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

Journal of Conference Abstracts
Volume 5(2), 357
© 2000 Cambridge Publications

The Nature of Kimberlite Source Regions: A Hf-Nd Isotopic Study of Slave Craton Kimberlites

David Dowall[1], **Geoff Nowell**[2], **D. Graham Pearson**[1] & **Bruce Kjarsgaard**[3]

[1] Department of Geological Sciences, South Road, Durham, DH1 3LE, UK
[2] NIGL, Keyworth, Nottingham, NG12 5GG, UK
[3] Geological Survey of Canada, 601 Booth St, Ottawa, Ontario, K1A 0E8, Canada

Introduction

Recent investigations into Hf-Nd-Sr isotope characteristics of kimberlites and lamproites have demonstrated that these deep-seated magmas commonly plot below the MORB-OIB ε_{Hf}-ε_{Nd} "mantle array" [1-2], implying long-term storage of a source component isolated from the homogenising effects of convective processes. Possible sources of such a signature (negative $\Delta\varepsilon_{Hf}$, [3]) include the subcontinental lithospheric mantle [2, 4], or a deeper boundary layer such as the core-mantle boundary (CMB) [1-2]. It is important to better constrain the location and possible extent of the negative $\Delta\varepsilon_{Hf}$ reservoir because its existence within the mantle may explain the proposed displacement of Bulk Silicate Earth (BSE) beneath the mantle array in terms of the Hf and Nd isotopic mass balance [5].

To date most work has been conducted on samples from the Kaapvaal Craton [1-2, 4]. We are investigating the extent of the negative DeHf signature in kimberlites from other cratonic areas. As part of a more extensive project including megacryst analysis, we present preliminary results of isotopic and trace element analyses of six kimberlites from the Slave Province of north-western Canada. Samples are drawn from around Contwoyto Lake, and Hardy Lake, Lac de Gras area, where the majority of Canadian kimberlite discoveries have been made in the last decade [6]. Implications for recognition of negative DeHf signatures on a global scale are then discussed.

Samples and Methods

Nine samples from six kimberlites of the central and northern Slave craton have been studied. Drill-core samples indicate that these kimberlites are megacryst-poor, hypabyssal facies rocks. Whole rock powders were prepared from fresh, minimally contaminated (C.I. = 0.87-1.24) sample. Hf, Nd and Sr were preconcentrated prior to analysis using ion-exchange procedures at Durham University and NIGL. Hf isotope analyses were obtained by solution mode PIMMS on a VG Elemental Plasma 54, and Nd and Sr analyses by TIMS on a Finnigan MAT 262, at NIGL. Trace element analyses were obtained by solution mode quadrupole ICP-MS using the Perkin Elmer ELAN 6000 at Durham.

Results

Incompatible trace element abundances of the samples are broadly consistent with those of Kaapvaal Group I (GPI) and transitional kimberlites, notable differences being enrichment in barium and depletion in HFSE relative to the average GPI signature. In Sr-Nd isotope space the samples plot from the GPI field into that of transitional kimberlites, with $\varepsilon_{Nd(T)}$ values as low as -3 and $\varepsilon_{Sr(T)}$ values of up to +22. The five samples for which Nd-Hf isotope data are available also span the range from Kaapvaal GPI to transitional. Four samples plot well within the "mantle array" while one (HL-12) plots significantly below, with a $\Delta\varepsilon_{Hf}$ of -9.9. This sample has very similar Sr-Nd-Hf isotopic characteristics to the South African transitional Melton Wold kimberlite and is our first convincing indication of a component with negative DeHf contributing to the source of Slave kimberlites.

Discussion

These analyses of Canadian kimberlites indicate that they plot within error of the fields defined by GPI and transitional kimberlites of the Kaapvaal craton in both Hf-Nd and Nd-Sr space, and so could potentially be subject to the same petrogenetic interpretations, [1-2]. Our results show that kimberlites with Hf-Nd isotope compositions plotting significantly below the mantle array occur in both the Kaapvaal and Slave cratons; these signatures have also been recorded from the Siberian, Kimberley and Wyoming cratons [2]. This result is consistent both with models involving kimberlite genesis from a globally extensive ultra-deep reservoir such as the core-mantle boundary, and models invoking inheritance of the negative $\Delta\varepsilon_{Hf}$ signature in the sub-continental lithosphere.

These results do not preclude lithospheric contamination as a source of enrichment of deep-seated magmas in non-radiogenic Hf and Nd. However, it would imply that the degree and nature of the enrichment provided by the continental lithosphere was extremely similar between areas at great separation. Given the extreme isotopic variation that characterises the lithospheric mantle it is somewhat surprising that variable lithospheric interaction produces such similar isotopic variations in kimberlites from two different cratons. Clearly our current results do not provide definitive evidence of the origin of negative DeHf and we aim to obtain firmer constraints on the sub-lithospheric contribution to Slave kimberlites through analysis of megacryst suites.

Nowell GM et al., *Ninth Annual V.M. Goldschmidt Conference*, 211-212, (1999).
Nowell GM et al., *Procs. 7th Int. Kimb. Conf.*, **2**, 616-624, (1998).
Vervoort JD et al., *Earth. Planet. Sci. Lett*, **168**, 79-99, (1999).
Griffin WL et al., *Geoch. Cosmo. Acta*, **64**, 133-147, (1999).
Blichert-Toft J & Albarede F, *Earth. Planet. Sci. Lett*, **148**, 243-258, (1997).
Carlson JA et. al, *Procs. 7th Int. Kimb. Conf*, **1**, 81-89, (1998).