Multistage mantle metasomatism beneath the Sangilen Highland

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Migration of magmas though the subcontinental lithospheric mantle is one of the key processes driving in the evolution of its modal composition. Late Ordovician lamprophyric dykes of the Agardag alkaline basaltic complex of West Sangilen carried up numerous large and unaltered xenoliths of spinel facies peridotites [1, 2] with several composite xenoliths - veins of volatile-bearing minerals in spinel peridotites. Here we report the results of detailed mineralogical investigations of four samples of contact xenoliths.

The studied samples are represented by CPx-Phlog, Amp-Phlog, and Amp veins crossing peridotites of the spinel facies. Detailed study of veined mantle xenoliths shows significant differences in the distribution of major- and trace elements at the contacts with veins of different compositions. Peridotites at the contact with Phlog-bearing veins are modified to wehrlites and characterized by profiles of metasomatic enrichment [3]; peridotitic minerals are characterized by trends with enrichment in Fe, Ca, Al, Ti and HREE in the rather narrow zone - 16 mm away from the contact [3]. Peridotitic minerals at the contact with Amp veins show practically no compositional variations with distance from the veins but have high Fe# (in comparison with those from xenoliths without magmatic veins [1]).

Detailed mineralogical and geochemical studies of composite xenoliths revealed the presence of at least two stages of metasomatic enrichment of the lithospheric mantle beneath the West Sangilen [4]. The last stage was related to the formation of the Phlog-bearing vein network. The time of their formation was closely preceded the camptonite intrusion that is evidenced from the surviving of the metasomatic enrichment profiles at the contact with Phlog-bearing veins. Parental melts of such veins are the alkaline silica-undersaturated melts, enriched in Ti and K, and volatiles such as H_2O, Cl, F, CO_2 and P_2O_5, incompatible elements, and probably related to the host camptonites. The earlier stage of the peridotite metasomatic enrichment was related to the formation of the amphibole veins, which crystallized from mildly alkaline transitional basaltic melts (iron reach, with lower titanium and potassium contents), and probably have older age in comparison with the Phlog-bearing veins [3]. The iron enrichment of peridotites at the contact with Amph-bearing veins could be formed by reaction of host refractory peridotites with evolved (Mg numbers 0.6-0.7) silicate melts at high melt/rock ratios, which replace olivine with orthopyroxene and decrease Mg numbers.

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A structural study of Cr-spinels from mantle xenoliths of Cameroon, Libya and Morocco

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Cr-spinels of mantle xenoliths from Cameroon (CAM), Libya (LB) and Morocco (MOR) have been analysed by X-ray single crystal diffraction.

The cell edges of LB show the largest variability spanning between 8.1219 (1) and 8.2458 (2) Å, while, for MOR spinels, they are in the range 8.1334 (4) - 8.2021 (2) Å, and for CAM they vary between 8.1268 (1) to 8.1485 (2). For MOR and CAM, the oxygen positional parameter is very similar ranging between 0.2625 (1) and 0.26285 (9). However, for LB samples we noticed two distinct oxygen positional parameters, allowing their subdivision in two groups: Group I has an average value of about 0.2626 (1), lower than that determined for Group II with an average value of 0.26335 (7), that, till now, is the highest recorded for mantle xenoliths worldwide.

LB samples show a Cr/(Cr+Al) [Cr#] ratio in the range 0.07-0.50 and a $Mg/(Mg+Fe^{2+})$ [Mg#] ratio between 0.69-0.82, while those from MOR show a narrower distribution with Cr# 0.10 - 0.40 and Mg# 0.74 - 0.82. CAM has Cr# between 0.09 and 0.17, whereas Mg# range from 0.79 to 0.83.

In LB, TiO_2 is usually below 0.15%, MnO below 0.25 % and NiO between 0.1 and 0.4 %. In CAM samples, TiO_2 is on average higher than in LB samples but lower than 0.2 %, except for one sample which presents contents approaching 0.5 %, MnO below 0.15 % and NiO between 0.3 and 0.5 %. MOR samples show TiO_2 below 0.2%, MnO below 0.15 %, NiO between 0.3 and 0.4 %. It is interesting to notice that the content of MnO is somehow positively correlated with Cr# while NiO is negatively related with it.

Calculated intracrystalline closure temperatures (T*c*) are in the range 550-750°C (MOR), 480-650°C (LB I), 680-950°C (LB II), 630-760°C for CAM, suggesting different cooling histories for each of the studied suites. The effects of cooling preserved in mantle xenolith spinels have been usually related to the cooling rate of the lava hosting the xenoliths, to the size of the xenoliths and to the position of the crystal within the xenoliths. This is because large xenoliths are expected to cool more slowly than small ones and crystals close to the rim will close at a higher temperature than those located in the core of the xenolith. Alternatively, it was suggested that low T*c* for Antarctica spinels could be related to their higher Fe^{3+} content.

Unpublished data on Cr-diopside from the same xenoliths show that the equilibrature pressure is close to the spinel - garnet peridotite transition for all of them. Considering that the size of the xenoliths is similar, they all are from the core of the xenoliths and that Fe^{3+} content seems to be not very relevant for the here studied spinels, we propose that LB II spinels equilibrated deeper in the mantle and have been brought to the surface from that depth, while CAM, MOR and LB I spinels, probably re-equilibrated at a shallower depth before being disrupted and brought to the surface.

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