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The Effect of Original and Initial Saturation on Residual Nonwetting Phase Capillary Trapping Efficiency

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Injection of supercritical carbon dioxide (CO2) into geological formations is used for both atmospheric greenhouse gas reduction (climate change mitigation) and enhanced oil recovery. In an effort to fully understand CO2 trapping efficiency, the capillary trapping behaviors that immobilize subsurface fluids were analyzed at the pore-scale using pairs of proxy fluids representing the range of in situ (supercritical) nonwetting and wetting fluids. The pairs of fluids were cycled through imbibition and drainage processes using a flow cell apparatus containing a sintered glass bead column. Computed x-ray microtomography (microCT) was used to identify immobilized nonwetting fluid volumes after imbibition and drainage events.
From the images, the trapped residual (post-secondary imbibition) nonwetting phase was spatially correlated to both the original (post-primary imbibition) and the initial (post-primary drainage) nonwetting phase; relationships referred to as the original saturation dependence (So-dependence) and initial saturation dependence (Si-dependence), respectively. Statistically significant trends of decreasing So- and Si-dependence with increasing wetting and nonwetting fluid phase viscosities were observed. This finding implies that the amount of CO2 injected and ultimately trapped is dependent on the nonwetting phase (e.g. oil or gas) already present in the formation, as well as on the manner in which supercritical CO2 is initially injected.

References

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