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Preliminary findings from the GFV experiment: Investigating the role of multiscale geological heterogeneity on plume migration and trapping

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In 2023 the GeoCquest project team joined forces with the CO2CRC in Australia to design and carry out the GeoCquest Field Validation (GFV) Experiment at the Otway International Test Centre. The goal of the experiment is to test and refine approaches for predicting plume migration and trapping in highly heterogeneous rocks using advanced multiscale characterization and simulation approaches, including: geomodeling with composite rock types; petrophysical characterization of directional and rate-dependent relative permeability and capillary pressure functions; and high-resolution reservoir simulation. Between November 2024 and January 2025, 10,000 metric tons of supercritical fluid containing 80% CO2 and 20% CH4 is being injected into a 10-m thick interval at a depth of 1450 m in a highly heterogeneous sandstone in the Paaratte Formation of the Otway Basin. The plume is moving updip to intersect CRC-8, a passive purpose-built monitoring well where daily saturation measurements are being obtained with a high-resolution pulsed neutron logging instrument (PNL) over a period of 5-6 months. Plume saturation measurements are being made during both the injection and post-injection phases, to enable observations of plume migration followed by residual gas trapping. Solubility trapping will be measured by fluid sampling at the injection well in and above the injection zone after injection stops.

Continuous core was collected in both the injection well (CRC-3) and a newly drilled well (CRC-8), located 115 m updip of the injection well. A new high resolution (0.3m x 3.3 m x 3.3 m) geomodel has been developed based on a combination of well log, core, and seismic data, that includes 2 homogeneous and 4 composite rock types that are representative of the reservoir in this depth interval. Detailed petrophysical characterization of the cores includes continuous CT, minipermeameter measurements, routine core analysis, special core analysis for capillary pressure and relative permeability measurements in each of the major rock types, as well as a suite of cased-hole well logs.

Our presentation will provide an overview of preliminary results from the experiment, including CO2 plume migration and saturations as measured by the PNL, injectivity and pressure buildup, and temperature measurements made using behind-casing fiber optic sensors. In addition, we will present comparisons of probabilistic predictions of plume migration and trapping using two modeling approaches: 1) full physics modeling using GEOS and 2) a machine learning model (CCSNet.ai). These pre-injection predictions provide a benchmark against which to compare actual plume migration and trapping. Together, work elements of the GFV experiment are designed to test, improve, and validate multiscale approaches for predicting the performance of geological storage in highly heterogeneous environments.

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References

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