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Certain Key Data for the Phanerozoic Time-Scale

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ABSTRACT

Complementary data have been obtained on micas, basic effusives and glauconites which allow to date the D_3, C_2–C_3, as well as certain Mesozoic divisions, in much the same way, as was done for the Soviet Geologic Time-Scale of 1964. Recently obtained data for the above geologic boundaries closely approximate those age-values which were previously published in 1964.

The different geological time-scales presented in 1964 and 1968 at the XXII. and XXIII. Sessions of the International Geological Congress on behalf of Soviet geochronologists were reasonably well-based geological and geochronological statements.

During the last few years, previous dates for selected critical key points of the time-scale have been checked by separate laboratories using different methods. Concurrently with this work a number of measurements have been made on material recently obtained from new regions.

Data reputed as reliable from the stratigraphical and geochronological point of view, obtained by different laboratories in the USSR and published in 1964 for the time-scale of certain Phanerozoic divisions, are listed in Table 1.

It is a fact of geochronological experience, that in order to obtain more accurate and unambiguous results, the dating of geological limits between systems and their smaller units should be based on the radiometric age determinations of stratified rocks. As such, the biotite-sanidine effusives, unaltered basic effusives and sedimentary rocks containing glauconite may be pointed out.

It should be noted that the K, Ar, Rb and Sr in stratified rocks is rather well preserved in a particular area under platform conditions.

Dating of the limits of geological systems from rock-constituents of intrusive series is far more complicated and, in fact, less consistent. The geological age of a granite intrusion may usually be determined, but values may spread considerably. When we correlate intrusions of similar petrography to provide the necessary interpretation of their geological age, again, various approaches appear to be possible. And, finally, these intrusions appear to be far more susceptible to the processes of autometamorphism, which disturb the relationship between the daughter products of decay and the parent elements.

On the whole, if we take into account the worldwide laboratory data, much of which has been compiled in our publication of 1964, then the principal limits of Phanerozoic subdivisions dated from stratified rocks (effusives, glauconite and whole rocks), may be thought of as being securely defined.

Table 1

NN of key (critical) points selected from the 1964 time-scale	Locality, rock-type	Geological age and sample analysed	K-Ar age, m.y. $\lambda_K = 0{,}557 \times 10^{-10}\ y^{-1}$	Reference: (AFANASS'YEV et al., 1964)
5	North Caucasus ignimbrite	Upper Pliocene biotite	3.3 ± 0.6	5
13	Trancarpatia perlite	Upper Miocene (Lower Sarmathian) total rock sample	14.2 ± 2	5
20	Fore-Caucasus region core sample	Lower Miocene glauconite	24 ± 2	42
22	UAR Cairo	Oligocene-lower-most Miocene basalt	25.0 ± 1	5
34	Fore-Caucasus region sandstones	Eocene, Kievian stage glauconite	46 ± 3	42
51	Kazakhstan Turgai	Paleocene glauconite	67 ± 5	45
56	Dagestan	Danian glauconite	70 ± 4	42
60	USSR Saratov	Lower Senonian glauconite	78 ± 4	42
63	Azerbaijan Kazakh city	Lowermost Campanian Uppermost Santonian biotite	86 ± 5	13
67	Belorussia	Cenomanian glauconite	90 ± 4	45
79	North Caucasus Baksan river	Upper Aptian glauconite	107 ± 5	
85	Moscow district	Valanginian glauconite	125 ± 6	42
88	Moscow district	Uppermost Jurassic (Volgian, glauconite)	136 ± 6	42
96	Armenia Allaverdy	Bajocian plagioporphyry	153 ± 5	13
97	Abkhazia Mount Bzyb'	Bajocian pyroxene basalt	164 ± 6	5
139	Central Kazakhstan	Upper Carboniferous-Permian. Granites from Akchatau complex Mean of 39 analysis: U, Th-Pb,	293 ± 15	
		mean of 10 measurements	287 ± 10	
		Rb-Sr, isochr.	291 ± 20	
143	USSR village Dergunovka	Middle Carboniferous (Vereyan horiz.), glauconite	308 ± 10	
163	Central Kazakhstan	Post-Frasnian Pre-Turonian (Famenian?) granites	355 ± 10	5
170	Kurskiy district	Frasnian (D_3) glauconite	366 ± 10	

197	South Urals Plava river	Lower Ordovician (Lowermost Arenigian) biotite	450 ± 10	
214	Pakistan Salt Ridge	Middle Cambrian, lowermost strata glauconite	530 ± 20	5
216	Leningrad district	Lower Cambrian, glauconite	542 ± 20	
218	Siberia Olenek river	Lower Cambrian (Aldanian stage) glauconite	533 ± 20	
220	Ukraine Dnieper river	Upper Proterozoic (Beds with *Laminarites antiquis*), glauconite	590 ± 15	28

Table 2

NN of Samples	Locality	Geological age	K %	Ar^{40} rad nmm^3/g	Ar atm %	T m.y.
21/64	Bulgaria. Swinetch Mt.	Albian	7.06	0.0298	—	106 ± 4
23/64	North Caucasus Well sample	Albian-Aptian	5.09	0.0221	—	110 ± 5
27/64	North Caucasus Core sample	Lower Cretaceous	4.82	0.0242	—	128 ± 5
22/64	Bulgaria. Wratza Mt.	Callovian	6.67	0.0382	52	145 ± 5
20/64	Bulgaria Sofia	Lower Aalenian	4.12	0.0258	39	160 ± 6
331/64	North Caucasus Dolerite sills in Pliensbachian beds	Uppermost Strata of Lower Jurassic	0.90	0.0068	40	175

Palaeozoic geological systems require a more detailed subdivision – into stages and substages. This may be achieved, to the best advantage, on the basis of material taken from geological sections in regions that where always subject to a platform regime.

