



Chlorine and fluorine behavior in apatite-fluid-silicate melt systems

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The fluctuation of halogen contents (Cl, F) of volcanic gases is potentially a good precursor signal of volcanic crises, yet the Cl and F behavior in magmas is complex due to the interplay between melt, fluid and halogens-bearing crystals. In magmatic rocks, Cl and F are the main constituents of apatite, an ubiquitous accessory magmatic mineral. As a result, apatite is increasingly being used as a geochemical tool for unravelling halogen behavior as it allows to record the fugacities of key volatile species.

In this context, the behavior of Cl and F in coexisting apatite, fluids and a variety of silicate melts (rhyodacite, basalt, phonolite) has been investigated experimentally as a function of pressure, temperature, oxygen fugacity, and fluid composition. Experiments have been done using internally heated pressure vessels at 50-200 MPa, 800-1100°C, f_{O_2} from NNO-1 to NNO+2 and starting fluid : Cl content between 0 and 15 wt%. Run products were analysed by SEM, EPMA and Raman spectroscopy. F and Cl contents of fluids were estimated by mass-balance.

The results show that chlorine and fluorine partitioning in the apatite-melt-fluid system is dependent on all investigated parameters. In detail, for the rhyodacite composition, when the Cl content in starting fluid increases, the chlorine content of apatite increases (from 0.2 to 2.5 wt%) with the Cl content of melt (between 0.1 and 1 wt%) and fluid (between 0.2 and 22 wt%). When the pressure decreases (200 to 50 MPa with temperature and Cl content of the starting fluid being constant) the Cl content in apatite increases (2.2 to 2.7 wt%) with Cl content in melt (0.7-1wt%) while the bulk Cl content in fluid decreases (from 22 to 5 wt%). Cl and F always favor apatite relative to fluid and silicate melt, though in several run products, the behavior of F is difficult to evaluate owing to analytical errors for its measurement in glasses at low contents (<1000 ppm). For the two other compositions, experiments have been performed and their analytical characterisation is underway.

With the gathered data, a solubility model of Cl (and F) is being currently developed for the magma compositions investigated, using the method of Piccoli & Candela (1994) to obtain Cl and F fugacities.

Finally, in situ experiments using a transparent IHPV equipped with sapphire windows connected to a Raman spectrometer will be carried out in the near future in order to determine the fluid composition in equilibrium with the melt and the conditions of salt (Na-K)Cl saturation in silicate melts.