Induced Seismicity: Relationships between Earthquake Frequency and Magnitude to Saltwater Injection in Oklahoma Arbuckle Group

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Oil and gas fuel our lives and our world, but the impact of certain operational methods could have negative consequences on the environment and the earth, including what lies beneath the surface. Oil production in Oklahoma increased to an all-time high in 2017 and continues to rise, according to the Oklahoma Economist. However, as the oil industry grows, these production operations can incite human-made seismic activity disrupting nearby communities. Understanding the causes of induced earthquakes helps predict and prevent future events —saving buildings, businesses, and lives. As part of a larger professional study, my individual project objective was to analyze and evaluate earthquake seismicity data and oil companies' return saltwater injection data from 1974-2018 within an Area of Interest (AOI) in Oklahoma to understand relationships between induced earthquakes and saltwater injection. The saltwater injection volumes versus earthquake data led me to further analyze and contrast public data and maps to find relationships between earthquake frequency, magnitude, depth, well location, saltwater injection volumes and tectonic settings within the AOI. This integration of data determined that there is a correlation between injection volume and frequency, but not magnitude. Additionally, this project provides evidence that earthquakes are occurring across a large segment of the stratigraphic column. Lastly, this project concluded that tectonic provinces within the AOI are creating boundaries which influence the geographic distribution of these induced earthquakes. Understanding the geologic behavior of different tectonic provinces in operational areas, we have the potential to regulate saltwater injection and mitigate induced seismicity more accurately.

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