

**REVISED RADIOMETRIC TIME-SCALE FOR THE CENTRAL
PARATETHYAN NEOGENE**

by

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At the 6th Congress of RCMNS (Bratislava, 1975) and, later, at the 25th International Geological Congress (Sydney, 1976) a radiometric time scale for the Central Paratethyan Neogene was presented (D. VASS et al., 1975; D. VASS and G. P. BAGDASARYAN, 1978). During the past 10 years many new radiometric dates of volcanic rocks from the Paratethys realm appeared. On the basis of new datings, the authors have tried to complement the radiometric time-scale of the Central Paratethyan Neogene and to add more precision to it.

A reliable radiometric age of the Egerian is still missing. New and reliable age data of the Eggenburgian, Karpatian, Upper Miocene (the Pannonian and the Pontian) and Pliocene were obtained. The new data concerning the Badenian and the Sarmatian are more or less conformable to the older ones and they only add precision and detail to the existing numeric scale.

Eggenburgian

Up to the present only two radiometric datings of a volcanic rock from biostratigraphically identified Eggenburgian deposits have been done. The rhyodacite tuff near the village Lipovany (S Slovakia, ČSSR) was dated by the F. T. method (I. REPČOK) as 20.6 ± 0.5 Ma. The Eggenburgian age of the formation from which the dated tuff comes (Filaková Fm., Lipovany Member) is proved by molluscs (A. ONDREJIČKOVÁ, 1972), by Foraminifera (*Globigerinoides primordius*, *Uvigerina bononiensis primiformis*, *U. parkeri breviformis*, V. KANTOROVA's unpublished data) and by calcareous nannoplankton of the zone NN2 (including the index form *Discoster druggi*, R. LEHOTAYOVÁ, 1984 and unpublished data).

The tuff layer inside the Upper Krosno formation of the Silesian succession (tectonic unit of the outer West Carpathians in Poland) was dated by F. T. method as 20.5 ± 0.9 Ma. According to W. NOWAK et al. (1985), the dated tuff is Lower Burdigalian, i.e. Eggenburgian, in age.

Eggenburgian—Ottangian

In S Slovakia and Hungary a rhyodacite—rhyolite tuff horizon (Gyulakeszi Rhyolite Tuff Formation or Lower Rhyolite Tuff in Hungary) is at the Eggenburgian/Ottangian boundary. It is biostratigraphically well defined, representing the lowermost part of the Ottangian stage. In the past the tuffs were dated by the *K/Ar* method applied to whole rock. The radiometric ages showed a great variation (19.9—21.9 Ma) and a great error. New and more precise dating were carried out on minerals separated from the rock. The ages obtained are younger and we consider them as closer to the actual age of the tuffs.

The age of a tuff from the vicinity of the village Lipovany (the tuff lies above the biostratigraphically and radiometrically dated Eggenburgian) is 20.1 ± 0.4 Ma (F. T. method, I. REPČOK). Rhyolite tuffs, floodtuffs and andesites in the Mecsek Mts (Hungary), according to the biostratigraphy proposed by E. NAGY (1969) and M. SÜTŐ-SZENTAI (1983), are closed to the Eggenburgian—Ottngian boundary. The radiometric age of tuffs from the Váralja-quarry and Szászvár, Szekernye valley (Hungary) is 19.5 ± 1.4 Ma and 19.6 ± 1.9 Ma (G. HÁMOR et al., 1981). The age of the andesite coming from the borehole Komló-170 is 19.5 ± 0.9 Ma (K. BALOGH, unpubl.). The tuff coming from the Upper Krosno of Skole succession (tectonic unit of the Outer West Carpathians in Poland) is probably Ottngian in age. The radiometric age of the tuff is 18.4 ± 1.0 Ma and the tuff should be, according to W. NOWAK et al. (1985), Upper Burdigalian in age (i.e. Ottngian?). Because of the uncertainty of the biostratigraphic age record we do not consider the age as a key datum.

Karpatian

Three radiometric dates concerning the Karpatian are mentioned in a D. VASS—G. P. BAGDASARYAN (1978) paper (19.4 ± 20.7 Ma). They seem to be unreliable. Rhyodacite tuffs from Fót and Tar (N Hungary, uppermost Karpatian) (M. HAJÓS, 1968; J. Halmai, 1981) were dated as 16.2 ± 0.6 Ma and 16.4 ± 1.1 Ma, respectively (G. HÁMOR et al., 1981), and the average age of the Tar Dacite Tuff Formation (Middle Rhyolite Tuff) corresponds to the uppermost Karpatian, being quite close to the Karpatian—Badenian boundary (G. HÁMOR and Á. JÁMBOR, 1971), is 16.4 ± 0.8 Ma (G. HÁMOR et al., 1981).

