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Origins of spinel- and garnet-pyroxenites in the shallow sub-continental lithospheric mantle

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Spinel- and garnet-pyroxenites form a small (1-5%) but integral part of xenolith suites and ultramafic massifs worldwide. Their mineralogy ranges from monomineralic orthopyroxenite through websterites to clinopyroxenite, with or without olivine. New results, combined with literature data, show that their major element compositions vary between three end-members: (1) low MgO (probably cumulus clinopyroxene), (2) high MgO (probably cumulus orthopyroxene) and (3) a component with concentrations of CaO, Al_2O_3, TiO_2 and Na_2O that are close to basaltic levels, interpreted as intercumulus melt.

Most mantle pyroxenites have whole-rock REE patterns that are LREE-depleted, although with lower absolute concentrations than MORB. Laser ICP-MS data on clinopyroxenes confirm that very few mantle pyroxenites are LREE-enriched. New $\delta^{18}O$ values for clinopyroxenes fall in the typical mantle range 5-5.8 per mil. Only rare garnet-pyroxenite layers from a few ultramafic massifs show higher values that may reflect recycling of an oceanic crustal component. Sr and Nd isotopic ratios from pyroxenites mostly fall in the depleted mantle field, although there is a slightly wider range of values than for shallow mantle peridotites. The majority of mantle pyroxenites are most easily explained products of crystal accumulation of mantle-derived magmas, together with variable amounts of trapped interstitial melt. Only pyroxenites in Ronda and Beni Bousera display evidence of being formed from subducted recycled oceanic crust, and only those from Cabo Ortegal appear to have crystallised from subduction-related melts.

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Cretaceous metasomatism of lithospheric mantle: Trace element and isotopic composition of spinel lherzolite xenoliths from NW Argentina

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Spinel lherzolite samples had equilibrated at high T (most samples > 1000C) and P below garnet-in. Sm-Nd systematics of clino- (cpx) and orthopyroxene, in absence of compositional zoning in the minerals, indicates a Cretaceous minimum age of the thermal anomaly giving rise to these rocks. The thermal anomaly could be related to an extended late Mesozoic rift system in the eastern part and to the east of the present Central Andes. Major elements and Cr, Ni, Co, and V of the xenoliths show element concentrations and correlations with the MgO content (35-48wt%) that are similar to those observed in other upper mantle xenolith suites worldwide and that have values between fertile and depleted mantle.

Trace element composition of cpx indicate metasomatism of a depleted mantle ($La/Yb_N < 1$) by enrichment of Sr, U, Th, Pb and light to medium REE (La/Yb_N between 0.5 – 110). $^{144}Nd/^{143}Nd_i$ ratios, corrected for in situ decay to the time of eruption of the host basanite at ca. 100 Ma, of the main group of xenoliths decrease with increasing Nd content from > 0.5130 (depleted samples) to ca. 0.5127. $^{87}Sr/^{86}Sr_i$ ratios (0.7127-0.7131, depleted samples; 0.7130-0.7134, enriched samples) show no variation with variable Sr contents (8-330 p.p.m.). Pb_i isotope ratios of the enriched samples are rather radiogenic ($^{206}Pb/^{204}Pb_i$ 18.8-20.6; $^{207}Pb/^{204}Pb_i$ 15.6-15.7; $^{208}Pb/^{204}Pb_i$ 38.6-47) compared with the Pb isotope signature of the depleted samples. Nd_i and Sr_i isotope ratios and Pb isotope ratios from U decay of the enriched xenoliths fall close to the initial isotopic composition of their host basanite. The presumable $^{208}Pb/^{204}Pb$ composition of the metasomatic agent is however not directly related to the $^{208}Pb/^{204}Pb$ composition of any known nearby crustal or mantle source. The high initial $^{208}Pb/^{204}Pb$ ratios and their considerable scatter could be inherited from a precursor mineral e.g. from cpx of early Mesozoic or Paleozoic age with high Th/Pb ratios and enhanced radiogenic growth of ^{208}Pb. The measured $^{232}Th/^{204}Pb$ ratios (3.6 – 600) of cpx show the capability of this mineral to fractionate Th and the effectiveness of such process to create high $^{208}Pb/^{204}Pb$ ratios (measured ratios up to 50) in a relatively short time of ca. 100 Ma.