^{186}Os-^{187}Os and highly siderophile element abundance systematics of Earth's upper mantle

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Osmium isotope and highly siderophile element (HSE) abundance systematics of abyssal peridotites may provide new constraints for interpreting isotopic and elemental signatures preserved in terrestrial lavas, as well as for deciphering melt depletion and recycling in the convecting mantle. Here we report new high-precision ^{186,187}Os/^{188}Os isotope and HSE abundance data for bulk samples of abyssal peridotites from the Arctic (Gakkel), Indian (central [CIR] and southwest [SWIR]), and Atlantic (Kane) ridges.

Peridotites from the global suite range from relatively fresh to serpentinized harzburgites and lherzolites, with no systematic variation observed for HSE abundances or ^{186,187}Os/^{188}Os with alteration. Average HSE abundances of different ridge segments are broadly similar (0.007±2 × CI-chondrite). The HSE are in approximately chondritic-relative abundances, although all ridges studied have supra-chondritic Ru/Ir (Kane = 1.4±0.2; Gakkel = 1.6±0.6; SWIR = 1.5±0.3; CIR = 1.4±0.1), similar to estimates for primitive upper mantle (PUM). Unlike PUM, there is no systematic supra-chondritic Pd/Os in SWIR, CIR, or the majority of Gakkel peridotites. There is greater HSE abundance variability in ultra-slow spreading Gakkel, versus Indian or Atlantic peridotites. Abyssal peridotites analyzed in this study have ^{187}Os/^{188}Os ratios ranging from 0.1217 to 0.1587. The ^{186}Os/^{188}Os of SWIR peridotites (0.1198385±4), which were affected by the Bouvet hotspot at ~20Ma, are, on average, higher than for CIR (0.1198360±5), Kane (0.1198353±7 [1]), and Gakkel peridotites (0.1198332±6). SWIR show a general positive correlation for ^{187}Os/^{188}Os-^{186}Os/^{188}Os, but no other correlations are observed between these ratios in the dataset. If CIR, Kane and Gakkel peridotites are representive of convecting upper mantle, then this reservoir has evolved with a long-term Pt/Os that is well within the range of chondrites. In contrast, SWIR peridotites derive from a mantle source with higher Pt/Os. If SWIR ^{186}Os/^{188}Os values relate to high time-integrated Pt/Os, how this signature is transferred from the hotspot to the peridotites is unclear. Lack of correlation between Pt/Os and ^{186}Os/^{188}Os for the suites suggests abyssal peridotites do not record absolute and relative abundances of the HSE in the convecting upper mantle with high fidelity.

Metasomatism beneath the Kerguelen Plateau associated with heterogeneous mantle plume

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The Kerguelen Plateau, in the Southern part of the Indian Ocean, represents the second largest igneous province on Earth. Its main emerging feature is the Kerguelen Archipelago, located in the Northern part of the plateau (NKP). Basic and ultrabasic xenoliths are commonly found disseminated within alkaline lava series, especially in the Southern and South-East part of the archipelago. The xenoliths were formed in PT conditions generally comprised between 0.75 to 1.6 GPa and 880 to 1010°C, corresponding to lithospheric conditions [1]. The xenoliths thus provide a unique opportunity to understand the processes that occurred during the construction of the NKP.

While there is no evidence for contamination of the xenoliths from their host lavas during their ascent, the xenoliths are metasomatized, as showed by the presence of both silicate and carbonate melt inclusions [2], and enrichment in incompatible trace elements [1]. In light of the comparable isotopic signatures for the Kerguelen alkaline volcanism and the xenoliths, the origin of this metasomatism, both silicate and carbonatitic-silicate melts, seems related to the Kerguelen Mantle Plume itself [3]. Using various types of xenoliths, we show here that (i) the metasomatism event is ~40 million years old, corresponding to the onset of the interaction between the South-East Indian Ridge and the Kerguelen mantle plume [4], and (ii) the two metasomatic melts can be distinguished using both trace element and isotope ratios. As such, xenoliths metasomatized by carbonatitic-silicate melts have $(Sm/Yb)_N > 1$, and ^{206}Pb/^{204}Pb < 18.200. Using Nd, Hf and Pb isotope ratios, xenoliths metasomatized by carbonatitic-silicate melts show a stronger affinity with the EM-I component, while the one metasomatized by silicate melts are closer of the EM-II component. This suggests that the carbonatitic-silicate and silicate melts do not initially originate from a homogeneous source that later separated due to immiscibility at shallow depths between silicate and carbonatitic melts, but instead reflect the heterogeneity of the Kerguelen mantle plume.

[1] Grégoire *et al.* 1994 *Nature* **367**, 360-363. [2] Schiano *et al.* 1994 *Earth Planet. Sci. Lett.* **123**, 167-178. [3] Mattielli *et al.* 1999 *J. Petrol.* **40**, 1721-1744. [4] Doucet *et al.* 2002 *J. Petrol.* **43**, 1341-1366.