

Effect of water on the F and Cl partitioning behavior between olivine and silicate melt

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Owing to their incompatibility and volatility, the distribution of halogens in the Earth's mantle is influenced by processes such as fluid mobility, oxygen fugacity, fractionation, degassing or partial melting, which makes them excellent tracers of volatile transport processes.

In this study, we investigated the effect of small amounts of water on the F and Cl partitioning behavior between olivine and melt. Results show that, within uncertainty, there is no effect of water on the chlorine partitioning behavior for bulk water contents ranging from 0.03 (2) wt% H₂O ($D_{Cl}^{ol/melt} = 1.6(9) \cdot 10^{-4}$) to 0.33 (6) wt% H₂O ($D_{Cl}^{ol/melt} = 2.2(11) \cdot 10^{-4}$). In contrast, fluorine partition coefficients increase linearly in this range and may be described with:

$$D_{F}^{ol/melt} = 3.6(4) \cdot 10^{-3} \cdot X_{H_2O}(wt\%) + 6(4) \cdot 10^{-4}$$

Considering the effect of water on the F partitioning behavior between olivine and silicate melt indicates that OIB source region estimates are about 10% lower than previously expected [1]. This implies that, in contrast to Cl, the effect of water on the F partitioning behavior needs to be considered for a correct estimation of F abundances in OIB source regions.

A recent model proposed that multiple episodes of small degree partial melting are required to generate magmas with a high F/H₂O ratio between 0.1 and 0.9 in the upper mantle [2]. Our results imply that addition of small amounts of water to a dry peridotitic system may lead to a significantly stronger increase in the F/H₂O ratio of the residual during a single small degree partial melting event. Thus, the effect of water on the F partitioning behavior provides an alternative model that may explain the generation of high F/H₂O ratios and high F concentrations in the upper mantle without the requirement of multiple partial melting episodes.

[1] Joachim *et al.* (2015) *Chem. Geol.* **416**, 65-78. [2] Beyer *et al.* (2016) *Chem. Geol.* **437**, 88-97.