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Effect of dissolution and heterogeneity on supercritical CO2 invasion in porous media: an experimental study using X-ray micro-computed tomographic imaging

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In this study, with the utilization of quasi-dynamic X-ray micro-computed tomographic (MCT) imaging, pore-scale fluid configurations were tracked for CO_2 injected into two different brine-saturated Bentheimer sandstone cores under conditions relevant to geologic carbon sequestration. CO_2 injection was performed at low capillary number (Ca = 10^{-9}) into cores saturated with live- and dead-brine, consecutively. Two cores with different pore space characteristics were used to investigate the impact of heterogeneity on the resultant fluid configurations. We also interrogated possible wettability alteration during CO_2 injection based on the obtained MCT images. We find that invasion patterns continue to evolve long after breakthrough, with distinct and gradual saturation changes occurring after decades of pore volumes injected. For one core, the invasion patterns for both live- and dead-brine conditions eventually converge after 16.5 pore volumes; for the second core, the patterns are distinct under the different injection conditions for up to 30.1 pore volumes. The presence of pore-scale heterogeneities in the cores has a strong influence on the ultimate CO_2 distribution under the different conditions. It is expected that results from this study will contribute to better understanding of the pore-scale invasion of CO_2 and ultimately, the field-scale application of geologic carbon sequestration.

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