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## The effect of utilization of the Theistareykir (N-Iceland) high temperature field on the natural geothermal surface manifestations and groundwater composition

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The global framework of the Paris Agreement aims for rapid reduction of GHG emissions to keep the global average temperature below 2 °C above pre-industrial levels. Renewables including geothermal are crucial in transition from a current carbon intensive to carbon neutral or carbon negative energy sources. Although considered as green and sustainable, the subsurface pressure changes caused by thermal fluid extraction might affect the spatial distribution and content of surface manifestations, e.g., fumaroles and may disturb the groundwaters system in the area. As such monitoring of natural features and groundwaters during the geothermal utilization is crucial in the sustainable management of the power plant and it contributes to the understanding of the hydrothermal system through its production lifetime. The aim of this study is to assess the possible effect of the Theistareykir power plant operation on the fumaroles and groundwater chemical composition.

The deep exploration wells in Theistareykir drilled in 2002-2012 confirmed predicted downhole temperatures of >300 °C and high energy generation capacity of the field. The production drilling in 2016-2017 and construction of the power plant carried out in 2015-2017 resulted in a 45 MW<sub>e</sub> production unit that started commercial operation in 2017. In 2018 a second 45 MW<sub>e</sub> unit was added increasing the total power output to 90 MW<sub>e</sub>. Today 12 production and 2 reinjection wells are in use. The results of the continuous fumarole monitoring within the geothermal field since 2012, show no substantial differences in the gases' concentrations. The current temperature of the reservoir based on the gas geothermometers is similar to the one obtained during the exploration stage (270-315 °C). The fumaroles located in the center and eastern parts of the production field show a continuous decrease in H<sub>2</sub>S and H<sub>2</sub> since 2015, before commencement of the power plant. The concentrations of the elements of concern such as As, Al, Cu, Zn, Cd, Pb, Cr, Ni in groundwaters show no major variations since monitoring first began in 2011. Furthermore, they have not exceeded limits established by the Icelandic directive for surface waters to protect sensitive biota. Even though the absence of noticeable changes in the compositions of the fumaroles and groundwater indicate that the production that started in 2017/18 has currently not posed an environmental threat, observations made in the other production fields suggest that this

can be expected in the future.