F. RÖGL and F. STEININGER (1983) suggested a numeric age of 17.5 Ma for the Ottngian/Karpatian boundary. Unfortunately, this numeric age could not be proved by radiometric datings because reliable radiometric ages from the Lower Karpatian as well as the Ottngian are still missing.

Lower Badenian (Moravian)

The radiometric age of the Lower Badenian was documented by 9 dates (15.6^* — 16.9^* Ma: D. VASS—G. P. BAGDASARYAN, 1978). New datings: Andesite volcanoclastics at the village Kamenica at Hron (S Slovakia, ČSSR) intercalated with marine sediments and containing Lower Badenian fauna (fauna and calcareous nannoplankton described by R. LEHOTAYOVÁ, E. BRESTENSKÁ, D. VASS, A. ONDREJIČKOVÁ in borehole K—5 Salka in A. PAPP et al., 1978, p. 175, 181—184) were dated by the K/Ar method as 15.6 ± 1.2 Ma (G. P. BAGDASARYAN, unpubl.) and by the F. T. method as 15.7 ± 1.4 Ma and 16.1 ± 0.4 Ma. From the borehole GK—3 near village Horné Rykynice (S Slovakia, ČSSR) andesite volcanoclastics were dated by the F. T. method as 16.3 ± 0.2 Ma (I. REPČOK, 1981). The Lower Badenian age is proved by Foraminifera (R. LEHOTAYOVÁ, E. BRESTENSKÁ in V. KONEČNY et al., 1983).

On the southern periphery of the Krupiná plateau (S Slovakia, ČSSR) andesite volcanoclastics of the Vinica formation, Lower Badenian in age (D. VASS et al., 1979), were dated by the F. T. method. The age is 16.5 ± 0.6 Ma and 16.8 ± 0.8 Ma (I. REPČOK).

In the Mátra Mts, at Gyöngyössolyos (N Hungary), the rhyolite is younger than lowermost Badenian (M. HAJÓS, 1968, GY. VARGA et al., 1975, J. HALMAI, 1981).

* K/Ar ages recalculated by constants: $\lambda_K = 0.581 \times 10^{-10} \text{y}^{-1}$; $\lambda_\beta = 4.96 \times 10^{-10} \text{y}^{-1}$; $^{40}\text{K} = 0.01167\%$.

The average K/Ar age measured on biotite and whole rock samples is 15.9 ± 0.5 Ma (K. BALOGH, 1984).

All new datings agree with the older ones and support the numeric calibration of Karpatian/Badenian boundary at 16.5 ± 0.6 Ma as suggested by D. VASS and G. P. BAGDASARYAN (1978).

Reliable radiometric dates from the Middle Badenian (Wielician) are still missing. A preliminary F. T. datum—the age of rhyolite tuffite from Poziom I—WT, from Wieliczka (Poland)—is of 15.0 ± 3.5 Ma. The tuffite was sampled by E. LUCZKOWSKÁ and dated by J. KRÁL (Bratislava, pers. comm.).

Upper Badenian (Kosovian)

The radiometric age of the Upper Badenian is based on 5 datations (from 14.3^* to 15.4^* Ma: D. VASS—G. P. BAGDASARYAN, 1978). A new dating comes from Hungary. The rhyolite tuff near Bántapuszta (Transdanubia) has been dated. The tuff is interbedded in the lower part of the Upper Badenian (J. KÓKAI, GY. RAINCSÁK, 1983). The K/Ar age of the tuff is 15.0 ± 0.4 Ma (K. BALOGH, 1984).

Sarmatian

The Sarmatian (in the sense of E. SUSS, 1866) was dated by 24 radiometric age data (11.5^* — 13.9^* Ma) and three dates came from rocks considered as Upper Sarmatian—Lower Pannonian (11.0^* — 11.44^* Ma: D. VASS, G. P. BAGDASARYAN, 1978).

