NEW DATA ON THE PUTIKOV VŔŠOK ALKALI BASALT VOLCANO, CENTRAL SLOVAKIA

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Abstract: Putikov vŕšok alkali basalt volcano is composed of a scoria cone in the vent area and a related complex of lava flows forming a wide plateau at the alluvial flat of the Hron river north of the cone. Heating of water in alluvial gravels resulted in secondary steam-driven eruptions giving rise to pseudocraters and related small scoria cones. The basalt shows the initial ratio $^{87}Sr/^{86}Sr = 0.703605 \pm 12$ implying depleted mantle as the source.

Key words: lava flows, pseudocraters, alkali basalt, digital relief model, Sr isotopes

Introduction

The Putikov vŕšok alkali basalt volcano situated near Nová Baňa in central Slovakia is the youngest one among alkali basalt volcanoes of Western Carpathians and Pannonian basin (Šimon in Konečný et al., 2001). It was dated by K/Ar method to 0,53 ± 0,16 Ma (Konečný et al., 1995), however, as it covers terrace accumulations of the Hron river assigned to the Riss stage of Pleistocene, the age of the volcano corresponds most probably to the time interval 0,22 – 0,13 Ma (Šimon and Halouzka, 1996). The Hawaiian to Strombolian type volcanic eruptions created a sizeable scoria cone and related lava flows. The cone grew up in a small valley about 1.5 km south-east of the Hron river. Lava flows followed this former valley north-westward and finally spread over the alluvial flat of the Hron river in a 1.5 km broad, fan-shaped lava plateau.

The volcano as well as lithology and petrography of its products have been already described elsewhere (Fiala, 1952; Šimon and Halouzka, 1996). However, a succession of lava flows building up the lava complex is obscured by an extensive soil and loess cover. A geomorphologic analysis assisted by digital modelling of relief has been used to study construction of the lava complex in a greater detail. Recent extensive earth-works in the frontal part of the lava plateau (next to the old quarry west of Brehy) have exposed a set of previously unknown pseudocraters and related small scoria cones, extending our list of volcanological features. An analysis of the Sr-isotope ratio should confirm a common origin with older alkali basalts in other parts of the Pannonian basin.

The lava complex

Due to the young age of the volcano its morphology has not been modified significantly by erosion. However, former minor morphological features allowing to distinguish individual lava tongues are obscured by weathering as well as by soil and loess accumulation. A digital elevation model (DEM) has been used to enhance morphological features with the aim to identify individual lava tongues and their succession (fig. 1). The DEM was constructed on the basis of a topographic map in the scale 1 : 10 000, improved by field mapping using GPS. Input data are represented by the irregular network of points with co-ordinates and elevation. These were converted to the regular grid of cells 5 x 5 m using regularized splain with custom tension and smoothing of the GIS GRASS 5.0 software. Geometric parameters of the relief as there are dip of the slope, aspect and curvature of the relief were generated too.

As it is demonstrated by the fig. 1, morphology of the lava flow complex allows its division into two parts: (1) a steeper fan-shaped accumulation of lava flows in the mouth of the former valley directly attached to the NW side of the scoria cone; (2) a rather flat, gently sloping lava plateau spreading in the Hron valley.

1. Rare outcrops at the southern and northern edge of the lava flow complex show, that the complex is formed of rather thin aa-type lava flows. Individual tongues are only few meters thick, formed mostly of vesicular lava with a great proportion of reddish or brown aa-type scoraceous breccias at the top and sides - typical features of lava flows close to the source. Spatial relationship of the lava flow complex to the scoria cone implies, that effusion of lava took place mostly from a fissure at the NW side of the scoria cone, though, an occasional overflow of the low north-western (windward) side of the crater can not be ruled out. Local step-like morphological features in the slope towards the lava plateau are interpreted as lava tongue fronts. It follows, that a decreased rate of lava outflow during the late stage activity was not able to feed long lava tongues and that the lava plateau is related rather to the earlier activity with a higher outflow rate of lava.

2. Outcrops along the eastern side of the lava plateau (in the Brehy village) and in a large quarry west of the village demonstrate, that the lava plateau is build of thick and wide lava tongues, that are formed mostly of massive lava with platty, blocky and/or columnar jointing. Thickness of individual tongues is variable, up to 30 m, respecting morphology of the forme surface and earlier tongues. Individual tongues are separated by zones of black, brown or reddish aa-type scoraceous breccias, with local transitions into vesicular blocky breccias or breccias showing features of vesicular hyaloclastite breccias (glassy angular fragments, partial palagonitization indicated by yellow and green coatings of vesicular fragments). A construction of the lava plateau from a set of lava tongues is partially visible also in the details of the relief, especially at the lava plateau front (fig. 1).

The pseudocraters

These interesting volcanic forms had been hidden until recent times by a thick soil horizon including loess accumulations (Šimon and Halouzka, 1996). They were exposed temporarily by extensive earth-works related to a road construction, however, subsequently they were mostly also removed. Pseudocrates occur at the surface of lava flows forming the lava plateau, roughly 50 - 250 m from their front. Activity at pseudocraters formed a set of small, nested secondary scoria cones up to 50 m in diameter (four pseudocraters have been already identified). These are formed of crudely stratified, fine to coarse tuff, lapilli, scoria, vesiculated bombs and blocks up to 1 m in diameter (photo 1, 2). Scoria surface as well as fine tuffaceous material are affected by palagonitization resulting in variable yellow, brown, reddish and greenish colours. Scoraceous fragments show variably features of the Hawaiian type spatter and Vulcanian type “chilled” lapilli and bombs, implying a variable interaction with water and steam. Angular fragments and blocks represent pieces of already solidified lava. Secondary phreatomagmatic eruptions were obviously driven by expanding steam from heated boiling water in alluvial sediments, covered by rather fluid basalt magma. As the pseudocraters do not extend over all the area where lava flows rest on alluvial gravels, but rather they occur in a zone parallel with the lava plateau front and Hron river, we speculate, that their presence indicates a position of a former bayou (billabong, a marshy extinct river arm).

