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Mantle evolution in a collision-related setting: from depletion in a suboceanic arc environment to re-fertilization in an intracontinental setting – the example of East Serbian lithospheric mantle

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A suite of highly depleted peridotite xenoliths in East Serbian Palaeogene basanites has been studied. These xenoliths erupted in a collision-related setting and their composition records effects of strong depletion, which probably occurred in a suboceanic arc setting, and subsequent metasomatic enrichment caused by alkaline silicate melts. The xenoliths are divided into: (a) Type I/Cr-diopside group (harzburgites, clinopyroxene-poor lherzolites and rare dunites), (b) Type II/Al-augite group (clinopyroxene-rich lherzolites, Fe-rich dunites, clinopyroxene megacrysts, etc), and (c) a special group of orthopyroxene-rich olivine websterites.

Type I xenoliths contain mostly <5 vol% of modal clinopyroxene and are characterized by high Mg# in silicates (>91), high Cr# in spinel (mostly 0.5-0.7), and by distinctively low Al_2O_3 contents in orthopyroxene (mostly 1-2 wt%). These characteristics imply a composition which is significantly more depleted than most non-cratonic sub-continental mantle xenolith suites, as well as orogenic peridotites and abyssal peridotites. Geological and compositional evidence exclude the possibility that the xenoliths represent Archean or Proterozoic mantle. On the other hand, they are compositionally very similar to peridotites of modern oceanic sub-arc settings. The existence of such a depleted lithospheric mantle segment is also inferred from the presence of rare orthopyroxene-rich xenoliths in the same suite. These are interpreted to have originated as lithospheric precipitates of high-Mg, SiO_2-saturated magmas that require a highly depleted mantle source. Such source is typically required by boninitic-like magmas of intraoceanic suprasubduction settings.

The Type II lithology comprises: (IIa) clinopyroxene ($\pm$olivine) megacrysts and Fe-rich dunite xenoliths, (IIb) protogranular clinopyroxene-rich lherzolite and olivine websterite xenoliths and (IIc) texturally variable metasomatic assemblages found in Type I xenoliths. The first group is interpreted as having originated by direct crystalization of alkaline magmas in the lithosphere, while the latter two groups are related to various melt-peridotite reactions. Major element modeling suggest that the IIb fertile lithology could have originated by addition of 5-20 wt% of a melt similar in composition to basanite to a refractory mantle. The IIc lithology is mostly represented by secondary pocket and vein mineral associations and rare clinopyroxene-olivine-spinel symplectites or irregular intergrowths. Observed textural relationships and compositional variations in mineral phases indicate that these metasomatic assemblages originated due to the following reaction: orthopyroxene + Cr-rich spinel + Si-undersaturated alkaline melt = Ti-Al-clinopyroxene + Ti-rich spinel $\pm$ other minor phases. The calculated composition of liquids supposed to have been in equilibrium with metasomatic clinopyroxene implies generally similar trace element patterns to the host basanites. Numerous orthopyroxene replacements found in a majority of metasomatic associations as well as disintegrated spinels with spongy/recrystallized Ti-rich rims observed in sheared zones in some harzburgite xenoliths can be regarded as the frozen evidence for this reaction. Similar effects of infiltration of metasomatic melts, which was assisted by deformation events were reported from a composite peridotite-pyroxenite xenolith from the Pannonian Basin.

A geodynamic model proposed here involves: (i) Mesozoic accretion or underplating of the Tethyan oceanic lithosphere, previously depleted within sub-oceanic arc setting, (ii) formation and subsequent collapse of the Dinaride branch of the Alpine orogen, and (iii) metasomatism of the base of lithosphere by small-scale asthenospheric melts which acted as precursors of Palaeogene mafic alkaline magmatism.