Multicomponent fluid chemistry of the high-enthalpy geothermal system, Krafla volcano, NE Iceland

MATYLDA HEŘMANSKÁ[1*] AND ANDRI STEFÁNSSON[1]

[1]Institute of Earth Sciences, University of Iceland, Sturlugata 7, 101 Reykjavík, Iceland (mattylda@hi.is)

Active volcanoes are commonly associated with high-enthalpy geothermal system. The Krafla high-enthalpy geothermal system provides a good opportunity to study the hydrogeology and associated fluid chemistry of such systems. Krafla is an active central volcano, located in NE Iceland. Over forty deep wells have been drilled into the system with fluids discharged temperatures of <200 to >450°C with reservoir fluids being liquid only, two phase liquid and vapor and superheated vapor only.

Here, we present a new combined hydrological and chemical model for such high-enthalpy geothermal systems across P-T conditions. The model is based on combining the heat and fluid mass transfer modelling [1] with fluid-fluid and fluid-rock interactions as a function of temperature, pressure, enthalpy and composition (T-P-h-X). Within the reservoir at temperatures of 250-300°C liquid water predominates. Under these conditions, the concentrations of most major elements are controlled by equilibrium with secondary minerals. Geochemical modelling and observations at Krafla support these findings. Around the magma intrusions, superheated vapor is formed by fluids discharged by the IDDP-1 well at 450°C. According to the model, superheated vapor is produced upon heat addition by the intrusion to the surrounding geothermal water resulting in boiling to dryness, precipitation of non-volatiles (Si, Fe, Mg, Al, SO_4, Na, K, Ca) whereas volatiles (CO_2, H_2S, Cl, F, B) are unaffected. By mass, quartz is the predominant secondary mineral around the intrusions. The chemical composition of the modelled and observed superheated vapor compared well.

Upon ascent and depressurization of the liquid geothermal water and the superheated vapor various processes may occur, including superheated vapor condensation, mixing and depressurization boiling. This leads to formation of two-phase liquid and vapor fluids, dilute acid fluids produced upon vapor condensation and mixtures thereof. Such fluids are indeed observed within the Krafla system supporting the results of the geochemical modelling.

[1] Hayba, DO, Ingebretsen SE (1997) Multiphase groundwater flow near cooling plutons. *Journal of Geophysical Research* **102**: 12, 235-252.