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Hydrogeochemical changes in trace element concentrations in connection with earthquakes and a volcanic eruption in Iceland

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The aim of this study was to identify changes of trace element concentration in groundwater and test for coupling with seismic and volcanic activity in Iceland. Samples used in this study were collected between September 2010 and June 2018 from the HA-01 groundwater well in Hafralækur (Northern Iceland), south of the Tjörnes Fracture Zone (oblique transform zone), and near the Laxá and Skálfandafljót river valleys. The temperature of the groundwater from the HA-01 well is 71–76 °C, pH is ca. 10.2 (at ~ 25ºC), and the dissolved solid content is about 240 ppm, which is typical of low temperature geothermal groundwaters in inland areas of Iceland. The HA-01 well groundwater is also influenced by mixing between old ice age aquifer and younger aquifer groundwater. The same samples were previously analyzed for major element concentrations and isotopic ratios, with results - changes prior to seismic activity - being published in recent papers. The 495 earthquakes (Mw≥4.0, September 2010 to June 2018) considered in this study are from the USGS database. Twenty-two of these earthquakes occurred in the Tjörnes Fracture Zone with M_w between 4.1 and 5.5 whereas the remaining ones with M_w between 4 and 5.5 were related to the Bárðarbunga eruption in central Iceland, which began on 29 August 2014 and ended on 27 February 2015. Results of trace element analysis highlight characteristic variations in the temporal series related to the Bárðarbunga eruption (onset in August 2014) and to the 2018 seismic swarm that occurred in the Tjörnes Fracture Zone. In particular, a marked increase of Li, B, Ga, Mo and Rb and a slight increase of Sr and V were observed prior to and in connection with the onset of the Bárðarbunga eruption. Moreover, our results show a pre-seismic (2018 seismic swarm in the Tjörnes Fracture Zone) hydrogeochemical variability greater than the background variability. Despite the distance to the Bárðarbunga eruption site, GPS data from northern Iceland show a clear strain changes that are associated with the large dike intrusion that fed the eruption and are possibly correlated with the hydrogeochemical time series. Results from this study in Iceland show that the hydrogeochemical monitoring of volcanic and seismic areas is a promising method in the science of seismic and volcanic precursors.