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Characterization of the metasomatizing agent in the upper mantle beneath the northern Pannonian Basin based on Raman imaging, FIB-SEM, and LA-ICP-MS analyses of silicate melt inclusions in spinel peridotite

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Abstract

Silicate melt inclusions (SMI) containing several daughter minerals, residual glass, and a CO_2 bubble were analyzed to constrain the composition and evolution of the metasomatic melt present in the upper mantle beneath the Nógrád-Gömör Volcanic Field (NGVF), northern Hungary to southern Slovakia. The SMI were analyzed with a combination of Raman spectroscopy, FIB-SEM, and LA-ICP-MS to identify phases and obtain their volume proportions and major- and trace-element geochemistry. Slicing through the entire volume of the inclusions and collecting geochemical information at each slice with FIB-SEM allowed us to model the 3D appearance of the phases within the SMI and to use this information to calculate bulk major-element compositions.

The partially crystallized SMI are hosted in clinopyroxene in a lherzolite xenolith that shows evidence of a metasomatic event that altered the lherzolites to produce wehrlites. Based on bulk compositions, the SMI trapped the metasomatic melt linked to wehrlite formation in the NGVF. The melt is enriched in Fe and has an OIB-like trace-element pattern, which suggests an intraplate mafic melt similar to the host basalt, but with slightly different chemistry. Pre-entrapment evolution and reaction with the lherzolite wall rock produced an intermediate melt composition. Petrogenetic modeling indicates that the melt was generated as a result of a very small degree of partial melting of a garnet lherzolite source. Following entrapment, a volatile bubble exsolved from the residual melt during ascent to shallow depths as suggested by consistent densities of CO_2 in vapor bubbles. Small crystals, including sulfates and mica, that formed at the boundary of the bubble and the glass indicate that the exsolved fluid originally contained S and H_2O, in addition to CO_2.

Keywords: Silicate melt inclusions, Raman spectroscopy, FIB-SEM, lithospheric mantle, metasomatism, Pannonian Basin; Applications of Fluid, Mineral, and Melt Inclusions