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Induced earthquakes in the Hellisheidi geothermal field, Iceland

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The 300 MW Hellisheiði, Iceland geothermal power plant was commissioned in 2006 and as of January 2018, the 63rd production well is being drilled. Additionally, there are 17 injection wells in the region. Drilling of a few of these wells has been accompanied by significant (M ∼2-3) earthquakes [Vogfjord & Hjaltadottir , 2007; Ágústsson et al., 2015], whereas no seismic events were observed during the drilling of others. Often the induced seismicity is coincident with either; 1) loss of circulation fluid, when drilling through large fractures, which absorb the drilling fluid or 2) well testing after completion of drilling, during which fluid is pushed into the hole with increasing pressure. Most of the wells are located in the highly fractured fissure swarm of the central volcano Hengill, which includes hyaloclastite ridges and lava fields and it is considered that the fluid flow is fracture dominated.

In addition to the seismicity induced in connection to drilling, the level of seismicity in the region has been highly increased by reinjection of affluent water (including two Mw 4.4 earthquakes in 2011), as well as by the production itself.

In this study we document the seismicity associated with the drilling of each well, and correlate that with other well parameters, for example lithology, temperature, injectivity/productivity and faults observed cutting the wells. Furthermore, we compare the seismicity during drilling with that during production/injection.