Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 975


# Melt Inclusion Evidence for Komatiite Genesis in the Gorgona Plume

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## Introduction

Komatiites, ultramafic tuffs, picrites and basalts of Gorgona Island, Colombia, form part of the ~90 Ma Caribbean-Colombian ocean plateau (Kerr et al., 1997). The komatiites have received much attention as the sole Phanerozoic example of well-documented, spinifex-textured ultramafic lavas. Models for the origin of the komatiites involve high-temperature melting in a rising mantle plume (Arndt et al., 1997) but details of the melting event, particularly the nature of the source materials and the depth of melting, remain unclear. One way to address these issues more closely is through studies of melt inclusions trapped in liquidus minerals preserved in the lavas. Melt inclusions from mid-ocean ridge (Kamenetsky et al., 1998) and ocean-island (Sobolev et al., 2000) basalts have revealed a greater range of compositional diversity than is seen in the whole rock samples, permitting more detailed assessments of magma genesis.

## Methods

Thirty-two melt inclusions (30-100 µm in width) in olivine phenocrysts from 4 Gorgona komatiite samples were studied. Fifteen were homogenized by heating and quenching, and analyzed for major elements by electron microprobe. Compositions were corrected for olivine fractionation to equilibrium with olivine Fo91, the liquidus phase in the melt. Twenty-four inclusions were analyzed for trace elements by ICPMS-laser ablation microprobe. Calcium was used as the internal standard element and BCR-2 G was the calibration standard.

## Results

The inclusion set is remarkably homogeneous in composition, possessing none of the large differences between inclusions seen, even within single olivine grains, in other basaltic systems (Sobolev et al., 2000). The average inclusion composition (and%RSD) is 47.86% $SiO_2$ (1%), 14.5% $Al_2O_3$ (1%), 9.3% $FeO_{total}$ (5%), 14.29% MgO (5%), 12.68% CaO (3%) and 1.63% $Na_2O$ (3%). CaO/ $Al_2O_3$ (~0.88) and $Al_2O_3/TiO_2$ (~19) ratios are similar to those for pyrolite. All inclusions are strongly depleted in incompatible elements with primitive mantle normalized Rb = 0.35 ±0.08, Nb = 0.53 ±0.20 and La = 0.83 ±0.17. As in whole rock Gorgona komatiite samples, [La/Sm]n is very low (0.25 ±0.06) and [Gd/Yb]n is near unity. All of the inclusions exhibit positive Sr anomalies with [Sr/Ce]n = 2.44 ±0.34, which is increasingly being recognized as a common characteristic of many ultradepleted MORB and OIB melt inclusions (Kamenetsky et al., 1998; Sobolev et al., 2000).

## Discussion

Melting experiments (Walter, 1998) indicate that near-pyrolitic CaO/ $Al_2O_3$ and $Al_2O_3/TiO_2$ ratios in the Gorgona inclusions can be explained by 20-30% batch (garnet-out) melting of a MORB-like, peridotite source at mantle depths of ~ 90 km (~3 GPa). Strongly depleted Nd isotope compositions of whole rock Gorgona komatiites (Echeverria and Aitken, 1986; Arndt et al., 1997) also suggest a MORB-like mantle source region. However, the high Sr/Ce of the inclusions is difficult to reconcile with MORB-like mantle melting. It is unlikely that the anomalous Sr/Ce reflects crustal assimilation of plagioclase-rich materials by komatiite magma because this would have produced decidedly non-pyrolitic CaO/ $Al_2O_3$ and $Al_2O_3/TiO_2$ ratios, which is not observed. Moreover, the lack of significant Sr/Ce variability in the inclusion set would not be expected for assimilation unless the magma was extremely well-mixed afterwards. High Sr/Ce ratios can be achieved by fractional melting of a MORB-like source at very shallow mantle depths (~30 km), where plagioclase is stable (Kamenetsky et al., 1998). This would have been possible, however, only if the rising Gorgona plume intersected a spreading ridge (Kerr et al., 1997) and thus was not ponded at depth beneath a lithospheric cap. Perhaps the more likely explanation for the high Sr/Ce ratios is that the mantle source region of Gorgona komatiites contained a recycled, Sr-rich but otherwise incompatible-element-poor, crustal component such as cumulus-plagioclase-bearing, ocean-floor gabbro (Sobolev et al., 2000) or seawater-altered, MORB or harzburgite. During melting, the recycled component may have supplied Sr, but little else, to the pyrolitic melt, leaving CaO/ $Al_2O_3$ and $Al_2O_3/TiO_2$ ratios unaffected by the process. Gorgona komatiites have Sr isotope compositions somewhat higher than those expected for MORB mantle (Echeverria and Aitken, 1986), consistent with the addition of a seawater-altered, recycled crust component to the source region.

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