# MODELS OF INJECTION-INDUCED SEISMIC SLIP WITH PERMEABILITY ENHANCEMENT AND RATE-AND-STATE FRICTION

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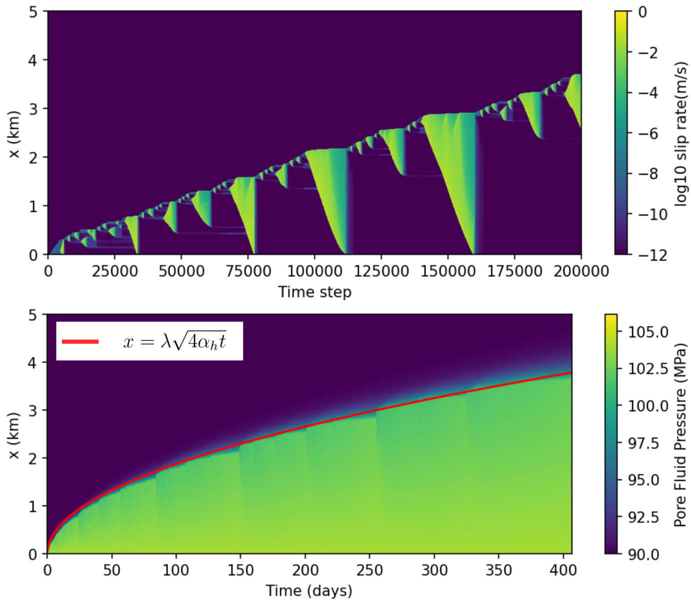
Anthropogenic fluid injections and natural fluid flow in Earth's crust leads to an increase in pore pressure, which can trigger earthquake swarms characterized by a migrating seismicity front. Observations of seismicity expanding with the same diffusive space-time behavior as analytical solutions for aseismic slip have been interpreted as evidence for seismic slip triggered by stress changes from aseismic slip. In some cases, aseismic slip is confirmed from crustal deformation and shear wellbore casing. Our work offers another interpretation of migrating seismicity that may be relevant when there is no independent evidence for aseismic slip. We show that pressure diffusion and elastic stress transfer can independently drive the diffusive expansion of seismicity fronts, and that analytical solutions for aseismic slip can explain this seismicity pattern, even when all slip is seismic. Here we present a 2D earthquake cycle model that simulates constant-pressure injection into the end of a velocity-weakening rate-and-state fault, permeability enhancement with slip, and fluid transport. Our simulations produce microseismicity concentrated along the slip front and large events that rupture back to the injector, with minimal aseismic slip prior to or during the sequence. The fault is planar with uniform friction and stress, likely concentrating seismicity at the slip front. Although we find that simulations for understressed faults have some distributed seismicity behind the slip edge, future work accounting for heterogeneities may produce more realistic spatial distributions of seismicity. Our results suggest that aseismic slip solutions can be used to quantitatively interpret the space-time behavior of migrating swarms, even in cases with negligible aseismic slip.

*Note: Figure is on the next page.*


x (km)
Time step
log10 slip rate(m/s)
$x = \lambda\sqrt{4\alpha_h t}$
Time (days)
Pore Fluid Pressure (MPa)