the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Combining Space Geodesy, Seismology, and Geochemistry for MVA of CO_2 in Sequestration

Background

Through its core research and development program administered by the National Energy Technology Laboratory (NETL), the U.S. Department of Energy (DOE) emphasizes monitoring, verification, and accounting (MVA), as well as computer simulation and risk assessment, of possible carbon dioxide (CO_2) leakage at CO_2 geologic storage sites. MVA efforts focus on the development and deployment of technologies that can provide an accurate accounting of stored CO_2, with a high level of confidence that the CO_2 will remain stored underground permanently. Effective application of these MVA technologies will ensure the safety of geologic storage projects with respect to both human health and the environment, and can provide the basis for establishing carbon credit trading markets for geologically storing CO_2. Computer simulation can be used to estimate CO_2 plume and pressure movement within the storage formation as well as aid in determining safe operational parameters; results from computer simulations can be used to refine and update a given site's MVA plan. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with geologic storage of CO_2, and helping to ensure that these risks remain low.

Project Description

This four-year project — performed by faculty and researchers from the University of Miami's Rosenstiel School of Marine and Atmospheric Science and the University of South Florida, assisted by UNAVCO, Inc., a non-profit consortium funded by the National Science Foundation — aims to develop an integrated, low-cost methodology for assessing the fate of CO_2 injected into various classes of geologic reservoirs. The project team will integrate data from space geodesy (which utilizes high-precision Global Positioning System [GPS] and Interfero-metric Synthetic Aperture Radar [InSAR] technology to measure subtle surface displacements), seismology, and geochemistry in a straightforward series of procedures and algorithms, and assess the cost and efficacy of these procedures for long-term tracking of CO_2. This new approach will be tested at a large-scale CO_2 injection test site. Results are expected to confirm suitability of this methodology for most carbon storage sites.

Primary Project Goal

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).

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PARTNERS

The University of South Florida
UNAVCO, Inc.

COST

Total Project Value
$2,134,997

DOE/Non-DOE Share
$1,708,545 / $426,452

PROJECT NUMBER

DE-FE0001580

U.S. DEPARTMENT OF ENERGY

The primary objective of this project is to develop and test a new, integrated approach for MVA of CO_2 that is stored in deep geologic formations. This objective will help to improve and demonstrate the need for efficient storage operations and further demonstrate CO_2 storage permanence in the subsurface. The essence of this approach is to integrate reconnaissance-scale space techniques with ground-monitoring methods of seismic and geochemical techniques, including:

- High-precision space geodesy to measure subtle surface displacements associated with pressure/volume changes at depth due to injection of CO_2 in a storage reservoir (Figure 1).
- Analytical and numerical (finite element) modeling to relate deformation at the surface to pressure/volume changes at depth.
- New, state-of-the-art algorithms using passive seismic monitoring and use of compressional velocity, shear-wave velocity, and attenuation from recorded seismic data, to monitor fluid motions, porosity changes, and other conditions in the reservoir and overburden.
- Geochemical reservoir modeling to assess the fate of injected CO_2.
- Geochemical surface monitoring to measure CO_2 seepages should they occur, using a combination of sensors to measure concentration and isotopic ratios.

Accomplishments

- InSAR algorithms have been tested on selected case study and potential field deployment sites.
- Work was conductedon the site selection task to determine the CO_2 injection site the field equipment will be deployed at (seismic, GPS, geochemical) and the InSAR satellite monitoring will be conducted.
- The cavity ring downhole spectrometer was procured and delivered to the Univ. of Miami, and lab testing of the equipment has been completed. The assessment identified several major flaws in the equipment. Changes are being implemented in the design of the instrument.
- The algorithm used for seismic monitoring and modeling has also been developed, and will be used to infer changes in the subsurface including fluid movement.
- Selected field site for monitoring, coordinated with operator for deployment of monitoring equipment, and designed and installed monitoring field instrumentation at field site.
- Acquired InSAR satellite imagery and initiated data acquisition and analysis of monitoring instrumentation for field site.

Benefits

It will be necessary to improve existing monitoring technologies, develop novel systems, and protocols to satisfy regulations to track the fate of subsurface CO_2 and quantify any emissions from reservoirs. The Carbon Storage Program is sponsoring the development of technologies and protocols by 2020 that are broadly applicable in different geologic storage classes and have sufficient accuracy to account for greater than 99 percent of all injected CO_2. If necessary, the tools will support project developers to help quantify emissions from carbon capture, utilization, and storage (CCUS) projects in the unlikely event that CO_2 migrates out of the injection zone. Finally, coupled with our increased understanding of these systems and reservoir models, MVA tools will help in the development of one of DOE's goals to quantify storage capacity within ± 30 percent accuracy.

Assessment of the efficiency, safety, and long-term fate of CO_2 injected into various types of geologic storage reservoirs remains a challenge. If successfully proven, the integrated methodology for CO_2 monitoring in a storage reservoir described above can be implemented at relatively low cost at most proposed carbon storage sites. It will require only the installation of a sparse network of GPS, seismic, and geochemical stations, and low-cost commercial satellite imagery.

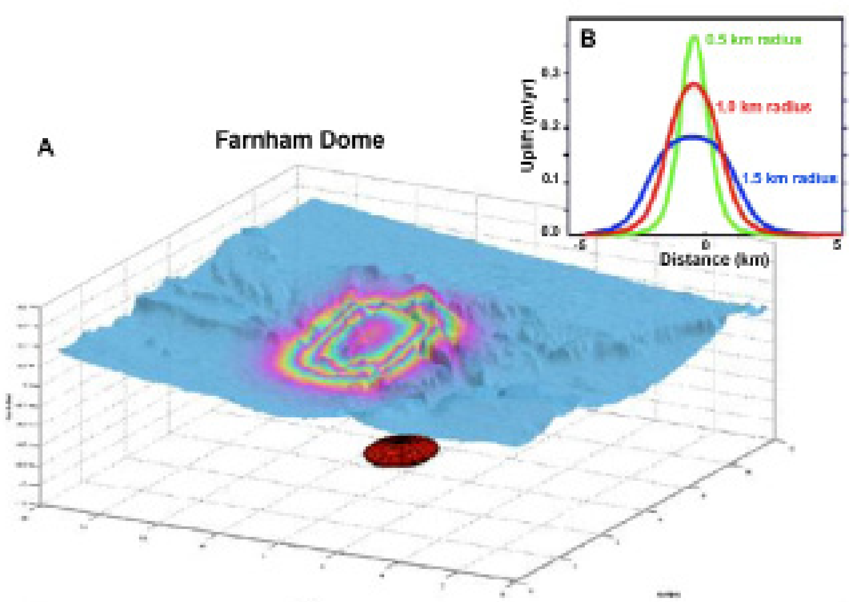

Figure 1 - Simulated surface deformation at Farnham Dome observed with InSAR, assuming a nominal 1-year CO_2 injection (10^6 m^3) into a lens-shaped reservoir at 1 km depth. One color cycle corresponds to 3 cm of displacement; 1B: Inset shows expected uplift for 3 sources with different radius.