GEOCHRONOLOGY OF THE NEOGENE VOLCANISM IN THE VIHORLATSKE VRCHY MOUNTAIN RANGE, EASTERN SLOVAKIA

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Abstract: Amphibole-pyroxene andesite extrusive domes and lava flows of the Vinné Complex, as well as the Beňatina Rhyodacite extrusive dome and Ladomirov andesite dykes show radiometric ages in the range 12.6 – 11.7 Ma, corresponding to Middle/Late Sarmatian. Overlaying basaltic andesite to pyroxene andesite stratovolcanoes show ages in the range 12.0 – 10. 0 Ma, corresponding to late Middle Sarmatian - Early Pannonian. The youngest radiometric data 9.7 and 9.4 Ma correspond to the late stage lava neck of the Vihorlat and late stage dyke of the Diel stratovolcano stratovolcano, respectively.

Key words: geochronology, stratigraphy, Neogene, andesite, volcanoes, Slovakia

Introduction

The Vihorlatske vrchy mountain range represents a group of eroded andesite stratovolcanoes at the western end of the East Carpathian volcanic arc. Owing to a lack of relevant biostratigraphic data their stratigraphic assignment varied widely from the Late Badenian to the Pliocene time. Radiometric dating during the seventies established the Middle Sarmatian to Early Pannonian age (12.0 - 9.2 Ma; Ďurica et al., 1978; Repčok et al., 1988) of andesite volcanics in general, however, a lack of well defined succession and paleovolcanic reconstruction prevented a more exact interpretation and detailed analysis of volcanic evolution. Kaličiak et al. (1995) and Žec et al. (1997) carried out a paleovolcanic reconstruction of andesite stratovolcanoes, established lithostratigraphic units and defined their succession. While their work enabled a more advanced discussion of stratigraphy, relevant data for individual volcanoes were mostly absent.

Essential units and their age

Volcanic rocks of the Vihorlatske Vrchy mountain range rest over the eroded surface, variably covering rocks of the Magura flysch, Klippen belt, Inner Carpathian Paleogene and Early to Middle Miocene sediments. Kaličiak et al. (1995) and Žec at al. (1997) have distinguished following essential lithostratigraphic/structural units.

Hrabovec Tuff

Reworked, fine grained rhyodacite tuffs affected by bentonitization and zeolitization make up a 20 to 50 m thick horizon among Badenian marine sediments. It is exposed only in the western (Oreske) and eastern parts (Podhorod) of the Vihorlatske vrchy mountain range, otherwise being covered by younger volcanics. Stratigraphic position of the tuff horizon is well constrained by biostratigraphic evidence. Underlying marine sediments at the locality Podhoroď contain Early Badenian fauna (Gašpariková and Slávik, 1967; Zlínska, 1994), while overlying marine sediments at the locality Oreské contain Late Badenian fauna (Slávik, 1964). Due to a strong alteration the tuff could not be dated by K/Ar method.

Beňatina Rhyodacite

Rhyodacite extrusive dome underlying rocks of the Popriečny andesite stratovolcano. Radiometric dating to 12.O ± 0.5 Ma indicates the Middle Sarmatian age (which should be considered as the minimum age of emplacement), corresponding roughly to the age of the Vinné complex. Almost the same age show rhyodacite extrusive domes around Perecin in Ukraine (Pécskay et al., 2000).

Ladomirov andesite intrusions

Hornblende-pyroxene andesite dykes and intrusions close to the village Ladomirov are emplaced in Paleogene sandstones and shales of the Magura flysch unit. Radiometric dating to 12.4 ± 1.0 Ma indicates the Middle Sarmatian age, corresponding to the age of the Vinné complex.

