The Observation of Long-Period, Long-Duration Seismic Waveforms at CO₂ EOR Operations in Texas and Kansas

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Introduction

• During Enhanced Oil Recovery (EOR), CO₂ is injected into oil-bearing formations to increase production from depleted wells.
• Long-Period, Long-Duration (LPLD) events are seismic events of low frequency (0.8-10 Hz), that can have a duration from tens of seconds to a few minutes.
• Seismic waveforms recorded by broadband seismometers during CO₂ injection operations in Farnsworth, Texas and Wellington, Kansas were screened for the presence of LPLD events (Fig. 1).

Methods

• NETL and USGS used an array of Nanometrics-Trillium Compact 120 Posthole broadband seismometers to record seismic data (Fig. 2).
• KGS used an array of Mark Products L22 broadband seismometer/Reftek 130 Data Logger to record seismic data.

Results and Discussion

• LPLD events were found at both the Farnsworth and Wellington EOR sites.
• At Farnsworth, 466 low-frequency events were detected; of these, 155 events were determined to be LPLD events of local origin (within 40 km).
• At Wellington, 433 low-frequency events were detected; of these, 112 events were determined to be LPLD events of local origin.
• At Farnsworth, two LPLD events were located within the CO₂ plume; 4 LPLD events were located within the modeled pressure plume.
• The number and spatial distribution of LPLDs within the CO₂ and pressure plume is similar to the regional occurrence and distribution of LPLD events, suggesting that LPLD events may not be directly related to the CO₂ injection.

Data

• Seismic data for the Farnsworth site was obtained from a broadband seismometer network operated by the United States Department of Energy-National Energy Technology Laboratory (USDOE-NETL).
• Seismic data for the Wellington site was provided by the Kansas Geological Survey (KGS) and the U.S. Geological Survey (USGS).

Conclusion

• LPLD events were identified in Wellington, Kansas and Farnsworth, Texas during EOR operations by manually scanning seismic data in the low-frequency range of 0.8-10Hz.
• Of 466 detected events at Farnsworth, only 2 were found to be within the CO₂ plume; 4 events were found to be within the modeled pressure plume.
• Spatial distribution of LPLD events at Farnsworth suggests that LPLD events may not be directly related to CO₂ injection.