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Time-lapse magnetotellurics and micro-gravity monitoring of the Theistareykir geothermal field (Iceland)

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The Theistareykir geothermal field is located on the path of the Mid-Atlantic ridge in Northeastern Iceland. A power plant in the area produces 90 MWe since autumn 2017 using 13 production wells of around 2 km depth and 3 injection wells of about 450 and 100 m depth.

We monitor the spatial and temporal evolution of the geothermal reservoir using time-lapse magnetotellurics (MT) and micro-gravity methods. Surveys were performed before and after the beginning of the electricity production in summer 2017, 2018 and 2019.

9 MT stations were used to image the resistivity variations. Repeated MT measurements may help identifying the geothermal fluid path and characterizing the evolution of the reservoir, such as alteration of the medium or changes in water salinity or temperature. 5 components i.e. the horizontal electric field (Ex, Ey), the horizontal magnetic field (Hx, Hy) and the vertical magnetic field (Hz) components, were recorded simultaneously by METRONIX ADU-07e stations during 48 to 96 hours with a sampling rates of 512 Hz, 8,192 Hz and 65,536 Hz. Then, filtered time series were processed using the Bounded Influence Remote Reference Processing (BIRRP) program to derive apparent resistivity and phase sounding plots. Preliminary results indicate that the geothermal production increases the resistivity of the medium. No clear resistivity change is observed near the injection area.

27 gravity stations were measured with a relative Scintrex CG5 gravimeter in summer 2017, 2018 and summer 2019 to highlight the subsurface mass changes induced by the geothermal operations, and hence, help estimating recharge of the geothermal reservoir. These surveys were combined with Micro-g Solutions Inc. FG5#206 absolute gravity measurements and continuous gravity measurements to apply a fully hybrid micro-gravity method. In this context, GFZ Potsdam deployed three iGrav superconducting gravimeters and one gPhone spring gravimeter at the Theistareykir geothermal area since autumn 2017. The time-lapse gravity data are corrected for instrumental drift and vertical displacements deduced from GPS measurements performed by the University of Iceland. First results show a gravity decrease near the production area which can be explained by the extraction of 6.5 Mt at 1.6 km depth. We do not observe any significant gravity change near the injection area which suggests that the reinjected geothermal fluid is drained by faults.

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