

## **Experimental and modeled chlorine solubilities in aluminosilicate melts at 1 to 7000 bars and 700 to 1250 °C: Applications to magmas of Augustine Volcano, Alaska**

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### **ABSTRACT**

Hydrothermal experiments were conducted at ca. 1 to 7000 bars and 700 to 1250 °C in 121 rhyolitic to basaltic systems to determine Cl solubility in silicate melts, i.e., the maximum Cl concentration in melts that are saturated in a hydrosaline liquid with or without an aqueous or aqueous-carbonic vapor. The Cl concentration of melts increases with the Cl contents of the fluid unless the melt coexists with vapor plus hydrosaline liquid at fixed pressure and temperature; this phase assemblage buffers the Cl content of each phase with increasing Cl in the system. The Cl content of fluid(s)-saturated melts is independent of the CO<sub>2</sub> concentration of the saline liquid ± vapor with up to 21 wt% CO<sub>2</sub> in the fluid(s). The experiments show that Cl dissolution in aluminosilicate melts increases with temperature and pressure. Chlorine solubility is also a function of melt composition; it increases with the molar  $[(Al^{1/2}+Ca^{1/2}+Mg^{1/2}+Na)/Si]$  of the melt.

These experimental data have been integrated with results involving 41 other experiments (Webster and De Vivo 2002) to develop a broadly expanded model that supports calculation of Cl solubility in 163 aluminosilicate melts. This empirical model applies to Cl dissolution in melts of most silicate magmas at depths as great as 25 km. It determines the exsolution of hydrosaline liquid, with or without a coexisting vapor, as magmas ascend from depth, cool, crystallize, and differentiate from mafic to felsic compositions. In combination with H<sub>2</sub>O solubility models, our model supports determination of H<sub>2</sub>O-Cl solubility relations for most aluminosilicate magmas and is useful for barometric estimations based on silicate melt inclusions containing low CO<sub>2</sub> and moderate to high-Cl concentrations.

The model is applied to the phase relations of fluids in volatile-enriched magmas of Augustine volcano, Alaska. The Cl and H<sub>2</sub>O concentrations of melt inclusions from 14, basaltic to dacitic eruptive units are compared with modeled solubilities of Cl and H<sub>2</sub>O in Augustine melts. The majority of these eruptions involved magmas that first exsolved aqueous to aqueous-carbonic vapors when the melts were dacitic in composition (i.e., before the residual melts in these magmas had evolved to felsic compositions) and well prior to the eruptions. Hydrosaline liquid with or without a vapor phase exsolved from other, more-felsic fractions of Augustine melts at low, near-surface pressures of several tens of bars.

**Keywords:** Hydrothermal experiments, chlorine solubility, brine, rhyolite melt, basalt melt, melt inclusions