Slovak Geol. Mag. 6, 4 (2000), 363–366

$^{40}Ar/^{39}Ar$ data from contact aureole of Súľová granite (Gemericum, the Western Carpathians)

ANNA VOZÁROVÁ[1], WOLFGANG FRANK[2] and JÁN KRÁĽ[3]

[1] Fac. of Nat. Science, Comenius University, Bratislava, Mlynská dol. pav. G, 842 15 Bratislava, Slovak Republic.
[2] Geozentrum, Universität Wien, Althanstrasse 14, 1040 Wien, Austria.
[3] Geological Survey of Slovak Republic, Mlynská dol. 1, 817 04 Bratislava, Slovak Republic.

Abstract: $^{40}Ar/^{39}Ar$ method was used for the dating of amphibole and paragonite from contact aureole of Hnilec granitoides in Súľová area. Both samples originated from the Smrečina Formation of the Rakovec Group, from the basal part. The dating of both minerals showed identical ages of 140 Ma. These data are concordant with Rb/Sr ages from this site (145 Ma – whole-rock and mineral ages, Kovach et al., 1986). However, both radiometric ages are in contrast with radiometric ages determined in other occurrences of Gemericum granitoides. The following interpretations are provided: in Gemericum region there were two magmatic events – Late Variscan and Paleo-Alpine; $^{40}Ar/^{39}Ar$ ages can signal a strong thermal Alpine overprint caused by the amalgamation of the northern and southern Gemeric basement.

Key words: Western Carpathians, Gemericum Superunit, granitoides, $^{40}Ar/^{39}Ar$ data.

Introduction

The age of Gemericum granitoides has a long been discussed-for and despite the wide range of radiometric data available, this question has not yet been satisfactorily resolved. On the surface the granitoides form only small apical bodies that predominantly penetrate successions of the Early Paleozoic Gelnica Group. Only in small occurrences in the Hnilec valley are they situated in the basal parts of rock successions of the Rakovec Group. The only granitoid body that penetrates the tectonic contact between rock complexes of the Gelnica and Rakovec Groups occurs in the Súľová area.

The original understanding of the Gemericum as the innermost Alpine tectonic unit consisting mainly of low-metamorphic Variscan basement and its Mesozoic cover unit of "Oberostalpine" type (Andrusov, 1968) has recently been set aside. This resulted through the findings of the differences in deposition-tectonic facies of Late Paleozoic rock complexes occurring in this region (Varga, 1971; Vozárová, 1973; Reichwalder, 1973) and Mesozoic (Kozur and Mock, 1973). Finally, these new data have lead to the partition of the Late Paleozoic cover units and various Alpine structural units (Bajaník et al., 1984) and to definition of a northern and southern Gemericum (Vozárová & Vozár, 1988; Vozárová in Rakús et al., 1998). These units differ in the geodynamic development of their pre-Alpine basement and the development of their Late-Paleozoic-Mesozoic cover units. Their mutual contact is tectonic. Granitoid bodies are predominantly situated in rock complex of pre-Alpine basement of Southern Gemericum that is formed by meta-