Two datings carried out in 1968 seem to have basic data for the Lower Sarmatian: The andesites at Horša and Brhlovec (near the town of Levice, Southern Slovakia, ČSSR) were dated both as $13.2 \pm 0.5^*$ Ma (G. P. BAGDASARYAN et al., 1968). Both dated andesites are covered with Lower Sarmatian sediments, and their lateral equivalents rest on the Upper Badenian.

In the Štiavnické vrchy Mts and the Phronský Inovec Mts (Central Slovakia, ČSSR) andesite ignimbrites of the Drastvica Formation have been dated. In the upper part of the Drastvica Formation there are pelitic intercalations containing Lower Sarmatian fauna (M. VAŇOVÁ, E. BRESTENSKÁ in V. KONEČNÝ et al., 1983, p. 101—102). The average of 15 datings by the F. T. method is 13.3 ± 0.2 Ma (I. REPČOK, 1981 and unpublished data). West of the town Zvolen, andesites of the Breznica complex interbedded with Lower Sarmatian sediments (V. Konečný et al., 1983, p. 105) were dated by the F. T. method. The four obtained age data vary between 12.2 ± 0.4 Ma and 12.7 ± 0.5 Ma (I. REPČOK).

In the Zsámbék basin (Hungary, W of Budapest) boreholes Budajenő 3 and Perbál 6 penetrated a rhyolite tuff layer in the lower third part of the Sarmatian (Á. JÁMBOR, 1976; Cs. RAVASZ, 1978). The average K/Ar age on biotites is 13.7 ± 0.5 Ma (G. HÁMOR et al., 1981; K. BALOGH, 1984).

The Lower Sarmatian of Moldavia, USSR, was dated by the F. T. method. Obtained dates: 13.6 ± 0.89 , 13.54 ± 0.89 , 13.75 ± 1.08 Ma (S. S. GANZEJ, 1984, J. S. TCHUMAKOV et al., 1984). S. S. GANZEJ dated the Upper Volhynian (Middle Sarmatian in sens of SUSS, 1866) of Kerch peninsula, USSR: 12.24 ± 0.97 Ma.

Along the Soviet—Hungarian border rhyolite tuff and rhyolite production ended near the end of the Sarmatian (L. KULCSÁR, 1968). K/Ar ages fall in the range of 11.0—11.3 Ma (K. BALOGH et al., 1983b). Since very little rejuvenation cannot be excluded, these data may be used for the approximation of age of the Sarmatian—Pannonian boundary.

In the Štiavnica Mts and the Kremnica Mts (Central Slovakia, ČSSR) rhyolites and tuffs of the Jastrabie Formation were dated by the F. T. method. According to palynological data the Jastrabie Formation is Upper Sarmatian—Lower Pannonian (V. KONEČNÝ et al., 1983). The resulting 11 age data vary between 10.9 ± 0.5 Ma and 12.3 ± 0.1 Ma (I. REPČOK, 1981 and unpublished data).

Pannonian

Several new results have been added to the seven radiometric ages concerning the Pannonian ($7.8^* - 10.9^*$ Ma D. VASS and G. P. BAGDASARYAN, 1978) and the biostratigraphic control of the newly dated rocks is better than that of the previous ones.

In NE Hungary rhyolite tuff production ended near the Sarmatian—Pannonian boundary (T. ZELENKA, 1964; GY. RADÓCZ, 1969; Á. JÁMBOR, 1971). Therefore the *K/Ar* dates of 10.7–11.0 Ma measured on alunite crystals from veins in the uppermost Sarmatian tuff correspond to the Pannonian (K. BALOGH et al., 1983b). On the other hand the Lower Pannonian dacite tuff from borehole Nagykozár 2 (S Hungary) yielded an older age of 11.6 ± 0.5 Ma.

Basalts from boreholes Kecel 1, 2 and Kiskunhalas—Ny 3 (S Hungary) are accompanied by marls with a Middle and Upper Pannonian fauna (B. CSEREPES MESZÉNA, 1978). The radiometric age of basalts is 8.47 ± 0.77 Ma, 8.13 ± 0.71 Ma and 9.61 ± 0.38 Ma respectively (K. BALOGH et al., 1983a).

An andesite agglomerate from Valea Poiana, Ignis Mts, Roumania, is in a formation containing Middle—Upper Malvensian fossils. The radiometric age of an andesite fragment is 11.08^* Ma (O. EDELSTEIN et al., 1977).

