Geophysical Research Abstracts
Vol. 14, EGU2012-12630, 2012
EGU General Assembly 2012

Geochemical and Sr-Nd isotopic characteristics of mantle xenoliths from NE Spain

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Mantle xenoliths in alkaline mafic lavas and pyroclasts from the Neogene-Quaternary volcanism in NE Spain are studied using major, trace element geochemistry and Sr-Nd isotopes, to compare the lithospheric mantle of this area with that of other European zones, and to assess the different processes that conditioned its evolution.

The xenoliths mostly come from two volcanoes and are mainly formed of anhydrous spinel lherzolites and harzburgites, in approximately equal proportion. Accessory amphibole and phlogopite are occasional, as it happens with plagioclase, which appears in corona textures around lherzolite spinel. Much subordinated cumulate pyroxenite xenoliths (olivine wbsterite, clinopyroxenite types) are also found. Textures are mostly protogranular, but there are also porphyroclastic, transitional between protogranular and porphyroclastic, and equigranular forms among lherzolites. Pyrometamorphic textures are observed in a few xenoliths.

Co-variation diagrams for basaltic components and MgO concentrations in whole rock analyses show gradation from lherzolites to harzburgites. This is also the case for compatible and mildly incompatible trace elements, but not for the most incompatible ones. This gradual variation is also confirmed by mineral compositions, most of which correspond to off-craton xenoliths. REE patterns for lherzolites and for their clinopyroxene are LREE and MREE depleted, whereas for harzburgites are LREE and MREE enriched. U-shaped REE patterns are rarely observed in lherzolite clinopyroxene that also shows more significant negative anomalies at Zr and Ti. Clinopyroxene from harzburgites is also remarked by more significant negative anomalies at Nb, Ti and Zr, and by higher Th and U abundances, than lherzolite clinopyroxene .

Sr and Nd isotopic compositions for clinopyroxene define a continuous and inverse trend from DMM lherzolites to enriched harzburgites ($^{87}Sr/^{86}Sr$: 0.702486-0.709772; $^{143}Nd/^{144}Nd$: 0.513359-0.512411). Harzburgite clinopyroxene is remarked by increasing $^{87}Sr/^{86}Sr$ at quasi-constant $^{143}Nd/^{144}Nd$ values. The relationships between both isotopic compositions and LREE enrichment differ in lherzolites and harzburgites, but the two trends converge towards the isotopic composition of pyroxenites.

Most of these characteristics match those observed in other areas of the European lithospheric mantle showing fertile composition in average. Depletion by partial melting could explain the good correlation of major basaltic components, compatible and mildly incompatible trace elements vs. depletion indexes. However, refertilization of refractory harzburgites by percolating N-MORB basalt cannot be discarded as the origin of some lherzolites. The scatter of most incompatible trace element concentrations vs. a depletion index indicates that metasomatism affected especially harzburgites. Their high radiogenic Sr compositions could be caused by subduction-related hydrous fluids, most likely during the Variscan orogenesis. Later metasomatism shows characteristics of alkaline silicate melt and carbonatite components, which could be associated in space and time by chromatographic fractionation-reaction processes. Cumulate pyroxenites could represent the isotopic composition of the percolating alkaline silicate melt.