THE EFFECT OF WATER ON THE FLUORINE PARTITIONING BEHAVIOR BETWEEN OLIVINE AND SILICATE MELT, FLUORINE CONCENTRATIONS AND F/H_2O RATIOS DURING PARTIAL MELTING IN THE UPPER MANTLE

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Halogens show a range from moderate (F) to highly (Cl, Br, I) volatile and incompatible behavior, which makes them excellent tracers for volatile transport processes in the Earth's mantle.

In this study, we investigated experimentally the effect of small amounts of water on the F and Cl partitioning behavior between olivine and melt at 1280°C and 0.3 GPa. Results show that there is, within uncertainty, no effect of water on the chlorine partitioning behavior for bulk water contents ranging from 0.03 to 0.33 wt% H_2O ($D_{Cl}^{ol/melt}$ = 2.2 (11) · 10^{-4}). In contrast, fluorine partition coefficients increase linearly in this range and may be described with $D_F^{ol/melt} = 3.6(4) \cdot 10^{-3} \cdot X_{H2O}$ (wt%) + $6(4) \cdot 10^{-4}$.

Our findings are consistent with the formation of clumped OH/F defects in forsterite (Crépisson et al. 2014), which increase the defect stability compared to solely hydrolytic weakening and thus the partitioning of fluorine into olivine.

Results of this study further imply that water may have a strong effect on estimates of OIB source fluorine concentrations and fluorine recycling rates in subducting slabs.

Beyer et al. (2016) suggested that multiple episodes of small degree partial melting are required to generate magmas with a high F/H_2O ratio between 0.1 and 0.9 in the upper mantle. Our results indicate that addition of small amounts of water to a dry peridotitic system may potentially lead to a significantly stronger increase in the F/H_2O ratio of the residue during a single small degree partial melting event. Thus, the effect of water on the F partitioning behavior may explain the generation of high F/H_2O ratios and high F concentrations in the upper mantle without the requirement of multiple partial melting episodes.

BEYER, C., KLEMME, S., GRÜTZNER, T., IRELAND, T.R., MAGEE, C.W., FROST, D.J. (2016): Chem. Geol., 437,88-97.

CRÈPISSON, C., BLANCHARD, M., BUREAU, H., SANLOUP, C., WITHERS, A.C., KHODJA, H., SURBLÉ, S., RAEPSAET, C., BÉNEUT, K., LEROY, K., GIURA, P., BALAN. E. (2014): Earth. Planet. Sci. Lett., 390, 287-295.