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Stabilization of Forced Heat Convection: Applications to Enhanced Geothermal Systems (EGS)

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The natural permeability of geothermal reservoirs is low and needs to be enhanced
to ensure an efficient use and economic viability. Next to chemical enhancement, the main technique used for that purpose is hydraulic fracturing. Here, hydraulic fracturing is introduced in a thermo-poroelastic framework. The main addition to this framework is a fracturing model, phrased in terms of Terzaghi's effective stress that governs the evolution of size and aperture of the fractures in all directions of space. At any geometrical point, a fracture-induced anisotropic permeability tensor is calculated: Next to the injection pressure and thermal shrinking, the directional properties of this tensor are strongly influenced by geological stresses. The fully integrated framework is henceforth used in simulating thermal recovery from enhanced geothermal reservoirs.
Evidently, the credibility of the numerical simulations cannot be sufficiently trusted with large spurious wiggles in the temperature field and consequently in those of the effective stresses. This paper provides several approaches
to stabilize convection of heat due to extreme injection conditions at early stages, sudden increase in permeability due to hydraulic fracturing, and near the production wells at late injection stages. Emphasis is paid to the subgrid scale/gradient subgrid scale method where the transient problem is placed into a stabilized advection–diffusion–reaction problem.

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