From the equivalent of the Pannonian (Khersonian) from the Kerch and Taman peninsulas, USSR, the following F. T. were obtained: 11.18 ± 0.74 (lower ash level), 10.6 ± 0.75 (middle ash level), and 5 data fell in the range of 9.45–10.20 Ma (upper ash level). The age of 7.14 ± 0.58 Ma comes from the Meotian (Upper Pannonian), (S. S. GANZEJ, 1984).

Pontian

In the previous radiometric time scale the Pontian was not calibrated. In the past few years several Pontian volcanic rocks were radiometrically dated.

A basalt lava flow at Podrečany (near the town of Lučenec, S Slovakia) is in the Poltár Formation which is Pontian in age according to palynological data (E. PLANDEROVÁ in lit.). The basalt was dated by two laboratories. The isochronous *K/Ar* age is 6.19 ± 0.43 Ma (K. BALOGH et al., 1981), the analytical *K/Ar* age being 7.15 ± 0.23 Ma (J. KANTOR and V. WIEGEROVÁ, 1981).

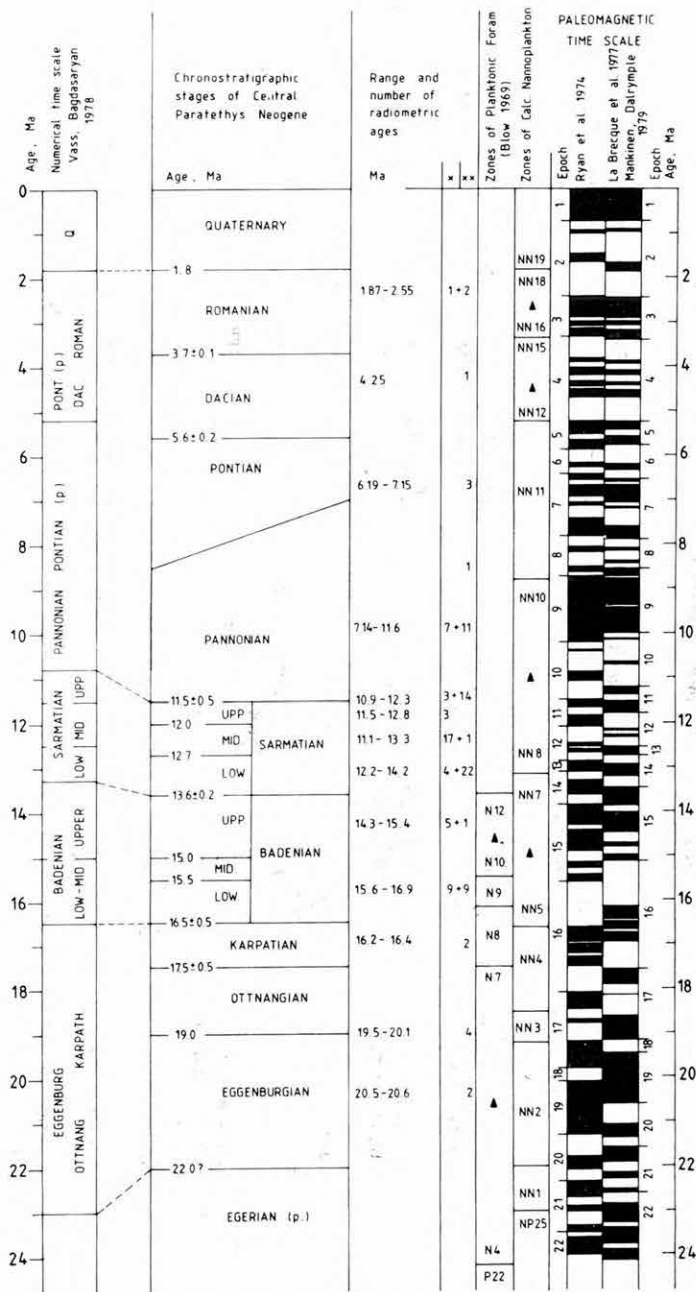
The Pontian of the USSR was dated by the F. T. method as 7.07 ± 0.6 Ma (S. S. GANZEJ, 1984).

The Meotian—Pontian basalt from the valley of the river Liachva (Geogia, USSR) was radiometrically dated as 8.0 Ma (A. T. ASLANYAN et al., 1982).

