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Numerical modelling of deformation and fracturing of thermo-poroelastic media

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In addition to significantly impacting flow properties, fractures may deform and propagate due to changes in the stress state. Such stress changes may e.g. be caused by changes in fluid pressure or rock temperature. Accounting for all interacting processes and structures leads to a tightly coupled and highly complex system.

We apply a mixed-dimensional model explicitly accounting for both rock matrix and fractures, the latter as two-dimensional objects. This framework enables tailored modeling in the different parts of the domain. We impose conservation of mass and energy in both fractures and matrix and conservation of momentum in the matrix. At the fractures, we impose contact mechanics relations and propagation criteria based on the local stress state. Coupling between fractures and matrix is formulated as interdimensional fluid and heat fluxes and displacement at the two fracture surfaces.

We demonstrate the model through three-dimensional transient simulations focusing on process-structure interaction. That is, we investigate the interplay between thermo-hydraulic processes and fracture deformation, including propagation of pre-existing fractures.