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Pore-Scale Insights into Freshwater Displacement Dynamics in Brine-Saturated Berea Sandstone Using 4D Microtomography

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In recent years, oil and gas companies operating in regions with high-salinity reservoirs have shown a growing interest in the processes occurring at the pore scale during the displacement of brine with freshwater. This interest is driven by the potential for freshwater injection to alter the physicochemical properties of the rock-fluid system within the pore spaces of the reservoir, thereby improving oil recovery. Such alterations can lead to changes in surface tension between oil and water, enhancing the mobility of oil within the porous medium and consequently increasing its extraction. Additionally, the interaction between the fluid and the rock matrix can affect the wettability of the rock; a transition towards more hydrophilic conditions could facilitate the easier displacement of oil by water. This study employs 4D microtomography to experimentally investigate brine displacement by freshwater in Berea sandstone at the pore scale under reservoir conditions using an X-ray transparent Hassler core holder. The in-situ visualization allowed for the mapping of salt concentration distribution within the fluid during displacement, capturing the main front of concentration drop within the pore space of the sample. These observations were corroborated by breakthrough moment determination based on the measurement of electrical resistance at the sample's output. The findings provide direct insights into fluid mixing in complex porous media, offering both data and validation for pore-scale process modeling.

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