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

Journal of Conference Abstracts
Volume 5(2), 574

N-MORB or a Depleted Plume Component? Evidence from Hf-Nd Isotope Systematics of Tertiary Picritic and Basaltic Lava Flows from Baffin Island

Pamela D. Kempton (p.kempton@nigl.nerc.ac.uk)[1], **J. Godfrey Fitton** (gfitton@glg.ed.ac.uk)[2], **Donald Francis** (donf@eps.mcgill.ca)[3] & **Solveigh Lass**[2]

[1] NERC Isotope Geosciences Laboratory, Kingsley Dunham Centre, Keyworth NG12 5GG, UK
[2] Grant Institute, University of Edinburgh, Edinburgh EH9 3JW, UK
[3] Earth and Planetary Sciences, McGill University, Montreal, Quebec, Canada

Introduction

Approximately 60 m.y. ago, igneous activity began synchronously over a wide area of the North Atlantic - in eastern Canada, West Greenland, eastern Greenland and the British Isles, encompassing a pre-drift distance in excess of 2000 km. Many authors attribute volcanism across the whole province to the impact of a single "proto-Icelandic" plume head, initially centred beneath East Greenland. Recent numerical modelling suggests that this plume rapidly spread laterally as a thin sheet along the base of the lithosphere (Larsen et al., 1999).

However, Gill et al. (1995) point out that the high Fo content of olivines in picrites from West Greenland indicates eruption of magmas with high liquidus temperatures and, by implication, high mantle source temperatures on what is thought to be the periphery of the plume. They argue that the much lower abundance of picritic compositions in East Greenland, located directly above the supposed plume axis, contradicts the single-plume model. Interestingly, the Baffin Island picrites occur as two stratigraphically interbedded, but geochemically distinct, lava types, which Kent et al. (1998) described as respectively E-MORB-like and N-MORB-like. E-MORB-like glasses are LREE-enriched and have $^{87}Sr/^{86}Sr > 0.703$ and $^{143}Nd/^{144}Nd < 0.5130$, similar to basalts derived from the enriched component of the Iceland plume. In contrast, N-MORB-like glasses are LREE depleted and have $^{87}Sr/^{86}Sr < 0.7030$ and $^{143}Nd/^{144}Nd > 0.5130$. If N-MORB source mantle contributed to the magmatism of West Greenland, it has significant implications for plume dynamics in the North Atlantic.

Distinguishing N-MORB and depleted plume sources

Distinguishing between alternative plume models is complicated by the lack of unambiguous criteria for recognizing all the possible mantle sources involved. For example, some authors have argued that the depleted plume component required to explain the range of radiogenic isotopic ratios measured in Icelandic basalts is entrained upper (MORB-source) mantle, while others have suggested that it is a distinct component intrinsic to the plume. Our recent work applying Hf-Nd isotope systematics to this problem (Kempton et al., 2000) supports the latter interpretation (see Figure 1). In addition, our work suggests that the head of the ancestral Iceland plume was zoned (Fitton et al., 1997), with a heterogeneous inner part that originated in the lower mantle (possibly in the D" layer) which is surrounded by a relatively thick outer sheath derived from the thermal boundary layer at the base of the upper mantle (Kempton et al., 2000). Today, basalts derived from the outer plume sheath occur along the Reykjanes and Kolbeinsey Ridges north and south of Iceland, respectively. Although compositionally similar to North Atlantic N-MORB, they have distinctly higher ε_{Hf} at a given ε_{Nd} value (Figure 1).

Results

We have analyzed seven N-MORB-like, high-MgO basalts and picrites from Baffin Island (Padloping) in order to determine whether N-MORB source mantle was available during the earliest phase of plume magmatism in the North Atlantic. Our results are summarized in Figure 1. In ε_{Hf} vs ε_{Nd} space, the data overlap the field for Iceland. These data confirm that the basalts are not derived from an N-MORB source, consistent with the high $^{3}He/^{4}He$ of picrites from the area (Graham et al., 1998). Furthermore, although the depleted plume sheath and the depleted plume component overlap in ε_{Hf} vs ε_{Nd} (Figure 1), they are distinguishable in plots of Nb/Y vs Zr/Y and ε_{Hf} vs Zr/Y (Kempton et al., 2000). Iceland shows a strong negative correlation between ε_{Hf} vs Zr/Y, whereas the plume sheath has higher Zr/Y for a given ε_{Hf} (i.e. it is slightly more fertile). In ε_{Hf} vs Zr/Y, the Baffin Island samples overlap the Iceland array, but trend toward the composition of the modern-day plume sheath rather than toward the depleted Iceland plume component. This suggests that a single, zoned plume head, which rapidly spread out beneath the continental lithosphere, is a more likely explanation for the magmatism in West Greenland and Baffin Island than is a second plume.

