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# Fumarole gas chemistry of the Theistareykir geothermal field, NE Iceland

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The Theistareykir geothermal field is situated in the centre of the 70-80 km long and 7-8 km wide Theistareykir fissure swarm, which is the westernmost of the five NNE striking left-stepping en echelon volcanic systems that constitute the Northern volcanic zone of Iceland. The field has been studied for possible geothermal utilisation since the 1970s, with the first deep exploration well drilled in 2002. Since 2016, development of the field has accelerated and to date a total of 19 exploration and production wells have been sunk. The first 45 MW turbine of the Theistareykir power plant was commissioned in December 2017 with another 45 MW expected to go online in 2018.

We present gas concentrations and stable isotope results for steam and condensate samples collected from fumaroles in the Theistareykir geothermal field in NE-Iceland in 2012-2017. The major gases are $CO_2$ (40-80%-mol), $H_2S$ (10-25%-mol), $H_2$ (5-30%-mol) and $N_2$ (1-5%-mol). He concentration ranges from 15 to 115 ppmV. The gas composition suggests reservoir temperatures of about 280-300°C, which agrees well with the results of drilling.

The steam is depleted in heavy water isotopes, with $\delta$D ranging between -124‰ and -108‰ and $\delta^{18}$O from -19‰ to -12‰ (both relative to V-SMOW), exhibiting significant positive and negative deviations from the meteroric water line. Local groundwater is much less depleted, with $\delta$D in the range -80‰ to -70‰ indicating that the recharge of the geothermal system is non-local in origin.

The geothermal gas in Theistareykir is characterised by a low $^{40}$Ar/$^{36}$Ar ratio (294–296), a $N_2$/$^{36}$Ar ratio of about 14,000 to 16,000 and a negative but variable measured $\delta^{15}$N in $N_2$ (-2.0‰ to -0.5‰ relative to air), indicating that $N_2$ and Ar are to a large extent surface-derived. The $\delta^{13}$C values measured in $CO_2$ are approximately -2.5‰ (relative to V-PDB) which agrees well with the estimated pre-eruptive $\delta^{13}$C of magmatic basaltic melts (Barry et al., 2014). The measured $^3$He/$^4$He ratio is 10.4-10.8 Ra, which is somewhat higher then the MORB value. The He/Ne ratio suggests that there is little atmospheric contribution, and therefore the corrected $^3$He/$^4$He ratios are only slightly higher (10.7-11.0 Ra).