Sr isotopes

Sr isotope composition was measured on a sample of massive fresh basalt (nepheline basanite in the precise terminology) from the quarry west of the Brehy village. Sr was separated from a decomposed sample by the method of elution chromatography. Ratio $^{87}Sr/^{86}Sr$ was measured on the mass spectrometer VG 54E in the dynamic multicollector mode, using the standard SRM 987, with the accepted value $^{87}Sr/^{86}Sr = 0.710248$. The ratio $^{86}Sr/^{88}Sr$ 0.1194 was applied in a correction for fractionation. The result represents an average of 100 measurements. Owing to the very young age of the rock, the measured ratio represents the initial ratio within the limits of the analytical error ($\pm 12 \times 10^{-6}$).

The measured ratio $^{87}Sr/^{86}Sr$ = 0. 703605 ± 12.

The obtained result is identical or comparable with results on alkali basalts elsewhere in the Carpatho-Pannonian region (Embey-Isztin, 1993; Downes et al., 1995; Dobosi et al., 1995), despite their variable geotectonic setting. Considering a common petrography, geochemical features and Sr isotope ratio, petrologic models designed for alkali basalts in other parts of the Carpatho-Pannonian region are fully applicable also to the alkali basalt of the Putikov vŕšok volcano. Generally, the source is interpreted as depleted asthenospheric mantle, uprising magma being affected on the way by enriched lithospheric mantle. Magma generation was stimulated by a continuing back-arc extension following the final stage of subduction in the relevant segment of the arc.

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Fig. 1. Digital relief model of the Putikov vŕšok volcano including a scheme of main volcanic structures.

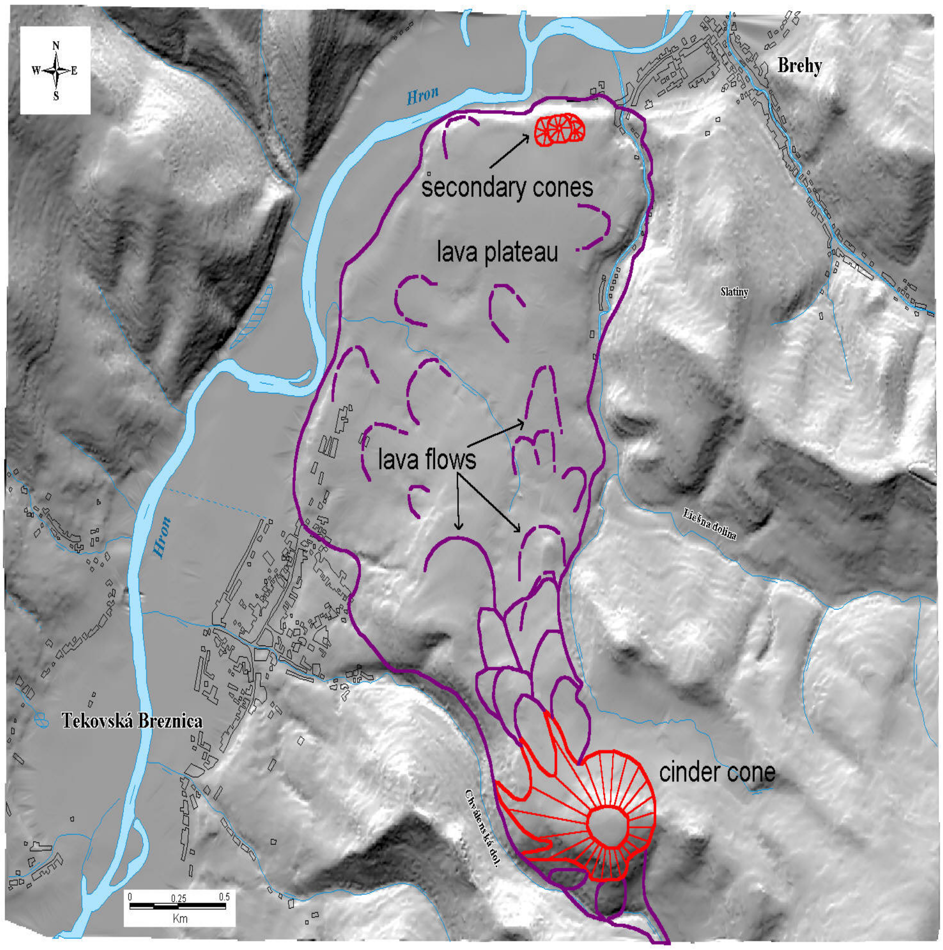

Photo 1. Crudely stratified pyroclastic rocks related to one of the pseudocraters west of the Brehy village.

Photo 2. Volcanic bomb in stratified pyroclastic rocks related to one of the pseudocraters west of the Brehy village.