Pyroxenites as carriers of isotopic heterogeneity in the oceanic mantle

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Pyroxenites are estimated to comprise around 5% of the lithospheric mantle, both in oceanic and subcontinental settings. Because they are both geochemically diverse and geochemically distinct from their enclosing mantle peridotites, understanding pyroxenite formation and evolution is crucial to evaluating mantle heterogeneity and evolution.

Highly siderophile elements (HSE) and Os isotopes have been shown to be highly fractionated in pyroxenites, making them suitable as tracers for interaction between melts associated with pyroxenite formation and adjacent peridotite. Stable isotopes of transition metals, such as Zn and Cu, have recently been shown to record fractionation during melt generation and differentiation, and coupled with HSE and Os isotopes show potential as a powerful tool to study mantle processes.

Layered pyroxenites and websterites from the mantle massifs of External Ligurian ophiolites show highly radiogenic $^{187}Os/^{188}Os$ up to 1.1 along with enrichments of Pd and Re over Os and Ir. Fertile peridotites sampled in close proximity show unradiogenic to moderately radiogenic $^{187}Os/^{188}Os$ between 0.1239 and 0.1385 typical of oceanic mantle massifs, sometimes extending above primitive mantle estimates. Pyroxenites display $\delta^{66}Zn/^{64}Zn$ of up to +0.66 and $\delta^{65}Cu/^{63}Cu$ between -1.04 and +5.10, compared to peridotite values around 0. Neither Zn or Cu isotopes show clear correlation with $^{187}Os/^{188}Os$, but the most radiogenic Os values correspond to the most fractionated Zn and Cu isotopes.

Pyroxenitic layers in the ophiolitic mantle sections, suggested to form by interaction of melt derived from recycled crustal material, show distinctive signatures of HSE and chalcophile transition metals. These layers thus preserve crustal signatures in terms of chalcophile and siderophile radiogenic and stable isotopes, and provide additional insights into global crust-mantle element fluxes as well as mantle evolution and heterogeneity.