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Towards fully coupled models of deformation, reaction, and fluid flow with dissolved aqueous species

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Fluid-rock interaction plays a fundamental role in geological processes. It is well known that chemical reactions in rocks are facilitated by fluids, transport of chemical elements is enhanced, and so is deformation. Numerical models currently involve complex and realistic rheological behaviour coupled with porous flow involving dynamic permeability. Most sophisticated models are fully coupled and include chemical reactions together with fluid flow and deformation. Yet, the fluid, the main transport agent of chemical elements in these models, is treated unrealistically simple (i.e. usually as pure water).

We are currently developing numerical models in which solid deformation, fluid flow and reaction are fully coupled, density and porosity are varying and chemical elements can be dissolved in the fluid as aqueous species. Here, we present our first model attempts that simulate how a piece of rock consisting of multiple minerals deforms, where the fluid flows, which minerals dissolve and precipitate, how the chemistry evolves through time due to advection and diffusion, and what aqueous species would be present at any location in the model domain.

We aim to demonstrate the feasibility of running numerical models for fluid interaction in reacting and deforming rocks involving a more realistic fluid that has complex chemistry and aqueous species. This will be useful in better understanding natural fluid-rock interaction processes and in deciphering and interpreting microstructures and chemistry of field and microscopic observations in rocks.