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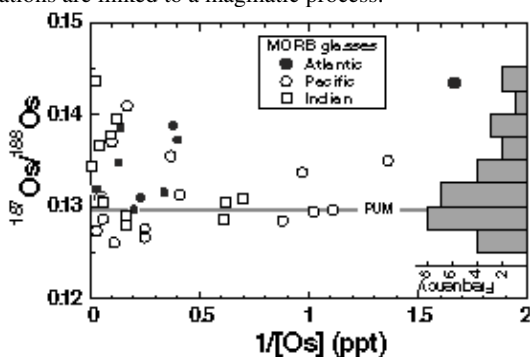
Assessing the scale of osmium isotope heterogeneity in Mid-Ocean Ridge Basalts

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Mid-ocean ridge basalts (MORB) are produced by partial melting of the Earth's upper mantle, and for the long-lived isotopes of heavy elements, their isotope compositions should directly reflect that of their source. However, MORB glasses yield osmium (Os) isotope compositions that are markedly more radiogenic than those of seafloor peridotites [1]. The observed range of $^{187}\text{Os}/^{188}\text{Os}$ (from 0.127 to 0.164) have been attributed by some to seawater contamination and/or post-eruptive decay of ^{187}Re to ^{187}Os [2], while others have argued that the variations reflect a chemical heterogeneity of the upper mantle. Despite the controversy surrounding the MORB glass data, no attempt has been made to reproduce these measurements.

This study presents Re-Os isotope data using ultra low-blank chemistry, for 30 pristine MORB glasses, from the East-Pacific, the Mid-Atlantic and Indian Ridges including 17 samples investigated previously [1]. Surprisingly, $^{187}\text{Os}/^{188}\text{Os}$ ratios are found to vary from 0.126 to 0.144 with an average value of 0.133 ± 0.005 (1σ). Os isotope ratios are not correlated with Os abundances (see figure) or with $^{187}\text{Re}/^{188}\text{Os}$, and hence, no evidence for binary mixing can be inferred. Additionally, no covariations are observed between $^{187}\text{Os}/^{188}\text{Os}$ and $^{206}\text{Pb}/^{204}\text{Pb}$ or with $^{143}\text{Nd}/^{144}\text{Nd}$. The small, but resolvable, variations that do exist cannot be easily explained by age or seawater contamination. However, in general, the more evolved samples possess the least radiogenic Os isotope compositions suggesting that the variations are linked to a magmatic process.



References

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Re-Os isotope and PGE systematics of peridotites from the Oman Ophiolite

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The Oman Ophiolite provides complete sections through crust and upper mantle formed at an oceanic spreading center. In the southern Oman massifs (Samail and Wadi Tayin) some lavas and dikes have compositions indistinguishable from MORB. The mantle section of the Wadi Tayin massif probably has a structural thickness of more than 10 km and comprises harzburgites with discordant dunites. The harzburgites are residues of partial melt extraction and are geochemically similar to abyssal peridotites. Dunites represent channels of focused melt transport through the harzburgites, and were formed by melt-rock reaction between MORB-like melts and harzburgite [1].

In terms of $^{187}\text{Os}/^{188}\text{Os}$, both harzburgites and dunites are within the range of abyssal peridotite compositions [e.g., 2], but dunites, on average, have higher $^{187}\text{Os}/^{188}\text{Os}$, similar to MORB. Assuming that Re/Os and/or $^{187}\text{Os}/^{188}\text{Os}$ have not been modified by later processes, initial (at 90 my) $^{187}\text{Os}/^{188}\text{Os}$ compositions of harzburgites range from 0.1159 to 0.1362 (average = 0.1257), and of dunites range from 0.1245 to 0.1477 (average = 0.1307). The more radiogenic nature of the dunites may be due to relatively high $^{187}\text{Os}/^{188}\text{Os}$ in melt transported through the dunites. This suggests that melt-rock ratios were high within the dunites, and that a significant proportion of the Os in MORB comes from a component in the mantle with distinctly more radiogenic Os compositions than the ubiquitous depleted peridotite component represented by the residual harzburgite.

PGE abundances are generally lower and more variable in dunites compared to harzburgites. Both show relative Pt depletion and Pd enrichment, but whereas the harzburgites have Os/Ir ratios clustering tightly around 1, dunite Os/Ir range from 0.5 to 8.3. Os/Ir ratios do not correlate with isotopic composition, abundance of any of the PGE elements or sulfur concentration. Sulfides in the peridotites have variable Os/Ir ratios, and we speculate that Os/Ir fractionation in the dunites is controlled by igneous sulfides during melt extraction. Alternatively, the effect of alteration may on PGE concentration and/or $^{187}\text{Os}/^{188}\text{Os}$ may be different in dunites compared to harzburgites.

References

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