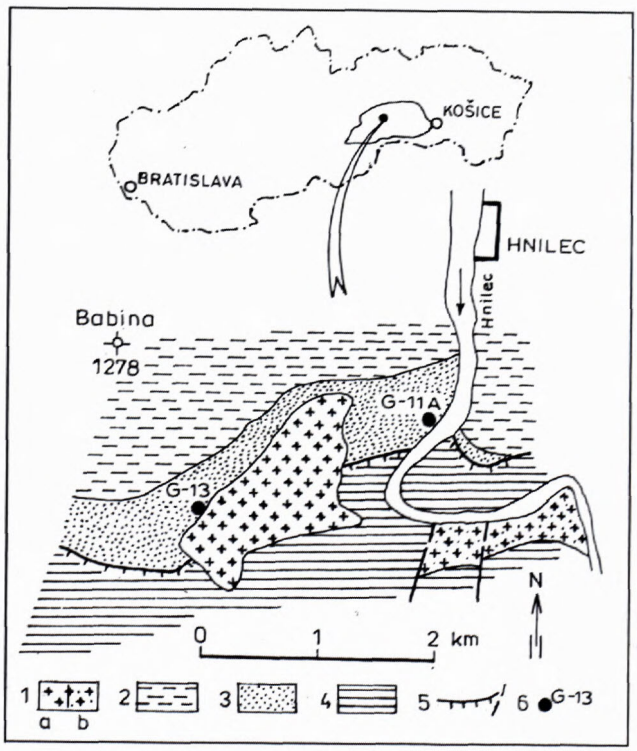

Fig. 1. Geological map of the Súľová-Hnilec area (modified after Bajanik et al., 1984) showing the sample localities.
1 – granitoides: a – Súľová type; b – Hnilec type; Rakovec Group: 2 – metasediments and metavolcanites of the Sykava Formation; 3 – metasediments, metabasalts and metabasaltic tuffites of the Smrečiny Formation; Gelnica Group: 4 – metasediments and metarhyolite tuffites of the Vlachovo Formation; 5 – overthrust plane; 6 – sample localities.

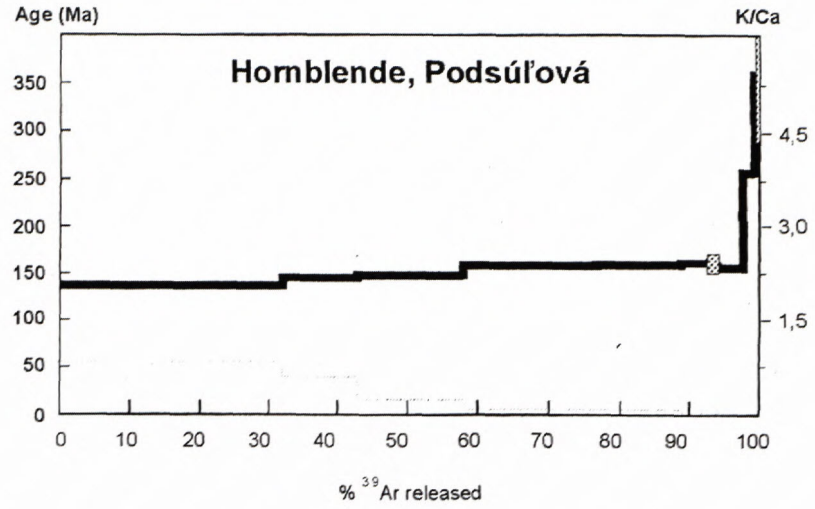

Fig. 2. $^{40}Ar/^{39}Ar$ apparent age diagram from amphibole, Suľová

volcanic-sedimentary successions of Gelnica Group. The rare occurrence within pre-Alpine basement of the Northern Gemeric Unit, and the penetration of tectonic contact of both units by a granitoid body, are highly significant. The direct contact is not overlapped by post-Variscan or by post-Alpine cover sediments. For this reason resolving of age problem of the Gemericum granites can resolve the problem of amalgamation of both tectonic units (?Alpine or ?Hercynian). Data originating from structural analyses and analyses of development of Late Paleozoic deposition basin support rather their Alpine age, because the polarity of Hercynian orogenesis derived from Carboniferous-Permian development of deposition basins supports the southward vergency (Vozárová, 1996; Vozárová a Vozár, 1996). This is in contradiction with presently inferred north-vergent structures in both units and in their tectonic contact.

In cover of particular granitoide body there are contact aureoles with characteristic zoned distribution of mineral associations that depends upon distance from the contact (shown on the geological map of Bajaník et al., 1984). It is important to emphasise that minerals formed in contact aureoles of granitoids are younger than the development of the last cleavage, what is valid of both tectonic units. These geologic observations have been the main reasons why these granitoides were previously held to be of Alpine ages.

