Distributed Fiber Optic Arrays: Integrated Temperature and Seismic Sensing for Detection of CO_2 Flow, Leakage, and Subsurface Distribution

Award Number: DE-FE0012700

Project Summary:

The project focused on the field acquisition of fiber optic data using distributed acoustic sensing (DAS) arrays for subsurface imaging of geologic structure and to track the carbon dioxide (CO_2) migration in the injection interval using time-lapse techniques. A second component of the project used a novel heat-pulse monitoring method that relies on distributed temperature sensing (DTS) to evaluate near-field leakage of CO_2 or brine in and around the wellbore. The Southeast Regional Carbon Sequestration (SECARB) partnership hosted the project at the Anthropogenic Test site near Citronelle, Alabama after the original site host, the Kansas Geological Survey (KGS), experienced significant delays in permitting its CO_2 injection well at the Wellington Oil Field site in Kansas. A second field trial was planned for the Livingston Oil Field, located in Louisiana, but the site host ran into financial difficulty and the project was terminated in 2015. A replacement field-site host was not found for the Livingston field trial.

Prime Performer:
Electric Power Research Institute, Inc.

Principal Investigator:
Robert Trautz

Project Duration:
10/1/2013 – 9/30/2018

Performer Location:
Palo Alto, California

Field Sites:
Citronelle, Alabama

Program:
Carbon Storage

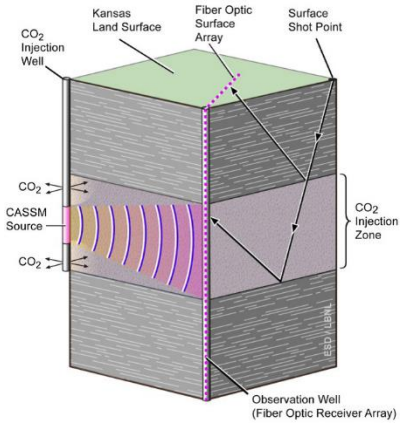

Figure 1: Schematic showing potential survey configurations that will be performed at the project site.

Project Outcomes:

The Modular Borehole Monitoring (MBM) system, a novel sensor platform, was utilized by the project. Two different seismic sensor technologies were incorporated in the Citronelle MBM system design including: (1) a semi-permanent, tubing-deployed, 18-level geophone array with custom hydraulic clamps; and (2) two single-mode optical fibers for DAS. A heat-pulse monitoring system consisting of two multi-mode optical fibers for DTS and copper heater element were also incorporated into the MBM package. The heat-pulse monitoring technique was used to diagnose a completion problem with an observation well, thus successfully demonstrating its application for leak detection. A time-lapse image of the redistribution of CO_2 after injection ended in September 2014 was obtained using two DAS vertical seismic profile surveys from June 2014 and December 2015, thus successfully demonstrating its application. DAS data were also acquired during a crosswell seismic survey conducted in 2014. The DAS technique was not successful in the crosswell survey configuration because the noise level was too high.

Presentations, Papers, and Publications

Final Report: Distributed Fiber Optic Arrays— Integrated Temperature and Seismic Sensing for Detection of CO_2 Flow, Leakage and Subsurface Distribution: Final Report (December 2018) Robert Trautz, Thomas Daley, Barry Freifeld, Paul Cook, Michele Robertson, Thomas Coleman, Joseph Greer, Douglas Miller