CO_2 content in high-K melts: High-P/T experiments on melt inclusions

I.K. NIKOGOSIAN[1] *, W. VAN WESTRENEN[1], J.C.M. DE HOOG[2] AND J.M. KOORNNEEF[1]

[1]Faculty of Science, Vrije Universiteit, Amsterdam, The Netherlands (*correspondence: i.nikogosian@vu.nl)
[2]School of GeoSciences, University of Edinburgh, UK

Italian high-K magmatism records contributions of subducted components such as carbonate or pelagic sediments to the mantle source. Magma carbon dioxide (CO_2) concentrations in conjunction with abundances of other volatiles, trace elements and isotopes play an important role in the characterisation of such subducted components [1]. Melt inclusions (MIs) trapped in high-Fo olivines are expected to yield the most realistic estimates for CO_2 concentration in primary melts. However, changes in CO_2 solubility during transport to the surface cause exsolution of CO_2 vapour from the melt and development of a shrinkage bubble, leading to significant underestimation of the magma CO_2 content when analysing MI glass. Up to 30–90% of the initially dissolved CO_2 in MIs can be lost to the shrinkage bubble by this post-entrapment modification process [2].

Routine homogenisation heating/quenching experiments at 1 atm pressure cannot dissolve CO_2 back into the melt because of the pressure dependence of CO_2 solubility and thus require empirical data corrections [1,2]. Recent high-P experiments [3] at 3–5 kbar and high water contents (12 wt%) resulted in determined MI CO_2 contents of 4000 ppm compared to 2000 ppm in experiments at 1 atm.

Here we present initial results of nominally dry piston cylinder experiments on Italian olivines at 20 kbar and 1550°C to attain complete homogenisation of their melt inclusions. We apply the experiments to MIs trapped in high-Fo olivine from HKS and SHO-series from the Roman Province, Italy (Vulsini, Sabatini, Latera). CO_2 contents in the fully homogenised MIs at high P reach up to 6000 ppm in HKS and 1000 ppm in SHO melts, compared to 1000 ppm and 600 ppm in routine experiments at 1 atm.

We will discuss: 1) the comparison of experimental and empirically corrected results; 2) the effects of potential loss of CO_2 in MIs; and 3) the variations in carbonate metasomatic input to the mantle sources of high-K Italian magmas. These pilot data clearly demonstrate that high-pressure homogenisation of melt inclusions is required to derive accurate initial magma CO_2 contents.

[1] Wallace, 2005 J. Vol.Geo.Research. 140, 217-240.
[2] Aster et al., 2015, J. Vol.Geo.Research. 323, 148-162.
[3] Mironov et al., 2015, Earth Planet. Sci. Lett. 425, 1-11.