



## Isotope systematics of volatile elements in Icelandic thermal fluid

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Please fill in your abstract text. Thermal fluids in Iceland range in temperature from <10 to >450°C and are dominated by water (>95 mol%) and variable salinity with Cl concentration from <10 to >20,000 ppm. The isotope systematics of volatile elements of the fluids reveal many important features of the source(s) and transport of volatiles from the mantle beneath Iceland and through the crust to surface. Studies spanning over four decades have shown a large range of values for  $\delta D$  (-131 to +3.3‰, tritium (-0.4 to +13.8 TU) and  $\delta^{18}O$  (-20.8 to +2.3‰ for H<sub>2</sub>O,  $^3He/^4He$  (+3.1 to +30.4 RA),  $\delta^{11}B$  (-6.7 to +25.0‰,  $\delta^{13}C-CO_2$  (-27.4 to +4.6‰,  $^{14}C-CO_2$  (+0.6 to +118 pMC),  $\delta^{13}C-CH_4$  (-52.3 to -17.8‰,  $\delta^{15}N$  (-10.5 to +3.0‰,  $\delta^{34}S-H_2S$  (-10.9 to +3.4‰,  $\delta^{34}S-SO_4$  (-2.0 to +21.2‰ and  $\delta^{37}Cl$  (-1.0 to +2.1‰ in both liquid and vapor phases. Based on this isotopic and chemical dataset, it can be concluded that the thermal fluids originate from meteoric and/or seawater. For other volatiles, degassing of mantle-derived melts contribute to He, CO<sub>2</sub> and possibly also to Cl in the fluids whereas water-rock interaction also contributes to CO<sub>2</sub> and is the major source of H<sub>2</sub>S, SO<sub>4</sub>, Cl and B in the fluids. Air-water interaction mainly controls N<sub>2</sub>, Ar and Ne concentrations. The large range of many non-reactive volatile isotope ratios, such as  $\delta^{37}Cl$  and  $^3He/^4He$ , are considered to indicate heterogeneity of the mantle and derived melts beneath Iceland. In contrast, the large range of many reactive isotope elements, such as CO<sub>2</sub> and H<sub>2</sub>S, are heavily affected by processes occurring within the geothermal systems, including fluid-rock interaction, depressurization boiling, and isotopic fractionation between secondary minerals and the aqueous and vapor species. Variations due to these geothermal processes may exceed any differences observed among various sources highlighting the importance and effects of chemical reactions on the isotope systematics of reactive elements.