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Focal plane array FTIR imaging as a semi-quantitative tool to reveal the metasomatic origin of amphibole lamellae in pyroxenes of upper mantle xenoliths

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Amphibole is the most common hydrous mineral in the upper mantle, and therefore plays a key role in the mantle water budget. Contrary to nominally anhydrous mantle minerals such as olivine and pyroxenes, which are often in the focus of Fourier-transform infrared spectroscopy (FTIR) studies, amphiboles are rarely analysed with this method because of their complex structure and wide compositional range. Amphibole is generally acknowledged as a product of hydrous metasomatism, however, when it is present as lamellae in pyroxenes, it is questionable whether they can also form without external H_2O source upon decreasing P-T conditions and consequent destabilization of hydrous point defects in the host pyroxene.

We studied ortho- and clinopyroxene grains containing amphibole lamellae in upper mantle xenoliths from the Carpathian-Pannonian region, by using focal plane array FTIR imaging to reveal the amount and distribution of the lamellae. The hyperspectral images can be used to estimate the volume proportion of amphibole lamellae within the pyroxene grain. From the volume proportions, an estimation can be given on the amount of water needed to be present in the pyroxene in order to form the amphibole lamellae by subsolidus exsolution solely. However, since the FTIR analyses were carried out using unpolarized light, it was necessary to apply a thickness-dependent empirical correction factor to make up for the underestimation of absorbance in the OH-region of the amphibole spectra. The resulting bulk H_2O contents are around ~330-670 (orthopyroxene) and ~740-1430 (clinopyroxene) wt. ppm, which are too high for mantle pyroxenes, even for an aqueous-fluid saturated upper mantle. This suggests that the formation of the studied amphibole lamellae is related to a metasomatic event with fluid input from an external water source, most likely the same melt which produced interstitial amphibole grains in the xenolith suite.