Investigation of multiphase modeling approaches for behavior of supercritical CO_2 in deep formations using analog fluids in the laboratory

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Abstract. Laboratory investigations of supercritical carbon dioxide ($scCO_2$) injection and migration are challenging due to difficulties in recreating the high pressures that exist in deep formations and conditions the physicochemical properties of the fluid phases. Simulation of $scCO_2$ injection into deep saline formations could be conducted experimentally at the laboratory scale by using combinations of analog fluids that mimic the flow dynamics of the phases involved in the actual $scCO_2$ injection and migration. In the presented study, dimensional analysis is used to describe the interplay of relevant forces acting on the fluid system during flow experiments conducted in a synthetic aquifer. Fluid phases employed in these experiments consist of a glycerol-water mixture and an isoparaffin solvent as displaced and invading phases, respectively. Viscosity and density ratios of this analog fluid combination are consistent with brine and $scCO_2$ at deep reservoir conditions. We present an experimental study of $scCO_2$ injection and migration using a 3 ft x 2 ft synthetic 2D reservoir with the goal to quantify capillary entrapment due to hysteresis effects and successfully reproduction of the plume migration through numerical simulations. In order to compare the trapping enhancement under different geologic conditions we will include different homogeneous sand packing as well as highly heterogeneous permeability fields. Considering some of the potential limitations of the processes captured by the existing modeling codes, an investigation is carried out using a multiphase code developed by our team to reproduce the conceptual model based on experimental observations. The dataset of trapped non-wetting phase saturations obtained via x-ray attenuation method will be used to test the developed multiphase code.

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