Fluorine partitioning between hydrous minerals and aqueous fluid at 1 GPa and 770 – 947 ℃: A new constraint on slab flux

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Mechanisms of volatile element transfer from subducting slab to the melting region beneath arc volcanoes are probably the least understood process of arc magma genesis. Fluorine, which suffers minimum degassing in arc primitive melt inclusions, retains the information about the role of volatiles during magma genesis at the depth. Given that volatile elements play a critical role and magma evolution and eruption processes, in-depth investigations into the behavior of F in magma and associated fluid should provide a new constraint.

Experimentally determined solubility of F in aqueous fluid, and partition coefficients of F between fluid and minerals provide first order geochemical constraints about the character of the volatile-transporting agent. We report experimentally determined F solubility in fluid in equilibrium with hornblende and a humite group mineral at 1GPa and from 770 to 947 ℃, and partition coefficients among these phases. The composition of the fluid is determined by mass-balance calculation and consistency is verified by high-pressure liquid chromatography measurements of the quenched fluids. The $D_F^{(Fl/Hb)}$ can be represented by a single value 0.13 ±0.03. Similarly, partitioning of humite group minerals shows that F is strongly bound to the minerals, $D_F^{(Fl/Nobergite)}$ = 0.01, and $D_F^{(Fl/Chondrodite)}$ = 0.02. The average F concentration in the fluid is 2700 ppm for F-rich experiments and it constrains the maximum amount of F carried by fluid in the presence of amphibole. With a model accounting for F concentration in slab that is much lower than in our experiments, the increase of F concentration in the subarc mantle by fluid, in equilibrium with hornblende, is expected as no more than by a few ppm. Significant F enrichments found in arc lavas cannot be derived from aqueous fluid of subduction slab, or fluid in lower arc crust in the presence of amphibole, or humites.