FLUID INCLUSION STUDY FROM THE IDDP2 BOREHOLE

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Abstract: Fluid inclusions were studied in felsic veins from drill core 11 (4634.20 to 4638.00 m depth) of the IDDP2 borehole, Reykjanees peninsula. The major aim of this study was to characterise the physical state, temperature and the chemical composition of the geothermal fluid. We combined petrographic and microthermometric observations, Raman microspectroscopy and Focused Ion Beam-Scanning Electron Microscopy slice & view (FIB-SEM) techniques to answer these questions.

Based on petrographic observations, we distinguished primary and secondary fluid inclusions. Our work focused on the secondary inclusions as those are more representative of the current geothermal fluid than the primary ones. In general, three types of inclusions were observed, commonly coexisting in the same secondary inclusion plane. These are vapour-rich inclusions, brines and silicate melt inclusions. The bubble to brine ratio is very variable in the fluid inclusions, which indicates boiling during inclusion entrapment. Therefore, the fluid is not a single supercritical fluid, but separated into two phases.

Vapour-rich inclusions are composed of a large dark vapour bubble and a thin liquid film at the edges. Additionally, a small opaque phase can also be observed in some vapour-rich inclusions. Based on Raman microspectroscopic measurements, these inclusions are dominated by CO_2 and H_2O (in the liquid film), and contain additional H_2S, N_2 and H_2 in minor amounts. Brine inclusions are composed of four different solid phases, a vapour bubble, ± a minor liquid phase. Solid1 is a green to yellow mineral with one polarizer and is strongly anisotropic with crossed polarizers. It has characteristic Raman bands at 3451, 1626 and 200 cm^{-1} and it disappears from the fluid inclusions at ~175-180°C during heating experiments. FIB-SEM analyses revealed that this phase is a Fe-K-chloride with significant OH^- component. Solid2 is also green with one polarizer but isotropic with crossed polarizers. It is not Raman active and it disappears between 220 and 240 °C upon heating. Based on FIB-SEM analyses, this mineral is another Fe-K-chloride with a different stoichiometry compared to solid1. Solid3 is an isotropic and transparent mineral, commonly showing cubic crystal habit. It is not Raman active, it disappears at 380-390 °C in all brine inclusions upon heating. FIB-SEM analyses suggest that this mineral is a sylvite-halite solid solution. Solid4 is an opaque mineral, a Fe-Cu sulphide, which disappears at ~600°C upon heating.

When heating experiments are combined with Raman microspectroscopy it is evident that neither the brine nor the vapour-rich inclusions are homogenized below 590 °C. The disappearance of the sulphide phase in the brine inclusions and the disappearance of the liquid film in the vapour-rich inclusions however happens at 600 ±10 °C, which should be representative of the real fluid temperature.

Silicate melt inclusions are composed of a colourless silicate glass and a vapour bubble. The vapour bubble contains CO_2 and H_2S. As melt inclusions are commonly found in the secondary inclusion assemblage, it is clear that melt was percolating in the system after the formation of the felsic veins.