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A Stochastic Method to Characterize Caprock by History-Matching Pressure Monitoring Data

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An ultra-tight sealing caprock is essential for safe storage of CO2 in deep geological basins. One of the basic requirements of this shale sealing is to ensure it is free of faults/fractures or other high permeable zones that may lead to unintended leakage of CO2 from its storage reservoir to above zones. Sealing capability of caprock is typically characterized by permeability measurement of a sample cored from the desired caprock formation. However, this does not ensure the presence of any faults/fractures or other high permeable zones in the caprock at field-scale. Characterizing a sealing caprock is a challenging task because dynamic data is not available from any region inside the caprock. However, monitoring data from above and below the caprock can be used for its characterization at field-scale. This study presents a method to stochastically characterize a sealing caprock (e.g. ultra-tight shale) using pressure monitoring data from above and below the caprock. This monitoring data is used in combination with other readily-available data from laboratory and outcrop in a history-matching optimization process to characterize the spatial variation in porosity and permeability of the caprock. An optimum geological model of caprock, representing a most-likely scenario, is selected from an ensemble of stochastic realizations generated using optimized parameters.

The method is demonstrated using four representative heterogeneous fractured seal types ranging from impermeable to highly permeable. The sensitivity to caprock thickness, pressure variation, and time length of monitoring data is also investigated.

References

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