Vinné Complex

Extrusive domes, lava flows and related coarse breccias of hornblende-pyroxene and leucocratic pyroxene andesites (the Vinné Complex) underlying rocks of the Kyjov andesite stratovolcano in the western part of the mountain range. Epiclastic volcanic breccias assigned to this complex on the basis of petrographic composition are interbedded with the Middle

Sarmatian marine sediments (Brodňan et al., 1959). Radiometric dating to 12.0 ± 0.5 and 12.6 ± 0.6 Ma as well as older K/Ar data in the range 12.0 – 11.7 Ma indicate the Middle to Late Sarmatian age in agreement with structural position and biostratigraphic evidence. Paleomagnetic measurements show both, normal and reversed polarities (Orlický, 1993), corresponding probably to periods of normal and reversed polarities between 12.4 and 11.5 Ma. (Here and elsewhere we refer to the Berggren's et al., 1995 paleomagnetic scale. We should be also aware of the fact, that a measured reversed remanent magnetic polarity might be a results of selfreversal (Orlický, oral communication).

Andesite stratovolcanoes

The mountain range itself is build of several basaltic andesite to pyroxene andesite stratovolcanoes, still pronounced in morphology. Monogenous volcanoes Kyjov, Sokolský potok and Vihorlat are build of medium grained basaltic andesites to two-pyroxene andesites. Larger stratovolcanoes Morské Oko, Diel and Popriečny evolved in two stages: the first stage is equivalent in lithology and petrography to other volcanoes; the second stage involves more evolved rocks - porphyritic andesites, leucocratic pyroxene andesites and fine grained basaltic andesites. At the west stratovolcanoes Kyjov, Vihorlat and Morské Oko rest upon the eroded surface of the Vinné Complex, at the east stratovolcano Popricny rests upon the Beňatina Rhyodacite. No reliable biostratigraphic data are available.

Kyjov and Sokolský potok stratovolcanoes

The monogene volcanoes Kyjov and Sokolský Potok show ages in the interval 11.0 – 10.2 Ma. These ages fit well their normal polarity (Orlický, 1993), corresponding obviously to the normal field interval 10.95 – 9.92 Ma. K/Ar ages 11.7 and 12.0 Ma on lava flows N of Klokočov (Ďurica et al., 1978) do no fit this pattern. If we do not consider these results as erroneous, the lava flows can not be a part of the Kyjov stratovolcano. Their age corresponds to the Vinné Complex.

Vihorlat stratovolcano

The monogene volcano Vihorlat shows ages 11.0 – 10.9 ± 0.5 Ma. These ages fit their reversed polarity (Orlický, 1993) , corresponding most probably to the reversed field interval 11.48 – 11.10 Ma or 11.05 – 10.95 Ma. A younger protrusion at the top of the volcano shows ages in the range 9.7 – 9.2 Ma. Having a reversed polarity (Orlický, 1993), the emplacement

of the protrusion took place most probably during the reversed field interval 9.74 – 9.64 Ma or less probably during the reversed field interval 9.58 – 9.38 Ma.

Morské Oko stratovolcano

Stratovolcano Morské Oko is composed of two structural units separated by an erosion surface indicating a short break in volcanic activity. Results of dating on rocks of the lower structural unit (Hámre Formation) are in the time interval 12.0 - 10.6 Ma. These ages are compatible with their reversed magnetic polarity (Orlický, 1993), corresponding to the long interval of mostly reversed field 11.94 - 10.95 Ma. The result 10.0 ± 0.4 Ma on one of the rocks fits rather the age of the upper structural unit (see bellow) and the given outcrop represents probably an intrusion.

K/Ar ages on lava flows of the upper structural unit (Sninský Kameň Formation) are in the interval 10.6 - 10.2 (10.0) Ma, in the agreement with their structural position. However, in this case their reversed magnetic polarity does not fit the magnetic polarity scale - the ages are in the middle of a long interval of normal field 10.95 - 9.74. The only solution seems to be the concept of selfreversal (Orlický, oral communication).

Diel Stratovolcano

A succession of four units has been recognised in the structure of the Diel stratovolcano (Žec et al., 1997). Results of 3 datings on rocks of the lower structural unit (Bystrá Formation) are in the time interval 11.6 - 11.2 Ma. These ages are compatible with their reversed magnetic polarity (Orlický, 1993), corresponding to the long interval of mostly reversed field 11.94 - 10.95 Ma.

