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Upscaling investigations of dissolution using machine learning and GeoChemFoam

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Dissolution of solid mineral in porous media due to the introduction of reactive fluids is of utmost importance for a wide range of subsurface applications, including CO2 storage, geothermal systems, fuel cell technology, and enhanced oil recovery. The conditions of the injection process as well as the mineral properties strongly influence the resulting dissolution pattern, leading to compact, uniform, wormholing, or channeling dissolution that change the permeability and flow properties of the reservoir. In this work, we present a comprehensive analysis of the impact of pore-space heterogeneity on the various regimes during acid injection at the pore-scale using numerical simulation. Our fast, efficient dissolution numerical model, based on the Darcy-Brinkman-Stokes method within the OpenFOAM toolbox in GeoChemFoam, is used to run 2D simulations of dissolution on ultra-large synthetic, stochastically created geometries with varying levels of pore-space heterogeneity. For each model, the influence of flow and reactive conditions on the local dissolution is characterized. We observe that heterogeneities in the pore space facilitate the development of local flow instabilities that result in wormholes and channels due to the existence of preferential flow paths. These flow and reactive parameters are extracted with mage analysis and used to train a deep neural network to predict the porosity and permeability changes on Darcy-scale grids. This is the first work to directly compare pore and Darcy scale model results for reactive dissolution systems, giving insight into the interplay between flow, reaction, and heterogeneity across scales.

Participation

In-Person

References

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