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MIXED ANDESITE-RHYOLITE IGNIMBRITE FROM THE MIOCENE BÜKKALJA IGNIMBRITE VOLCANIC FIELD, NORTHERN HUNGARY: EVIDENCE FOR MAGMA MIXING

by

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Many rhyolitic ignimbrite sequences are compositionally zoned, reflecting pre-eruptive gradients in magma chambers (e.g. [1]). Studies of these volcanic products can help to have a better understanding on the processes operating in the high-level magma chambers and the magmatic processes occurring in either intra-continental areas or destructive plate margins. Compositional zonation in rhyolitic magma chambers is often resulted by intrusion of mafic magmas. The subsequent processes depend on the time between the intrusion and the eruption. Convective mixing producing hybrid magma occurs within long-lived magma chambers. Over time, the magma chamber becomes compositionally stratified. If there is insufficient residence time in the magma chamber, syn-eruptive mixing can develop during simultaneous withdrawal of two or more magmas from the magma chamber (e.g. [2]). In this paper, we present examples for various mixing processes operating in silicic magma chamber under the Miocene Bükkalja Ignimbrite Volcanic Field.

The Bükkalja Ignimbrite Volcanic Field (BIVF) is located in the Northern Pannonian Basin, North Hungary. It exposes a silicic pyroclastic sequence originated roughly continuously between 20 Ma and 13.5 Ma [3], at the beginning of the Neogene volcanism of the Carpathian-Pannonian Region. The pyroclastic products are mainly unwelded and welded ignimbrites and subordinately phreatomagmatic fall deposits [4,5]. The pyroclastic sequence is divided into three horizons and named as Lower, Middle and Upper Ignimbrite Units (LIU, MIU, UIU; [3]).

The MIU is represented by dominantly welded ignimbrites and provides a key horizon in the BIVF. These pyroclastic flow deposits contain plagioclases, orthopyroxenes, biotite, amphibole and quartz. Composition of plagioclases and orthopyroxenes shows large variation: the An-content of plagioclases is in the range of 28 % and 90 %, whereas En-content of orthopyroxenes is in the range of 50 % and 92 %. This large geochemical variation cannot be explained by simple fractional crystallization, but suggests magma mixing process. This suggestion is supported by the occurrence of a mixed ignimbrite deposit in certain localities of the BIVF. The mixed deposit overlies a fiamme-bearing welded ignimbrite and shows reverse gradation.

It contains different kinds of juvenile fragments, such as dark and light scoriae, pumice and composite clasts. In addition to these juvenile components, hybrid clasts showing a transitional character between pumice and scoria also occur. Among these juvenile fragments, scoria clasts dominate and have the largest size (up to 10 cm), whereas pumices are rare (less than 10 vol.%) and are smaller (up to 3 cm). The composite clasts show a dark scoria-type core and a light rim. Composition of the glasses of these fragments is in the range of dacite (dark scoria and core of the composite clasts) to rhyolite (pumices and fiamme; Fig. 1).

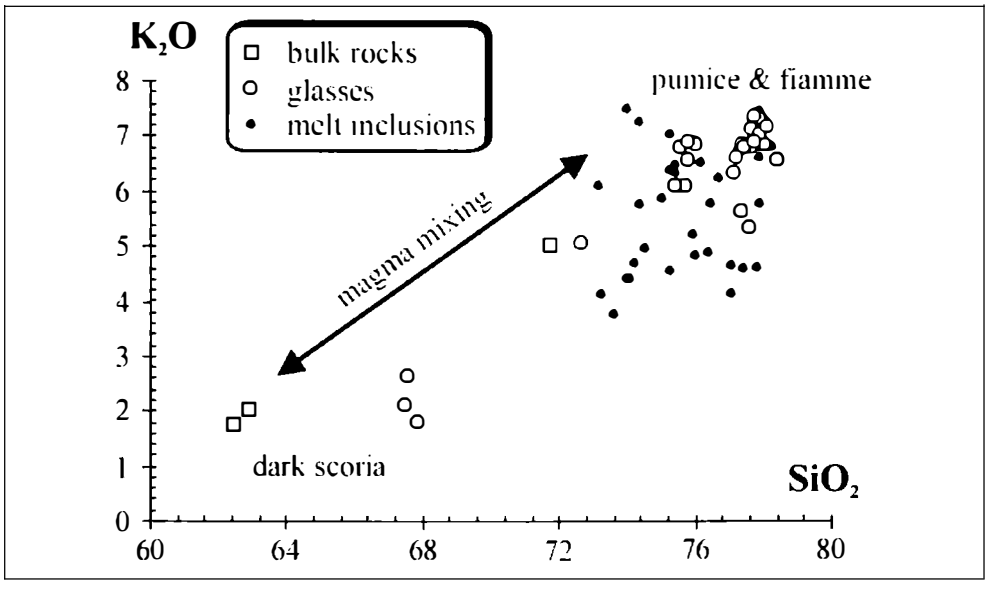

Figure 1

Compositional variation in bulk rocks (dark and light scoriae), glasses of scoria, hybrid clasts, pumices and fiamme and silicate melt inclusions hosted by various phenocrysts. The nearly linear trend with strong increase of K_2O content can be best explained by magma mixing.

Dacites are sodic ($K_2O/Na_2O < 1$), whereas rhyolites are strongly potassic ($K_2O/Na_2O > 2$). It is remarkable that composition of glasses shows linear trends in the Harker diagrams and the hybrid clasts are between the two end-members.

Silicate melt inclusions (smi) are common in each phenocryst (orthopyroxenes, plagioclases, ilmenite, quartz, biotite) of the MIU. They represent trapped magmas during different phases of magma evolution; therefore they provide important information on the processes operating in the high-level magma chamber. During the first stage of our study we analysed first the composition of glasses of the smi without apriori homogenisation [6]. Compositional variation of the smi glasses overlaps that of the bulk rocks and the glasses of the juvenile clasts (Fig. 1).

Based on the volcanological, petrologic and geochemical study, we propose various mixing process operated in the high-level magma chamber beneath the Miocene BIVF. Intrusion of andesitic magma into the rhyolitic magma chamber triggered explosive eruption of the most differentiated rhyolitic magma producing strongly welded ignimbrite.

Withdrawal of the rhyolitic magma was associating with suction of the deep-seated more mafic magma resulting in mixing and mingling between the two magmas. Local hybridisation could occur at the contact of the two magmas. The next explosive eruption removed both magmas from the chamber and syn-eruptive incomplete mixing took place producing a mixed ignimbrite deposit.

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