Large-scale response of injection-induced seismicity modulated by geomechanics

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The central and eastern United States have seen an unprecedented rise in the number of earthquakes in the past decade. The vast majority of these earthquakes have been tied to injection operations for the disposal of wastewater or for hydraulic fracturing. Wastewater injection in the states of Oklahoma and Kansas, specifically, has been tied to thousands of induced earthquakes across the two states. In both states, crystalline basement faults respond to stress changes from injection based upon the hydrogeologic and geomechanical parameters governing the region. Here, I will show that variations in the seismic response at the regional-scale may be explained by regional geomechanical properties. Stochastic models of geomechanical properties show that the regional stress state can modulate the availability of critically stressed fractures and faults. These fractures and faults are the primary pathways for fluid flow in the otherwise low-permeability crystalline basement. Regions of Oklahoma and Kansas which have exhibited shorter lag times between the onset of injection and seismicity are also regions which are predicted to have a greater density of critically stressed faults and fractures.

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