Dacian

In the previous radiometric time scale the Dacian was not calibrated.

The basalt from the vicinity of Pula (Hungary), according to the biostratigraphic control (Á. JÁMBOR et al., 1981), poured out at the end of the Congeria balatonica zone. Its *K/Ar* age is 4.25 ± 0.17 Ma (K. BALOGH et al., 1983a).



x Ages taken from Vass, Bagdasaryan, 1978
 xx Ages in this paper

Fig. 1. Radiometric time-scale for the Central Paratethyan Neogene

Review of the basic radiometric dates of Paratethyan Neogene time-scale
(measured between 1976 and 1984)

Table 1

Stratigraphic unit	Site	Rock	Method (Mineral)	Radiometric age (Ma)	Analyst	Published	
Eggenburgian Upper Eggenburgian	Lipovany, ČSSR S Poland Lipovany, ČSSR	rhyodacite tuff	F.T. (biotite)	20.6 ± 0.5	REPČOK	NOWAK et al., 1985	
		tuff	F.T.	20.5 ± 0.9			
		rhyodacite tuff	F.T. (biotite)	20.1 ± 0.4	REPČOK		
Lower Otnangian	Komló 170, Hungary Váralja, Hungary Szászvár, Hungary	andesite	K/Ar (w.r.)	19.5 ± 0.9	BALOGH et al.	unpublished HÁMOR et al., 1979 HÁMOR et al., 1979	
		rhyolite tuff	K/Ar (biotite)	19.5 ± 1.4	BALOGH et al.		
		rhyolite tuff	K/Ar (biotite)	19.6 ± 1.9	BALOGH et al.		
Kárpátian	Fót, Hungary Tar, Hungary	rhyodacite tuff	K/Ar (biotite)	16.2 ± 0.6	BALOGH et al.	HÁMOR et al., 1979 HÁMOR et al., 1979	
		rhyodacite tuff	K/Ar (biotite)	16.4 ± 1.1	BALOGH et al.		
Lower Badenian	Kamenica at Hron, ČSSR	andesite	K/Ar (w.r.)	15.6 ± 1.2	BAGDASARYAN	unpublished	
		volcanoclasts canoclasts					
	GK 3 900 m Horné Rykynce, ČSSR Sirákov, ČSSR Hrusov, ČSSR	andesite	F.T. (hornblende)	F.T. (hornblende)	15.7 ± 1.4	REPČOK	REPČOK, 1981
			volcanoclasts	(biotite)	16.1 ± 0.4	REPČOK	REPČOK, 1981
		andesite	F.T. (hornblende)	F.T. (hornblende)	16.6 ± 0.3	REPČOK	unpublished
			volcanoclasts	(biotite)	16.3 ± 0.2	REPČOK	REPČOK, 1981
Upper Badenian	Bántapuszta, Hungary	andesite	F.T. (hornblende)	16.8 ± 0.8	REPČOK	REPČOK, 1981	
		volcanoclasts					
Lower Sarmatian	W Zvolen, ČSSR	andesite	F.T. (hornblende)	16.5 ± 0.6	REPČOK	REPČOK, 1981	
		rhyolite tuff	K/Ar (w.r. biotite)	15.9 ± 0.5	BALOGH et al.	BALOGH, 1984	
Upper Badenian	Bántapuszta, Hungary	rhyolite tuff	K/Ar (biotite)	15.0 ± 0.4	BALOGH et al.	BALOGH, 1984	
		andesite	F.T. (biotite)	12.2 ± 12.7 (4 data)	REPČOK		

