Partitioning behavior of volatiles between apatite and melt in natural andesitic-rhyolitic magmas

M. Dokyu[1], T. Kogiso[1]*, Y. Sano[2], N. Takahata[2], A. Ishida[2], M. Koike[2], T. Kawakami[3], AND A. Yasuda[4]

[1]Graduate School of Human and Environmental Studies, Kyoto University, Kyoto 606-8501, Japan (*correspondence: kogiso@gaia.h.kyoto-u.ac.jp)
[2]Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba 277-8564, Japan
[3]Department of Geology and Mineralogy, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan
[4]Earthquake Research Institute, University of Tokyo, Bunkyo, Tokyo 113-0032, Japan

The minral apatite contains volatiles (F, Cl and OH) in its structure, and therefore has been used as a tool to estimate volatile concentrations in its host magmas and mantle sources. Several experimental studies on the partitioning behavior of volatiles between apatite and silicate melts (e.g., [1-3]) have demonstrated that relative volatile abundances in apatite are not proportional to those in melts, and that apatite-melt partition coefficients are dependent on melt composition. However, it is still unclear which components in melt control the partitioning behavior of volatiles between apatite and melt, so it is difficult to know whether the experimentally determined partition coefficients are applicable to natural magma systems. In this study, we analyzed volatile concentrations of apatite crystals and melt inclusions in plagioclase in scoria/pumice samples taken from Aso pyroclasic flow depsits, Kyushu, Japan, and attempted to reveal the detailed partitioning behavior of F, Cl and OH between apatite and melt in natural andesitic-rhyolitic magmas. Hydrogen concentrations in apatite crystals were analyzed with NanoSIMS, and those in melt inclusions were analyzed with FT-IR micro-reflectance spectroscopy. F, Cl and other major element concentrations were analyzed with EPMA. The exchange coeffecients (K_d) of all volatile pairs (OH-F, OH-Cl and Cl-F) between apatite and melt calculated from the analyzed data were broadly consistent with those determined by the previous experiments. Clear correlations were observed only between K_{dOH-Cl} and SiO_2, FeO, CaO and Na_2O in melt inclusions. Because Cl concentrations can be detemined more accurately than F, K_{dOH-Cl} would be the most useful for estimating OH in melt from apatite compositions.

[1] Mathez & Webster (2005) *GCA* **69**, 1275-1286.
[2] Doherty *et al*. (2014) *Chem. Geol*. **384**, 94-111.
[3] McCubbin *et al*. (2015) *LPSC* **45**, 2741.