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# The possible role of magma and geothermal fluid in the episodic uplift cycles and intense seismicity beneath the Svartsengi high temperature geothermal field, Iceland

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The highly productive high temperature geothermal fields in Iceland are located within active volcanic systems on the plate boundaries. When an earthquake swarm or an unusual surface uplift or subsidence occur, it is important to assess the hazards and whether the unrest is triggered or controlled by volcanic or anthropogenic processes, or a combination of both.

On January 22nd, 2020, a rapid, large-scale uplift (14 km x 12 km) started at the Svartsengi geothermal field on the plate boundary of the Reykjanes Peninsula, along with an intense earthquake swarm that began simultaneously about 3 km east of the centre of uplift. The centre of uplift was located about 1 km west of Mt. Thorbjörn, in the middle of the Svartsengi geothermal field, close to the reinjection wells. Over a period of 6 months, three such uplift cycles occurred, each lasting for several weeks and followed by periods of relatively rapid subsidence. The duration and timing of the uplift-subsidence cycles appears to follow a clear trend where the successive inflation episodes lasted longer but with lower inflation rate.

The centres of uplift and the deflation cycles are the same and remained stationary. The accompanied intense earthquake swarms migrated along the 40 km long oblique plate boundary of the Reykjanes Peninsula, demonstrating a major plate tectonic event. The maximum depth of earthquakes was close to 4.5 km directly above the centre of uplift but extending to 6-7 km in the surroundings where the maximum magnitudes reached $M_W$ 4.8.

A few weeks after the onset of the unrest, nine additional seismic stations were deployed to densify the local seismic network in place. In addition, complimentary data from an existing 21 km long fibre optics cable were used to monitor high-frequency linear strain rates. Both measures led to a significant improvement in the earthquake detection and location which predominantly occurred in swarms. Likewise, InSAR data analysis of temporal uplift cycles was performed, repeated gravity measurements at permanent sites were performed, and resistivity was remeasured at chosen sites.

Multiple different elementary models were developed and tested to explain the cyclic excitation of the uplift, subsidence, and seismicity. While the individual unrest episodes might be controlled by possible magma intrusions into the lower crust, our favoured model explains the spatio-temporal pattern of ground uplift by the rise and diffusion of pore pressure in a 4-5 km deep geothermal aquifer. To distinguish between different models, we use multi-disciplinary geophysical datasets, such as deformation, seismicity, and gravity.