Numerical Modeling of Flow, Energy Transfer, and Deformation in Fractured Geothermal Systems

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Engineered geothermal reservoirs exhibit strongly coupled thermo–hydro–mechanical–chemical (THMC) processes that govern reservoir evolution and performance during injection and production. For example, frictional sliding and opening of fractures and/or phase change arise from process-structure interactions among fluid flow, heat transport, rock deformation, stress transfer, and fracture geometries, representing strongly nonlinear multiphysics behaviour.

The presentation focuses on mathematical models and numerical methods for simulating the coupled multiphysics. The mathematical modeling is based on a mixed-dimensional approach, where fractures are modelled as co-dimension one objects. The surrounding rock is considered as thermo-poroelastic and the deformation of the fractures is modelled by frictional contact mechanics. We consider flow models of different complexity, ranging from single-phase isothermal models to thermal compositional models with phase separation. Various numerical challenges are highlighted and discussed, with emphasis on choice of model formulations and solvers. Numerical examples demonstrate how the proposed models can improve understanding of reservoir response to engineering operations.

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