

# **Monitoring CO<sub>2</sub> Injection at a 1,000,000 Metric Tonne Carbon Capture Utilization and Storage Demonstration Project**

**Robert Balch<sup>1</sup>, Richard Esser<sup>2</sup>, and Robert Will<sup>3</sup>**

<sup>1</sup>Petroleum Recovery Research Center, New Mexico Tech, Socorro, NM, United States.

<sup>2</sup>Energy and Geosciences Institute, University of Utah, Salt Lake City, UT, United States.

<sup>3</sup>Carbon Services, Schlumberger, Denver, CO, United States.

## **ABSTRACT**

The Southwest Partnership on Carbon Sequestration (SWP) is a CO<sub>2</sub> carbon capture utilization and storage (CCUS) project sponsored by the U.S. Department of Energy, with a goal of permanently storing 1,000,000 tonnes of CO<sub>2</sub>. The SWP project is located in a mature waterflood undergoing conversion to enhanced oil recovery (EOR) at Farnsworth, Texas, USA. Utilized CO<sub>2</sub> is anthropogenic, sourced from a fertilizer and an ethanol plant. The field has 15 CO<sub>2</sub> injectors and stored 505,494 tonnes of CO<sub>2</sub> between October 2013 and October of 2016. Major project goals are optimizing the storage/production balance, ensuring storage permanence, and developing best practices for CCUS. Several invert 5-spot patterns are converted to CO<sub>2</sub> every year, allowing for rigorous testing of monitoring technologies as each new set of patterns provides opportunities to record zero CO<sub>2</sub> baseline, mid-flood data, and fully flooded pattern data. The project has acquired multiple data sets for seismic monitoring of CO<sub>2</sub> including a baseline 42 mi<sup>2</sup> 3D seismic survey, baseline and repeat 3D vertical seismic profiles (VSP) centered on three injection wells, baseline and repeat tomography profiles between injector/producer pairs, borehole and surface passive seismic arrays, distributed temperature arrays, and bottom-hole pressure and temperature sensors. The 3D VSP and cross-well data with repeat surveys have allowed for direct comparisons of the reservoir prior to CO<sub>2</sub> injection and at eight, and 20 months into injection. Plume images are refined as production and injection data are integrated with newly acquired and interpreted data, and as geologic and simulation models are regularly updated. Surface and near-surface monitoring methods are used to ensure storage security. CO<sub>2</sub> soil flux measurements from 90 surface locations are recorded quarterly and compared to baseline data collected monthly during the first project year. An eddy covariance tower is located on site to monitor atmospheric CO<sub>2</sub> flux and identify point-source leakage. Additional Farnsworth Unit monitoring focuses on groundwater chemistry, reservoir fluids chemistry, and aqueous- and gas-phase tracer studies. This paper presents the seismic and direct monitoring programs and describes the current state of plume imaging using time lapse seismic data. Funding for this project is provided by the U.S. Department of Energy under Award No. DE-FC26-05NT42591. Additional support has been provided by site operator Chaparral Energy, L.L.C.