Project Archive - Monitoring Mitigation & Verification

Project Title	Primary Contractor	Project End Date	Fact Sheet Listing
Natural Analogs for Geologic Sequestration	Advanced Resources International	7/31/2005	PAM-3
A Sea Floor Gravity Survey of the Sleipner Field to Monitor CO_2 Migration	University of California, San Diego	12/31/2005	PAM-5
Development of Science-Based Permitting Guidance for Geologic Sequestration of CO_2 in Deep Saline Aquifers Based on Modeling and Risk Assessment	University of Texas at Austin	6/30/2006	PAM-7
In Field, Continuous, Non-Invasive Soil Carbon Scanning System	Brookhaven National Laboratory	9/30/2008	PAM-9

(UCR projects not included)

* Factsheet Not Available

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PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

03/2006

NATURAL ANALOGS FOR GEOLOGIC SEQUESTRATION

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Background

Large geologic deposits of high-purity carbon dioxide (CO_2), created entirely by natural geologic processes, occur in many sedimentary basins. They have acted as relatively stable repositories for CO_2 over many thousands of years and prove that geologic sequestration offers a secure, environmentally sound way of storing CO_2. Most importantly, they provide an excellent natural laboratory in which to study the effects of long-term CO_2 exposure on the reservoir minerals. These conditions cannot be replicated by short term laboratory experiments or geologic sequestration tests. CO_2 fields may be viewed as unique "natural analogs" that can be used to assess crucial aspects of geologic sequestration. These assessments include: integrity of storage, candidate site screening and selection, and operational safety and efficiency. Thus, these CO_2 deposits offer considerable potential for understanding and publicizing geologic sequestration and can serve to build public confidence in this CO_2 management technique.

At present, five large natural CO_2 fields in the United States provide a total of 25 million tons of carbon dioxide that is injected into oil fields for enhanced oil recovery (EOR). This project performed a multi-disciplinary geologic engineering study of U.S. CO_2 deposits. The overall objective is to compare the naturally occurring CO_2 reservoirs with the capability of depleted oil and gas fields to securely and economically sequester carbon dioxide.

Primary Project Goal

The overall goal is to study natural CO_2 fields to document empirically, both to the scientific community and the public at large, the capability of depleted oil and gas fields to sequester carbon dioxide safely and securely. The effort also investigates long-term reactions between CO_2 and the various minerals in the reservoir and cap rocks.

Objectives

- Evaluate the safety and security of geologic sequestration
- Adapt specialized CO_2 operations technology to an emerging sequestration industry
- Document analogs for public review
- Evaluation of environmental and safety related factors are made based on the results of a geochemical analysis of CO_2 impacts and geochemical modeling

PARTNERS

Advanced Resources International
Kinder Morgan CO_2 Company, Ltd.
Ridgeway Petroleum Corporation
British Geological Survey
NASCENT Project
Australian Petroleum
Cooperative Research Center

