Effect of fault architecture and permeability evolution on response to fluid injection

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Abstract

Injection induced seismicity is thought to be, mainly, due to increase in pore pressure, which reduces the strength of a nearby fault. Here, we address the modeling and prediction of the hydro-mechanical response of faults due to fluid injection, mainly as waste water disposal. We consider the full poroelastic effects and the changes in porosity and permeability of the medium due to changes in local volumetric strains. Our results include effects of the fault architecture (low permeability fault core and high anisotropic permeability damage zones) on pressure diffusion and the fault poroelastic response. By studying a geological based model, taken from Guy-Greenbrier fault earth-quake sequence in Arkansas from September 2010 to July 2011, we show that the existence of highly permeable damage zones facilitates pressure diffusion and results in a sharp increase in pore-pressure at levels much deeper than the injection wells, while the low permeability fault core and anisotropic permeability in damage zones can act as barriers to fluid flow. We calculate the changes in coulomb failure stress, due to injection, and show that their positive values (favoring failure) match the migration of seismicity along the fault from northwest, at early injection times, to southeast and deeper levels at later periods.

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