Large-scale Carbon Storage Effects on Up-dip Freshwater: Simulating Plume, Pressure and Salinity Changes in the Wilcox Aquifer, DeWitt County, Texas, USA.

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ABSTRACT

Deep clastic saline aquifers, like the Paleogene Wilcox Group in the Texas Gulf Coast area, have potential for large-scale CO_2 storage due to their thick sandy units, moderate to good porosity (e.g., 10–30%) and permeability (e.g., 1–100 mD), and overlying confining systems. Texas population and industrial centers have substantial carbon emissions that could be stored in the saline portion of these aquifers. US EPA regulations ensure protection of freshwater aquifers (< 10 g/L TDS), but the delineation of the Area of Review (AoR) is focused on the overlying protected aquifers and vertical conduits (e.g., faults and wells), but overlooks the potential effect on aquifers up-dip from the CO_2 storage zone.

This study evaluates: (1) the CO_2 plume migration, pressure diffusion and salinity dispersion from large-scale carbon storage, (2) the simulation parameters that have the largest impact on those effects, and (3) whether common regulatory practices consider such effects on freshwater aquifers. The study area is located in the south-central part of the Wilcox aquifer in DeWitt County, Texas, which has been previously shown to have the greatest effect on up-dip freshwater from large-scale carbon storage. New geophysical and petrophysical data from within the study area are employed which have not been used in previous large-scale studies of carbon storage.

Simulation parameters within the expected range had a small effect on CO_2 plume and pressure migration at the 10s of kilometers scale. These simulations did not show, unlike previous studies, that large-scale carbon storage in the lower Wilcox aquifers causes CO_2 to migrate into fresh water. This difference from prior studies is likely due to differences in the fluid models and static model, especially near the storage zone. Simulations also show that salinity mixing along a sharp freshwater-saltwater interface can change salt concentrations up to 15 g/L at pore pressures expected from large-scale carbon storage. This may have implications for injection in saline aquifers with up-dip connection to freshwater aquifers. Finally, most simulation cases were unrealistic for carbon storage due to pressures that would be identified within a properly delineated AoR and exceed the storage zone fracture pressure, which is prohibited by federal regulations.

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