Geophysical Research Abstracts
Vol. 21, EGU2019-6846, 2019
EGU General Assembly 2019

Halogen diffusion in dry rhyodacitic melt

Yves Feisel (1), Jonathan M. Castro (1), and Donald B. Dingwell (2)

(1) Institute of Geosciences, Johannes-Gutenberg Universität Mainz, 55128 Mainz, Germany, (2) Department für Geo- und Umweltwissenschaften, Ludwig Maximilians Universität München, 80333 München, Germany

Chemical diffusion of the halogens (F, Cl, Br, I) in halogen-enriched dry rhyodacitic melt synthesized from natural Hekla pumice (Iceland) and Cordón Caulle lava (Chile) was studied experimentally using the diffusion couple technique. Experiments were conducted in vertical tube furnaces over the temperature range 750 – 950 °C at 1 bar for durations from 1 to 35 days. Concentration profiles of F and Cl in the experimental samples were measured with an Electron Microprobe, while some additional measurements of all four halogens including Br and I were undertaken using a Secondary Ion Mass Spectrometer.

All investigated halogens exhibit Arrhenian behaviour during diffusion. Fluorine diffusivity is almost identical in both compositions while chlorine diffuses slightly faster in the Cordón Caulle melt than in Hekla. In the temperature range investigated, fluorine has diffusion coefficients on the order of 10^{-15} to 10^{-13} m^2/s while chlorine diffusivity on average is about 1.4 orders of magnitude slower. Preliminary data on bromine and iodine diffusivities indicate even slower diffusion, with coefficients in the range of 2 x 10^{-17} to 1.3 x 10^{-15} m^2/s and 1.7 x 10^{-17} to 3.9 x 10^{-16} m^2/s, respectively. The activation energies for fluorine and chlorine were calculated to be ~210 and ~200 kJ/mol.

These results are the first halogen diffusion data in natural rhyodacitic melts obtained by the diffusion couple technique and, to our knowledge, the very first to investigate iodine diffusion in volcanic melts. The pronounced differences in diffusivity amongst the halogens suggest that a strong diffusive fractionation may be possible, especially under conditions of rapid magma ascent and bubble growth, as this would favour partitioning of the relatively fast-diffusing halogens into growing bubbles. Halogen species ratios monitored in actively degassing vents could in turn be used as a measurable probe of volcanic unrest. The correlation between atomic radius and diffusivity compared to more primitive melts suggests that the halogen diffusion mechanism is dependent on the melt structure and that pronounced fractionation is therefore likely expected in evolved systems only.