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Failure patterns in poro-elasto-plastic medium: Results from a two dimensional time-dependent pore-pressure model.

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Fluid flow in the earth is controlled primarily by fractures and fracture networks. These networks evolve over time in response to the regional stress field and local stress perturbations caused by faulting, while faulting can change the hydraulic properties by many orders of magnitude. Recent studies have shown that degassing of deeply trapped high pressure pockets can have a major influence on aftershock generation, but models of this process have been limited to a non-linear permeability model. They do not include the effects of shear and tensile cracking on the evolving permeability structure, nor do they include seepage forces (from pore pressure gradients) and their role in the initiation and propagation of fractures. We have developed a model of these processes by advancing the model of Rozhko et. al. (2007), who coupled steady state fluid flow in a deforming elasto-plastic media, to include fluid flow through evolving fracture networks. The elasto-plastic deformation code is coupled with a time-dependent Darcy fluid flow code, where permeability evolves in response to the growing fractures and a proxy crack aperture determined by the amount of accumulated plastic strain. We will present the results of simulations in which we study the effects of (1) rheological heterogeneities on fluid flow and crack initiation, (2) dynamic evolution of permeability as a function of plastic damage and (3) influence of the nucleation of new shear zones on patterns of fluid-flow.

Reference:

Rozhko, A. 2007. Role of seepage forces on hydraulic fracturing and failure patterns. Ph. D. thesis. University of Oslo.