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Pore-Scale Influences on Saline Aquifer CO_2 Sequestration

In the absence of large-scale permeability barriers within a saline aquifer the main trapping mechanism will be pore-scale petrophysical characteristics. Injection of CO_2 into a saline aquifer for sequestration is a two-phase flow condition. Relative permeability and residual CO_2 saturation are the salient properties that influence sequestration under this condition. Drainage relative permeability controls the ability of CO_2 to flow into the aquifer as it is being injected, and residual saturation dictates the volume of CO_2 held immobile in the aquifer by capillary forces after injection. In the context of CO_2 sequestration the most favorable geologic situation is to optimize the relative permeability effects to enhance injection while maximizing the residual CO_2 saturation. We characterized relative permeability and residual saturation such that their prediction could be accomplished from sandstone rock quality. Parameters used to model relative permeability were correlated with rock quality and between themselves to determine interrelationships. Published and non published residual gas saturation data were analyzed to determine the influence of rock quality. An integrated petrophysical model was then established to predict residual saturation at both varying initial saturations and rock quality.

Varying rock quality has a strong influence on optimizing CO_2 sequestration in saline aquifers. A dependency was found between rock quality and end-point relative permeability saturations and the crossover point between phases. Decreasing rock quality was shown to increase residual saturation. These relationships illustrate that moderately low rock quality is the optimal geologic rock type for CO_2 sequestration. Thick sections of moderately low rock quality would allow rapid injection of CO_2 as well as maximizing immobile sequestered CO_2.