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Visualization and measurement of CO_2 flooding in an artificial porous structure using micromodels

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Geological CO_2 sequestration is one of the most important technologies to mitigate greenhouse gas emission into the atmosphere by isolating great volumes of CO_2 in deep geological formations. This novel storage option for CO_2 involves injecting supercritical CO_2 into porous formations saturated with pore fluid such as brine and initiate CO_2 flooding with immiscible displacement. Despite of significant effects on macroscopic migration and distribution of injected CO_2, however, only a limited information is available on wettability in microscopic $scCO_2$-brine-mineral systems. In this study, a micromodel had been developed to improve our understanding of how CO_2 flooding and residual characteristics of pore water are affected by the wettability in $scCO_2$-water-glass bead systems. The micromodel (a transparent pore structure made of 1 mm diameter glass beads between two glass plates) in a high-pressure cell provided the opportunity to visualize spread of supercritical CO_2 and displacement of pore water in high pressure and high temperature conditions. CO_2 flooding followed by fingering migration and dewatering followed by formation of residual water were observed through a imaging system with a microscope. Measurement of contact angles of droplets of residual water on and between glass beads in a micromodel were conducted to estimate differential pressure between wetting and nonwetting fluids in a $scCO_2$-water-glass bead system. The experimental observation results could provide important fundamental informations on capillary characteristics of reservoirs and caprocks for geological CO_2 sequestration.