Southwest Regional Partnership on Carbon Sequestration

Quarterly Progress Report

Reporting Period: October 1, 2018–December 31, 2018

Brian McPherson, PI, and Robert Balch, PI/Project Director

DE- FC26-05NT42591

Recipient: New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, New Mexico 87801
Table of Contents

Table of Contents .......................................................................................................................... 2

List of Figures and Tables ............................................................................................................ 3

Executive Summary ...................................................................................................................... 4

TASK 2 Public Outreach and Education ................................................................................... 5

   Subtask 2.2 Project Website ....................................................................................................... 5

TASK 6 Operational Monitoring and Modeling ........................................................................ 5

   Subtask 6.1 Surface and Near-Surface Monitoring ................................................................. 6
   Subtask 6.2 Subsurface Monitoring .......................................................................................... 13
   Subtask 6.3 Seismic Activities ................................................................................................. 15
   Subtask 6.4 Reservoir Modeling ............................................................................................... 17
   Subtask 6.5 Risk Assessment .................................................................................................... 31
   References ............................................................................................................................... 32

TASK 8 Project Management and Oversight .......................................................................... 35

Cost Status ................................................................................................................................... 39

Anticipated Delays ...................................................................................................................... 48

Significant Achievements ........................................................................................................... 48
List of Figures and Tables

Figure 1. A map view of the CO₂ surface flux measurements locations. ........................................7
Figure 2. Cumulative CO₂ storage. .................................................................................................. 14
Figure 3. Calcite concentration after 130 days of simulation time. ................................................18
Figure 4. The plots show the gas phase hysteresis models using the three different correlations. 20
Figure 5. The plots show the supercritical storage of CO₂ with residual trapped gas using the different correlations. .............................................................. 21
Figure 6. CO₂ storage profile showing the amount of injected fluid (CO₂) and storage in the Farnsworth unit. ................................................................................................................22
Figure 7. Hysteresis gas trapped saturation in the first layer .................................................. 23
Figure 8. Oil mole fraction of CO₂ in layer 1. ..............................................................................23
Figure 9. Water mole fraction of CO₂ in layer 1. ..........................................................................23
Figure 10. Gas mole fraction of CO₂ in layer 1. ...........................................................................23
Figure 11. Results from the simulation from 4 cases. A) Cumulative oil production, STB (stock tank barrel at surface conditions). B) Oil recovery efficiency (the amount of oil displaced from the reservoir). C) Cumulative water production, STB. D). Cumulative water injection, STB.....26
Figure 12. Oil and gas saturation simulation corresponding to July 2018. A/B) Model 1 C/D) Model 4. .........................................................................................................................................27

Table 1. CO₂ Surface Flux Data for July 1–September 30, 2018....................................................7
Table 2. CO₂ Surface Flux Data for October 1–December 31, 2018 ...............................................10
Table 3. CO₂ Storage Summary through September 2018 ............................................................13
Table 4. Project Budget and Expenditures for Quarter 45, October–December 2018 .................40
Table 5. Milestones for Budget Period 3. Table 5 divided into 5A, (Critical Milestones) and 5B (Technical milestones that may or may not be path-critical) (Quarters of Federal Fiscal Year)...41
Executive Summary

**Task 2–Public Outreach and Education:** SWP continued to support the Domain Name System (DNS) and registration of the SWP Internet presence. The project team also continued improvements to the MVA data website to allow for more secure and user-friendly SWP-wide access. Researchers continued to maintain SWP-Velo with no significant bugs reported.

**Task 6–Operational Monitoring and Modeling:** the MVA Database was maintained and updated. A separate database was started for eddy tower data. In 6.1 Surface and Near-Surface: No gravity measurement fieldwork was done and no water samples were collected. CO₂ flux measurements were taken (also taken in Q44; erroneously reported not taken). SWP continued work on LiCor data collected in Q44 and gathered the latest eddy tower data in December. In 6.2 Sub-surface: CO₂ storage data as of September 2018 was reported; Phase III storage period did not meet goal of 1,000,000 metric tonnes, but this was met over the course of the CO₂ injection project started in 2010; over 2 million metric tonnes of CO₂ have been injected. Ongoing analysis of tracer tests continued. In order to interpolate and integrate seismic monitoring efforts into reservoir modeling grids, the project team investigated the open source seismic modeling package Madagascar. Coupled analysis of NMR logs and µCT imaging resumed in December. In 6.3 Seismic: the velocity model for the reprocessed 3D seismic data was in the QC process. Seismic stratigraphic interpretation was completed. Memory pressure and temperature gauges were deployed in Well 13-10A and the new borehole seismic array, with downhole temperature and pressure gauges and DTS fiber cable, was placed in Well 1310. Internet connection between the data shed and NMT server was established and telemetry cables were installed. Planning for the surface microseismic array advanced. In 6.4 Reservoir Modeling: Work continued on building and executing a STOMP three-phase tertiary recovery reactive transport model for a five-spot well pattern. Models successfully simulated the injection and physical migration of CO₂ but appeared to be underpredicting the pH of the formation water. Researchers detected and fixed some bugs in STOMP-EOR. Work progressed on completing current tracer simulations and interpretation of tracer experiments. Flow-through relative permeability core experiments were finished. Researchers continued to run simulations for the NRAP wellbore leakage study and finished creating the simulation cases for the 13 relative permeability relationships derived from MICP data on the Morrow Sandstone. The project team continued to work on a software project in Python that would allow for grids developed in Petrel to be run using other simulation codes. A Topical Report summarizing core measurements for relative permeability was initiated. In 6.5 Risk Assessment: researchers continued using NRAP tools to characterize leakage at the Farnsworth site. Column experiments of CO₂ intrusion into the overlying groundwater aquifer (the Ogallala) began and assessment continued of the impact of geochemical reactions on CO₂ storage via three-phase reactive transport models of FWU. Modelling results showed stratigraphic trapping sequestered the most injected CO₂. Early results with a two-dimensional reactive transport model of FWU caprock showed it would maintain its integrity in the scenario for at least 5000 years.

**Task 8–Project Management and Oversight:** Two field trips to the FWU were made. The first was to install P/T gauges in well 13-10A (see 6.3, Seismic), to collect field data, and to meet with site personnel. The second was to reconfiguring computer wiring in the data shed (ongoing) and to investigate reported gas leaks in well 1310 (not found) and other tasks. The SOPO was submitted in October and the Continuation Application and Budget for BP4 in December 2018. Planning began for the 2018 SWP annual meeting February 6–7 in Allen, Texas. Book preparation continued and a number of presentations were given at meetings.