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RESULTS OF ABSOLUTE AGE DETERMINATION OF ROCKS IN CENTRAL AND EASTERN SLOVAKIA

(Fig. 1—2)

Abstract: In the report there are results of absolute age determinations of Neogene volcanic rocks of West Carpathians. 6 samples come from Central Slovakian volcanic area, 1 sample from East Slovakia. The absolute age of these rocks is from 16,4 to 11,2 mil. years. One of the sampled rocks is so young that the radiogene Ar is missing. The results are confronted with the scale of absolute age of Neogene which was submitted on the 4th Congress of Mediterranean Neogene in Bologna 1967 and with Russian geochronological scale.

Radiologic investigation of the Neogene rock samples in Slovakia was carried through in the Laboratory for nuclear geochronology at the Geological Institute of the Armenian Academy of Sciences on the request by the Geological Institute of D. Štúr in Bratislava.

Petrographic characteristics of the rocks under question is presented in numerous publications (cf. References).

Orientational description of rock slices of the samples was done by Mrs. L. G. Daniloviè from Lvov.

In is necessary to mention that the determination of the precise absolute age of the samples was rather complicated a task, since these rocks: 1. belong to very young Neogene formations, i. e. they are including certain amount of radiogene argon which cannot be always accurately measured, 2. the samples represent volcanic rocks, sample Nr. 1, 2 and 4 are from andesite flows, sample Nr. 5 from basalt flow, sample Nr. 3 from andesite and Nr. 7 from rhyolite extrusive body, Nr. 6 from rhyolite welded tuffs, 3. the samples should be studied in the mean sample, i. e. in the rock as a whole, not taken from the rock, synchronous biotite, since these rocks partly contain biotite.

Considering the above mentioned facts, and the necessity of getting the most reliable determinations of absolute age for these samples, the investigation is to be realized by two methods controlling each other: the volumetric potassium-argon method, and the method of isotopic dilution.

Method of investigation

At the volumetric method, the 25 gr dose of the sample — after preparatory treating (warming to 150—200 °C, with the drawing in the course of an hour) was melted in quartz pipes at the temperature of 1250 °C within 4 hours. The amount of argon, purified in the usual way (in furnaces with CuO and Ca) was measured by Mac Leod's manometer. Admixture of the air argon in the whole measured argon (in per cents) was determined on the MS-2M mass-spectrometer by the two-ray method of measuring of the isotopic ratio Ar^{36}/Ar^{40} of the sample and in standard technical argon. Isotopic composition of the latter is periodically controlled in the laboratory according to argon got from the air.

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At the method of isotopic dilution the dose of sample in the amount of 10—12 gr was melted in metallic reactor from anticorrosive steel, fitted to the equipment for the volumetric determination of argon.

In the function of indicator monoisotope Ar^{38} diluted with Co_2 was used. Coefficient of dilution of the monoisotope (titre Ar^{38} in the mixture of $Ar^{38} + CO_2$) was determined also by the method of isotopic dilution, following a special series of experiments. In this case the air argon was used in the function of diluter, got from the air on the same apparatus.

For the dosing of the admixture of Ar^{38} and CO_2, there is an additional dosing device fitted to the apparatus. Measurings of the precise quantities of the dosed indicators were done on the normal Mac Leod's manometer. The error of dosing represented $\pm$ 0,5—1 %. Indicator was added after the melting of sample and after leading the exsoluted gas into the measure part of the apparatus. Analytical error in the determination of argon in both methods was found to be $\pm$ 5 %.

The potassium content in each sample was determined by three different methods: the perchlorate, dipicrilaminate and flame-photometric. The medium difference among the determinations of potassium by these methods is less than 5 %. In the calculations of age the mean values of chemical analyses and the following constants of disintegration of K^{40} recommended by the Commission for absolute geochronology at the Soviet Academy of Science, were used:

$\lambda k = 5{,}57.10^{-11}$ years^{-1}.

$\lambda p = 4{,}74.10^{-10}$ years^{-1}.

Chemical analyses of potassium by means of perchlorate method were realized by S. Shimian, by dipicrilaminate and flame-photometric methods — by V. I. Mikhailova. Argon was exsoluted on two apparatuses constructed by Chlopin-Herling — by E. A. Sarkisian and L. M. Khachatrian. Mass-spectrometric isotopic analysis was carried through by R. Ch. Gukasjan. The summary error in determination of the values of absolute age for the samples was estimated 6—8 % against 10 % admitted for the potassium-argon method.

