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Simulation of CO2-Brine Primary Displacement in heterogeneous carbonate rocks

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Prediction of fluid flow in the subsurface is crucial for many applications, including environmental contaminant remediation and climate change mitigation. However, many challenges are involved, as seen in many carbon dioxide storage sites worldwide; the carbon dioxide has migrated away from the injection points much faster than predicted. This suggests that understanding the underlying mechanisms needs to be improved, especially for heterogeneous reservoirs. Rock heterogeneity at the submeter scale significantly impacts single and multiphase fluid flow properties and is an essential control of flow at larger scales. Incorporating real heterogeneous flow properties into reservoir characterization is crucial to modeling and predicting fluid flow in the subsurface successfully.

Digital rock techniques are disclosing new opportunities to improve fluid flow and transport predictions across scales. They aim to include laboratory-based characterization protocols to incorporate the effects of small-scale capillary heterogeneity into reservoir scale simulations. When coupled with a numerical simulator and an optimization routine, the upscaled relative permeability and capillary pressure curves, and the corresponding effective petrophysical parameters are estimated.

This paper discusses an upscaling workflow that combines special core analysis (SCAL) and pore network modeling (PNM) interpretations with long-core experimental and numerical methods to characterize heterogeneous carbonate rocks. In this study, the Estaillades carbonate is analyzed using a numerical history match of a long core flood experiment with the 3D saturation distribution as a matching target and the 3D capillary pressure characteristics as a fitting parameter. Throughout this workflow, the reservoir core-analysis practices are improved in such a way that could address rock heterogeneities. Furthermore, the relative permeability and capillary pressure uncertainty range quantified from the stochastic SCAL simulations are proven for an upscaling workflow from the SCAL samples to the long core samples.

Participation

In-Person

References

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