Isotopic signatures of the Siberian flood basalts and alkaline magmatism of Polar Siberia (age, genetic link, heterogeneity of mantle sources)

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A close association between alkaline magmatism and continental flood basalts is observed worldwide. Nevertheless, the problem of a genetic link between the Siberian flood basalts (SFB) and the ultramafic-alkaline rocks of the Maimecha-Kotuy province in Polar Siberia is still being debated. The SFB with a volume of $1.6x10^6$ km^3 occur in the northern part of the Siberian platform. The Putorana plateau, where about 90% of all the basaltic volcanism occurred, is situated in the center of the SFB province, and some authors consider the Putorana basalts to be representative of the Siberian plume itself.

The ultramafic-alkaline Maimecha-Kotuy comprises the world's largest ultramafic-alkaline Guli massif, the ultramafic-alkaline-phoscorite Kugda complex, and 31 smaller ultramafic-alkaline intrusions.

A whole-rock U-Pb age of 250±9 Ma was determined for the Guli massif, which lies within the range of ages previously reported for the SFB. The combined Pb, Sr, and Nd isotopic systematics of the SFB and the Guli and Kugda alkaline rocks identify several discrete source components. The first component dominates many of the Guli rocks and is characterized by low $^{87}Sr/^{86}Sr$ (0.7031 to 0.7038), high (Nd (+5.35 to +3.97), and relatively unradiogenic Pb ($^{206}Pb/^{204}Pb$ = 17.88-18.31; $^{207}Pb/^{204}Pb$ = 15.38-15.46; $^{208}Pb/^{204}Pb$ = 37.33-37.70), which we associate with the depleted (or MORB source) upper mantle. The second component dominating the Putorana basalts demonstrates a notable chemical and isotopic uniformity with $^{87}Sr/^{86}Sr$ values of 0.7046 to 0.7052, ε_{Nd} values of 0 to +2.5, and an average Pb isotopic composition of $^{206}Pb/^{204}Pb$ = 18.3, $^{207}Pb/^{204}Pb$ = 15.5; $^{208}Pb/^{204}Pb$ = 38.0). This component is speculated to derive from a relatively primitive, lower mantle plume with a near-chondritic isotopic signature. The third mantle component characterizing most of the Kugda massif and some dykes is not as depleted as the Guli source, but more depleted in respect to the Rb-Sr system than the Putorana basalts [1]. Contamination by upper and lower continental crustal material, designated as components 4 and 5. Finally, metasomatic processes associated with the invasion of the Siberian super-plume add a sixth component responsible for the extreme enrichment in rare-earth and related elements found in some Guli and Kugda rocks and in the SFB.

References

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In situ detection of highly siderophile element micronuggets in peridotite by synchrotron radiation X-ray fluorescence mapping

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Abundances of highly siderophile elements (HSEs) in the Earth's mantle are key indices for understanding the Earth's formation processes and subsequent chemical evolution of the mantle. However, estimation of the primordial HSE abundances in the mantle from HSE concentrations in present-day peridotite samples is not straightforward, because the residence of HSEs in peridotite has not been well constrained. Sulfide minerals can account for whole-rock HSE abundances in some peridotite samples (e.g., Alard *et al.*, 2000), but the existence of micrometer-scale HSE nuggets (e.g., Luguet *et al.*, 2003; Lorand *et al.*, 2006) implies that such HSE micronuggets could also influence the behavior of HSEs in the mantle. We report in situ discovery of HSE micronuggets from peridotite by microbeam X-ray fluorescence mapping using synchrotron radiation X-ray at SPring-8, Japan. We found a few grains of HSE micronuggets (1~10 μm in maximum dimension) included in single sulfide grains in an orogenic lherzolite from Horoman peridotite complex, Japan. Only two of sixteen sulfide grains investigated contain the HSE micronuggets, indicating strongly heterogeneous distribution of HSEs between sulfide grains. Pt-rich and Os-Ir-rich micronuggets were included in both of the two sulfide grains. HSE concentrations within sulfides themselves were below detection limits. These results suggest that distributions of HSEs within peridotite are strongly controlled by HSE micronuggets. We interpret that the coexistence of Pt-rich and Os-Ir-rich micronuggets and the strong heterogeneity of HSE distributions are not fully attributed to secondary processes such as metasomatism but are at least partly of primary signature in the uppermost mantle. Thus, HSE micronuggets may play a significant role in controlling HSE abundances in the mantle. It is essential to reveal the origin of HSE micronuggetss and their spatial distribution in the mantle for understanding the HSE behavior in the mantle.

References

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