Seismic diffusivity: The influence of fracture networks on the patterns of induced seismicity.

Ryan Haagenson¹ and Harihar Rajaram²
¹University of Colorado Boulder, Civil, Environmental and Architectural Engineering, United States of America (haagenso@colorado.edu)
²Johns Hopkins University, Environmental Health and Engineering, United States of America (hrajara1@jhu.edu)

It has been long understood that the injection of fluids into the subsurface, a common practice in several industries, often leads to seismic activity by altering the fluid pressures and stress states acting along fault structures. In some cases, this puts the people and infrastructure located nearby at considerable risk. The effective mitigation of this potential hazard relies heavily on understanding the physical mechanisms controlling the behavior of injection-induced seismicity. Here, we aim to better understand the spatiotemporal patterns of the seismicity through the concept of triggering fronts (i.e. the propagating front where the onset of seismicity occurs). Previously, triggering fronts have been studied mostly in the context of homogenous porous media. Here, field scale simulations of fluid injection into fractured rock are modeled as linear, uncoupled fluid flow. While injection-induced seismicity is certainly affected by poroelastic stressing and nonlinear hydraulic parameters of the rock, the focus of this study is to understand the impact of a discrete fracture network on patterns of seismicity. Therefore, poroelastic and nonlinear effects are ignored. Results indicate that the pathways of high permeability within the fracture network greatly influence the migration of the triggering front. While the triggering front clearly follows a diffusive process as expected, the corresponding diffusivity is found to be distinct from the effective hydraulic diffusivity of the domain. We, therefore, call this diffusivity the seismic diffusivity of the fractured rock. Understanding seismic diffusivity may help us better interpret datasets of injection-induced seismicity and potentially forecast the patterns of injection-induced seismicity in well-characterized formations.