COST

Total Project Value
$1,736,390

DOE/Non-DOE Share
$1,123,390 / $613,000

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CUSTOMER SERVICE

1-800-553-7681

WEBSITE

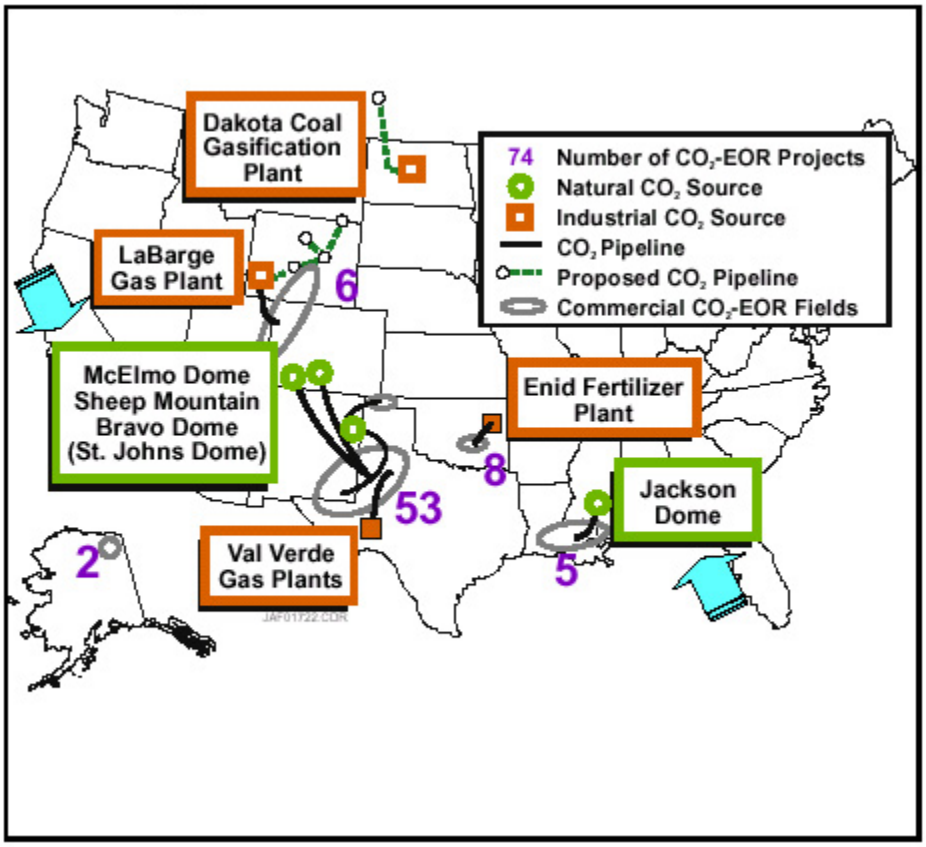
www.netl.doe.gov

Accomplishments

Literature reviews and collection of geologic and reservoir data have been performed. ARI has completed the first comprehensive analysis of several large natural CO_2 fields including Kinder Morgan's McElmo field in Colorado, Ridgeway's St. John's Dome in Arizona and New Mexico, and Denbury Resources' Jackson Dome field in Mississippi. Existing well log and other geologic information has been collected and is being used to build robust geologic models of these CO_2 fields.

Benefits

This project provides information that can be used to develop technologies for safe and secure sequestration of CO_2 in natural geologic formations. Furthermore, the results of this project provides an opportunity to study CO_2 sequestration in a non-intrusive manner at natural CO_2 sites and has obtained data not otherwise available on the long-term effect of CO_2 on mineral strata.



Location of natural CO_2 study sites in the USA and the CO_2 infrastructure for EOR projects

Project216.pmd

PROJECT facts

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

03/2006

A SEA FLOOR GRAVITY SURVEY OF THE SLEIPNER FIELD TO MONITOR CO_2 MIGRATION

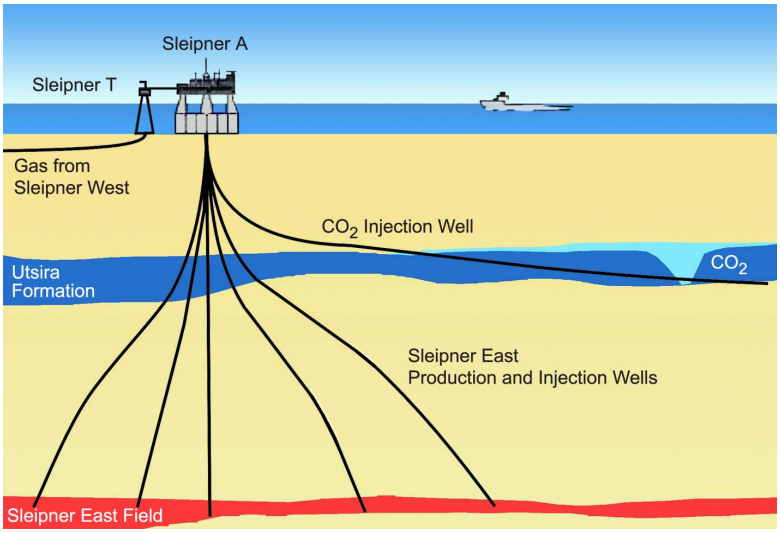
Background

In order for geologic sequestration of carbon dioxide (CO_2) to be a viable option for reducing greenhouse gas emissions, techniques have to be developed to monitor the emplacement and sequestration of CO_2 in an underground geologic environment. This project seeks to apply high precision gravitational surveying techniques to quantify the change in the local gravitational field associated with the sequestration of CO_2.

