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Enabling CO_2 Geological Storage within a Low-Carbon Economy

Supercritical CO_2 intrusion into caprocks: insights from numerical simulation of lab-scale CO_2 injection

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ABSTRACT

Carbon capture and storage in deep geological formations suggests a promising large-scale CO_2 mitigation option. Currently available pathways to meet the Paris climate goal of limiting global warming to well below 2 ºC involve significant contributions of geologic carbon storage. Nonetheless, this mitigation technology is not exempt from challenges. In particular, the potential CO_2 leakage through the caprock is a major concern. CO_2 is less dense than the in-situ brine in deep saline formations and tends to float. The upward migration of the buoyant CO_2, if causing leakage through the caprock, can put at stake the large-scale implementation of geologic carbon storage. Therefore, the assessment of the caprock sealing capacity is of paramount importance. This study provides an improved understanding of CO_2 flow mechanisms across the caprock based on insights gained from numerical simulations of core-scale CO_2 injections. We inject supercritical CO_2 into a caprock sample under representative subsurface conditions. We parameterize a two-phase flow model using laboratory data and reproduce the CO_2 injection experiments. Overall, we conclude that advective CO_2 flow is unlikely to take place through a caprock with sufficiently high capillary entry pressure and low intrinsic permeability. The ubiquitous molecular diffusion principally dominates CO_2 leakage. These findings favor long-term storage of CO_2 underground. Nevertheless, diffusive leakage over geological time scales has yet to be assessed through field-scale numerical simulations.