the ENERGY lab

PROJECT FACTS

Carbon Sequestration

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

Description

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, of possible carbon dioxide (CO_2) leakage at CO_2 sequestration sites, along with risk assessment of those 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 permanently sequestered. Effective application of these MVA technologies will ensure the safety of sequestration projects with respect to both human health and the environment, and provide the basis for establishing carbon credit trading markets for sequestered CO_2. Risk assessment research focuses on identifying and quantifying potential risks to humans and the environment associated with CO_2 sequestration, and helping to ensure that these risks remain low.

This four-year project — performed by faculty and scientists from the University of Miami's Rosenstiel School of Marine and Atmospheric Science, 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, 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 and its reaction products by demonstrating its approach at one of DOE's Phase 3 carbon sequestration test sites. Results are expected to confirm suitability of this methodology for most sequestration sites.

Primary Project Goal

The primary objective of this project is to develop and test a new, integrated approach for MVA of CO_2 that is sequestered in deep geologic repositories. The essence of this approach is to integrate reconnaissance-scale space techniques with more detailed seismic and geochemical techniques, including:

- High-precision space geodesy (Global Positioning System [GPS] and Interferometric Synthetic Aperture Radar [InSAR]) to measure subtle surface displacements associated with pressure/volume changes at depth due to pumping of CO_2.

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COST

Total Project Value
$2,077,256

DOE/Non-DOE Share
$1,735,545 / $341,711

PARTNERS

UNAVCO, Inc.

- Analytical and numerical (finite element) modeling to relate deformation at the surface to pressure/volume changes at depth.
- New, state-of-the-art algorithms for retrieval of compressional velocity, shear-wave velocity, and attenuation from seismic data, to monitor fluid motions and porosity changes.
- Geochemical modeling to assess the fate of sequestered gas or fluid and separate the effects of formation of new reaction products (generally a desired outcome, fixing CO_2 in solid form) from leakage or loss of gas or fluid from the reservoir (an undesirable outcome).
- Geochemical sampling to directly measure leakages should they occur, using a combination of CO_2 concentration sensors, plus advanced field mass spectrometers, to measure isotopic ratios.

Accomplishments

This project was awarded on October 1, 2009. Anticipated accomplishments relate to the scope of the work. During the first phase, the project team will conduct GPS-aided InSAR investigations at several of DOE's legacy sequestration sites, as well as two of DOE's Phase 3 sites. Based on these studies, the team will select one of the Phase 3 sites for focused studies in the second phase of the project. This will involve installation of specific geodetic (GPS), seismic (borehole and shallow vault seismometers), and geochemical (CO_2 sensors) equipment. Phase 3 will involve analysis and interpretation of the data from this site. Specifically, for the repository selected, the team will (1) precisely characterize the surface displacement field, (2) develop a realistic model for the inflation source, and (3) test for CO_2 leakage by comparing the geodetic observations with the model predictions, seismic observations, and chemical observations.

Benefits

Assessment of the efficiency, safety, and long-term fate of CO_2 injected into various types of geologic reservoirs remains a challenge. If successfully proven, the integrated methodology described above will become available for implementation at relatively low cost at most proposed sequestration sites, requiring only the installation of a sparse network of GPS, seismic, and geochemical stations, and low-cost commercial satellite imagery.

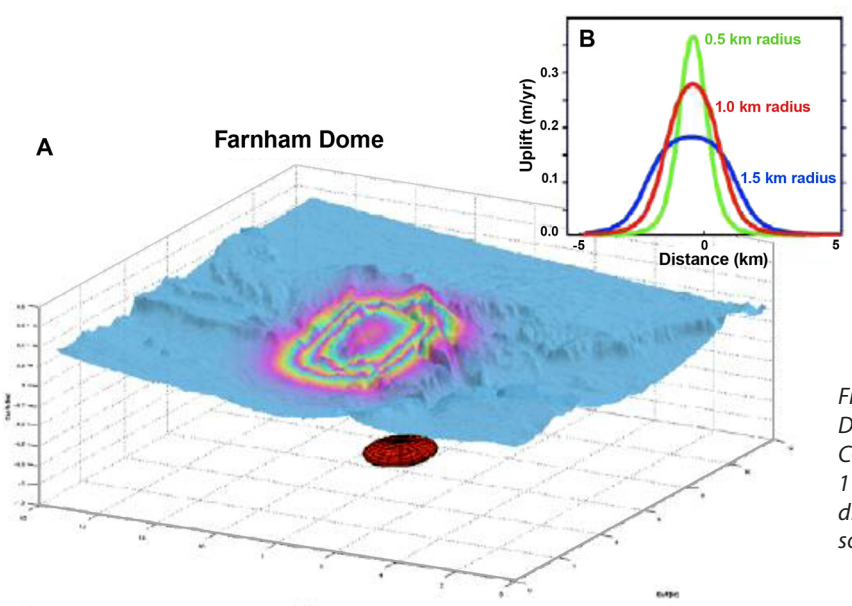

Figure 1A: Simulated surface deformation at Farnham Dome observed with InSAR, assuming a nominal 1-year CO_2 injection (10^6 m^3) into a lens-shaped reservoir at 1 km depth. One color cycle corresponds to 3 cm of displacement; 1B: Inset shows expected uplift for 3 sources with different radius.

DE-FE0001580, April 2010