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Diversity of minor elements in olivines from mantle xenoliths (Wołek Hill, SW Poland) – PIXE measurements

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Wołek Hill is one of the best examined exposures of Cenozoic volcanic rocks from SW Poland (Nowak, 2012). This is related with two facts: a great amount of mantle xenoliths were collected from that outcrop and this is one of two occurrences in Poland were modal metasomatism (related with amphibole crystals presence) was recognized. Wołek Hill is a relatively small exposure and belongs to the Złotoryja Volcanic Field, which is one of the volcanic concentrations in the Polish part of the Central European Volcanic Province (Ladenberger et al. 2006).
Based on previous observations olivine crystals from the inside part of xenoliths occasionally display internal inhomogeneity visible on a BSE image. Such inhomogeneity has been related to olivine "sub-grains" with slightly shifted crystal axis. Those "sub-grains" are visible in optical microscope as transitional lamellae (Nowak, Stawikowski 2009). Besides the mentioned visible inhomogeneity olivine crystals also show diversity in Ca content inside single crystals (sometimes even more than 200 ppm). EPMA standard measurements (15 kV, 20 nA, time: 40 seconds) were limited to beam size and detection limits of the microprobe (most of the obtained results oscillate close to the detection limits – or even below it). Special conditions EPMA analyses (15 kV, 100nA, time: 100s) confirmed the differences in Ca content in the studied olivines, but did not provide any idea on how to interpret the results (Nowak, 2012).
In this short summary we present preliminary data of olivine minor element composition (Ca, Zn, Cr, Ti, Co, K and also Mn, Ni, Fe) obtained with Particle Induced X-ray Emission(PIXE) measurements performed at the HZDR in Dresden using a 3 MeV proton beam, 1-1.5 nA current and an acquisition time of 3 hrs for each scan. The size of individual scans varied from ca. 30 μm up to 60-65 μm, with 8 x 8 measurement points – min. 4 μm in diameter. The measurements have been analysed with the GeoPIXE software (Ryan, 2001) to obtain (semi-)quantitative elemental distribution maps. The detection limits for each element varies, from below 40 ppm for Zn to ca. 100 ppm for Ca. Seventeen crystals from 6 samples with different stages of metasomatism have been measured. The content of every element increases with the increase of metasomatic changes – only Ni displays the opposite trend, and Cr displays an altogether different pattern. The highest values of Cr (up to 200 ppm) were noted in a sample with semi changes (MN63), the lowest Cr content is in a sample with no visible metasomatic changes (MN2b). The Ca concentration in many samples varies by about 200 ppm over a distance of 8 μm. Unfortunately we were unable to measure concentrations near the transitional lamellae. The present study provides a new insight on this topic. Additional recalculations are still possible for example to obtain Mg values.
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