



Alkali and chlorine-bearing fluids in the lithospheric mantle beneath the Carpathian-Pannonian region – a fluid inclusion study

László Előd Aradi (1), Ábel Szabó (1), Márta Berkesi (1), Alberto Zanetti (2), and Csaba Szabó (1)

(1) Lithosphere Fluid Research Lab, Eötvös University, Budapest, Hungary (aradi.laszloelod@ttk.elte.hu), (2) Istituto di Geoscienze e Georisorse - C.N.R., U.O.S. of Pavia, Italy

Fluid inclusions in amphibole-bearing mantle xenoliths from two basins of the Miocene extensional Carpathian-Pannonian Region (CPR), located within the chains of the Alps-Carpathians-Dinarides, have been the subject of this study. The Styrian Basin lies at the westernmost, whereas the Eastern Transylvanian Basin is located in the easternmost part of the CPR. Beneath both basins subducted slabs are suspected [1] [2], and subduction-related volcanism has been active since the Miocene. The subcontinental lithospheric mantle (SCLM) here might therefore be considered to have been affected by subduction related fluids/melts. In both areas Plio-Pleistocene alkali basalts sampled the SCLM in the form of mantle xenoliths. As a consideration, the fluid inclusions enclosed in the mantle xenoliths provide a good opportunity to better understand subduction related fluids in a mantle wedge environment.

We present mineral chemistry and fluid inclusion data from amphibole-rich (\pm phlogopite, \pm apatite) peridotite xenoliths. Primary fluid inclusions were found in ortho-, clinopyroxenes, amphiboles and apatite. The inclusion are mainly high-density CO_2 inclusions (density is above 1 g/cm^3).

By using Raman microspectroscopy minor amount of H_2O , N_2 and H_2S was also detected in the fluid phase. Raman mapping and Focused Ion Beam (FIB) - SEM techniques allowed the characterization of minor solid phases in the inclusions. These submicron sized phases within the inclusions of pyroxenes are usually magnesite, quartz, silicate glass, Fe-Ni sulfide and anhydrite. The amphibole hosted inclusions display a highly complex phase assemblage of Na-bearing minerals like alkali-hydrocarbonates (nahcolite) and various sulfate minerals (e.g. thenardite). These phases are interpreted as post-entrapment precipitates of an alkaline and volatile-rich fluid. Based on the volumetric data of the solid phases, we estimated that the fluid phase could have contained the sodium up to 250 ppm, and sulfur up to 450 ppm. Chlorine-rich apatites are often co-precipitated with the host amphiboles. These minor elements in the CO_2 -rich fluids could be signs of a brine origin.

The fluids found in the inclusions highly likely represent a residual fluid-rich phase from which the metasomatic assemblage might have formed. Our study agrees with previous studies [3] [4] that, besides dominant CO_2 , significant amount of other volatiles and alkalis (Na, H, N, S) can be present, and could have migrated through the SCLM. The source of these volatiles under the studied areas could be subducted slabs. Dehydration of a subducting slab can cause the migration brine-like fluids into the above lying mantle wedge. In the Styrian Basin the Eocene Penninic slab can be the source of these fluids (e.g. [1]), which also caused extensive annealing in the SCLM [5]. In the Eastern Transylvanian Basin, the recent subduction of the Vrancea slab can be traced as a source of a fluid-rich mantle metasomatism.

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

[3] Frezzotti, M. L. et al. 2012. EPSL 351-352, 70-83.

[4] Berkesi, M. et al. 2012. EPSL 331, 8-20

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