Journal of Conference Abstracts
Volume 5(2), 575

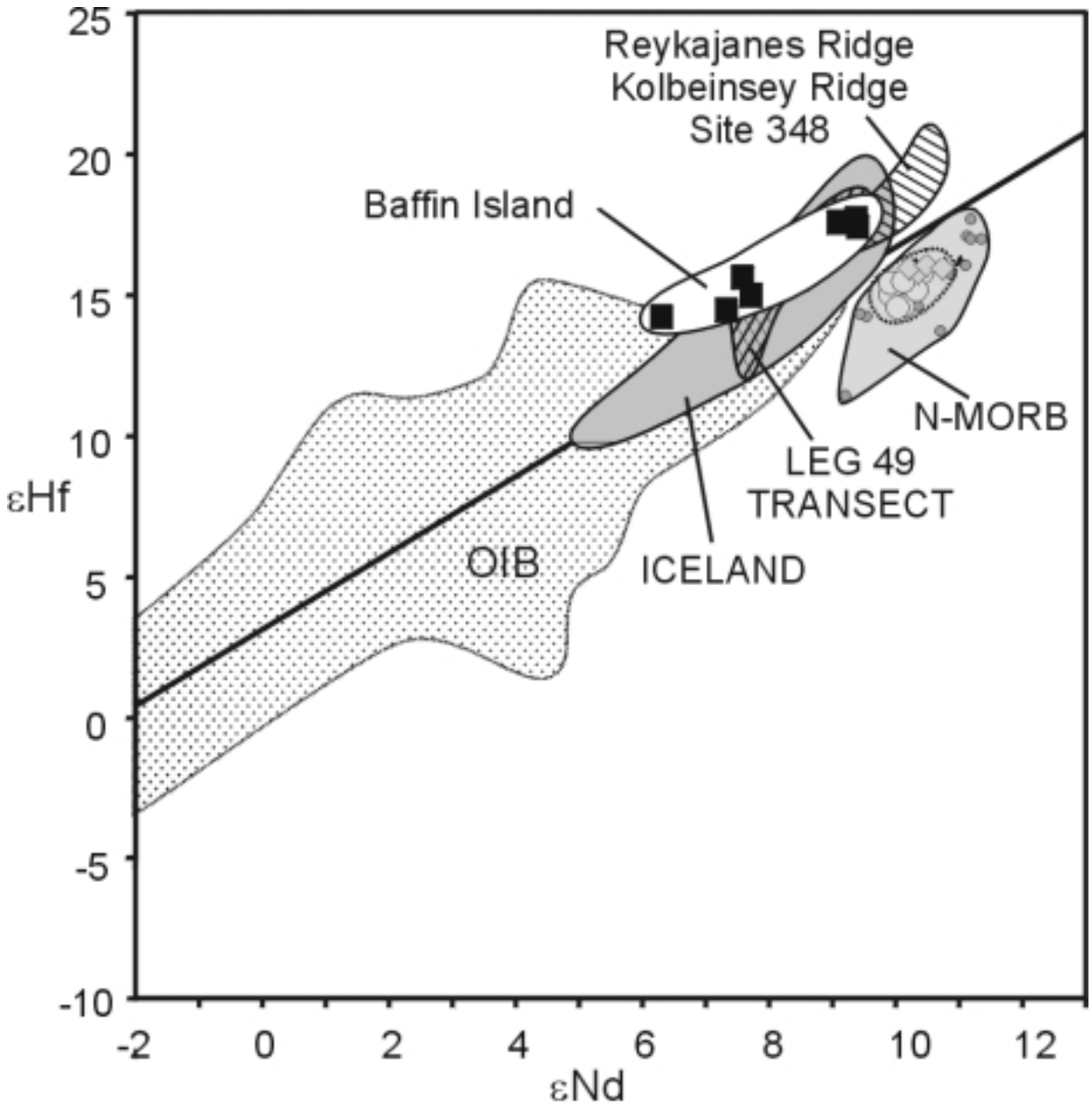

Figure 1. ε_{Hf} vs ε_{Nd} for Baffin Island basalts and picrites compared with fields for Iceland, Reykjanes and Kolbeinsey Ridges, DSDP Site 348 and DSDP Leg 49 transect. Also shown are global fields for OIB and N-MORB. Figure modified from Kempton et al. (2000).

Fitton, JG, Saunders, AD, Norry, MJ, Hardarson, BS, & Taylor, RN, *Earth and Planetary Science Letters*, **153**, 197-208, (1997).

Gill, RCO, Holm, PM, and Nielsen, TFD, *Lithos*, **34**, 27-39, (1995).

Graham, DW, Larsen, LM, Hanan, BB, Storey, M, Pedersen, AK & Lupton, JE, *Earth and Planetary Science Letters*, **160**, 241-255, (1998).

Kempton, PD, Fitton, JG, Saunders, AD, Nowell, GM, Taylor, RN, Hardarson BS, & Pearson, G, *Earth and Planetary Science Letters*, **177**, 255-271, (2000).

Kent, AJR, Stolper, EM, Woodhead, J, Hutcheon, ID, & Francis, D, *Mineralogical Magazine*, **62A**, 765-766, (1998).

Larsen, TB, Yuen, DA, & Storey, M, *Tectonophysics*, **311**, 31-43, (1999).