Above-zone pressure monitoring as a surveillance tool for carbon sequestration projects

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Abstract:

Geologic storage of CO_2 for atmospheric emissions reductions adds unique requirements to document containment through monitoring. Monitoring pressure stratigraphically above the injection interval has been proposed as a fit-to-purpose technique to document performance of confining system and degree of isolation provided by existing wellbore completions. To test the technique under field conditions, data have been collected over a >24-month period beginning in July 2008 during a continuous industrial-scale CO_2 injection at an enhanced oil recovery (EOR) site at Cranfield Field, Mississippi. Continuous downhole high-precision pressure and temperature data were collected at a single well at two depths: at the injection interval (3117 m) and at a selected above zone monitoring interval (AZMI). The AZMI is a prevalent non-productive ~100mD sandstone 112 m above the injection zone and above a thick confining system. These gauges monitor reservoir and above-zone pressure perturbations related to activities at 7 injection wells, 9 production wells, as well as potential contributions from other historic plugged and abandoned wells in the vicinity. Static initial reservoir pressure conditions prior to any CO_2 injection were similar to what would be encountered in typical sequestration projects, so pressure evolution prior to significant fluid production is representative of what may be expected in many sequestration scenarios into brine formations. Many injection wells have been shut in during 2010, allowing pressure decline similar to anticipated CCS project site closure to be observed. Recent arrival (July 2010) of CO_2 to the dedicated observation well allows the pressure and temperature response in both the injection and AZMI to be observed in the presence of CO_2.

Three primary observations suggest that interformational communication at the site due to large-volume CO_2 injection is negligible: 1) A significant pressure differential is sustained for the period of injection (currently over 2 years), reaching a maximum of >8 MPa; 2) Temperature data do not indicate significant fluid volumes moving from the injection interval to the AZMI in the vicinity of the observation well; and 3) The pressure trends and transients created in the injection interval by variable injection rates are not apparent in the AZMI data. Observed pressure data are being used to constrain the sensitivity of the technique for detecting inter-formational communication via wellbores and geologic confining systems, and to determine possible scenarios that can explain the dynamic but relatively minor observed AZMI pressure changes. Interpretation challenges include engineering-related contributions to the observed pressure signal related to the remediation and complex dual completion of the 60 year old observation well. Engineering-related contributions at the observation well appear to dominate the AZMI signal, increasing noise and reducing the sensitivity of the technique for detecting more subtle short-term dynamic (transient) pressure changes related to fluid flux that are demonstrably observed in the injection interval.

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