Impact of sub-core scale heterogeneity on CO_2/brine multiphase flow for geological carbon storage in the Minnelusa sandstone

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Abstract

CO_2 geological storage in deep saline aquifers is a mitigation option for CO_2 emissions due to its large storage capacity and immediate accessibility. Accurately determining the CO_2-brine relative permeability curves is key to the evaluation of CO_2 injectivity and sweep efficiency in reservoir simulation as well as the CO_2 injection in the field. This study highlights the remarkable effects of sub-core scale heterogeneity on the CO_2-brine multiphase flow properties of the Minnelusa Sandstone in Wyoming. Two unsteady state CO_2-brine drainage experiments were performed on the two samples. The first sample exhibits slanted laminated structure, while the second one represents a more homogeneous sandstone system. The CO_2 saturation distributions during drainage reveals that the main variation in multiphase flow properties of two core samples were attributed to the porosity distribution that leads to the capillary pressure heterogeneity. Assisted history matching was used to obtain the respective relative permeability curves, which suggests heterogeneity-dependent behavior. In addition, sensitive and uncertainty analyses indicate that physical and petro-physical properties of low-porosity and low-permeability bedding layers exert marked effects on CO_2 front breakthrough time and brine production. The results presented in this study help to gain insight into the CO_2-brine multiphase flow properties in heterogeneous sandstones and can pave the way for the upscaling of CO_2 migration and field-scale simulation accurately. This work is funded under the Department of Energy CarbonSAFE program (awards DE-FE0031624 DE0031891).