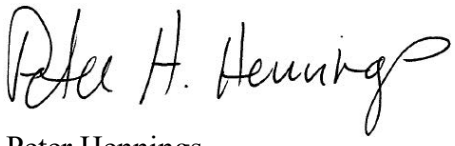
Understanding Anthropogenic Fault Rupture in the Eagle Ford Region, south-central Texas

Abstract

There is a well-known occurrence of increased felt seismicity and smaller seismic events in areas where hydraulic fracturing (HF) operations occur. The Eagle Ford shale play of south-central Texas experienced an increase in the rate of felt seismicity from 2014-2019, temporally coincident with petroleum development in the region. By mid-2019, the rate of seismicity decreased alongside a reduction in the rate of well completions, thus prompting this investigation of the relationship between HF operations and geologic conditions that contribute to induced earthquake hazards. The goals of this work included mapping and conducting a geomechanical characterization of faults that delineate seismogenic regions of the Eagle Ford to understand the conditions that lead to inducing fault rupture. An integrated regional dataset composed of published data, wells, earthquakes, and interpretations from operators provided input for a 3D structural framework. Earthquake relocation analyses helped constrain the distribution of earthquakes that correlate to interpreted faults and enable identification of those that have been seismogenic. In-situ stress state of faults was analyzed to determine fault sensitivity *in situ*. A spatiotemporal analysis of HF operations and earthquakes further revealed induced-earthquake clusters that are linked to specific faults. We show how seismogenic and aseismogenic fault systems relate to earthquakes by determining which faults are more sensitive and which faults have been seismogenic. Faulting is dominated by NE-SW striking normal faults with 21% having hosted induced earthquakes since 2017. Faults in the Eagle Ford region have a geologically quasi-stable *in situ* stress state. Using a conservative scheme, we directly associate 45% of earthquake ruptures to HF to build our analysis dataset. Of those events, 70% are located within 1 km of a mapped fault. Stress conditions on seismogenic faults show a wide range of sensitivity to rupture. This suggests that all faults close to HF operations should be considered as candidates likely to rupture.



Peter Hennings
McKeighan Supervisor and Thesis Committee Chair