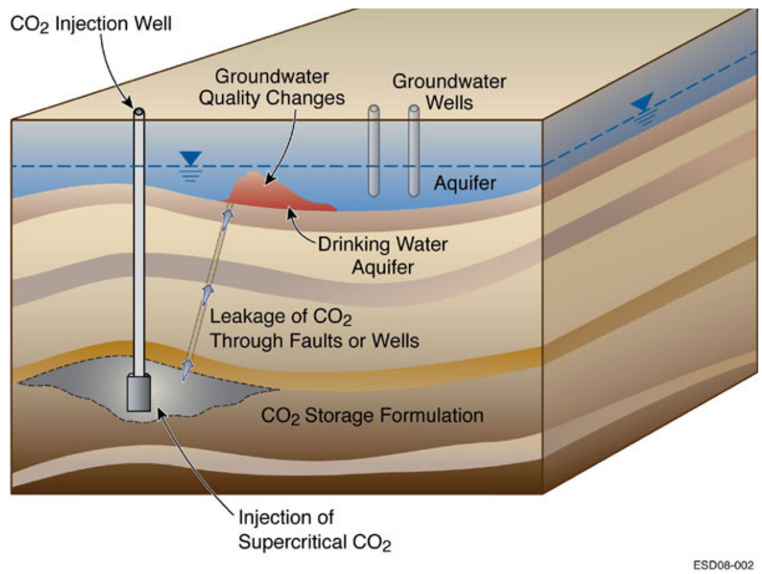

Figure 1. Schematic of the potential impact of leakage of injected CO_2 on groundwater quality. (Source: http://esd.lbl.gov/co2geostorage/research/CO2/co2_taska.html.)

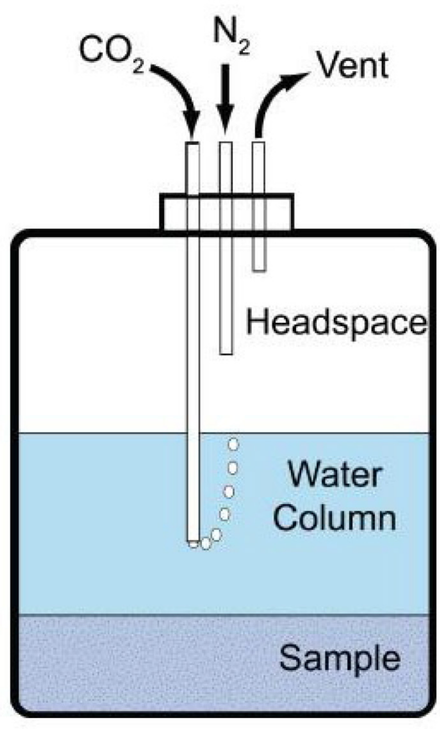

Figure 2: Duke's method for incubating sediments simulating a CO_2 leak in a range of redox conditions. Nitrogen provides a barrier in the headspace against the introduction of air. CO_2 is pumped into the system at a rate of approximately 0.2 liters per minute.

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