Table 1 continued

	Štiavnica and Pohron Inovec Mts, ČSSR	andesite ignimbrites	F.T. (biotite) (hornblende)	13.2±0.2	REPČOK	REPČOK, 1981 and unpublished				
	Moldavia, USSR	volc. tuff	F.T.	13.6±0.89	GANZEJ	TCHUMAKOV et al., 1984				
	Moldavia, USSR	volc. tuff	F.T.	13.54±0.89	GANZEJ	TCHUMAKOV et al., 1984				
	Moldavia, USSR	volc. ash	F.T.	13.75±1.08	GANZEJ	TCHUMAKOV et al., 1984				
	Horsa, ČSSR	andesite	K/Ar (w.r.)	13.2±0.5	BAGDASARYAN	BAGDASARYAN et al., 1968				
	Brhlouce, ČSSR	andesite	K/Ar (w.r.)	13.2±0.5	BAGDASARYAN	BAGDASARYAN et al.				
	Budajenő 3, Hungary	rhyolite tuff	K/Ar (biotite)	14.2±1.3	BALOGH et al.	BALOGH, 1984				
Middle Sarmatian	Perbál 6, Hungary	rhyolite tuff	K/Ar (biotite)	14.2±1.3	BALOGH et al.	BALOGH, 1984				
	Kerch, USSR	?	F.T.	12.2±0.97	GANZEJ					
Upper Sarmatian	Gelénés 1, Hungary	rhyolite tuff	K/Ar (biotite)	11.0±0.6	BALOGH et al.	BALOGH et al. 1983b				
	Barabás 1, Hungary	rhyolite	K/Ar (w.r.)	11.3±0.5	BALOGH et al.	BALOGH et al., 1983b				
	Barabás 1, Hungary	ignispumice	K/Ar (w.r.)	11.2±0.5	BALOGH et al.	BALOGH et al., 1983b				
Upper Sarmatian—Lower Pannonian	Štiavnica, ČSSR	rhyolite	F.T. (biotite, glass)	10.9—12.3 (11 data)	REPČOK	REPČOK, 1981 unpublished				
	Kremnica Mts, ČSSR				REPČOK					
Lower Pannonian	Szerencs Hills, Hungary	alunite veins	K/Ar	10.7—11.0 (3 data)	BALOGH et al.	BALOGH et al., 1983b				
	Nagykozár 2, Hungary	dacitic tuff	K/Ar (biotite)	11.6±0.6	BALOGH et al.	BALOGH et al., 1984				
Middle Pannonian	Valea Poiana Ignis Mts, Roumania	andesite agglomerate	K/Ar	11.08±0.5	SOROU	EDELSTEIN et al.				

Table 1 continued

Stratigraphic unit	Site	Rock	Method (Mineral)	Radiometric age (Ma)	Analyst	Published
Khersonian (= Middle Pannonian)	Kerch, USSR	volc. ash	F.T.	9.45 ± 0.88	GANZEJ	TSCHUMAKOV et al., 1984
	Kerch, USSR	volc. ash.	F.T.	9.59 ± 0.59	GANZEJ	TSCHUMAKOV et al.
	Taman, USSR	volc. ash	F.T.	10.6 ± 0.75	GANZEJ	TSCHUMAKOV et al.
	Taman, USSR	volc. ash	F.T.	11.18 ± 0.74	GANZEJ	TSCHUMAKOV et al.
Middle—Upper Pannonian	Keceel 1, Hungary	basalt	K/Ar (w.r.)	8.47 ± 0.77	BALOGH et al.	BALOGH et al., 1983a
	Keceel 2, Hungary	basalt	K/Ar (w.r.)	8.13 ± 0.71	BALOGH et al.,	BALOGH et al., 1983a
	Kiskunhalas-Ny 3, Hungary	basalt	K/Ar (w.r. and fractions)	9.61 ± 0.38	BALOGH et al.	BALOGH et al., 1983a
Upper Meotian (= Upper Pannonian)	Kesamen, USSR	volc. ash	F.T.	7.14 ± 0.58	GANZEJ	GANZEJ, 1984
Meotian—Pontian	Liachva Riv.	basalt	K/Ar (w.r.)	8.0	RUBINSTEIN	ASLANIAN et al., 1982
	Kobystan, USSR	volc. ash	F.T.	7.07 ± 0.6	GANZEJ	GANZEJ, 1984
	Podrečany, CSSR	basalt	K/Ar (w.r. isochron)	6.19 ± 0.43	BALOGH et al.	BALOGH et al., 1981
	Podrečany, CSSR	basalt	K/Ar (w.r.)	7.15 ± 0.6	KANTOR	KANTOR, WIEGEROVÁ, 1981
Upper Pannonian (uppermost Congeria balatonica z.) Romanian	Pula, Hungary	basalt	K/Ar (w.r. isochron)	4.25 ± 0.17	BALOGH et al.	BALOGH et al., 1983a
Lower Akshagyllyan	Kvarab, USSR	volc. ash	F.T.	2.55 ± 0.20	GANZEJ	GANZEJ, 1984
	Kvarab, USSR	volc. ash	F.T.	1.87 ± 0.15	GANZEJ	GANZEJ, 1984



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