Pore Scale Modelling of Fracture Permeability Evolution Under Coupled Flow-Geochemical Process

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Abstract. The coupled flow-geochemical process is essential for fracture permeability evolution in geological formations. As such, it is crucial to develop a modeling framework that accurately captures the coupled process and its influence on the permeability evolution of rock fractures. The proposed model couples fluid flow and geochemical processes in 3D roughed rock fractures, in which Navier-Stokes (NS) simulations describe fluid flow, and the geochemical process is modeled by an advanced reactive transport model. It considers the effects of chemical reactions, such as mineral dissolution and precipitation, on fracture permeability evolution. The model is solved using the mixed finite element (MFE) approach based on the open-source platform FEniCS. The preliminary results show that fracture permeability increased rapidly at early stages due to self-enhanced dissolution but decreased significantly at later stages due to mineralization. Additionally, it was observed that changes in fluid composition had a significant influence on the dynamics of the coupled flow-geochemical process and thus impacted fracture permeability evolution. Furthermore, interactions between fractures were identified as an essential factor affecting the magnitude and distribution of permeability changes. This works provides a comprehensive modeling framework for modeling fracture permeability evolution under coupled flow-geochemical processes in fractured rocks, providing insight into how hydro-geochemical process can affect fracture permeability.