Ancient Recycled Lithosphere Recognized in Mantle Xenoliths from Kauai, Hawaii

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Introduction

A fundamental question in Earth Sciences is the scales of heterogeneity in the Earth's mantle. Peridotite xenoliths are that accidentally brought to the surface by lavas provide us with a rare view of the small-scale (mm to cm) heterogeneity in the mantle. The peridotite xenoliths found in the Hawaiian Islands can further provide a glimpse of the lithosphere above the earths' largest mantle plume and provide clues on how the upwelling plume reacts with the overlying lithosphere. Here we report on the first comprehensive geochemical investigation (major - trace elements, and Hf-Os-Nd-Sr-Pb isotopes) of peridotite xenoliths from Kauai, Hawaii. The xenoliths were collected from six onland and one submarine locations and represent ca. 50km of north-south area coverage.

Results and Discussion

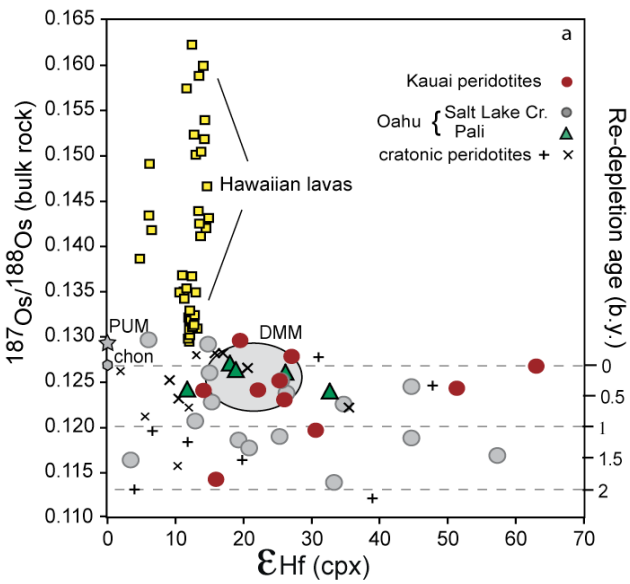

Fig. 1. Hf vs. Os isotope compositions of Kauai and Oahu peridotites.

The Kauai peridotite major and trace element compositions overlap those of abyssal peridotites (the melt residues of MORB), with most samples falling at the depleted end (e.g. cpx: Mg#= 0.906 - 0.93, Na_2O= 1.5 -<0.03wt%, Ti= 2800 - 150 ppm, $[Ce/Yb]_N$= 7 - < 0.002). Model calculations suggest >17% melt depletion of a MORB-source for the most depleted samples. In Sr-Nd isotope space the cpx extend to both more depleted (MORB-like) and more enriched (similar to Kauai and Mauna Kea tholeiites) compositions than the host lavas (cpx $^{87}Sr/^{86}Sr$ = 0.7027 – 0.7037, ε_{Nd} = 6.5 – 10). The cpx Hf isotope data (ε_{Hf} = 19.5 - 63) extend well above the terrestrial array in Hf-Nd space with very radiogenic Hf for a given Nd isotope compositions, similar to the Salt Lake Crater peridotites from Oahu [1]. The bulk rock $^{187}Os/^{188}Os$ ratios range from near bulk earth (0.1295) to extremely unradiogenic (0.114) and the total Kauai peridotite Hf-Os isotope variability overlaps that of the Oahu peridotites [1]. The presence of both enriched and depleted (up to 2 Ga old Re-depletion age and 650Ma Lu/Hf model age) isotopic compositions in the Kauai peridotites is difficult to reconcile with an *in situ* origin from the 100 Ma old Pacific lithosphere. Instead, some of these peridotites could be fragments of an ancient, depleted and recycled oceanic lithospheric mantle that is part of the upwelling Hawaiian plume. These recycled lithospheric pieces are brought to shallower levels (ca. 60km) within the Pacific lithosphere and are juxtaposed with in-situ Pacific lithosphere. Similar conclusion was reached for some of the Oahu peridotites, some 300km away [1]. Our data is consistent with replacement of the Pacific lithosphere by upwelling plume material and consistent with seismic observations [2] that argue for large-scale erosion and replacement of the Pacific lithosphere by the Hawaiian plume, downstream from the present day plume center, in the vicinity of Kauai and Oahu.

Acknowledgements

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References

[1] Bizimis M., *et al.*, EPSL **257**, 259-273 (2007).
[2] Li, X., *et al.*, Nature, **427**, 827-829 (2004).