Numerical modeling of the effects of equilibrium phase partition between the supercritical CO_2 and brine on CO_2 local capillary trapping

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Capillary trapping is generally considered to be an important physical trapping mechanism for CO_2 geological sequestration in saline aquifers. Usually, the role of some potential chemical reactions in this mechanism is largely ignored. This study numerically models the effect of the equilibrium phase partition between the supercritical CO_2 and brine on CO_2 local capillary trapping based on a simple capillary trapping scenario. Results reveal that the equilibrium phase partition can cause salt precipitation in pore spaces especially near the bottom of the high capillary-entry-pressure region during drainage processes, which locally lowers the permeability and increases the capillary pressure, thus improving the availability of the capillary trapping. In the case of salinity < 10 wt%, the increasing salinity of pore water obviously enhances the total amount of CO_2 trapped in the computational domain. When the salinity is increased from 0 wt% to 10 wt%, the total amount of the trapped CO_2 is increased by 184.0%. However, when the salinity exceeds 10 wt%, increasing the salinity contributes little to the increase in the amount of the trapped CO_2. Pressure and temperature have a remarkable effect on the capillary trapping by controlling thermodynamic conditions of the equilibrium phase partition. At high pressure or low temperature (e.g. 35 ^{o}C or 12.67 MPa), the amount of the precipitated salts decreases and the effect of the equilibrium phase partition on the capillary trapping weakens.