AN INTEGRATED STUDY ON SILICATE MELT INCLUSION AND ZIRCON TO TRACE ORIGINAL MAGMA CHARACTERISTICS ON PYROCLASTIC ROCKS IN THE BÜKKALJA VOLCANIC FIELD, HUNGARY

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Background

During the Miocene, repeated explosive eruptions of silicic magmas occurred in the Pannonian Basin, simultaneously with the main period of basin formation. The majority of the volcanic products are covered by post-Miocene sediments. These volcanic rocks can be, however, well studied in the Bükkalja Volcanic Field, North Hungary (a 10 km wide and 30 km long, SW-NE trending region). Traditionally, the Miocene silicic pyroclastic rocks of the Pannonian Basin have been divided into three horizons: Lower (21-18.5 Ma) Middle (17.5-16 Ma) and Upper (14.5-13.5 Ma) Rhyolite Complex. In the Lower- and Middle units, both welded and non-welded ignimbrites are found, whereas the outcrops of the Upper Unit (Demjén, Tibolddaróc and Harsány) only non-welded ignimbrites are known. The characteristic mineral components are plagioclase, quartz, biotite, while in some cases orthopyroxene and amphibole also occur. The juvenile components show Si-rich (rhyolite), potassic composition. Zircon is a frequent accessory mineral phase, and in some cases allanite is also found.

Zircon in generally

After studying 1271 zircons from 16 localities the following observations could be made:

- In the upper and lower volcanic horizons, bimodal zircon populations were found, which may indicate mixing of different (calc-alkaline and alkaline) magmas.
- The zircon main points fall into the hybrid magma field, suggesting mixing of mantle derived magma with crustal melts. This idea is supported by other geochemical data from biotites, silicate glass and silicate melt inclusions (Harangi, 2001; Czuppon et al., 2001; Lukács et al., 2002).

Morphological identification is a very important and first step of zircon analysis. But with the development of scientific methods, other analytical techniques are now more pronounced.

Through a selected and representative sample (Harsány) we will introduce some of these methods

Cathodoluminescent method is help for the geochemistry. It is well visible on the cathodoluminescent images of the Harsány sample, that discontinuities occur in the evolution of the pyramid faces. This means that the geochemical environment has varied during crystal growth. Signs of magma mixing were also found in the Harsány samples by Lukács et al., (2002) and Lukács (2002).

Silicate melt inclusions

Zircon crystals contain numerous inclusions. Most of the inclusions occur sub-parallel to the crystallographic orientation and the crystal faces of the zircon. Most of these are apatites (needle, rod shaped), rarely opaques are also found. The third group is formed by silicate melt inclusions. These are magma drops trapped in the zircon crystals during crystallization. The inclusions are made up of glass and are generally rounded or negative crystal shaped (Fig.1.).

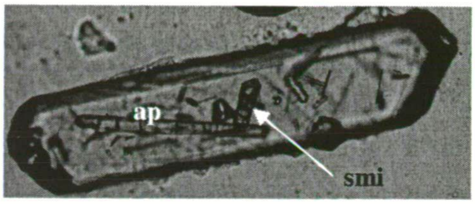

Fig. 1. Apatite (ap) and silicate melt inclusions (smi) in zircons

The chemical composition of the silicate melt inclusions represents the composition of the magma at the instant of crystallization. Zircons generally form in the early phases of magma crystallization, thus its silicate melt inclusions may represent the less differentiated magma composition.

The geochemical analysis of the Harsány sample shows well that composition of silicate melt inclusions in the zircons differs from those analyzed in silicate glass and silicate melt inclusions in quartz (Fig.2.). One group of the inclusions in zircon have higher SiO_2 and lower K_2O contents. These features can be accounted for by the occurrence of K-feldspar in the parental rock, and zircon crystallization only takes place after the early fractionation of K-feldspar. Another explanation, which is indicated by many other features such as oscillatory zoning in feldspars (Szabó (2000) and Lukács et al., (2002)), is magma mixing. This means that the silicate melt inclusions enclosed in zircons represent a different silicic magma compared with the erupted rhyolitic magma represented by the juvenile components. The other group of inclusions in zircon has lower SiO_2 and the same K_2O contents. Maybe they represent the drops from the initial magma.

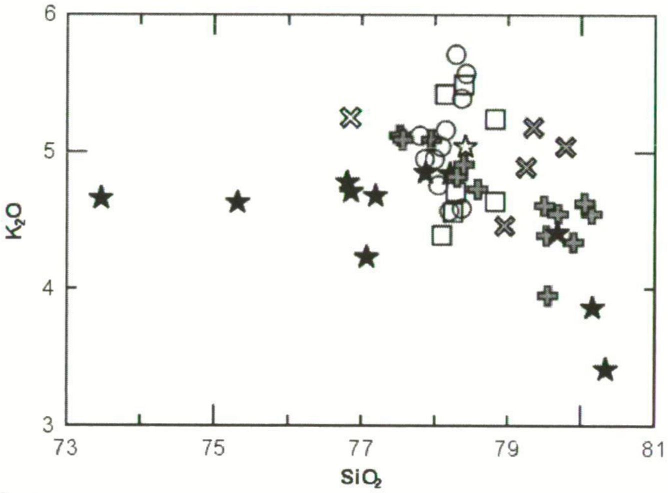

Fig. 2. Preliminary results of geochemical analyses on pyroclasts.
Filled signs: silicate melt inclusions in zircons.
Empty signs: silicate melt inclusions in quartz, pumice and glass shardes

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