the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Modeling and Evaluation of Geophysical Methods for Monitoring and Tracking CO_2 Migration in the Subsurface

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

DOE is partnering with The Ohio State University (OSU) to conduct research that focuses on enhancing geophysical methods to better characterize geologic conditions and monitor the effects of CO_2 injection. To achieve substantial CO_2 emissions reductions via geologic storage of CO_2, thousands of large volume (> 1 million tons CO_2 injected) injection facilities having extremely low leakage rates will be required. Geophysical characterization and monitoring methods are necessary to gain a better understanding of geological processes at all scales, including understanding target reservoirs and caprock formations, which prevent the leakage of injected CO_2 into other formations.

Developed for use in petroleum exploration, subsurface seismic and electromagnetic techniques are the only remote detection methods that can provide a detailed image of the subsurface. The value and impact of this type of geophysical imaging lies in non-invasively (i.e., drilling holes) evaluating site geology and hydrology for changes in structural integrity, and to monitor changes in the CO_2 plume location before and after injection. OSU is testing and enhancing these methods through numerical simulation and physical modeling to provide a graphical user interface program through which previously developed numerical tests can be interfaced for the purpose of determining the optimum spatial distribution of boreholes for tracking a CO_2 plume.

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PARTNERS

None

U.S. DEPARTMENT OF ENERGY

PROJECT DURATION

Start Date

12/01/2009

End Date

11/30/2011

COST

Total Project Value

$299,936

DOE/Non-DOE Share

$299,936/$0

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

The primary scope of this research is to bridge a gap between graphical model building and seismic monitoring capabilities, thus providing opportunities to generate three dimensional (3-D) models (cross-hole and surface modes) for both electromagnetic and seismic methods. Formation density and seismic return velocity are the key parameters required for testing and modeling seismic measurements. Conductivity and electric permittivity of the geology and the injected CO_2 are critical parameters of the model variation for the electromagnetic measurements. The resultant models based on these data can then be visualized and analyzed to determine the detection limits for geophysical imaging, using high frequency electromagnetic and seismic measurements. These models will be capable of optimizing the spatial distribution of wellbores for CO_2 plume tracking based on site-specific geologic data. Ultimately, OSU will provide practical guidelines for use of geophysical imaging techniques at CO_2 injection sites, and provide easy to use geophysical evaluation tools for researchers and stakeholders.

During the project, OSU will develop a graphical user interface-program, including modules capable of assigning and manipulating geologic, seismic, and electromagnetic data for the purpose of optimizing project site monitoring, verification, and accounting (MVA) plans to track CO_2 plumes, particularly for borehole and well placement. Modeling results can be utilized to help aid the design of cross-hole, hole-to-surface, and geophysical surveys for the purpose of monitoring CO_2 injection sites. The interface program will be capable of determining the optimum number and location of wells necessary to approximate the extent of CO_2 plume migration given a plume migration scenario, and displaying the data in a three dimensional format. Once the interface is refined, OSU will apply the model to an injection site.

The project will support the thesis research of two graduate students.

Goals/Objectives

The main purpose of this investigation is to provide a quantifiable and verifiable means to establish geophysical methods for characterizing the background (pre-injection) geologic features of a CO_2 injection site, and to determine the sensitivity of geophysical methods to monitor changes in a plume's distribution in the subsurface and coincident changes in the geologic regime over time.

Benefits

Project results will be used to develop a graphical user interface to enable researchers and stakeholders to design and execute 3-D surface-to-surface (conventional, surface, and seismic) and borehole-to-borehole (cross-hole, seismic, and electromagnetic methods) tomographic modes of detection and imaging to provide definitive evaluation and monitoring tools for future CCS sites. Furthermore, the project will provide training opportunities for graduate and undergraduate students to gain knowledge in CCS and ultimately supply the human capital required to implement CCS technologies on a large-scale. The technical research involved in this work provides the foundation to advance the science in the MVA of CO2 storage in geologic systems. By addressing MVA issues in the context of geologic reservoirs, a vital contribution will be made to the scientific, technical, and institutional knowledge base needed to cultivate a trained work force with skill sets in geology, geophysics, geomechanics, geochemistry, and reservoir engineering.

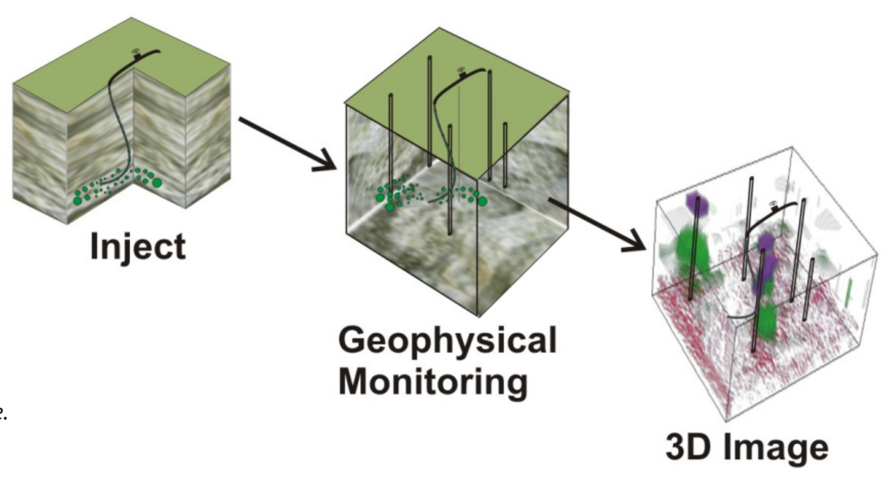

Figure 1. Time elapsed geophysical monitoring used to develop a three-dimensional image of the subsurface.