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Open-system evolution of the Füzes-tó alkaline basaltic magma: results from integrated textural and chemical analysis of minerals (western Pannonian Basin, Hungary)

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The alkaline basalt of the Füzes-tó scoria cone is the youngest (2.61 Ma) volcanic product of the Bakony-Balaton-Highland Volcanic Field (in the western part of the Pannonian Basin). The basaltic bombs and massive lava fragments are extremely crystal-rich: their unique mineral assemblage consists of a mixture of diverse crystals. The pheno- and microphenocrysts are represented by chromian spinel, olivine, clinopyroxene and plagioclase. Approximately the half of the bulk rock consists of xenocrysts (olivine, spinel, colourless clinopyroxene, orthopyroxene) derived from different regions of the subcontinental lithospheric mantle. In addition, it contains numerous peridotite xenoliths. The rarer green clinopyroxene xenocrysts could have various origins: e.g., they could have originated from lower crustal granulites and/or from magmatic cumulates stuck on the crust-mantle boundary.
Chromian spinel inclusions of the Fo-rich (Fo86-89) olivine phenocrysts can be divided into two groups. The dominant group1 chromian spinels are Al-rich which crystallized from the alkaline basaltic magma and indicate a fertile peridotite source based on their low Cr-number (18.53-41.46). Crystallization of both these chromian spinels and olivines was controlled by continuously decreasing pressure in the early stage of magma evolution. The scarce group2 chromian spinels are exotic Cr-rich (Cr-number=46.19-53.85) crystals which derive from the melt propagations of a veined peridotite xenolith (a protogranular spinel lherzolite). Beside the chromian spinels these melt propagations contain fresh vesicular glass, clinopyroxenes and olivines. Similarly to the chromian spinels the clinopyroxenes have also much higher Cr2O3 content than the clinopyroxene phenocrysts in the alkaline basalt. Accordingly, these melt propagations do not represent the host alkaline basaltic magma, but another asthenospheric melt that pervaded a part of the lithospheric mantle. The clinopyroxene phenocrysts of the alkaline basalt were formed in the late stage of the magma evolution, their crystallization could have begun in the upper crust (at depths shallower than approximately 18 km) after the formation of the reaction rim of the orthopyroxene xenocrysts. The reaction rim of the orthopyroxenes, as well as the resorbed colourless and green clinopyroxene xenocrysts acted as nucleation sites for the crystallization of the clinopyroxene phenocrysts. Similarly to the crystallization of the chromian spinels and olivine phenocrysts the precipitation of the clinopyroxene pheno- and microphenocrysts was also driven by decompression.
The Füzes-tó alkaline basalt doesn't reflect the original magma composition, but it is a mixture of mineral phases having different origins. The evolution of the alkaline basaltic magma was characterized by open-system processes: it incorporated a large amount of xenocrysts from the subcontinental lithospheric mantle, and mixing of two asthenospheric melts/melt batches cannot be excluded in the early stage of magma evolution.
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