Alkaline OIB melts: plume or lithospheric melts? Constraints from trace elements in olivine

NINA SØAGER[1]*, PAUL MARTIN HOLM[1], MAXIM PORTNYAGIN[2], DIETER GARBE-SCHÖNBERG[3]

[1]University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen-K, Denmark
(*correspondence: ns@ign.ku.dk)
[2]GEOMAR, Helmholtz Centre for Ocean Research, Wischhofsstraße 1-3, 24148 Kiel, Germany
[3]Christian-Albrechts-Universität zu Kiel, Christian-Albrechts-Platz 4, 24118 Kiel, Germany

On the basis of high precision electron microprobe and laser ablation ICP-MS analyses of olivines from 21 samples from the Cape Verde islands, and 6 samples from the Gough and Tristan da Cunha islands we can make inferences about the lithological nature of the mantle sources and estimate the magmatic temperatures and oxygen fugacities (fO_2) of the magmas.

The olivines from the Cape Verde islands display a wide range in compositions from Fe/Mn ~60-75 in the older and intermediate aged lavas up to 88 in the late stage lavas suggesting a transition from peridotite to pyroxenite melt dominated magmas with time. This transition is accompagnied by a dramatic drop in the magmatic temperatures from 1200-1300°C in the older lavas down to ~950°C in the youngest and most alkaline lavas, as calculated by the Sc/Y-in-olivine thermometer by Mallmann and O'Neill (2013, J Pet 54, 5, 933-949). The late stage lavas fall in two groups: a high-P and a high-K group. The fO_2 (calculated with the V-in-ol oxybarometer of Mallmann and O'Neill, 2013) decreases from ΔQFM = 1-1.5 in the older lavas to ΔQFM = -0.6 in the high-P lavas while the high-K group have fO_2 similar to the older lavas. The very low temperatures calculated for the late stage magmas using highly primitive olivines (Fo^{86-88}) indicate that these melts are lithospheric mantle melts. Considering the whole rock compositions of the younger lavas, we interpret these as melts of pyroxenite/amphibolite veins and metasomatised peridotite containing either phlogopite (high-K group) or apatite (high-P group).

The Gough olivines also indicate high pyroxenite melt contents in the magmas (e.g. Fe/Mn = 77-82) but the calculated magma temperatures (1200-1230°C) are as high as those of other plume magmas at similar olivine Fo (e.g. Spice et al., 2016, G3 17, doi:10.1002/2015GC006059) suggesting that the Gough magmas are plume melts and that the pyroxenite is contained within the upwelling plume.