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Pore scale characterization of dissolution process during CO2 injection in sandstones: an simulation study

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Dissolution trapping is one of the crucial trapping mechanisms for geological carbon storage in deep saline aquifers. The injected supercritical CO2 (scCO2) flow and dissolution processes are coupled and interact with each other. Therefore, we performed direct numerical simulations in three-dimensional micro-CT images of sandstones using the volume of fluid and continuous species transfer method. We investigated the coupled scCO2 flow and dissolution processes at pore-scale under different rock structures, capillary numbers, and rock wettability conditions. The dynamic evolution of the scCO2/brine phase distribution and scCO2 concentration distribution occurring during the injection period were presented and analyzed. Complicated coupling mechanisms between scCO2-brine two-phase flow and interphase mass transfer were also revealed. Our results showed that the scCO2 dissolution was highly dependent on the local distribution of scCO2 clusters. The rock with relatively high porosity and permeability would have more capacity for scCO2 injection resulting in a faster and greater dissolution of scCO2 in brine. The effect of capillary number on the scCO2 dissolution process was related to the range of capillary number. Rock wettability was found to be another factor controlling the scCO2 dissolution process by affecting the scCO2-brine interfacial area. Our pore-scale study provides a deep understanding of the scCO2 dissolution trapping mechanism, which is important to enhance the prediction of sequestration risk and improve sequestration efficiency.

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