Brief summary of isotopic dating

The first studies of the stratigraphic classification of the Gemericum granites led to given conflicting opinions about their intrusive ages ranging from Carboniferous to Cretaceous. Since the dating of potassic feldspar from the Betliar granite-porphyry by K/Ar method (98 Ma, Kantor, 1957), a Cretaceous age has been preferred. The following investigation indicated that the problem is much more complicated. Next K/Ar dating confirmed Alpine ages: 70 Ma at the Poproč site (Bojko et al., 1974); 87 Ma on Zlatá Idka site (Bagdasarjan et al., 1977); 141 Ma on the Čučma site (Bagdasarjan et al., 1977). Kantor and Rybár (1979) published many of K/Ar data from various bodies of Gemericum granites and in a case of muscovites they found that values range from 241 to 141 Ma. From this range the authors have concluded that the Gemericum granites were polyphased. Rb/Sr data (Kovach et al., 1986; Cambel et al., 1989) gathered from whole rocks and separated minerals (mainly muscovites and biotites) also documented considerable scatter of WR data and mineral isochrons of particular bodies (for instance Hnilec 290±40 Ma, Betliar 272±40 Ma, Podsúľová 145±6 Ma). Permian ages gained from Rb/Sr whole rock isochrons were confirmed for Hnilec and Betliar granitic bodies with a higher precision by U, Th – total lead determination through the use of a microprobe on monazites (Finger a Broska, 1999).

The dated samples

Samples of newly formed amphibole and white mica (paragonite) that occur in epidote-chlorite schists (metabasaltic tuffites) and fine-grained sandy metapelites of the Smrečina Formation of the Rakovec Group (Fig. 1) were separated from contact aureole of the Súľová granite. Both samples were taken from Northern Gemeric basement.

The sample G-11A was taken from metabasaltic tuffites (site on left slope of Hnilec river, about 700 m northwest of the railway station Delava), in which an association of regionally metamorphosed minerals occurs. These consist of chlorite + epidote ± albite, actinolite, calcite, quartz.

These minerals form fine-grained, markedly alined up aggregate, complexly deformed by transverse cleavage. In this fine-grained structure there are omnidirectionally oriented long-columnar crystals of green amphibole that were separated for radiometric dating. Metabasaltic tuffites alternate with chlorite-muscovite phyllites in which unoriented crystals of light brown biotite occur.

Sample G-13 was taken from the contact of fine-grained metasandstones and sandy metapelites with granitoide body, about 1 km NNW from the Súľová ranger's cottage, from a slope above the forest road. Fine-grained metasediment with a strong lineation contains two mineral associations. The one is a regional metamorphic mineral association consisting of quartz + muscovite ± chlorite. The second and younger lineation consists of thicker crystals of white mica (paragonite) + quartz + tourmaline ± plagioclase. For the radiometric dating the white mica was separated.

Results

The samples were dated by standard method that is recently used in the laboratory of GEOZENTRUM, Vienna. In Table 1 and 2 the basic analytic data from the sample of recrystallized amphibole G-11A and white mice are presented.

Tab. 1: Analytic data from the sample of newly formed amphibole G-11A

Step	T (°C)	$\%^{39}Ar$	$^{40}Ar^*$ (mV)	%Ar*	$^{40}Ar^*/^{39}Ar$ (±2 SD in%)	Age (in Ma) ±2 SD
1	700	32.0	149.46	94.9	15.92±0.8	137.0±1.1
2	750	11.0	54.55	94.4	16.88±1.0	144.9±1.4
3	800	15.0	76.68	96.0	17.43±0.7	149.5±1.0
4	850	18.7	102.26	96.4	18.62±0.8	159.3±1.2
5	900	11.3	61.81	96.3	18.70±1.4	159.9±2.2
6	950	4.1	22.90	87.9	19.00±2.2	162.4±3.4
7	1000	1.4	8.01	96.1	19.13±5.7	163.4±8.9
8	1050	4.5	24.22	99.0	18.56±1.2	158.8±1.8
9	1100	1.6	14.53	97.1	31.40±5.3	261.3±13.0
10	1250	0.3	4.40	82.3	44.87±21.3	363.2±70.5

