Induced earthquakes at the carbon sequestration site Carbfix2, Hellisheiði, Iceland

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The 303 MW Hellisheiði, Iceland geothermal power plant was commissioned in 2006 and in early September 2011, reinjection of geothermal fluid was initiated in the second reinjection site of the plant; Húsmúli. The site has 5 injection wells in operation, with depths of over 2000 m and a total of up to 500 l/s of fluid being reinjected into the site. Seismicity had previously been observed in the region, including both natural seismicity before power plant operations started (e.g. Foulger et al., 1988) and induced seismicity during drilling of the injection wells (Ágústsson et al., 2015). The reinjection caused severely increased level of seismicity within days, with two earthquakes of M 4.0 and M3.9 respectively, occurring a little over a month after the start of reinjection (Icelandic Meteorological Office catalog). The injection was also accompanied by uplift of approximately 2 cm (Juncu et al., 2018). Due to the increased level of seismicity, a committee was formed and several measures on how to control it were suggested – including starting reinjection gradually after it has been stopped (Bessason et al., 2012).

In 2014, as a part of the Carbfix2 project, the reinjection fluid in Húsmúli was combined with gas, and CO2 and H2S, previously being released into the atmosphere, is now captured and reinjected into the basaltic formation (Matter et al., 2016, Gunnarsson et al., 2018). It is estimated that the CO2 and H2S are crystalized into calcite and pyrite in under 2 years (Gunnarsson et al., 2018). This project has been very successful and is currently capturing and permanently storing an estimated 33% of the CO2 and 75% of the H2S extracted.

In this study we analyze seismicity data as reported by the Icelandic Meteorological Office Regional network, (1991-present) and the ON Power/ISOR local network (2016-present) and compare with operational parameters. We show 1) how the seismicity responds to changes in flow, pressure and temperature of the injected fluid, 2) how individual wells seem to respond differently, 3) how the mitigation measures taken by the operator have worked and 4) look for changes in seismicity due to the CO2 sequestration.

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