

Elemental mobility during alteration of bedrock in Krafla geothermal area

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Interaction between bedrock and geothermal fluid in the Krafla high temperature geothermal area has led to alteration of the bedrock. The aim of this study is to observe the mobility of major elements during alteration and to estimate relative changes in concentrations of different elements at different depths in the bedrock.

Fifteen rock samples from two boreholes in the Leirbotnar geothermal field in Krafla were analysed for major and trace elements. Thirteen of the samples were taken at approximately 100 m intervals from the surface down to 1196 m depth in the borehole KJ-9 and two samples at the depth of 2108 m and 2140 m in the KJ-11. In addition, one sample of pristine surface lava from the 1980 Krafla eruption was analysed. To represent the original composition of the altered bedrock in the wells, older analyses of major elements in unaltered surface lavas of quartz-tholeiite in the Krafla area are used. Phosphorus appears to have had low mobility during the hydrothermal alteration in Krafla and is used to calculate the original concentrations of each major element before alteration. The calculated concentrations are consequently compared with the measured concentrations in the samples. The difference between calculated and measured concentrations is taken to represent increases and decreases in the concentrations of major elements during alteration of the bedrock.

The results indicate changes in rock composition due to alteration and that the alteration increases compositional variability. Furthermore, all of the major elements in the bedrock are mobilized during alteration in the geothermal system. Many samples show accumulation of silica, aluminium and calcium, up to 35%, although the concentrations of these elements have slightly decreased or remained unchanged in some samples. On the other hand, in most samples the concentrations of iron, manganese, titanium and sodium have decreased to a large extent, up to 50%. The concentrations of magnesium and potassium display irregular variations: increasing concentrations, decreasing or remaining constant during alteration. The magnesium concentrations vary from 45% reduction to up to 45% augmentation while potassium shows the highest mobility with a 50% decrease in some samples and up to 85% increase in others. Thus, on the length scale of this study, the alteration of the bedrock in Krafla geothermal area is clearly not isochemical.