DEPLETION AND METASOMATIC PROCESSES WITHIN THE SUBCONTINENTAL LITHOSPHERIC MANTLE: EVIDENCE FROM PERIDOTITE XENOLITHS IN SARDINIA

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ABSTRACT

Spinel-peridotite xenoliths entrained by Plio-Pleistocene alkaline basic lavas from Sardinia (Italy) indicate a complex petrological history of the uppermost lithospheric mantle. They mostly show protogranular textures and are characterised by a four-phase equilibrated assemblage, ranging in composition from lherzolites (up to 18% of Cpx) to harzburgites, suggesting that the Sardinian subcontinental mantle underwent partial melting episodes with extraction of basic magmas. Trace element analyses (LAM-ICP-MS) and Sr-Nd isotope data, carried out on clinopyroxene (Cpx) separates, indicate a multistage history of depletion and enrichment processes. Clinopyroxene from Cpx-rich lherzolites are characterised by a LREE depletion, with low $^{87}Sr/^{86}Sr$ (0.70262-0.70391) and high $^{143}Nd/^{144}Nd$ (0.51323 - 0.51286) values, while clinopyroxene from less fertile lherzolites and harzburgites show LREE enrichments, higher $^{87}Sr/^{86}Sr$ (0.70410-0.70461) and lower $^{143}Nd/^{144}Nd$ (0.51288-0.51251).

Nd model ages (relative to CHUR) of the most LREE-depleted samples, with $^{87}Sr/^{86}Sr<0.703$, suggest that partial melting events occurred during Pre-Palaeozoic times. Modelling of the HREE distribution in clinopyroxene indicates that the Cpx-rich lherzolites could be interpreted as a residue after low (< 5%) melting degrees of an inferred fertile source, while higher melting degrees (up to 20-25%) are necessary to fit the Cpx composition of the most refractory harzburgites. Subsequent metasomatic processes are testified by the isotopic/LREE enrichments, mainly recorded in the Cpx-poor peridotites. This fact implies that the most refractory domains of the mantle are more easily percolated by fluids, while Cpx-rich domains are less permeable to metasomatic agents, as indicated by experiments on melt connectivity in peridotite materials. Geochemical modelling suggests that the above mentioned enriched compositions can be obtained by metasomatising previously depleted mantle peridotite with a small amount (< 3%) of a strongly alkaline silicate melt.

Neither the inferred metasomatic agents nor the Plio-Pleistocene Sardinian lavas show the HIMU geochemical imprint which, in addition to enriched mantle EM components, is recognised in Cenozoic anorogenic magmas throughout Central Europe (Wilson and Downes, 1991). The available data therefore indicate that the lithospheric mantle beneath Sardinia is heterogeneously enriched mainly by EM components, which reflect the complex multistage evolution occurring over the last 500 Ma.

Similar geochemical features are observed in other samples of the European lithospheric mantle, such as the peridotite xenoliths entrained in alkaline lavas from the Massif Central (Zangana et al., 1997), and Tallante (Southern Spain; unpublished data). Analogous metasomatic enrichments can also be recognised in the most residual peridotites from the Pyrenean and Lanzo massifs (Bodinier et al., 1991; Downes et al., 1991). This suggests that the observed geochemical features were probably acquired during pre-Middle Mesozoic times, due to the repeated percolation of uprising EM metasomatic fluids in the European lithosphere.

It should be emphasised that this metasomatic signature has not generally been observed for the lithospheric mantle of the African plate, where Cenozoic anorogenic magmas and associated mantle xenoliths are characterised by a prevalent HIMU metasomatic component (Beccaluva et al., 1998 and reference therein).

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