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Hydro-mechanical procesess at the base of seismogenic zones

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An array of recent observations including non-volcanic tremor, slow-slip earthquakes, swarms, and foreshocks all point to high pressure fluids as a likely driving culprit. This suggests that high pressure fluids and their migration patterns play a fundamental role in the earthquake cycle, particularly in the preparatory phase of large earthquakes. The hypothesized scenario is that volatiles generated by continuous Earth degassing migrate towards the surface via some (presumably ductile) process. These fluids (primarily CO_2 and H_2O) pool at high pressure at the base of the hydrostatically pressured crust, with the hydraulic networks growing and maturing over the earthquake cycle. Late in the earthquake cycle, this network begins to invade into the incipient slip zone, creating new fractures and opening the system to additional fluid flow. The foreshock behavior of the 2009 L'Aquila earthquake shows strong evidence of high pressure fluid near the base of the hypocenter invading into the incipient slip plane on a scale of months preceding this event, while subsequent analyses showed large pockets of highly overpressured fluid in the source region. We focus on pre-earthquake behavior in terms of fluid-driven processes and model hydro-mechanical interactions at the base of seismogenic zones in the presence of high pressure fluids. We model these interactions using an elasto-visco-plastic rheology and a fluid pressure (and aperture) dependent permeability. In the model, fractures grow in response to the prevailing regional stress field and perturbations due to crack growth. We investigate the response of the base of the crust undergoing different rates of volatile input, and show how the resulting network (and expected seismicity) patterns depend on those rates.