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Long-term Fate of Injected CO2 into a Carbonate Formation, Middle East

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SUMMARY

Injection of CO2 into a carbonate formation in the Middle East is considered as potential option for permanently storing CO2. Understanding the plausible migration pathways of the CO2 plume and predicting the long-term fate plays a crucial role, especially since faults are present and CO2 dissolves and dissociates in brine. The latter causes decrease of the pH and geochemical reactions with calcite, which is the dominant mineral in the reservoir. We use reactive transport modelling to understand the fate of CO2 during injection, as well as the long-term impact. We therefore computed structural trapping, dissolution trapping, capillary trapping, and mineral trapping of CO2 in the reservoir matrix and in faults.

The model takes into account various rock types and different porosity-permeability relationships. Several megatonnes of CO2 are injected into the lowest formation using one injection well during 30 years. The results of the reservoir modelling demonstrate that CO2 predominantly migrates along the high permeability layer near the top of the formation. A smaller plume migrates into a thinner high permeability zone near the base of the same formation. At the end of the injection, the plume reached a potentially conductive fault. After injection, CO2 may leak into the fault causing upward migration of CO2 throughout the entire carbonate formation. Away from faults, vertical migration is effectively blocked by a very low permeable formation (overlying the formation mentioned above), even on the longer term (i.e. 1,000 years). Uncertainty analysis demonstrates that the distance from the well to the faults determines the amount of CO2 that is leaking into the faults on the short-term (injection timescale). On longer term (1,000 years), the differences are much smaller. Calcite dissolution occurs due to buffering of the pH decrease, but effects on porosity increase are limited in the entire reservoir.