



Contribution ID: 311

Type: **Poster Presentation**

Investigation of coupled processes in fractures and the bordering matrix via a micro-continuum reactive transport model

Wednesday, 1 June 2022 09:20 (1h 10m)

In multi-mineral fractured rocks, the altered porous layer on the fracture surface resulting from preferential dissolution of the fast-reacting minerals can have profound impacts on subsequent chemical-physical alteration of the fractures. This study adopts the micro-continuum approach to provide further understanding of reactive transport processes in the altered layer, and mass exchanges with the bordering matrix and fracture. The modeling framework couples the Darcy-Brinkman-Stokes (DBS) solver in COMSOL Multiphysics and the geochemical modeling capability of CrunchFlow. 3D steady state simulations with systematically varied chemical-physical parameters of the altered layer were performed to examine the impacts of individual factors and processes. Our simulation results confirm previous observations that dissolution of the fast-reacting mineral (i.e., calcite) is largely controlled by diffusion across the altered layer. We also show that dissolution of the slow-reacting mineral (i.e., dolomite), which controls altered layer development and fracture enlargement, increases with surface area and has a complex dependence on different local rate-limiting processes. In particular, advection can result in evident spatial variations in the local dissolution rates of dolomite, although it does not affect the bulk chemistry significantly. The difference in the spatial patterns between simulations with and without advection in the altered layer is more noticeable in the locations with smaller apertures, with up to 20% difference in local reaction rates. Therefore, it is important to include a full depiction of advection, diffusion and reactions for accurately capturing local dynamics that control long-term fracture evolution.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Unsure

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Presenter: ZHANG, Qian

Session Classification: Poster

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media