



Chlorine and Fluorine partition coefficients between basalt and harzburgite at mantle wedge conditions – Geochemical implications.

C. Dalou (1), K. T. Koga (1), and N. Shimizu (2)

(1) Laboratoire Magmas et Volcans, Université Blaise Pascal, Clermont-Ferrand, France (c.dalou@opgc.univ-bpclermont.fr),

(2) Woods Hole Oceanographic Institution, MS#23, Woods Hole, Ma. USA

Volatile elements released from the subducting slab play a fundamental role during the formation of arc magmas and their geochemical cycle in the mantle wedge. Over the years, significant efforts were therefore made to characterize the behavior of such elements during arc magma genesis. Recent advances of melt inclusion studies enlarged the data on volatile abundance in arc magmas, and now it is possible to characterize some volatile contents in arc primary magmas, in particular F and Cl (e.g. Le Voyer et al. 2008 Fall AGU). Here, we present the results of an experimental determination of the Cl and F partition coefficients between orthopyroxene, olivine, and basaltic liquid, which are the most abundant phases in subduction zones. We achieved more than 110 measurements in 12 (nearly) dry melting experiments conducted over a range of Cl and F contents (0.13 to 0.61 wt% and 100 ppm to 1.2 wt%, respectively) at 1.2 GPa, 1330°C. The starting composition is a 30:70 mixture of PUM peridotite and basalt (similar to 82-72f, Gaetani and Grove, 1998, CMP). The low abundance F, Cl measurements in minerals were done by Cameca IMF 1280 at WHOI using negative secondary ion mode.

Our data show that the fluorine and chlorine partition coefficients are constant over 100 ppm to 1.2 wt% and below 2000 ppm, for F and Cl respectively. Instead, we found that the F partition coefficients between orthopyroxene and basalt increase from 0.043 to 0.064, as well as the Cl partition coefficients between orthopyroxene and basalt increase from 0.011 to 0.029 and both correlate linearly with D_{MgO} (ranging from 2.34 to 2.79). We also found that $D_F^{Opx/melt}$ and $D_{Cl}^{Opx/melt}$ correlate with E and D_0 parameters of lattice strain models of the orthopyroxene M2-site. These observations suggest that F and Cl incorporation in opx has consequences on the opx M2-site. Furthermore, F and Cl partition coefficients correlate with the NBO/T of basaltic melt, showing that F and Cl act as network-modifiers on basaltic melts. Cl and F are less incompatible in orthopyroxene than in olivine (in average: $D_{Cl}^{Opx/melt} = 0.02 \pm 0.003$ and $D_{Cl}^{Ol/melt} = 0.005 \pm 0.001$; $D_F^{Opx/melt} = 0.05 \pm 0.002$ and $D_F^{Ol/melt} = 0.007 \pm 0.0001$).

We found no variation of the $D_F^{Opx/melt}/D_{Cl}^{Opx/melt}$ ratio (in average: 2.17) with water content of the system (ranging from 170 ppm to 3.3 wt%), but when Cl concentration exceeds 2000 ppm in the system, the $D_F^{Opx/melt}/D_{Cl}^{Opx/melt}$ ratio increases drastically (in average: 17.3). Using $D_F^{Opx/melt}/D_{Cl}^{Opx/melt}$ ratio = 2.17, F and Cl concentrations of subduction zone melt inclusions and Cl concentration in a dry harzburgite, we calculated that F/Cl ranges from 0.24 and 3.08. This translates to F concentration ranges from 0.15 and 0.40 ppm, for the mantle wedge before metasomatism.