J= 0.004735±0.4% total gas age= 151.6 ± 3.1 Ma

Tab.2: Analytic data from the sample of newly formed white mica (paragonite) 171/13

Step	T (°C)	$\%^{39}Ar$	$^{40}Ar^*$ (mV)	%Ar*	$^{40}Ar^*/^{39}Ar$ (±2 SD in%)	Age (in Ma) ±2 SD
1	650	90.3	27.29	95.4	16.34 ±1.5	140.5±2.0
2	700	9.7	2.3	71.7	12.87±8.2	111.5±8.9

J= 0.004735±0.4% total gas age= 137.7 ± 3.7 Ma

Discussion and conclusion

The ages $^{40}Ar/^{39}Ar$ obtained from both minerals are partially different, although the $^{40}Ar/^{39}Ar$ age of paragonite degassed in one step is similar (140.5 Ma) to the apparent ages in low temperature steps of sample G-11A. These data are almost concordant with the youngest Rb/Sr ages. These data emphasise the importance of the remarkable Alpine event that can be interpreted in such different ways:

1. If we understood the transversal minerals in vicinity of the bodies as manifestation of their contact influences, then the granite from Súľová site could be considered as an Alpine one. However, this inference is negated by the fact that the body in Súľová area was until now considered to be a part of the Hnilec body that was dated at Permian by the Rb/Sr whole rock analyses and separated mineral analyses (Kovach et al., 1986) and U/Th, Pb method in monazite (Finger and Broska, 1999). But the Súľová and Hnilec bodies are separated from each other at the surface, although their interconnection under the surface was always assumed. A very important fact supporting the Alpine age interpretation of the granitoid body that occurs in ridge part of Súľová is 145 Ma Rb/Sr age that has been generally interpreted as age of Alpine overprint (Kovach et al., 1986; Cambel and Kráľ, 1989). The congruity of the older dating with the new mineral Ar/Ar dating is significant. This determination shows that the observed radiometric ages confirm an Alpine age of intrusion of the granitoid body in Súľová, with respect to the fact that the granitoids do not bear signs of dynamic-metamorphic reworking, and minerals in contact aureole are randomly oriented i.e., post-cleavage. In that case we should suppose that in the Gemericum zone the granitoides to two separate magmatogene events (Late Variscan and Paleo-Alpine).

2. Newly formed transversal amphibole and paragonite are not genetically connected with granite intrusion, they are products of hydrothermal changes connected with significant Alpine temperature event. It would mean that the total Alpine reworking is the most significant along the contact of two pre-Alpine basements. One possibility of interpretation is that the thermal flow was caused by infracrustal movements during the amalgamation of northern Gemeric and southern Gemeric basements and therefore our data gained from $^{40}Ar/^{39}Ar$ dating indicate an Alpine age of this event.

The new Ar/Ar dating evoked new questions in the problem of dating the Gemericum granitoids. A reliable solution of this problem calls for the verification of mineral ages of contact aureole of other apical bodies, i.e., those that are situated directly in the south Gemericum basement.

Acknowledgements

Igor Broska is thanked for his helpful reviews. The manuscript was improved by helpful comments as well as careful reviews by H.Drewes.

References

Andrusov, D.1968: Grundriss der Tektonik der Nördlichen Karpaten. SAV Publ., Bratislava, 1-188.

Bajaník, Š., Ivanička, J., Mello, J., Pristaš, J., Reichwalder, P., Snopko, L., Vozár, J. & Vozárová, A. 1984: Geological map of the Slovenské rudohorie Mts., 1 : 50 000. D. Štúr Inst. Geol., Bratislava.

