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Capturing poromechanical coupling effects of the reactive fracturing process in porous rock via a DEM-network model

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Fluid transport in a porous medium has important implications for understanding natural geological processes. At a sufficiently large scale, a fluid-saturated porous medium can be regarded as a two-phase continuum, with the fluid constituent flowing in the Darcian regime. Nevertheless, a fluid mediated chemical reaction can in some cases change the permeability of the rock locally: Mineral dissolution can cause increased permeability, whereas mineral precipitation can reduce the permeability. This might trigger a complicated hydro-chemo-mechanical coupling effect that causes channeling of fluids or clogging of the system. If the fluid is injected or produced at a sufficiently high rate, the pressure might increase enough to cause the onset and propagation of fractures. Fractures in return create preferential flow paths that enhance permeability, localize fluid flow and chemical reaction, prevent build-up of pore pressure and cause anisotropy of the hydro-mechanical responses of the effective medium. This leads to a complex coupled process of solid deformation, chemical reaction and fluid transport enhanced by the fracture formation.

In this work, we develop a new coupled numerical model to study the complexities of feedback among fluid pressure evolution, fracture formation and permeability changes due to a chemical process in a 2D system. We combine a discrete element model (DEM) previously used to study a volume expanding process[**?**, **?**] with a new fluid transport model based on poroelasticity[**?**] and a fluid-mediated chemical reaction that changes the permeability of the medium. This provides new insights into the hydro-chemo-mechanical process of a transforming porous medium.

References

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