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Fluid/melt partitioning coefficients of chlorine in basaltic melt

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Volatile solubility and partitioning between a silicate melt and a coexisting vapour fluid phase are of a great importance in the understanding of magma degassing processes. The solubility and partitioning affect not only the composition of the exsolving vapour phase, but also the kinetics of bubble formation and growth. We present a preliminary study of chlorine partitioning between a aqueous fluid phase and a basaltic melt at 1260 ˚C and 10 bars, conditions chosen to simulate shallow-level degassing of volcanic systems. To perform the experiments we built a specialized furnace pressurized by argon gas and equipped with a rapid quench device that allowed quenching of the sample from run conditions to room temperature in under 10 s.

Our starting material was prepared by adding 1 % of chlorine as NaCl and 5 % H_2O to a hawaiitic basalt and fusing the mixture at 10 kbars, 1400 ˚C in a piston cylinder apparatus for 2 hours to produce a homogeneous, bubble-free glass. Chips of this glass were then placed in sealed AuPd or Pt capsules, pressurized to 10 bars and heated to 1260 ºC resulting in rapid vesiculation of the samples. After each experiment samples were quenched and the capsule was weighed, punctured, dried at 110 ºC and weighed again to measure the exsolved water. The chlorine concentration in the starting glass and the vesiculated glass produced at 10 bars was measured by electron microprobe. These measurements combined with mass balance allowed us to measure the Cl partition coefficient.

Experiments were performed with durations ranging from 2 to 22 hours; the measured partition coefficient demonstrated no time dependence and varied between 11 and 17.

Combining the experimental results yields an average chlorine partition coefficient of 14 with a standard deviation of 3. This value is comparable with the low-pressure fluid/melt partition coefficient ($D_{Cl} \sim 10$) derived from melt inclusion analysis on Stromboli [1].

These results encourage us to further develop this technique to explore the partitioning of other volatiles during shallow magma degassing.

Reference

[1] Metrich et al. (2001), Journal of Petrology, 42, 1471-1490