the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Development and Test of a 1,000-Level 3C Fiber Optic Borehole Seismic Array Applied to Carbon Sequestration

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research aimed to advance state-of-the-art technologies that address geologic storage of carbon dioxide (CO_2) in multiple formation types and across all phases of CO_2 geologic storage operations.

Geologic storage involves the injection of CO_2 into underground formations that have the ability to securely contain it over long periods of time. Research efforts are currently focused on several geologic storage formation types: deltaic, coal/shale, fluvial, alluvial, strandplain, turbidite, eolian, lacustrine, clastic shelf, carbonate shallow shelf, and reef. Basaltic interflow zones are also being considered as potential reservoirs. These formations contain different fluids such as saline water, oil and natural gas. A principal element of DOE's Carbon Sequestration Program is Core Research and Development (R&D), and one of the R&D focus areas—geologic storage—is aimed at addressing the challenges of CO_2 storage in these formations.

Critical challenges identified in the geologic storage focus area include CO_2 well bore integrity, geochemical and mechanical responses, fluid flow and containment, and development of mitigation technologies. This research will develop a geologic reservoir assessment tool based on borehole seismic technology that can generate ultra high resolution P (primary) and S (secondary) wave images for detailed characterization and precise monitoring of CO_2 storage sites.

Project Description

Paulsson investigators are building and testing a prototype downhole seismic system capable of deploying one thousand 3C (3 component) downhole receivers using fiber optic geophone technology deployed on drill pipe. The drill pipe provides structural strength and can act as the conduit for the hydraulics that will provide the power needed to clamp the sensors to the borehole wall. The all-metal clamping system using drill pipe hydraulics, and the fiber optic receivers made with high temperature fibers will permit the design and manufacture of receiver arrays capable of operating at temperatures and pressures of up to 300 °C (572 °F) and 30,000 psi in corrosive CO_2 environments; the arrays will be viable and operational for long periods since no electronics or electric power will be used in either the hydraulic clamping system or fiber optic geophones. Positive attributes of the fiber optic geophone technology to be used in the receiver array include a low noise floor, high sensitivity, and extreme

CONTACTS

John Litynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4922
john.litynski@netl.doe.gov

Karen Kluger
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
Pittsburgh, PA 15236
412-386-6667
karen.kluger@netl.doe.gov

Bjorn Paulsson
Principal Investigator
Paulsson, Inc.
P.O. Box 337
Woodland Hills, CA 91365-0337
310-780-2219
bjorn.paulsson@paulsson.com

PARTNERS

None

PROJECT DURATION

Start Date
10/01/2010

End Date
09/30/2012

COST

Total Project Value
$4,180,609

DOE/Non-DOE Share
$1,995,682 / $2,184,927

Award Number: DE-FE0004522

U.S. DEPARTMENT OF ENERGY

robustness and reliability. The goal is to use high resolution, active and passive source P and S wave data recorded using an ultra-long borehole seismic system equipped with sensitive geophones to provide the data necessary to generate quantitative, three dimensional (3-D) maps of the architecture and properties of reservoir and caprock formations. This technology will also assist in tracking fluid flow in the rock formation by using active or passive sources. The system will be tested and evaluated at a CO_2 storage site once the prototype has been completed.

Goals/Objectives

The scope of work is to design, build, and test the next generation downhole seismic system using the most advanced sensor and deployment technology available, and assess the applicability of the system to carbon geologic sequestration.

The objectives are to:

- Design and build a prototype seismic array.
- Test the system at a CO_2 storage site, and complete a performance assessment of the system.

The team will design a 1,000 level, 3C fiber optic seismic receiver borehole array for high resolution seismic imaging. A prototype 5 level 3C seismic array system will be initially built and field tested. This array will be deployed using a small diameter drill pipe. The drill pipe provides structural strength and will act as the conduit to clamp the sensors to the borehole wall. Positive attributes of the fiber optic geophone technology to be used in the receiver array include a low noise floor, high sensitivity, and extreme robustness and reliability. Upon successful completion of this prototype test, a 150 level 3C seismic array will be built and field tested. Data collected from the field test seismic surveys will be analyzed, and results will be provided to assess the performance of the system and its applicability to CO_2 storage reservoirs and operations.

Benefits

The successful sequestration of CO_2 in geologic media is critically dependent on a precise understanding of the complexity of the geologic repositories and dynamics of the CO_2 injection process. CO_2 sequestration and monitoring will be better understood and managed with the high-resolution reservoir imaging technology developed under this project. This technology will benefit CO_2 sequestration in geologic reservoirs by developing an imaging tool that can acquire geologic data at the quality needed to create highly accurate 3-D maps of the architecture and physical properties of geologic reservoir and caprock formations. The seismic array will also assist in tracking fluid flow within the rock formation. High-resolution seismic imaging and monitoring technology developed for the carbon capture and sequestration (CCS) process is also directly applicable to the development of economically feasible enhanced oil recovery processes for the oil and gas industry.

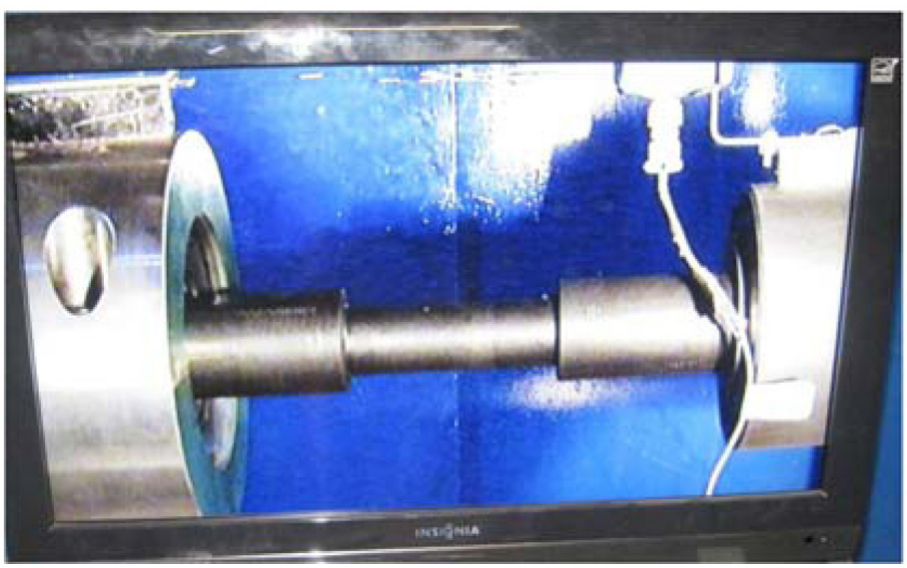

Figure 1. Development of the deployment system. Destructive test of pipe joints for the 1,000 level system.