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Types of metasomatism in ultramafic xenoliths enclosed in Neogene Quaternary alkaline mafic lavas from Catalonia (NE Spain)

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The intrusion of Neogene Quaternary alkaline mafic lavas in Catalonia is favoured by late Alpine extensional fractures that can be traced all along the Mediterranean coast and to the north, defining the European rift system. Xenoliths of both type I and type II are enclosed by these lavas, type I being the most frequent. Type I xenoliths from three different volcanos are used to assess the nature of this part of the European continental lithospheric mantle and the melting and metasomatic processes implicated in its evolution.

Anhydrous spinel lherzolites and harzburgites, with dominant protogranular textures and subordinate pophyroclastic and equigranular types, are the most frequent lithologies, although amphibole and phlogopite are occasionally observed as accessory minerals. Pyroxenite xenoliths, some with accessory phlogopite, also occur, but are less frequent.

Rock mode, together with whole rock and mineral geochemistry (major and trace elements), indicate depletion by melting affected the peridotites. According to the Al^{vi}/Al^{iv} ratio in clinopyroxene and corona textures around both clinopyroxene and spinel, the melting processes could be caused by decompression.

It is inferred from the presence of amphibole and phlogopite that modal metasomatism affected these rocks. In addition, more widespread cryptic metasomatism is also deduced from the trace element composition of both whole rocks and minerals and the presence of sporadic glass veins. The metasomatism is conspicuous in both protogranular and porphyroclastic harzburgites, but some lherzolites are also affected. Two main types of metasomatism are distinguished: one is mainly characterised by Ti enrichment and the other by increasing LREE contents without Ti enrichment. This suggests two different metasomatic agents: 1) a hydrous silicate melt would account for the crystallisation of amphibole or phlogopite and for the Ti enrichment of anhydrous minerals in harzburgites; and 2) percolation of carbonatite melts along with chromatographic fractionation is necessary to explain the extreme high LREE/HREE ratio in clinopyroxene from other samples. The two types of metasomatism are better distinguished by the REE and multi-element patterns of clinopyroxene than by the whole rock patterns. Clinopyroxene affected by carbonatite metasomatism shows high LREE/HREE, high Th and U and significant negative anomalies in HFSE, whereas clinopyroxene affected by silicate metasomatism is mainly characterised by MREE enrichment. This is also the case for REE patterns of clinopyroxene in the clinopyroxenites, which are typical of cumulates in equilibrium with an alkaline melt. The intrusion of these pyroxenites or other related alkaline liquids into the peridotites, before the entrainment by the host lavas, could be responsible for the silicate metasomatism, whereas the origin of the carbonatite agent is much less clear.