

The impact of geological heterogeneity on CO₂ storage in brine formations: a case study from the Texas Gulf Coast

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Abstract:

Geological complexities such as variable permeability and structure (folds and faults) exist to a greater or lesser extent in all subsurface environments. In order to identify safe and effective sites in which to inject CO₂ for sequestration, it is necessary to predict the effect of these heterogeneities on the short- and long-term distribution of CO₂.

Sequestration *capacity*, the volume fraction of the subsurface available for CO₂ storage, can be increased by geological heterogeneity. Numerical models demonstrate that in a homogeneous rock volume, CO₂ flowpaths are dominated by buoyancy, bypassing much of the rock volume. Flow through a more heterogeneous rock volume disperses the flow paths, contacting a larger percentage of the rock volume, and thereby increasing sequestration capacity.

Sequestration *effectiveness*, how much CO₂ will be sequestered for how long in how much space, can also be enhanced by heterogeneity. A given volume of CO₂ distributed over a larger rock volume may decrease leakage risk by shortening the continuous column of buoyant gas acting on a capillary seal and inhibiting seal failure. However, where structural heterogeneity predominates over stratigraphic heterogeneity, large columns of CO₂ may accumulate below a sealing layer, increasing the risk of seal failure and leakage.

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