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Capillary-Driven Solute Transport and Precipitation in Porous Media during Dry-Out

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The injection of dry or under-saturated gases or supercritical (SC) fluids into water bearing formations might lead to a formation dry-out in the vicinity of the injection well. The dry-out is caused by the evaporation/dissolution of formation water into the injected fluid and the subsequent transport of dissolved water in the injected fluid away from the injection well. Dry-out results in precipitation from solutes of the formation brine and consequently leads to a reduction of the rock's pore space (porosity) and eventually to a reduction of permeability near the injection well, or even to the loss of injectivity.

Recently evidence has been found that the complexity of the pore space and the respective capillary driven solute transport plays a key role. While no effective-permeability (K_{eff}) reduction was observed in a single-porosity sandstone, multi porosity carbonate rocks responded to precipitation with a strong reduction of K_{eff}. The reason for the different response of K_{eff} to salt precipitation is suspected to be in the exact location of the precipitate (solid salt) in the pore space.

In this study, we investigate dry-out and salt precipitation due to supercritical CO_2 injection in single and multi-porosity systems under near well-bore conditions. We image fluid saturation changes by means of μCT scanning during desaturation. We are able to observe capillary driven transport of the brine phase and the respective transport of solutes on the rock's pore scale. Finally we have access to the precipitated solid-salt phase and their distribution. The results can proof the thought models behind permeability porosity relationships $K(\phi)$ for injectivity modeling. The topic and the mechanisms we show are of general interest for drying processes in porous material such as soils and paper.