Rocks of the middle structural unit (Vávrová Formation) have not been dated with the one exception - an isolated neck Drieň among rocks of the lower structural unit. The age 11.85 ± 0.55 Ma does not fit its structural position. Additional datings are requiered.

Two datings 11.1 ± 0.5 and 10.8 ± 0.7 Ma on rocks of the upper structural unit (Diel Formation) fit their structural position. However, if we take seriously their reversed polarity (Orlický, 1993), they should not be younger than 10.95 Ma (beginning of a long interval of normal field). A late stage dyke was dated to 9.4 ± 0.6 Ma.

Popricny stratovolcano

Stratovolcano Popricny is in its Slovak part composed of two structural units separated by an erosion surface indicating a short break in volcanic activity. Results of three datings on rocks of the lower structural unit (Popricny Formation) are 11.7 ± 0.5, 11.5 ± 0.6 and 10.6 ± 0.5 Ma. The first two ages are compatible with their reversed magnetic polarity (Orlický, 1993), corresponding to the long interval of mostly reversed field 11.94 - 10.95 Ma. A reversed magnetic polarity of the third rock implies, that it also should not be younger than 10.95 Ma. The result of dating in this case corresponds rather to the age of the upper structural unit.

Ages on lava flows of the upper structural unit (Petrovce Formation) are in the interval 10.7 - 10.0 Ma, in the agreement with their structural position. Rocks of the upper structural unit show both, normal as well as reversed magnetic polarity (Orlický, 1993). Rocks with the reversed polarity represent a problem - they should be either older than 10.95 Ma or younger than 9.92, or even 9.74 Ma. A selfreversal is another plausible solution (Orlický, oral communication).

Discussion and conclusions

The late Early Badenian age of the Hrabovec Tuff horizon is well constrained by biostratigraphic evidence. The horizon extends far beyond limits of the Vihorlat mountain range, both, westward (the Hrabovec Tuff) and eastward into Ukraine and Romania (the Novoselica Tuff, Dej Tuff). Most probably it is a product of areal siliceous volcanism with centers in north-eastern Hungary and along the Zemplín - Beregovo - Baia Mare horst system (Pécskay et al., 1995; Lexa and Konečný, 1998).

Radiometric ages of the Beňatina Rhyodacite and Ladomirov andesite intrusion correlate these rocks with the Vinné Complex, which is considered a part of the much greater alignment of andesite/dacite subvolcanic and extrusive bodies of the same age Pieniny - Kapušany - Vinné - Popricny - and further eastward along the northern edge of the Gutin range in Ukraine (Lexa and Konečný, 1998). In the Popricny area the presence of corresponding rocks has been confirmed recently, also by dating (Pécskay et al., 2000).

Volcanic activity of andesite stratovolcanoes took place in the time interval 12.0 to 10.0 Ma (with a sporadic activity as young as 9.4 Ma), what corresponds to the Late Sarmatian to Early Pannonian age. Comparing individual stratovolcanoes we observe some differences. “Eastern” volcanoes Vihorlat, Morské Oko, Diel and Popricny show a longer interval of volcanic activity corresponding to there multiple phase evolution. The younger

phase of volcanic activity followed a break of a variable length, roughly a half million years. In the case of Vihorlat and Diel volcanoes activity of the youngest rocks followed a break over one million years. “Western” monogene volcanoes Kyjov and Sokolský potok show a shorter volcanic activity in the time interval 11.0 - 10.2 Ma, corresponding approximately to the time of inactivity of the “eastern” volcanoes. So, their activity was not coeval with the first phase of the “eastern” volcanoes as it was assumed formerly (Kaličiak et al., 1995).

Results of radiometric dating on rocks from the Gutin range in Ukraine (Pécskay et al., 2000) cover the same time interval as rocks of the Vihorlat mountain range. Volcanic activity in the whole segment of the volcanic arc from Vihorlat mountain range at the west to the Gutii mountain range in northern Romania was contemporaneous.

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