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Modeling of fluid injection and withdrawal induced fault activation using discrete element based hydro-mechanical and dynamic coupled simulator

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Operation of fluid injection into and withdrawal from the subsurface for various purposes has been known to induce earthquakes. Such operations include hydraulic fracturing for shale gas extraction, hydraulic stimulation for Enhanced Geothermal System development and waste water disposal. Among these, several damaging earthquakes have been reported in the USA in particular in the areas of high-rate massive amount of wastewater injection [1] mostly with natural fault systems. Oil and gas production have been known to induce earthquake where pore fluid pressure decreases in some cases by several tens of Mega Pascal. One recent seismic event occurred in November 2013 near Azle, Texas where a series of earthquakes began along a mapped ancient fault system [2]. It was studied that a combination of brine production and waste water injection near the fault generated subsurface pressures sufficient to induced earthquakes on near-critically stressed faults. This numerical study aims at investigating the occurrence mechanisms of such earthquakes induced by fluid injection [3] and withdrawal by using hydro-geomechanical coupled dynamic simulator (Itasca's Particle Flow Code 2D). Generic models are setup to investigate the sensitivity of several parameters which include fault orientation, frictional properties, distance from the injection well to the fault, amount of fluid withdrawal around the injection well, to the response of the fault systems and the activation magnitude. Fault slip movement over time in relation to the diffusion of pore pressure is analyzed in detail. Moreover, correlations between the spatial distribution of pore pressure change and the locations of induced seismic events and fault slip rate are investigated.

References

[1] Keranen KM, Weingarten M, Albers GA, Bekins BA, Ge S, 2014. Sharp increase in central Oklahoma seismicity since 2008 induced by massive wastewater injection, Science 345, 448, DOI: 10.1126/science.1255802.
[2] Hornbach MJ, DeShon HR, Ellsworth WL, Stump BW, Hayward C, Frohlich C, Oldham HR, Olson JE, Magnani MB, Brokaw C, Luetgert JH, 2015, Causal factors for seismicity near Azle, Texas, nature communications 6:6728, DOI: 10.1038/ncomms7728
[3] Yoon JS, Zimmermann G, Zang A, Stephansson O, 2015, Discrete element modeling of fluid injection-induced seismicity and activation of nearby fault, Can Geotech J 52: 1457-1465, DOI: 10.1139/cgj-2014-0435.