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$^{3}He/^{4}He$ monitoring of groundwater in Hafralækur, North Iceland: preliminary results

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Borehole HA-01, in Hafralækur, North Iceland, has been monitored for major elements and stable isotopes since 2008, where they have identified precursors to M > 5 earthquakes [1]. Noble gases, unlike most stable isotopes or major elements used as geochemical tracers, are less susceptible to water/rock interactions and display widely variable ratios among the Earth reservoirs, making them good tracers of source and fluid interactions.

For these reasons, we started sampling HA-01 for $^{3}He/^{4}He$ and $^{4}He/^{20}Ne$ ratios weekly on June 24th 2020, after a swarm of earthquakes occurred northwest of the borehole, and with SPARTAH, a continuous sampling system for groundwater and geothermal fluids [2], on September 16th 2020. We aim to identify possible relationships between the He-Ne ratios and seismic events in the region. In addition to the monitoring, we surveyed 8 boreholes in the area for $\delta^{34}S$, $\delta^{18}O$, $\delta^{2}H$, $\delta^{13}C$, $^{3}He/^{4}He$, $^{4}He/^{20}Ne$, and major and trace elements. Here we present preliminary results from this survey and the monitoring at HA-01, including samples from July 2015-February 2016.

HA-01 shows both mantle and air components. Samples from 2020 present slightly higher $^{3}He/^{4}He$ and $^{4}He/^{20}Ne$ ratios than 2015-2016, displaying a trend further from the air component. The stable isotopes are relatively homogeneous in the area and plot near or along the Icelandic meteoric water line, except for a sample from Húsavík, which has a significant seawater contribution. The wells north and west of HA-01 have relatively low $^{3}He/^{4}He$ (R_m/Ra) ratios, below 8 Ra, whereas samples near and south of HA-01 are up to 14 Ra. The latter group is near the Þeystareykir and Krafla volcanic systems; however, geothermal fluids from these systems display $^{3}He/^{4}He$ ratios up to 10.4 Ra [3], indicating that the area near and south of HA-01 might be buffered by a higher He flux. The surveyed wells show very distinct isotopic signatures consistent with different aquifers and are unlikely to have contributed to the shifts previously observed [1] at HA-01.

[1] Skelton et al. (2014), *Nature Geoscience* 7, 752– 756 [2] Barry et al. (2009), *G-cubed* 10, 1–9. [3] Füri et al. (2010), *Geochim. Cosmochim. Acta* 74, 3307–3332.