Bagdasarjan, G.P., Cambel, B., Veselsky, J. & Gukasjan, R.Ch. 1977: K-Ar isotopic ages of the Western Carpathians crystalline rock comlexes: preliminary interpretation of results. Geol. Zborn. Geol. carpathica, 28, 2, 219-242 (in Russian).

Bojko, A., Kamenický, L., Semenenko, N.P., Cambel, B. & Ščerbak, N. 1974: Partial results of isotopic geochronology of the Western Carpathians crystalline rock complex: the present status. Geol. Zborn. Geol. carpathica, 25, 25-39 (in Russian).

Cambel, B. & Kráľ, J. 1989: Isotopic geochronology of the Western Carpathians crystalline complex: the present status. Geol. Zbor. Geol. carpath. (Bratislava), 40,4, 387-410.

Cambel, B., Bagdasarjan, G.P., Veselsky, J. & Gukasjan, R.Ch. 1989: Rb-Sr geochronology of the leucocratic granitoid rocks from the Spišsko-gemerské rudohorie Mts. and Veporicum. Geol. Zborn. Geol. carpathica, 40, 323-332.

Finger, F. & Broska, I. 1999: The Gemeric S-type granites in southeastern Slovakia: Late Palaeozoic or Alpine intrusions? Evidence from electron-microprobe dating of monazite. Schweiz. Mineral. Petrogr. Mitt. 79, 439-443.

Kantor, J. 1957: Method of radiometric age dating and its application in Betliar granite. Geol. Práce, Správy, 16, D. Štúr Inst. Geol., Bratislava, 5-11 (in Slovak).

Kantor, J. & Rybár, 1979: Radiometric ages of granites from Spišsko-gemerské rudohorie Mts. and adjacent part of Veporicum. Geol. Práce, Správy, 73, D. Štúr Inst. Geol., Bratislava, 213-235 (in Slovak).

Kovach, A., Svingor, E. & Grecula, P. 1986: Rb-Sr isotopic ages of granitoids from the Spišsko-gemerské rudohorie Mts. Western Carpathians, Eastern Slovakia. Mineralia slov., 18, 1, 1-14

Kozur, H. & Mock, R. 1973: Zum alter und zur tektonischen Stellung der Meliata Serie des Slovakischen Karstes. Geol. Zborn. Geol. carpathica, 25, 1, Bratislava, 113-143.

Reichwalder, P. 1973: Geologische Verhältnisse des jüngere Paläozoikum im SÖ Teil des Zips-Gemerer Erzgebirges. Zborn. Geol. vied, Západné Karpaty, 18, D. Štúr Inst. Geol., Bratislava, 99-140 (in Slovak).

Varga, I. 1971: Demonstration of Hercynian orogenic events in the Permian development of the Gemericum. Geol. Práce, Správy 57, D. Štúr Inst. Geol., Bratislava, 349-360 (in Slovak).

Vozárová, A. 1973: Pebble analysis of Late Paleozoic conglomerates of the Spišsko-gemerské rudohorie Mts. Zborn. Geol. vied, Západné Karpaty, 18, D. Štúr Inst. Geol., Bratislava, 7-98 (in Slovak).

Vozárová, A. 1996: Tectono-sedimentary Evolution of Late Paleozoic Basins based on Interpretation of Lithostratigraphic Data (Western Carpathians; Slovakia). Slovak Geol. Mag., 3-4/96, D. Š. Publ., Bratislava, 251-271.

Vozárová, A. & Vozár, J. 1988: Late Paleozoic in West Carpathians. Monogr., D. Štúr Inst. Geol., Bratislava, 1-314.

Vozárová, A. & Vozár, J. 1996: Terranes of West Carpathians - North Pannonian Domain. Slovak Geol. Mag., 1/96, D. Š. Publ., Bratislava, 61-83.