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Mineral precipitation driven alteration of fractured porous media – a pore scale perspective

HANG DENG[1], JENNA POONOOSAMY[2] AND SERGI MOLINS[3]

[1]Lawrence Berkeley National Laboratory
[2]Forschungszentrum Juelich
[3]LAWRENCE BERKELEY NATIONAL LABORATORY

Presenting Author: hangdeng@lbl.gov

Mineral precipitation is ubiquitous in many natural and engineered systems due to mineral-fluid interactions, fluid mixing, etc. The spatial patterns and amount of mineral precipitation are dependent on the physical-chemical properties of the substrate, fluid chemistry, reaction kinetics, and transport rates. As a result of mineral precipitation, the structures and transport properties (e.g., permeability and diffusivity) of fractured porous media can undergo significant alteration. The resulting changes in transport properties are typically related to porosity change, however, pore-scale dynamics that are not considered in these relationships can be important.

Pore-scale dynamics of the mineral precipitation involve complex interplays between multiple processes, including nucleation, crystal growth, and local transport limitation. In this study, we use the micro-continuum approach to perform pore-scale reactive transport simulations that explicitly consider coupled dissolution and precipitation reactions, passivation of surface area due to mineral precipitation, and different nucleation and reaction pathways.

The simulations are used to systematically investigate the sensitivity of pore-scale precipitation dynamics to uncertainties associated with precipitation mechanisms and rate coefficients, and the changes in effective diffusivity in porous media and fracture permeability as a result of mineral precipitation. These data will be used to inform continuum-scale modeling of precipitation driven alteration of fractured porous media.