Real-Time In Situ Carbon Dioxide Monitoring Network for Sensitive Subsurface Areas in Carbon Capture and Storage

Award Number: DE-FE0012706

Project Summary:

This objective of this project was to develop a fiber optic-based monitoring system capable of highly sensitive detection of carbon dioxide (CO_2) in groundwater. The stand-alone system included novel distributed fiber optic sensors for CO_2, pH, and salinity. The project involved developing two novel sensitive claddings for pH and salinity testing. In addition, the project also developed low-cost, compact electronic instrumentation that enables placement of the sensors thousands of meters away from the electronic unit. The sensors were field tested at a site in Austin, Texas and validation studies were conducted in a laboratory. The technology was then demonstrated at the Quest field site in collaboration with Shell Canada.

Prime Performer:
Intelligent Optical Systems, Inc.

Key Performers:
University of Texas at Austin
Shell Canada

Principal Investigator:
Jesus Delgado Alonso

Project Duration:
10/1/2013 – 6/30/2019

Performer Location:
Torrance, California

Field Sites:
Quest site

Program:
Carbon Storage

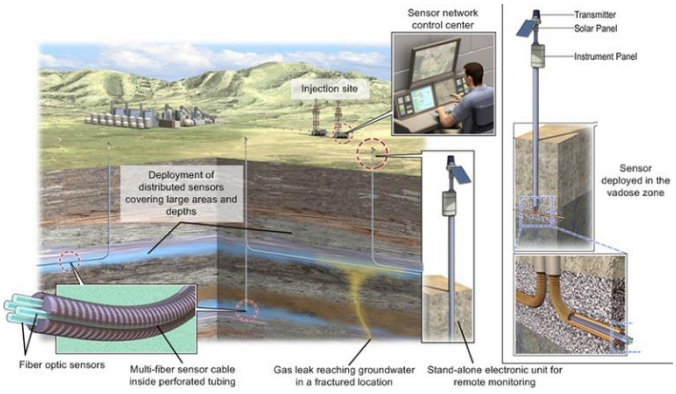

Figure 1: (Left) Depiction of the multi-parameter system deployed in a highly fractured area with sources of drinking water. (Right) Depiction of the distributed sensor deployed in the vadose zone.

Project Outcomes:

The CO_2 detection sensor technology developed in this study can meet the requirements of CCUS monitoring: (1) The fiber optic sensors are capable of measuring dissolved CO_2 in drinking water and subsurface aqueous media; (2) the measurement range can be tuned to monitor CO_2 saturation in brine; and (3) the fiber optic CO_2 detection sensors are also capable of operating on gaseous phase to detect gas leakage in the vadose zone. In field tests, the sensors demonstrated the capability to detect controlled leaks of CO_2 at very low concentrations. However, quantification of the concentration of CO_2 in the aquifer with the optical sensors was not accurate. Researchers installed four systems and sensors in eight monitoring wells at the Quest site, with depths varying from 20 meters to 200 meters. Data was collected from the eight monitoring wells over ten months, and demonstrated sensor lifetimes of over six months. Software and hardware errors occurred and, while revisions were made, researchers concluded that the electronic unit must be redesigned before commercialization. Overall, the data that was analyzed revealed good correlation with the data collected by other water monitoring systems. However, data in several monitoring wells was not consistent with the measurements collected by other monitoring systems, which could not be explained during the course of the study. Additional laboratory studies and field data collection were recommended.

Presentations, Papers, and Publications

Final Report: Automated High Power Permanent Borehole Seismic Source Systems for Long-Term Monitoring of Subsurface CO_2 Containment and Storage (March 2019) – James Kengo Andersen

[illegible] (September 2019) – Jesus Delgado Alonso