R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

04/2008

Development of Comprehensive Monitoring Techniques to Verify the Integrity of Geological Sequestration Reservoirs Containing Carbon Dioxide

Background

Research aimed at monitoring the long-term storage stability and integrity of carbon dioxide (CO_2) sequestered in geologic formations is one of the most pressing areas of need if geologic sequestration is to become a significant factor in meeting the United States' stated objectives to reduce greenhouse gas emissions. The most promising geologic formations under consideration for CO_2 sequestration are active and depleted oil and gas formations, brine formations, and deep, unmineable coal seams. Unfortunately, the long-term CO_2 storage capabilities of these formations are not yet well understood.

Primary Project Goal

The goal of this effort is to develop and demonstrate advanced monitoring techniques to assess the capacity, stability, rate of leakage, and permanence of CO_2 storage in geologic formations.

Soil-gas monitoring conducted by NETL personnel at an enhanced coalbed methane recovery site (Southwest Regional Sequestration Partnership) located at the San Juan Basin in northern New Mexico.

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Midwest Geological Sequestration Consortium

Midwest Regional Carbon Sequestration Partnership

Sandia National Laboratory

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Southwest Regional Partnership on Carbon Sequestration

West Virginia University

PERFORMANCE PERIOD

10/01/2007 to 09/30/2008

COST

$1,940,000

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Objectives

The primary objective of this project is to apply a complementary suite of surface and near-surface monitoring techniques to detect short-term, rapid loss, or long-term intermittent leakage of CO_2 from geologic storage formations. These techniques include monitoring perfluorocarbon tracers added to the injected CO_2 that can be detected in soil-gas at parts-per-quadrillion levels, shallow water aquifer chemistry changes, fluxes of CO_2 at the surface, and natural tracers (e.g., radon and light hydrocarbons) in soil-gas.

Additional objectives are to:

- Perform geophysical site analysis using ground-based measurements and remote sensing that combines satellite-visible and infrared views with optical aerial photography.
- Monitor for long- and short-term leakage during the Regional Carbon Sequestration Partnerships' (RCSPs) Phase II and Phase III projects.
- Locate abandoned wells using airborne and ground-based magnetometry, while simultaneously evaluating the leakage potential using radiometry and methanometry.
- Evaluate the degradation of well-sealing cements under downhole conditions of temperature and pressure.

Benefits

The development of techniques to monitor the integrity of geologically sequestered CO_2 is needed to assure public health and safety and gain public acceptance of geologic sequestration technology. Active and depleted oil and gas formations, brine formations, and deep coal seams that were previously unused now have the potential to serve as sinks for CO_2 sequestration. Additionally, harmful emissions, which may contribute to global warming, are prevented from entering the atmosphere.

Accomplishments

The United States Department of Energy's (DOE) National Energy Technology Laboratory (NETL) is currently involved in collaborations with the seven RCSPs to monitor Phase II and Phase III pilot- to intermediate-scale field tests. These tests involve injection into unmineable coalbeds and saline formations, with injections ranging from hundreds of tons to a million tons of CO_2. For this effort, NETL is employing a large suite of complementary surface and near surface monitoring techniques as mentioned in the objectives statement above, developing risk-assessment software that will be applied to field sites, and performing geo-mechanical stress tests on RCSPs' reservoir and cap rock samples.

NETL participated in the ZERT field verification experiments, which injected small amounts of tracer-spiked CO_2 just below the soil from vertical and horizontal wells. Surface flux and tracer mappings were in agreement and provided complementary information for modeling CO_2 movement near the surface. Resistivity surveys were used to image subsurface features, including the development of the CO_2 plume. NETL successfully developed methods for finding and evaluating abandoned wells using ground-based and aerial magnetometry and methanometry surveys. The helicopter well-finding technology was selected by R&D Magazine as "one of the 100 most technologically significant products introduced into the marketplace over the past year." The precise location of abandoned wells and the evaluation of their leakage potential is an essential component of NETL's sequestration monitoring program. High-pressure and temperature tests with brine and CO_2 were performed to characterize the chemical reactions involved in the degradation of well-bore cements under simulated sequestration conditions. Finally, a detailed mechanism and the long-term kinetics of the chemical process were determined by NETL for the first time.