The Sleipner West natural gas field in the North Sea produces CO_2. To avoid paying a tax on CO_2 emitted into the atmosphere, Statoil, which owns the field, has been injecting most of this carbon into a saline aquifer, the Utsira formation, about 1,000 meters beneath the sea. The Utsira formation is a permeable sandstone saline aquifer about 200–250 meters thick and is overlain by mudstone. The studied site covers an approximately 3 x 7 km area, and the water depth averages about 80 meters.

Primary Project Goal

The primary project goal is to quantify the change in the local gravitational field associated with the sequestration of carbon dioxide in the saline aquifer below the bed of the North Sea to assess the ability of microgravity techniques to monitor geologically sequestered CO_2. This study will utilize high precision gravitational surveying techniques along with seismic data.



Schematic Cross-section of geologic strata for the Sleipner project

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Statoil

COST

Total Project Value
$651,986

DOE/Non-DOE Share:
$341,986 / $310,000

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Objectives

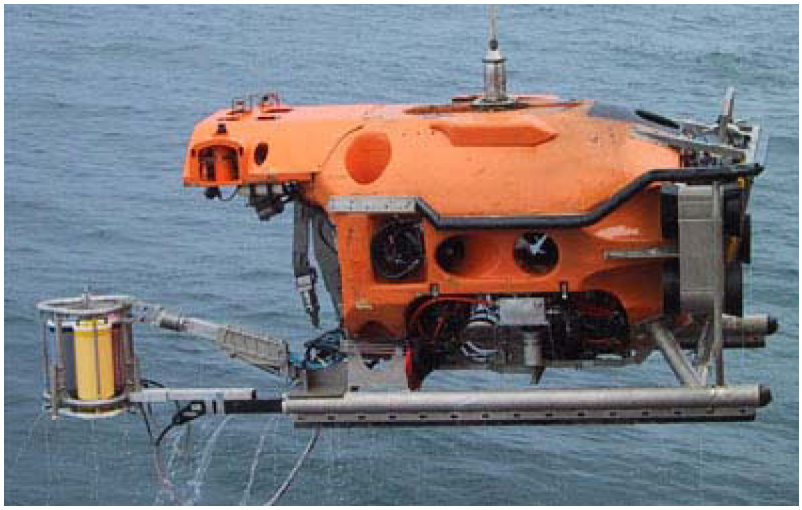
- Perform two high precision gravity surveys on the seafloor over the CO_2 injection. The first is to record the baseline gravity and the second (three years later) is to measure the changes due to the continued CO_2 injection.
- Reduce and analyze the gravitational potential field data along with existing seismic data to discriminate zones of geologic formation infused with CO_2 and to begin putting constraints on the density of the CO_2 within the reservoir.
- Use results of this application of high precision gravitational surveying techniques as a baseline for long-term monitoring of the sequestration of carbon dioxide in a saline aquifer.

Accomplishments

Microgravity surveys were successfully conducted in 2002 and 2005, both with better-than-expected repeatability.

Benefits

This project will develop new techniques to monitor CO_2 migration in a saline aquifer. Successful monitoring and verification are necessary to confirm that saline aquifers are a satisfactory repository for CO_2 and can be used to reduce greenhouse gas intensity by providing a viable geologic CO_2 sequestration option.



