Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17880

# Crystallisation driven deep volatile degassing in ocean island volcanoes: Integrating 3D imaging with chemical microanalysis of olivine-hosted melt inclusions from Pico (Azores).

**THOMAS VAN GERVE**[1], DAVID A. NEAVE[2], PENNY WIESER[3], HECTOR M LAMADRID[4], NIELS HULSBOSCH[1] AND OLIVIER NAMUR[1]

[1]KU Leuven
[2]The University of Manchester
[3]University of California, Berkeley
[4]University of Missouri
Presenting Author: thomas.vangerve@kuleuven.be

Constraining the initial differentiation of primary mantle melts is vital for understanding magmatic systems as a whole. Olivine-hosted melt inclusions provide insights into the evolution and storage of such melts and preserve unique records of their volatile budgets. Crucially, $CO_2$-$H_2O$ saturation barometry provides estimates of entrapment pressures of melt inclusions and by extension magma reservoir depths. However, determining total inclusion $CO_2$ contents is not straightforward, as they often need to be reconstructed from $CO_2$ dissolved in melts and $CO_2$ stored in a vapour bubble. Here we combine 3D X-Ray Computed Tomography (CT) with geochemical microanalyses of major, trace and volatile elements to improve upon existing reconstruction methods. We applied our improved methods to olivine-hosted melt inclusions from Pico volcano (Azores) in order to gain constraints on the deep differentiation system of a volcano formed in the context of a mantle plume. Results for these inclusions yielded 2664-9231 ppm reconstructed total $CO_2$, corresponding to some of the highest values reported for ocean island volcanoes to date. Importantly, CT data show traditional reconstruction methods using 2D photomicrographs often underestimate $CO_2$ budgets by more than 40%.

Entrapment pressures of 2.2–6.6 kbar indicate a magma reservoir comprising stacked sills near the crust-mantle boundary. Variability in trace elements (La, Y) shows that differentiation occurred via concurrent mixing and crystallisation of two endmember melts that were respectively depleted and enriched in trace elements. Numerical models constrain the total mass proportion of the enriched endmember to 33% and parent melt crystallisation extents to 60%.

Fractionated $CO_2$/Ba ratios of 3.6–63 suggest that up to 88% of primary $CO_2$ budgets degassed, of which 54% was driven by crystallisation of melts already saturated in volatiles. Degassing took place in-situ in the magma reservoir and provided a mechanism for melt mobilisation. Overall, our study illustrates that by combining 3D imaging, geochemical microanalyses and numerical modelling, melt inclusions provide us a unique record of differentiation, degassing and storage of deep magmas.