Cl/OH partitioning between hornblende and dacitic melt: An experimental study and its applications to Unzen dacite

Hiroaki Sato[1], Francois Holtz[2]

[1] Earth and Planetary Sci, Kobe Univ, [2] Univ. Hannover

http://shida.planet.sci.kobe-u.ac.jp/~kazan/hsato.html

We carried out high pressure melting experiments to determine the partition coefficient of cholorine/hydroxyle between hornblende and melt to estimate the variation of chlorine content of melt during degassing and crystallization of hornblende phenocryst. We obtained the partition coefficient of (Cl/OH)hb/(Cl/OH)melt = 0.5 to 0.6 at 200 and 300 MPa pressure, and temperatures of 850 and 800 C. Using the partition coefficient we obtained the amount of degassing of water to be ca. 2.2 wt% for the 1/3 decrease of chlorine from the core to the rim of hornblende phenocryst in the Unzen dacite.

We carried out high pressure melting experiments to determine the partition coefficient of cholorine/hydroxyle between hornblende and melt to estimate the variation of chlorine content of melt during degassing and crystallization of hornblende phenocryst. The starting material for the experiments are the powdered glass prepared by melting of bulk dacite of the 1992 eruption of Unzen volcano at ca. 1500 C + 4wt% NaCl aqueous solution, which are encapsulated in a gold tube welded shut and processed in a externally-heated pressure vessel. The experimenta conditions were at 200 and 300 MPa pressure, and temperatures of 850 and 800 C for ca. 7 days. The run products were analyzed for major element and chlorine content of glass and hornblende by electronprobe microanalyzer. We obtained the partition coefficient of (Cl/OH)hb/(Cl/OH)melt by assuming the water speciation and water solubility model of Zhang (1999, Rev. Geophys), and also stoichiometry of hornblende (OH+Cl=2 for O=23). The obtained partition coefficient is 0.5 to 0.6 in the present experimental conditions. Using the partition coefficient we can estimate the chlorine contents of melt at the time of crystallization of hornblende phenocryst. Natural hornblende phenocrysts show two types of compositional zonings; i.e., oscillatory zoning in the core, and reverse zoning at the rim of hornblende phenocrysts. Chlorine content varies from 500 to 900 ppm in the oscillatory zoning of the core of hornblende phenocryst, whereas it decreases down to 200 to 300 ppm at the rim. The large variation of chlorine content in the hornblende and melt may be caused mostly by degassing, because chlorine is strongly partitioned into vapour phase rather than melt phase (Shinohara et al., 1989). Using the experimental data of Webster (1992) on the partitioning of chlorine and water between vapor and melt, we calculated the amount of degassing of water to produce the 2/3 variation of chlorine content of hornblende in the core zoning to be ca. 1.0 wt%, and 1/3 decrease of chlorine from the core to the rim of hornblende to be ca.2.2 wt%. Actually, the rim of hornblende may have crystallized from mixed magma of low-temperature phyric magma and high-temperature aphyric magma, and the model calculation depends on the chlorine and water contents of the end member magmas. At any rate, it is most likely that the magma was almost vapor saturated, and degassing caused the wide variation of chlorine content of hornblende during phenocryst crystallization.