Most recent age data obtained for Mesozoic glauconites from Bulgaria and the Caucasus are listed below in Table 2. Moreover, numerous results of age measurements from dolerite sills (near-surface intrusions) cutting the Pliensbachian sandstones are given, which appear to date the uppermost portion of the Lower Jurassic at 175 m.y. The Triassic-Permian boundary may be consequently interpolated at 240 m.y., since an Upper Permian effusive-extrusive formation 245, 250 and 255 m.y. old (Table 3) is transgressively overlain by a Lower Triassic rock-unit (base of Scythian stage).

With a decay constant $\lambda_e = 0.585 \times 10^{-10}$ years^{-1}, the K-Ar-age for the Permian-Triassic boundary is estimated at 230 m.y.

Table 3 shows the latest numerical values obtained of age determinations for Carboniferous and Devonian rocks from the Caucasus and Kazakhstan.

Table 3

NN of Samples	Locality and geological position, sample	Geological age	K-Ar K %	Ar rad. nmm³/g	T m.y.	Rb-Sr Rb^{87} ppm	Sr^{87} ppm	T m.y.
145/65	Aksahut river. Andesite-basalt	Lowermost strata of Up. Permian	0.91	0.0094	255	—	—	—
1/65	North Caucasus. Amphibole from biotite-granodiorites	Lower Permian	2.89	0.0320	270	—	—	—
221/65	North Caucasus, Dahut river. Concordant andesito-basalt sheet at the base of C_3 conglo-merate - sandstone terraine. Conglomerates contain some pebbles of	Lower boundary of C_3						
230	Famenian Limestones		0.85	0.0102	292	—	—	--
	North Caucasus, Laba river Liparite extrusion	Uppermost Permian pre-Triassic	3.12	0.0309	245	—	—	—
c-4-d	Kaldyrmin complex Biotite from granites Determinations obtained give the age of C_2–C_3 boundary	C_2–C_3 boundary						
a)	IGEM. X1. 1964 (L. L. SHANIN)		7.27	0.091	304	910	3.58	289
b)	Bashkirian branch, Ac. Sci. USSR (M. A. HARRIS)		6.92	0.083	292	—	—	—
c)	Kazakhstan Ac. Sci. (A. I. IVANOV)		7.46	0.091	295	—	—	—
d)	Bern, Switzerland, 1969 (E. JÄGER)					923	3.81	296
e)	Armenian Ac. Sci. (G. P. BAGDASSARYAN)		7.28	0.096	320	1035	4.16	290
f)	Geochem. Inst. Siberian branch Ac. Sci. USSR (S. B. BRANDT)		7.47	0.089	292	—	—	—
g)	Geological Inst., Siberian branch Ac. Sci. USSR (L. V. FIRSOV)		7.42	0.089	295	—	—	—
Averaged date for C_2–C_3 boundary					299			291

Concerning the biotite standard c-4-d from the Bokhtinskyi granite massif, the possible time of intrusion of this rock-mass has been discussed in terms of having occured at the very verge of C_2–C_3.

Table 4 shows the K-Ar values obtained on North Caucasian igneous rocks attributed to the Devonian. The subalkaline basaltoids of Devonian age alternate with phyllites that contain a microfauna of *Archaesphaera minima* Sal. et al.

Table 4

NN of Samples	Locality	Geological position, sample	K %	Ar^{40} rad, nmm^3/g	T, m.y.	Author
115/65	North Caucasus, Aksahut river	Upper Devonian Famenian terrane of subalkaline basalts	2.21	0.0315	345 ± 10	S. B. Brandt
41/64	Voronezh crystalline massif	Basalt D_3 (Shchigrovian level)	0.15	0.00215	345 ± 20	L. L. Shanin
226/65	North Caucasus, Dahut River	Amphibole plagiogranite – porphyry of D_2–D_3 age (amphibole)	0.17	0.002	365 ± 20	S. B. Brandt
C	Central Kazakhstan, Sary-Adyr massif	Post-Franian up to Tournaisian	2.18	0.0323	355 ± 10	L. L. Shanin Mosc. State Univers.- M. A. Harris
152A/66	North Caucasus, Ugum Range	Granite pebbles from conlomerates at the verge D_2-D_3; overlies subalkaline Upper Devonian basalts	3.81	0.0056	355 ± 10	S. N. Voronov-skiy

According to R. N. SOBOLEV, the granites of the Sary-Adyr massif (sample "C" in Table 4) cut through the Jaksyn series (D_2gv–D_3fr). The age of this series is determined from the occurrence of enclosed flora and fish fauna (*Botriolepsis asiatica*). These species have been listed in a publication by G. D. AFANASS'YEV et al., 1963. The granites are overlain by limestones C_1t_1 (Tournaisian) with a fauna of *Cyrtospirifer dada* Nal. and *Athyris tau* Nal.

All age values obtained by K-Ar method have been calculated on the basis of $\lambda_e = 0.557 \times 10^{-10}$ years^{-1}, and those using the Rb-Sr decay with $\lambda_{^{87}Rb} = 1.39 \times 10^{-11}$ years^{-1}.

Conclusions

The above listed data obtained by K-Ar and by Rb-Sr methods for rock-units with a reliable geological age provide an additional body of evidence which corroborates certain dates within the Paleozoic and Mesozoic, adopted in the time-scale of 1964 (AFANASS'YEV et al.) and that of 1968 (AFANASS'YEV, 1968).

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