FLUID-TRIGGERED SEISMICITY IN A DISCRETE FAULT NETWORK WITHIN A LOW PERMEABILITY FORMATION

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Hydraulic stimulation in low-permeability formations is crucial for enhancing connectivity of fractures and faults in various industrial projects, such as Enhanced Geothermal Systems (EGSs), gas shale exploitation, and CO2 storage. However, the potential for injection-induced seismicity poses a significant risk to nearby populations.

Discrete Fracture Networks (DFNs) are commonly used to assess hydraulic properties, fluid diffusion and the associated hydromechanical evolution of fractured reservoirs. However, DFNs modeling is typically conducted under a quasi-static approximation, hence lacking a complete description of the interaction between pressurized fluids and the resulting fault slip behaviour, from aseismic creep to earthquake rupture.

Here, we developed a 2-dimensional DFN model to understand fluid-induced earthquakes on multiple interacting and intersecting faults. The model couples hydraulic diffusion together with multiple interacting faults whose slip is governed by Rate-and-State friction law. Elastic interaction between faults is computed using a boundary element method accelerated by H-matrices, and the hydraulic diffusion is modelled with a finite volume method.

With this model, we address the potential for fluid induced slow-slip events and the resulting seismicity on and around the fault system. The long-term goal of this model is to bridge the gap between different scales such as measurements of permeability and frictional stability retrieved from laboratory experiments, in-situ observations of fault slip and opening from fluid injection experiments at decametric scale, and finally, induced seismicity in crustal reservoirs.