Determination of fluid/melt partition coefficients in volatile saturated magmatic systems by LA-ICPMS analysis of coexistent fluid- and silicate melt inclusions

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Quantifying the partitioning of different major and trace elements between the silicate melt and exsolved fluid phase is a key to understand the composition of magmatic volatiles, which can form ore deposits or be released to the atmosphere through volcanic activity. We analyzed coexisting primary silicate melt and fluid inclusions in quartz crystals by Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICPMS) to quantify distribution of 24 major and trace elements between the two phases. The samples were collected from graphic intergrowth of quartz and feldspar and freegrown quartz crystals in the miarolitic cavities of the Baveno (Northern Italy) and the La Cabrera (Spain) granite intrusion, and alkaline-pegmatites of Mt. Malosa (Malawi). The silicate melt and fluid inclusions occur in the same assemblages, providing textural evidence of their coexistence. Their cogenetic origin is further supported by the presence of several heterogeneously trapped inclusions (composed of fluid and melt phase in variable proportions). High density aqueous fluid inclusions were entrapped in the Baveno and La Cabrera granite, while pegmatites from Mt. Malosa contain boiling assemblages. The entrapment pressure was estimated using microthermometric data on the fluid inclusions and is between 210 and 350 MPa for Baveno, 200 and 250 MPa for La Cabrera, and approx. 130 MPa for Mt. Malosa. The melt inclusions are recrystallized to an assemblage of microcrystalline quartz, feldspar±biotite±apatite. We first conducted LA-ICPMS measurements of some fluid and melt inclusions. We then homogenized the remaining MIs from the same assemblages. Because of the slow kinetics of the remelting, the use of cold seal pressure vessel apparatus for homogenization was required to prevent water loss through diffusion. We applied 180 MPa external pressure; the homogenization temperatures were around 730 °C for each location. On the rehomogenized MIs electron microprobe analyzes were carried out which provided an appropriate internal standard for the quantification of the melt inclusion measurements by LA-ICPMS. Thereafter we determined the water content of the homogenized melt inclusions by Raman-spectroscopy using the method of Zajacz et al. (in pres.). This yielded values between 10-12 wt% for MIs form Baveno, 5-7 wt% for MIs from La Cabrera and 5-5.5 wt% for MIs form Mt. Malosa. These water contents are in good agreement with the entrapment pressure estimations, given the wa-
ter solubility in haplogranitic melts (Holtz et al., 1995). Only Baveno has extraordinarily high water solubility which is probably due to the high F content (0.9-1.2 wt%) in the melt. The fluid/melt partition coefficients (D) for trace elements vary significantly between different locations. Cu (50<\(D_{\text{Cu}}\)<400) and Ag (3<\(D_{\text{Ag}}\)<200) display a strong preference for the fluid phase, however partition coefficients of other Cl-complex forming metals are relatively low (2<\(D_{\text{Zn}}\)<20; 1<\(D_{\text{Pb}}\)<20; 2<\(D_{\text{Sb}}\)<40). They have the highest values between the high salinity brines and the melt in the samples from Mt. Malosa. Partition coefficients for W and Mo are also relatively low (3<\(D_{\text{Mo}}\)<30; 2<\(D_{\text{W}}\)<20). B and As are also enriched in the fluid phase (3<\(D_{\text{B}}\)<30; 2<\(D_{\text{As}}\)<20).

REFERENCES
