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Investigation of supercritical CO2 mass transfer in porous media using X-ray micro-computed tomography

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Understanding the mass transfer of CO_2 into formation brine both qualitatively and quantitatively is important for improving the security of geologic carbon sequestration. In this study, quasi-dynamic X-ray micro-computed tomographic (MCT) imaging was used to track the time-evolution of supercritical CO_2 ($scCO_2$) clusters in a sandstone throughout brine injection. A cluster-matching workflow enabled the identification of depletion, merging, and snap-off of the $scCO_2$ clusters, and subsequently the mass transfer coefficient of individual $scCO_2$ clusters was found to range between 3.0×10^{-5} and 3.5×10^{-4} mm/s. The macroscopic average mass transfer coefficient was estimated as 1.4×10^{-4} mm/s. For application to geologic carbon sequestration, these values give an indication of the range of mass transfer coefficients that may be expected for similar state and flow conditions. With the macroscopic average mass transfer coefficient evaluated, we back-calculated the *in-situ* CO_2 concentration field for brine, which provides quantitative insight of the distribution of dissolved CO_2 in the sample. Despite slow injection rate ($Ca = 10^{-7}$), mobilization of small $scCO_2$ clusters was also observed, and was attributed to the combined effect of incomplete dissolution of snapped-off clusters and the reduction in the fluid–fluid interfacial tension (IFT) due to the high local CO_2 concentration in brine accompanying $scCO_2$ dissolution. This highlights the coupling of dissolution and mobilization processes and demonstrates the need to understand these interlinked dynamics to improve CO_2 storage in geological formations.

Participation

In-Person

References

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