Deployment of the Remotely Operated Vehicle with a Deep Ocean Gravimeter (ROVDOG)

Project247.pmd

PROJECT facts

U.S. DEPARTMENT OF ENERGY
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NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

12/2004

DEVELOPMENT OF SCIENCE-BASED PERMITTING GUIDANCE FOR GEOLOGIC SEQUESTRATION OF CO_2 IN DEEP SALINE AQUIFERS BASED ON MODELING AND RISK ASSESSMENT

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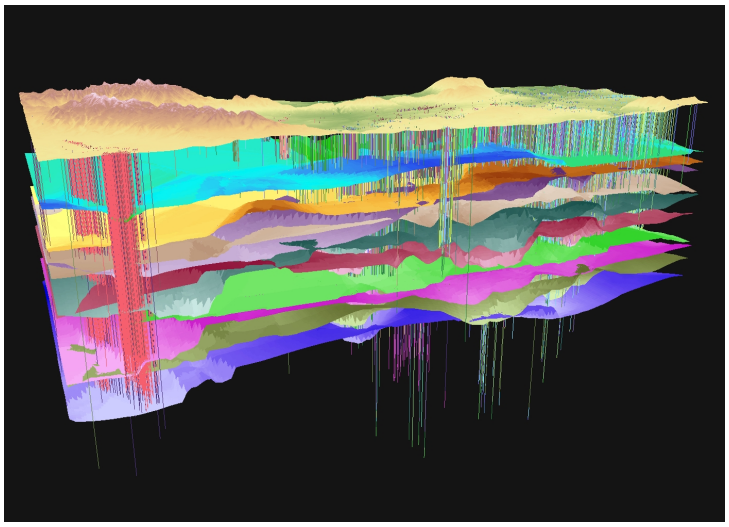
Background

Geologic sequestration of CO_2 has been recognized as a potentially important way to mitigate the increase in the concentration of CO_2 in the atmosphere. However, if geologic sequestration is to become a reality, procedures to permit geologic sequestration projects must be put in place. Reasonable permitting practices are critical to stakeholders, because overly restrictive permitting could limit the use of geologic sequestration, while lax regulation could result in widespread public objections or negative consequences, should leaks occur. This study will focus on long-term (hundreds to thousands of years) sequestration of CO_2 in subsurface formations in the Texas Gulf Coast and Ohio/West Virginia areas. Not only are there large releases of CO_2 in these areas, but high-quality data are also available from pilot injection projects. This study will build on previous and ongoing studies related to CO_2 sequestration conducted by the Bureau of Economic Geology (BEG) and Pacific Northwest National Laboratory (PNNL). This comprehensive approach to geologic CO_2 sequestration should increase confidence in the applicability of this technology, which is critical for its success and for public acceptance.



Schematic for the concept of geological sequestration

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WEBSITE

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PARTNERS

University of Texas at Austin

Pacific Northwest National Laboratory

COST

Total Project Value
$240,154

DOE/Non-DOE Share
$179,921/$60,233

This study will develop guidelines for permitting CO_2 sequestration projects on the basis of a review of permitting procedures in other programs (e.g., deep-well injection, gas storage systems, and high-level radioactive waste disposal), results of research programs on CO_2 sequestration and related projects, reservoir modeling, and risk assessment. CO_2 sequestration is an emerging field in which new results are being produced rapidly; therefore, it is critical to conduct a thorough search of the literature and to analyze the applicability of reported results to permitting issues. The modeling effort will build on modeling studies of the pilot CO_2 injection study in the Texas Gulf Coast conducted by Lawrence Berkeley National Laboratory (LBNL) in collaboration with the BEG. Sensitivity analyses will help identify critical issues and delineate potential leakage pathways. A risk assessment will extend the reservoir simulation results to aquifers, soil, biota, the atmosphere, and surface-waters. The results of these analyses will provide input needed to develop permitting protocols that will provide operators, regulators, and the public with increased confidence that the permitting process will ensure the selection of safe, optimal sites for CO_2 sequestration.

Primary Project Goal

The primary project goal is to develop a guidance document that addresses permitting issues relative to the geologic sequestration of CO_2, including specific recommendations for developing a permitting protocol. This can provide decision makers with a reasonable estimate of the potential future performance of a disposal system and a clearer understanding of how uncertainties affect that estimate.

Objectives

- To develop science-based permitting guidance.
- To perform reservoir and seal modeling.
- To perform risk and consequences assessments.
- To determine the implications of permitting.

Benefits

There is growing concern among climate scientists that the buildup of greenhouse gases, particularly CO_2, in the atmosphere is leading to global warming with potentially serious consequences. This may result in the need to reduce the amount of CO_2 emitted to the atmosphere. One promising technique for accomplishing this is the capture of CO_2 from large point sources, such as power plants, followed by sequestration in geologic formations. However, sequestration projects will not be possible until permitting protocols are in place. This project will develop science-based guidelines that can help government officials develop the required permitting procedures.