It is necessary to mention that in order to get the most precise data on absolute age, the whole series of investigations of each sample was carried through twice, independently upon each other. In case of different results the experiments are repeated till sufficient agreement is gained.

In addition to this — as a control of the radiologic research of samples — the controlling analyses of the standard samples are carried through by the Commission on absolute geochronology at the ONZ by Academy of Science.

This may increase the reliability of the age values of the samples under study. The enclosed table 1 presents all the material and results of 15 series of determinations on seven studied samples. The last column of the table 1 shows that determination of argon is done twice (by two methods) for each sample: by the method of isotopic dilution and by volumetric method.

The data presented in the table point out that the age results after two, and in the case of sample Nr. 7 after three determinations by two mutually controlling methods show great similarity, and on the mean value of these figures absolute age of the respective sample may be determined.

Table 1. Review of the Results of Absolute Age Determination

No.	Lab. no.	Name of rocks and the localities of the samples	% K	K^{40} g/g $.10^{-6}$	% rad. Ar	Ar^{40} cm³/g $.10^{-6}$	Ar^{40} g/g $.10^{-9}$	Ar^{40}/K^{40} $.10^{-3}$	age in mil. years	Mean value	Method of determination
1	1593/66	Andezite-lava flow, quarry near Horšia E of Levice	2,45 2,45	2,99 2,99	36,4 68,8	1,21 1,30	2,17 2,33	0,73 0,78	13,1 14,0	13,5 ± 0,5	isotop. dilut volumetric
2	1594/66	Andezite-lava flow, quarry near Brhlovce E of Levice	2,44 2,44	2,98 2,98	9,4 12,8	1,35 1,15	2,42 2,06	0,81 0,69	14,5 12,4	13,5 ± 0,5	isotop. dilut volumetric
3	1595/66	Amphibolic andezite suberustal body Siatoroš S of Fiľakovo	1,21 1,21	1,48 1,48	23,0 12,7	0,58 0,68	1,04 1,22	0,70 0,82	12,5 14,5	13,5 ± 1	isotop. dilut volumetric
4	1596/66	Bazaltoid andezite-lava flow SW of Stará Huta, Javorie Mts.	0,76	0,93	13,8	0,49	0,88	0,95	17,0	16,4 ± 0,6	isotop. dilut volumetric
5	1597/66	Nephelinitic bazanitoide-lava flow, quarry, near Brehy Nová Baňa	1,38 1,38	1,68 1,68	In the rock there is no radiogr. Ar, it indicated very young age of the rock (Upp. Pliocene or post-Pliocene)						isotop. dilut volumetric
6	1598/66	Welded tuffs rhyolitic borehole KO-1 Komárovce SW of Košice	3,15 3,15	3,85 3,85	11,6 13,0	1,61 1,45	2,88 2,60	0,75 0,67	13,4 12,1	12,75 ± 0,75	isotop. dilut volumetric
7	25	Rhyolite-extrusive body near Kremnička, Kremnické pohorie Mts.	4,36 4,36 4,36	5,31 5,31 5,31	13,5 12,6 11,5	1,89 1,92 1,70	3,38 3,44 3,04	0,64 0,65 0,57	11,6 11,7 10,3	11,2 ± 0,3	isotop. dilut volumetric

Comparison Between Absolute Age of Dated Rocks and Age Supposed on the Ground of Geologic Data

In no case the age of analyzed rocks was determined by reliable biostratigraphical methods. The rocks under question are either surrounded by older rocks penetrated by the former (samples No. 3 and 7) or they occur as a part of complexes — continental-sedimentary (sample Nr. 6) or volcanic-sedimentary and volcanic rocks, in which there are no organic remnants that could be used for biostratigraphic correlation (samples Nr. 1, 2, 4, 5).

Sample Nr. 3 (Šiatoroš, to the South of the town Fiľakovo) is from a preparated, denuded andesite body penetrating through older surrounding rocks. Andesite belongs to the type of pyroxenic-amphibolic andesite including garnet (M. Kuthan and coll. 1963). — Fig. 1.

