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Pyroxenite: a key component in creating enriched mantle sources

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Deep melt infiltration and melt-peridotite interaction are fundamental mechanisms to generate chemical and isotopic heterogeneity in the upper mantle. These processes originate pyroxenite-bearing peridotites, often invoked as a source of oceanic magmatism. Although being a volumetrically minor mantle component, pyroxenites thus play a crucial role to explain the origin of veined, enriched mantle sources. Natural analogs of such pyroxenite-bearing fertile mantle are rare, and our understanding of processes governing the chemical modification of mantle sources by pyroxenite emplacement is still limited. Pyroxenite-peridotite sequences from the Ligurian ophiolites (Italy) represent one of the most deeply studied proxy of such fertile veined mantle. Here we discuss the results of detailed spatially-controlled chemical and Nd, Hf, Os isotopic profiles in pyroxenites and host lherzolites. Reactive percolation of pyroxenite-derived melts caused systematic chemical modifications in the host peridotites. Sulphide distribution and composition vary across the profiles as a consequence of interaction between infiltrating melt and the host peridotite. Changes in whole-rock HSE and Os isotopic compositions in pyroxenites (correlated with major element variations) indicate variable extent of melt-peridotites interaction. Clinopyroxene in the infiltrated peridotites exhibits progressive increase in REE contents, coupled with decreased Sm/Nd and Lu/Hf ratios, extending up to 25 cm from cm-scale pyroxenite veins. Over time, this interaction resulted in significant Nd and Hf isotopic changes in the infiltrated peridotites, generating an enriched mantle component and significant isotopic heterogeneity encompassing the global variability of MORBs. The emplacement of pyroxenite veins by deep melt infiltration is therefore capable to modify a much larger volume of the host peridotite, propagating and amplifying enriched Nd and Hf isotopic signatures. Hybrid mantle domains made of pyroxenite, metasomatized peridotite and unmodified peridotite are best analogs of enriched mantle sources. Overall, our results point to the key roles of melt percolation and melt-peridotite reactions in generating pyroxenite-bearing mantle sources that account for the diversity of oceanic basalts.