Proj318.pmd

PROJECT facts

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OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

03/2006

IN FIELD, CONTINUOUS, NON-INVASIVE SOIL CARBON SCANNING SYSTEM

Background

Global warming is promoted by anthropogenic CO_2 emissions into the atmosphere, while at the same time it is partially mitigated by carbon sequestration in the terrestrial ecosystem. However, a better understanding and monitoring of the underground carbon processes is necessary for evaluating various strategies for carbon sequestration and quantification of the carbon stores for credits.

Brookhaven National Laboratory developed an instrument for carbon analysis in soil based on inelastic neutron scattering (INS). INS offers a non-invasive means for continuously monitoring the soil carbon inventory over both specific plots and large areas. This technique can significantly improve quantification of the efficacy of carbon sequestration methodologies. The proposed instrument enables a continuous scan and evaluates the mean soil carbon content in the field to a depth of about 20cm. This project offers to fill a void that exist in instrumentation in the area of monitoring belowground carbon processes in a fashion that is repetitive and provides a representative value for the soil carbon content over large areas. At present, carbon concentrations in soil are assessed indirectly using analytical models, and directly by taking core samples and subsequently subjecting the samples to physical and chemical analysis in the laboratory. However, the extensive variability of soil carbon both laterally and with depth in nearly every type of terrain requires large number of samples for statistically meaningful determination of mean carbon concentration with an acceptable level of error. This analysis process is labor intensive, expensive, slow and not amenable to up scaling for analysis of soil carbon at continent to global scales.

Mobile INS System Developed by BNL

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PARTNER

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COST

Total Project Value
$885,200

DOE/Non-DOE Share
$885,200 / $0

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Primary Project Goal

The purpose of this project is the development of an instrument with the capability for safe, rapid, non-destructive, multi-elemental, in situ soil carbon quantification and profiling over large areas and volumes.

Objectives

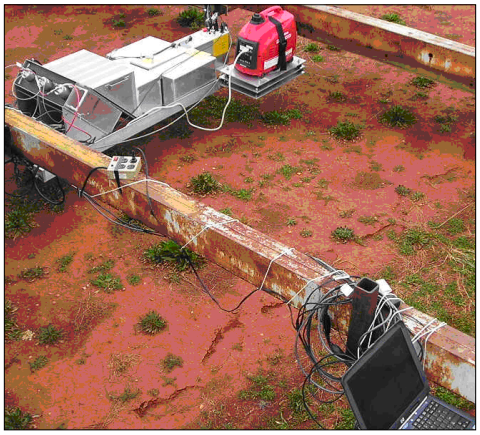
- The short-term objectives of present work are to construct a deployable prototype INS scanner for non-destructive soil carbon measurements in the field and to perform calibration and field verification of the system.
- The long-term objective is to perform measurements in various soil types in which the soil carbon content is well characterized. The system will also be used for comparison and possible development of conversion factors to scale specific point measurements obtained by other means to large field values.

Accomplishments

- Set of outdoor calibration measurements in a 4'x 5'x1.5' sand pit was obtained using sand mixed with known amounts of carbon.
- Partnered with USDA to conduct measurements of carbon in soil in Duke Forest in NC and at Auburn, AL ARS research facility. Measurements showed relatively good correlation between traditionally measured values and INS system measurements.
- Alpha stationary and mobile systems have been designed that are lightweight and field deployable with wireless communication between controller and measurement system.
- Determined the representative sample volume that is measured.

Benefits

This project is developing a robust, flexible, non-invasive, scanning system for in situ monitoring and verifying temporal changes in soil carbon over large areas. The anticipated benefit from such a system is the ability to monitor below ground carbon balances without disturbing the soil. Furthermore, the system enables continuous scanning of large areas thus providing a true mean carbon concentration in the soil. The proposed system enables, for the first time, repetitive measurement of the same site, thus allowing sequential monitoring of large areas.



INS System at USDA Facility in Auburn, AL

Project266.pmd