the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Double-Difference Tomography for Sequestration Monitoring, Verification, and Accounting (MVA)

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 Virginia Polytechnic Institute and State University (VT) to develop the framework necessary for data collection and processing requirements that will enable the use of double-difference seismic tomography as a tool for imaging changing conditions underground due to CO_2 sequestration (Figure 1). Seismic tomography is an imaging technique that uses seismic waves to generate three dimensional (3-D) images of the inside of the Earth. This and similar techniques are used to characterize site geology and track injected CO_2 plumes over time. Double-difference seismic tomography uses the absolute and differential arrival times to solve for the velocity distribution and the source locations simultaneously; thus improving the spatial resolution of the produced 3-D image.

The laboratory-based project will use synthetic data to optimize receiver locations and the mathematical parameters used in the inversion process. Data collection and processing requirements will be quantified by comparing "synthetic" seismic

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

Joshua Hull
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-0906
joshua.hull@netl.doe.gov

Erik Westman
Principal Investigator
Virginia Polytechnic Institute and State University
100 Holden Hall
Blacksburg, VA 24061
540-231-7510
ewestman@vt.edu

PARTNERS

None

PROJECT DURATION

Start Date

12/01/2009

End Date

12/30/2011

COST

Total Project Value

$257,818

DOE/Non-DOE Share

$248,441/$9,377

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

velocity models to "calculated" seismic velocity models. If the source locations and receiver array are optimized, then the calculated model will closely match the synthetic model. The synthetic models will be generated using curved-ray travel-time software developed by Dr. Westman of VT. They will simulate approximately 125 different combinations of plume migration, source locations, and receiver array locations. The source arrays will be microseismic emissions associated with the plume migration. The receiver arrays will be geophone arrays of various configurations. The synthetic data will be used with the double-difference tomography code to calculate velocity models for each of the 125 different combinations of plume migration, source locations, and receiver array locations. The output of the double-difference tomography will be calculated velocity models that can then be compared to the synthetic velocity models through cross-validation. A microseismic dataset will be selected, with input from NETL, to be analyzed using the double-difference tomography over several time periods to observe the time-dependant change within the subsurface due to CO_2 sequestration.

Goals/Objectives

The objective of the project is to establish data collection and processing requirements that will enable the use of double-difference seismic tomography to quantitatively map the mass and propagation of sequestered CO_2 as a function of time.

Benefits

This research effort will demonstrate how double-difference tomography can be used to successfully image the location and propagation of sequestered CO_2 and advance existing subsurface imaging techniques. Furthermore, project results will provide insight into optimizing the number and sensitivity of sensors that will be required for subsurface imaging at future CCS project locations, as well as develop the appropriate inversion parameters. The project's research will lead to the development of a graduate course that will enable students to apply the best and most recent methods for using geophysical tools to image geologic sequestration.

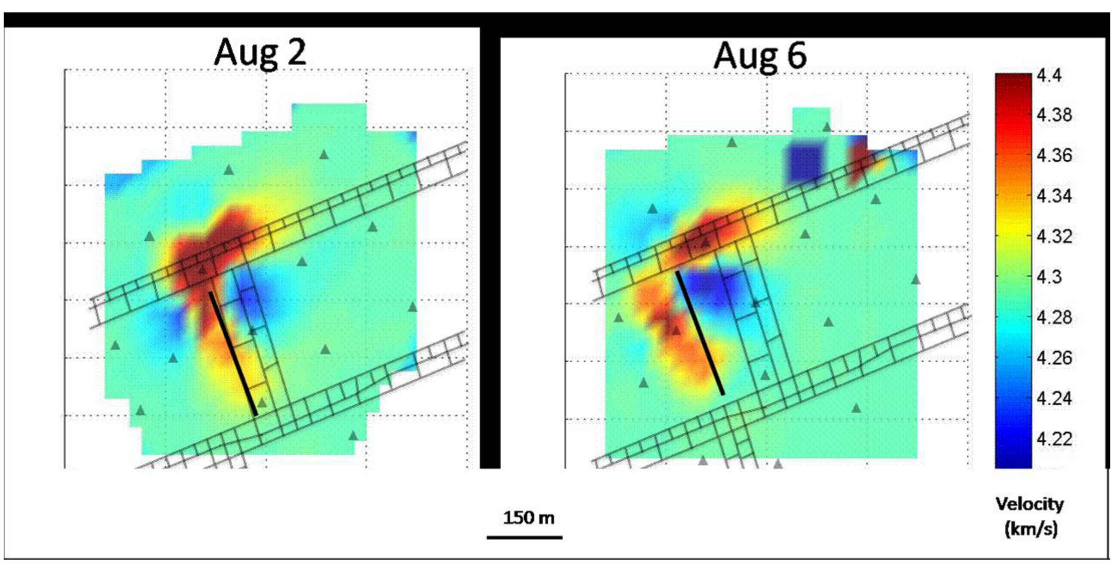

Figure 1. Daily tomograms showing velocity redistribution due to mining-induced stress change associated with longwall mining. Images are cross-sections taken at seam level.