On the ground of petrographic analogy andesite was considered a product of the I-st andesite phase of the Central Slovakian Neogene volcanism, and correlated with other products of the I-st andesite phase. Their age was biostratigraphically determined as Lower-Tortonian (Lanzendorfer series) in the area near Štúrovo. The Lower Tortonian of the West-Carpathian area corresponds to the North-Italian Serravallian or to its upper part. R. Selli and E. Tongiorgi (1967) determined 15—18,8 mil. years as the absolute age of the Serravallian. The Šiatoroš andesite with the absolute age of 13.5 ± 1 mil. years does not correspond with the Serravallian, i. e. neither with the Lower Tortonian (Lanzendorfer series), it is corresponding with the Tortonian with its age of 11.8—15 mil. years (R. Selli, E. Tongiorgi l. c.). Consequently, the Šiatoroš andesite is not the product of the so-called I-st andesite phase (in the sense of M. Kuthan).[1]

In case the correlation is right, then the re-evaluation of the position of other isolated occurrences of rocks considered the products of the I-st andesite phase in Central Slovakia by means of the determination of absolute age will be necessary.

Fig. 1. Sketch of sampling places

[1] Credibility of this is lowered by the absence of radiometric study of products of the first andesite phase of the Central-Slovakian Neogene volcanism, the age of which was biostratigraphically determined.

The same absolute age as the Šiatoroš andesite show also andesites in the vicinity of Horša and Brhlovce (samples No. 1, 2). Near Horša several andesite flows rest above each other, forming a uniform volcanic apparatus. In their substratum there are continental beds including rhyolite tuffs and pre-Neogene substratum below them. Since rhyolite tuffs in wider vicinity of the village Horša (southwards) form strata in marine Lower Sarmatian (the age being biostratigraphically determined), the tuffs in the substratum of andesites as well as andesites under question were considered Lower-Sarmatian.

Andesites from the village Brhlovce, surrounded by pyroclastics, are in 4 km distince from the Horša andesites, their petrographical composition being similar. Their position with respect to substratum is unknown. Andesites from Horša and Brhlovce may be considered products of the same volcanic activity. Absolute age of these rocks is 13.5 ± 0.5 mil. years.

In the Soviet scale of absolute geochronology the value 12 ± 1 mil years is presented for the Miocene-Pliocene. According to this scale andesites from Horša and Brhlovce correspond to the Upper Miocene. According to R. Selli and E. Tongiorgi's scale, these andesites correspond to the Italian Tortonian — its upper part being considered identic with the Sarmatian of the Viennese and Pannonian basins by these authors, on the ground of palaeontological correlation.

The sample Nr. 4 comes from the hyaloclastite formation of the Javorie Mts. (the cut of the road near the settlement Blýskavica — village Stará Huta), from the lava flow of basaltoid andesite (SiO_2 47.89 %) with phenocrysts: plagioclase — An 55, augite, titanaugite, olivine. Absolute age — 16.4 ± 0.6 mil. years. Lower content of K (small amount of Ar^{40}) in this rock caused the lower preciseness of radiometric age determination. — Fig. 2.

Position of andesite in the scale of absolute chronology by R. Selli and E. Tongiorgi corresponds to the upper part of the Serravallian i. e. to the West-Carpathian Lower Tortonian (Lanzendorfer series).

Near Kremnička, rhyolites from an extrusive body among volcanic, biostratigraphically undeterminable rocks. Near there are also limnic sediments with the strata of frequently benthonitized rhyolite tuffs. On the ground of pollen spectra, the Upper Sarmatian-Lower Pannonian age of these sediments was determined (M. Ciesarík, E. Planderová 1965).

Absolute age of the rhyolite extrusion (the sample Nr. 7) is $11,2 \pm 0.3$ mil. years. According to R. Selli and E. Tongiorgi's geochronological scale for the North-Italian Neogene, the rhyolites under question represent the chronological equivalent of the Messinian; according to the Soviet geochronological scale the rhyolites correspond to the Lower Pliocene, and as for the R. Selli and E. Tongiorgi's interregional correlation table — to the Pannonian of the Viennese basin.

Basalts from the vicinity of the village Brehy (near the town Nová Baňa) represent products of the so-called final volcanism (M. Kuthan 1963) by which the Neogene volcanic activity in Central Slovakia ended.

The lava flow of nephelinic basanitoide near Brehy rests on old terraces of the Hron r. that arose in the Upper Pliocene or in the Lower Pleistocene. The absence of radiogene argon in the sample of these rocks (Nr. 5) corresponds to geological data. The absence of Ar^{40} in fresh rocks indicates that the rocks are young, perhaps even post-Pliocene, and Ar^{40} could not accumulate in the rock in the course of that time.

