Time-Lapse Seismic in a CO_2 EOR Flood and Implications for CCS Reservoir Monitoring

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Abstract

The Intergovernmental Panel on Climate Change assessment on climate change includes industrial scale carbon capture and geological sequestration of CO_2 (CCS) as a mitigation strategy for limiting global warming and that the current rates of deployment are far below those needed. Consequently, governments are incentivizing industry to address this challenge and a rapid growth in CCS is underway.

A key requirement of geological sequestration is the monitoring of the CO_2 plume behavior. This will involve the use of time-lapse (4D) seismic monitoring along with other monitoring methods combined with reservoir modeling. The energy industry has expertise in all these elements from hydrocarbon exploration and development, and therefore industrial scale CCS is highly anticipated to be successful. However, CO_2 behavior in sequestration must be studied to calibrate reservoir models and deepen and refine our understanding of CO_2 movement.

The energy industry has many years of monitoring CO_2 movement for enhanced oil recovery (EOR) operations where the injection of CO_2 in oil fields facilitates more effective production. We present the time-lapse seismic monitoring results from a Denbury Gulf Coast EOR project. To date, five 3D surveys have been acquired for time-lapse monitoring starting with the baseline survey shot in March 2014.

Changes in seismic amplitudes of the injection intervals clearly demonstrate the ability of 3D Seismic surveys to monitor CO_2 movement and can be explained by the combination of the fluid properties of CO_2 and the high porosities of the reservoir sands. Amplitude variations over time can be interpreted as CO_2 movement and variations in sand quality. The discrete downdip amplitude changes conform to structure and supports that the amplitude changes are due to CO_2 movement and that the CO_2 movement is not creating diffuse or patchy CO_2 fluid distributions