Earthquakes and Oil Production at the Wilmington Oil Field: A Coupled Flow and Geomechanics Model

Annika Huprikar (Undergraduate, Shaw Lab Group)

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Abstract

While earthquakes have long been attributed to tectonic processes and natural stress changes underneath the Earth's surface, there is reason to believe that anthropogenic, man-made triggers may be responsible for some seismic activity. Fluid injection related to oil and gas production, geothermal energy extraction, and carbon capture and storage (CCS) are activities potentially causing sub-surface stress changes and inducing earthquakes. In this project, the area being studied is the Wilmington oil field in the Los Angeles Basin, which overlays the Wilmington thrust fault capable of inciting strong earthquakes of magnitudes 6.3-6.4. The goal is to determine the effect of Wilmington oil production and water injection on the stability of pre-existing geological faults. Studying this could demonstrate whether such sub-surface changes pertaining to fluid pressures are affecting seismicity, while also informing energy policies. We are in the process of building a coupled multiphase flow and geomechanics simulation in MATLAB to model Wilmington's historical oil production and water injection, utilizing data from 1936-2020. The overarching model is coupled because changes in reservoir rock pore pressures cause changes in its volume that can induce normal/shear stress changes along the Wilmington fault (multiphase flow fluid dynamics model). Together, the changes in fluid pressure and stress could trigger earthquakes, and may also cause vertical motions of the ground surface. We intend to determine the impact on the reservoir rock's pore pressures and deformation; additionally, we aim to look at how the changes in shear and normal stresses along the Wilmington fault compare with the maximum fault strength, thereby analyzing the stability of the fault overtime.