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Fluid-rock interaction in deep geothermal systems

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In enhanced or engineered geothermal systems (EGS) a fluid is pumped into a fractured reservoir through an injection well, exchanges heat with the hot rock and is extracted again in a production well. In order to minimise the risk for failure of Enhanced Geothermal Systems and maximise performance and live time predictive models coupling temperature and pressure variations with reactive transport and deformation have to be developed. While models of reactive transport coupled with temperature and thermo-mechanical-hydraulic models are in widespread use, models combining reactions and deformation are still in their infancy. A first and relatively straight forward step is to investigate the influence of pressure variations on reactions. This includes the effect of mechanical closure, which should be particularly relevant for reactions with large volume change (such as the observed formation of clay minerals in granitic EGS). On the other hand, high fluid pressures may facilitate the dissolution of some minerals, which are then re-precipitated when pressure drops (e.g. at the surface). A second step is to study the effect of reactions on rheology. High fluid pressures may result in fracturing of the reservoir. In addition pressure solution of minerals in e.g. sedimentary basins leads to viscous compaction of the rocks. Viscous rheology allows for the formation of porosity waves, which create transient or dynamic permeability in the reservoir. This in turn may allow for the rapid transport of fluids in and out of the area close to the well without invoking the existence of an additional connected network of open fractures. In addition to creating viscous behaviour reactions might enhance the formation of transient porosity during reactive transport of the fluid through the rock. If porosity waves form in EGS they create a pressure increase at their head and under-pressure in their tail. These pressure variations may again enhance or suppress reactions along the path of the wave.