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Traces of metasomatism beneath the Eastern Transylvanian Basin: evidence from upper mantle xenoliths

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Plio-Pleistocene alkali basalts in the Carpathian–Pannonian Region (CPR) brought a large amount of lithospheric mantle xenoliths to the surface. The easternmost and youngest alkaline basaltic volcanic field was developed in the Perşani Mountains (Eastern Transylvanian Basin), where numerous peridotite and pyroxenite xenoliths have been collected [1]. By studying these xenoliths, we may have an insight into the upper mantle regarding the chemical and physical processes that affected it, such as partial melting, metasomatism and deformation.

We selected seven amphibole-bearing spinel lherzolite/hornblendite composite, and four amphibole-clinopyroxenite xenoliths for this study in order to study mantle metasomatic processes, as well as to evaluate their possible geodynamic implications. The amphibole appears as disseminated grains in lherzolite or forms hornblendite and amphibole-pyroxenite veins. The peridotites contain small amounts of interstitial amphibole, whereas the hornblendites and amphibole-clinopyroxenites contain occasionally other OH-bearing minerals such as apatite and phlogopite as well. The amphiboles and clinopyroxenes in spinel lherzolites are depleted in incompatible trace (LRE and HFS) elements, whereas the same minerals in hornblendites and amphibole-pyroxenites show elevated incompatible trace element content.

Orthopyroxene and clinopyroxene of the spinel lherzolitic parts of the composite xenoliths enclose plane aligned and randomly distributed negative crystal shaped fluid inclusions. Size of fluid inclusions are ranging between 5 and 3 microns. At room temperature, liquid and solid phases are visible in the smallest (3-10 microns) inclusions. Microthermometry showed CO_2-dominance with high density (0.99 – 1.02 g/cm3) in the smallest fluid inclusions. Besides, Raman spectroscopy at 150 ˚C revealed that inclusions contain also H2O (4.2 – 11.6 mol. %). In the liquid phase small but detectable quantity of N2 (0.2-0.3 mol. %) was also detected during the room temperature Raman measurements, which support the idea that nitrogen is a common component in mantle fluids [2]. The solid phases in the inclusions were identified as anhydrite ($\sim$8 vol. %).

These geochemical variations of the amphiboles and the properties of the fluid inclusions hosted by pyroxenes suggest that the mantle reacted with an LREE, HFSE and fluid (CO_2, H2O) enriched mafic silicate melt. Since the incompatible element content of hornblendites are similar to those of amphibole-pyroxenites, it is probable that they crystallized from the same melt, depending on H2O saturation of the liquid. Based on major and trace elements data, this melt could originate from partial melting of a previously metasomatized mantle section.

These features indicate a complex volatile rich melt-mantle interaction beneath the study area, which can be related to the subduction of the European plate beneath the Eastern Carpathians [3] occurring in Neogene and causing extensive fluid/melt percolation and mantle metasomatism.

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[2] Berkesi M. et al. 2017. Eur. J. Min., 29, 423–431.

[3] Wortel, & Spakman 2000. Science, 290, 1910-1917.