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Modeling far-field poroelastic effects in EGS systems

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Geothermal stimulation often requires new techniques to address the challenge posed by induced seismicity. One of the proposed configuration is to have a doublet of underground horizontal wells linking multiple, heat-exchanger sources via hydraulic stimulation, delivering electricity over a working period of about 30 years. Such setting can be modeled as a set of multi-stage, parallel, tensile fractures system.
Injection of low temperature fluids alter both stress and pore-pressure fields, enhancing the permeability of the surrounding poroelastic rocks. Although induced seismicity caused by fluid injection is usually taught to be driven by pore pressure changes, according to the theory of poroelasticity, also variation in poroelastic stress must be expected. This effect can be particularly relevant in the far field, where the pressure propagation is limited by the low permeability of the basement rock. In EGS, most common tools simulate quite satisfactorily the seismicity directly associated with injection, but they do not explicitly treat the case of triggering a nearby and critically stressed fault in the relative far-field.
By accounting for a multi-stage scenario, we systematically compute the variation of the poroelastic stress in the medium surrounding the stimulated, multi-cracked region, and we address possible induced seismicity by means of a seed-model. We use a Green's functions approach to determine stress and pore pressure distribution in a horizontally layered, poroelastic half-space embedding both the EGS system and a potentially reactivating fault zone. The calculated stresses are then passed to a stochastic-geomechanical simulator to model seismic catalogs. The final embedded code results in a relatively quick tool to assess the potential for studying "outside" seismicity, as well as to address the effect of regional seismicity on the EGS region.