Sample Nr. 6 comes from different volcanic area — i. e. from the east-Slovakian

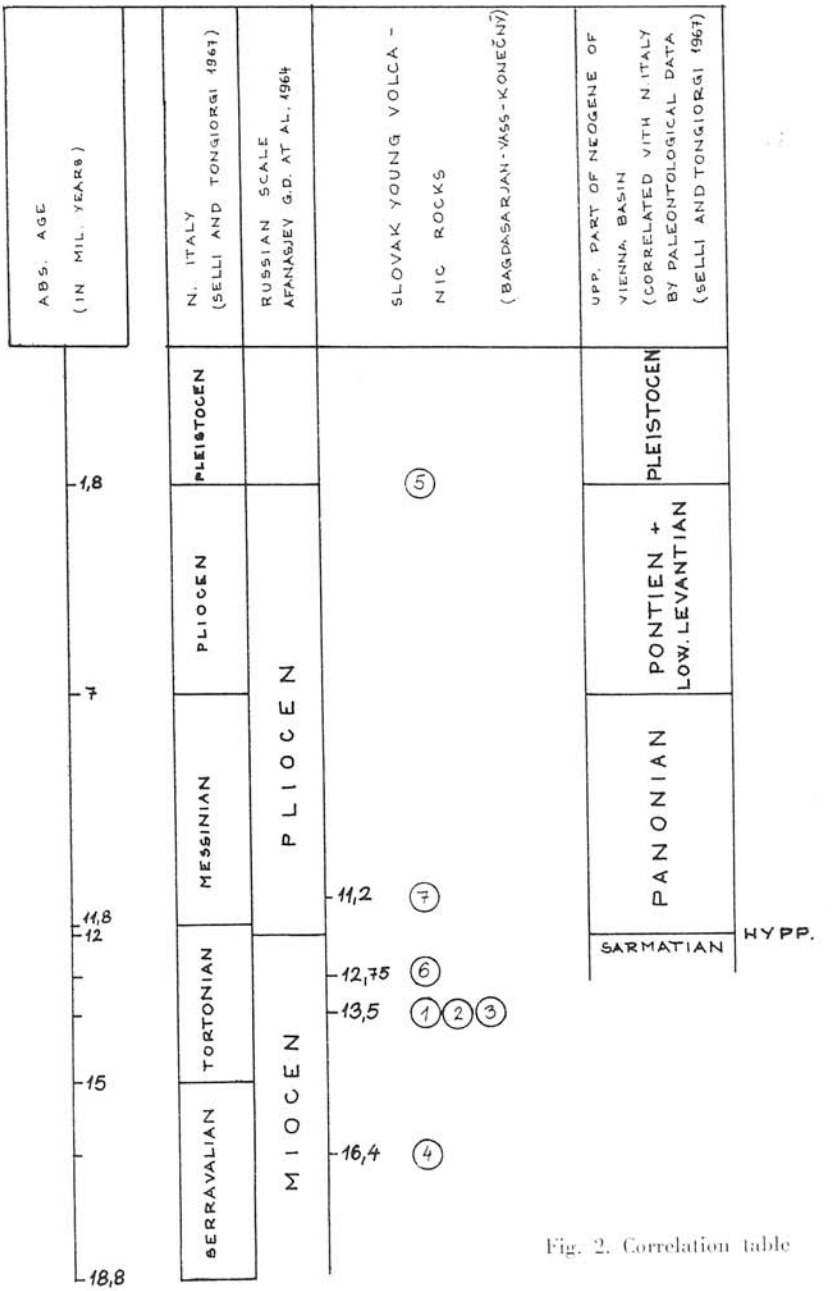

Fig. 2. Correlation table

rhyolite welded tuffs (ignimbrites), drilled by borehole KO-1 near the village Komárovce, to the SW of Košice. The tuffs of various degree of welding, form a stratum 86.3 m thick (within 606.7—693.0 m. M. Pulec, D. Vass, in lit.). Welded tuffs are

there amidst continental beds. On the ground of pollen spectra, petrographical correlation of the tuffs and of beds surrounded by these tuffs, as well as on the ground of palaeogeographic considerations, these tuffs. are correlated with the Lower Sarmatian (D. V a s s in lit.). The determined absolute age 12.75 ± 0.75 mil. years corresponds — according to the Soviet scale of the Miocene and Pliocene; according to R. S e l l i and E. T o n g i o r g i's scale — to the upper part of the North-Italian Tortonian, i. e. to the Sarmatian of the Viennese and Pannonian basins.

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