The University of Texas at Austin

M.S. Energy and Earth Resources

Estimating Across-Fault Migration Rates and their Financial Implications for CCS with Application to Offshore Gulf of Mexico

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Abstract

In the Gulf of Mexico, faults usually behave as CO2 flow barriers that aid containment, but sometimes across-fault migration of CO2 is possible. Petroleum fault seal analysis predicts whether a fault seals or transmits hydrocarbons. This suffices to reveal whether accumulations drain over geologic timescales. CCS operates on human timescales. Quantification of the rate of a potential migration is an essential and relatively unexplored component in CCS. Migration rates allow to anticipate costs related to liability and returned carbon credits, which affects the profitability of CCS investments. In this study, I create an algorithm to estimate across-fault migration rates of CO2. I use fault seal analysis plus application of Darcyâ€™s law to the areas on the fault with the highest transmission potential. I then transform the rates to cumulative transmitted masses and perform stochastic simulations to bracket the range of rates according to fault attribute uncertainties.

I illustrate the algorithm with a model of a double fault-bounded storage rate of 0.7 MtCO2. If the injector is placed 1 km away from the faults, the cumulative transmitted masses of CO2 are between 137.19 and 7,408.93 ktCO2 for open and closed boundary conditions respectively (or between 0.49% and 26.46% of the injected total). It is likely more realistic to assume the, at worst, the reservoir's boundaries are semi-closed. In this case, simulations output between 372.03 and 570.24 ktCO2 (1.61% average of injected total) of migration with 90% confidence. The results suggest that in similar GoM settings with abundant shales, the fault core permeability and thickness should be favorable for sealing. However, they can exhibit 3 and 1 orders of magnitude of variation respectively and thus should be modeled as uncertainty distributions. I found that pressure and area of highest transmission potential are the critical drivers of migration rate. In application to financial investment scenarios, the net present value of an injection project into the GoM trap varied from $52.32M to $63.02M depending on migration rates. The result indicates that migration rates are key in scoping for financially viable projects.

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