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Experimental constraints on the evolution of magmatic liquids and phenocrysts of Cumbre Vieja volcano (La Palma, Canary Islands): First results at 400 and 700 MPa

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Eruptive products of the Cumbre Vieja volcano cover a wide spectrum of alkali-rich rocks ranging from basanite to phonolite. A recent model [1] of the Cumbre Vieja plumbing system includes three major intervals of magma stagnation and fractionation, which have been obtained using clinopyroxene-melt barometry [2] and microthermometry of fluid inclusions (430–780 MPa, 180-420 MPa and <200 MPa). However, the relative influence of different thermodynamic parameters ($p - T - a\mathrm{H_2O}$-$f\mathrm{O_2}$) on the stability fields of phenocryst phases is unknown due to the lack of reliable experiments with basanite at pressures below 1GPa. Our experiments are aimed at evaluating the magma storage conditions in the course of basanite-tephrite-phonolite magma differentiation. We present first results of the experiments and further test our previous pressure estimates by using a modified cpx-melt barometer [3] on basanititic to phonolitic compositions at the experimental conditions investigated.

Phase relations of two natural basanites with MgO contents of 13.7 wt.% and 9.0 wt.% representing different differentiation stages of Cumbre Vieja primitive magmas were investigated at 400 and 700 MPa. Crystallization experiments were performed in an internally heated pressure vessel (IHPV) in the temperature range from 1000 to 1075 ˚C, keeping oxygen fugacities between QFM-1 to QFM+3.3. The H_2O content of the melts varied from nominally dry to H_2O-saturated conditions. Compositions of experimental products were determined by electron microprobe and compared to their natural counterparts.

Experiments with the more primitive sample at 400 MPa demonstrate that melts in equilibrium with spl, ol+spl and ol+cpx+spl have basanitic compositions identical to natural Cumbre Vieja basanites (7-12 wt.% MgO) even at very high water activities (5.8-6.8 wt.% H_2O in the melt) and low temperatures (<=1050 ˚C). Experiments with the differentiated sample at 400 MPa demonstrate that only runs with ol+cpx+spl or Ti-amph+cpx+mag assemblages are in equilibrium with melts resembling Cumbre Vieja tephriphonolites to phonolites. Crystallization of ol+cpx+spl in this sample was observed in runs with low to intermediate H_2O contents in the melt (0.2-6.9 wt.% H_2O, 1050-1025˚C). Melt compositions in these runs varied from basanites to tephriphonolites. At lower temperatures (1025-1010˚C) and higher water activities (9.9 to 6.4 wt.% H_2O) tephriphonolitic melts were observed in equilibrium with Ti-amph+cpx+mag. At 700 MPa tephritic to phonolitic melts were also produced in the runs with 7.0 to 3.2 wt.% H_2O (at 1075-1050˚C). However, all experimentally produced tephriphonolitic melts show slightly higher FeO and slightly lower Na_2O contents than the natural lavas. FeO discrepancies can be related to more oxidized conditions in the experiments resulting in crystallization of more iron-rich titanomagnetite. Low Na_2O contents in experimental melts, in turn, can be attributed to the high proportions of Ti-Amph in the mineral assemblage.

Our preliminary experimental data, mostly obtained at low temperatures (in gold capsules with melting temperature ∼1070˚C), demonstrate that natural basanitic magmas could differentiate to phonolitic melts under hydrous conditions at pressures between 400 and 700 MPa. Ongoing experiments at high temperatures are to complement the preliminary phase diagrams to understand the role of water activity in the genesis of Cumbre Vieja magmas.

Our crystallization experiments yielded cpx-melt pairs equilibrated at 400 or 700 MPa, which can be used to test the applicability of the Putirka barometer [3] for hydrous melts within the compositional range from basanite to phonolite. Calculated pressures obtained for 400 MPa runs varied in the range of 260 MPa to 1 GPa, whereas those obtained for 700 MPa experiments varied from 730 MPa to 1.3 GPa. Uncertainties are probably due to sector zonations of cpx and the unavoidable presence of quench crystals in some experimental runs.

[1] Klügel et al. (2005) *EPSL* **236**, 211 – 226. [2] Putirka et al. (1996) *CMP* **123**, 92 – 108. [3] Putirka et al. (2008) *AM* **88**, *1542-1554*.