Melting beneath the Theistareykir region, NE Iceland

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Introduction

100 samples from Theistareykir, the northernmost segment of the Icelandic neovolcanic zone, were analysed for major, trace and rare earth element concentrations. Additionally 30 melt inclusions in forsteritic olivines have been analysed for major and rare earth element concentrations. Melting beneath the region has been modelled using the rare earth element inversion procedure of M^cKenzie and O'Nions (1991). Results suggest that individual lava flows are not produced by mixing melt increments generated throughout the modelled melting column. Instead, they are partially homogenised melts sampled from different depths.

General setting

Theistareykir represents the southern subaerial continuation of the Kolbeinsey Ridge. It is offset from the ridge by the Tjörnes Fracture Zone. The central volcano and fissure swarm of Krafla is located south of Theistareykir. In this northern region of the neovolcanic zone the tectonic regime is relatively simple, with rifts running north-south orthogonal to spreading direction. The lavas of Theistareykir are dominantly olivine tholeiites erupted from shield volcanoes. Theistareykir is a good locality in which to study melt generation within the mantle because the tectonic regime is simple and the lava flows are well preserved and fresh.

Petrography and geochemistry

The new dataset of 100 samples covers the postglacial (<10,000yrs), early/late glacial and interglacial periods. The lavas are picrites or olivine tholeiites, which vary from olivine to plagioclase (+olivine) phyric and aphyric. The olivines chosen for the melt inclusion study are all forsteritic (Fo >89.5), and were extracted from high MgO (>11%) lavas. of which all except one are postglacial.

Whole rock major and trace element concentrations were determined by X-ray fluorescence spectroscopy on a Philips PW1450 spectrometer by standard techniques. Rare earth and trace element concentrations were determined by a Plasmaquad PQ2 STE inductively couple plasma - mass spectrometer, ICP-MS.

The olivines were heated to 1245°C, at 1 atmosphere with a buffered oxygen fugacity, to rehomogenise the crystalline melt inclusions. The amount of host phase that was melted during this rehomogenisation was calculated by the degree of disequilibrium between the host olivine and melt inclusion's major elements. The rare earth element concentrations of the melt inclusion were determined with a Cameca IMS 3f ion probe at Woods Hole Oceanographic Institution, using techniques described elsewhere (Shimizu & Hart, 1982; Johnson *et al.*, 1990) and their major element concentrations by a Cameca SX50 electron microprobe.

Results

Both theoretical models (M^cKenzie 1985) and recent observations of natural systems (Johnson et al 1990, Shimizu & Sobolev 1993) show that the generation of magmas occurs by fractional melting. The observed erupted magma composition is then dependent on the depth at which melt segregation occurs and the degree of mixing between the increments of fractional melting, in addition to source composition and degree of melting. The analysis of melt inclusions is one way to study the composition of the fractional melts that combine to produce the erupted magmas.

Melting beneath Theistareykir has been

modelled by the rare earth inversion procedure of McKenzie and O'Nions (1991). The inversion uses the observed rare earth element concentrations to calculate the degree of melting with depth. The fit of the melt model can be assessed by comparing the calculated with the observed concentrations. The inversion assumes that fractional melting occurs by decompression melting. The source composition is a mixture of the MORB soure and the primitive mantle that satisfies the measurements of ϵ_{Nd} (Elliott *et al.*, 1991).

Results of the modelling suggest that the erupted lavas do not represent an aggregation of melt increments generated throughout the melting column. Instead they are partially homogenised increments of melt extracted from different depths. Although mixing of melts produced by fractional melting does occur, the mixing is not perfect. This result is in agreement with recent published data from this area of Iceland (Elliott *et al.*, 1991, Nicholson & Latin 1992). The melts in the inclusions are less well mixed than the host magma, and therefore their compositions are closer to that of the melt as it is produced.

References

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