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Geologic Sequestration of CO₂ and Associated H₂S and SO₂ in Bedded Sandstone-Shale Sequences

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The injection of CO₂ and associated acid gases such as H₂S and SO₂ into deep sedimentary aquifers is a means by which net anthropogenic atmospheric emissions of greenhouse gases might be reduced. Aquifer host rock aluminosilicate minerals alter very slowly under ambient conditions and their study is not amenable to laboratory experiment. We therefore developed a numerical model to investigate the fate of CO₂ and other acid gases in bedded sandstone-shale sequences using hydrogeologic properties and mineral compositions characteristic of Texas Gulf Coast sediments. The simulations were performed using the reactive fluid flow and geochemical transport code, TOUGHREACT, to analyze mass transfer between sandstone and shale layers, the consequent immobilization of gases through mineral precipitation, and the impact of co-contaminated H₂S and SO₂ gases on CO₂ sequestration. The gas sequestration capacity by both aqueous and mineral phases was evaluated. Porosity changes due to mineral dissolution and precipitation were also monitored. The simulations provide useful insights into potential sequestration processes, and their controlling conditions and parameters during long-term containment of acid gases in deep sedimentary formations.