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CONTENTS OF TRACE ELEMENTS IN GRANITOID ROCKS OF THE WEST CARPATHIANS

(Tabs. 1—7, Figs. 1—7)

Abstract: In the presented work are evaluated the contents of trace elements in 234 spectrochemical analysed samples of granitoid rocks of the West Carpathians. The spectrochemical analysis of samples, the procedure of which is decribed later, was performed by J. Medveď in the spectrochemical laboratory of the Geological Institute of the Slovak Academy of Sciences in Bratislava. In the work is given the characterization of essential types of granitoid rocks from individual West Carpathian mountain ranges on the basis of trace elements B, Ba, Be, Co, Cr, Cu, Ni, Pb, Sc, Sn, Sr, V, Y, Zr. The content values of these elements are quoted in tables and graphs, which make possible parallelization of various rock types from various mountain ranges of the West Carpathians. So the possibility is provided to utilize common or also different geochemical marks to considerations about genetic competence of petrogenetically and geochemically different or approached types of rocks. The results confirm the competence of Variscan granitoids into one formation of Variscan or Caledonin-Variscan granite plutonism. This plutonism is characterized by a high content of Ba, Sr and prevalence of Na over K mainly in comparison with Gemeride granites, which form an independent formation of Neoid granitoids. From the whole comparison of trace element contents is evident that with relatively considerable geochemical homogeneity of granitoid magma of Variscan granitoids the greatest content differences are caused by various basicity of rocks, their degree of differentiation or degree of completeness of anatectic remelting or homogenization of palingenic magma.

Резюме: В работе оценены содержания следовых элементов в 234 спектрохимически анализированных проб гранитоидных пород Западных Карпат. Спектрохимический анализ проб, метод которого описан ниже, исполнял Я. Медведь в спектрохимической лаборатории Геологического института САН в Братиславе. В работе описана характеристика основных типов гранитоидных пород отдельных гор Западных Карпат на основании следовых элементов B, Ba, Be, Co, Cr, Cu, Ni, Pb, Sc, Sn, Sr, V, Y, Zr. Содержания этих элементов приведенные в таблицах и графиках, способствующих широкую параллелизацию разных типов пород из разных гор Западных Карпат. Этим предоставляет возможность использовать общих и различных геохимических знаков для рассуждений касающихся генетической принадлежности петрогенетически и геохимически различных или сближенных типов пород. Результаты подтверждают принадлежность варийских гранитоидов в одну формацию варийского, или-же каледонско-варийского плутонизма. Этот плутонизм характеризован высоким содержанием Ba, Sr и преимуществом Ni над K, особенно в сравнении с гемеридными гранитами, которые образуют самостоятельную формацию неоидных гранитоидов. Из общего сравнения содержаний следовых элементов вытекает, что в относительно значительной геохимической гомогенностью гранитоидной магмы варийских гранитоидов самые большие разницы вызывает разная основность пород, их степень дифференциации, или степень совершенства анатектического переплавления, или-же гомогенизация палингенетической магмы.

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Introduction

The granitoid rocks are very wide spreaded in the West Carpathians, they occur in the core mountains of Malé Karpaty, Považský Inovec, Suchý and Malá Magura, Žiar, Tríbeč, Malá and Veľká Fatra, High and Low Tatra, Branisko, further on in the Vepor crystalline and in the Čierna Hora, less in the Paleozoic of the Spišsko-gemerské rudohorie Mts.

The most extended West Carpathian granitoid rocks are Variscan granitoids or granitoid rocks of the Caledonian — Variscan cycle, which as older ones originated in the synkinematic phase of formation of migmatites and hybrid crystalline rocks. This process resulted in formation of palingenic granitoid magma, which remained in the zone of migmatites or in some mountain ranges, intruded in the Variscan orogene into less metamorphosed parts of supercrustal mantle. Some authors consider granites of Kralička type or some further granitoid bodies of the Veporide crystalline as synkinematic, relatively older granitoids. It is also proved the existence of volcano-intrusive, mainly hypabyssal types of acid magma as evidence of porphyric magmatism in the Early Paleozoic in the region of the Spišsko-gemerské rudohorie Mts. It is questionable whether to that period the origin of orthogneisses (Murán gneissose granites) can be assigned, which can be considered as metamorphosed hypabyssal equivalents of this acid Early Paleozoic magmatism (B. Cambel et al. 1979). The problem of granite plutonites in the Tatra-Veporides of pre-Variscan age can be solved only with difficulties and the opinions of individual geologists about their existence and genesis are different and usually missing appropriate evidence. The pre-Cambrian granitoid rocks have not been so far proved in the region of the West Carpathians.

It may be said, that in the presented article the published analysis of granitoid samples concern to a maximum extent the Variscan granitoid rocks of the Tatraveporides and only a part referts to Neoide granitoids or Late Variscan—Permian granitoids (according to the last works of A. Kovách et al., 1979 and J. Kantor et al., 1979), wich occur in the Spišsko-gemerské rudohorie Mts.

Our work includes and evaluates the results of study of trace element contents, which were analysed by spectrochemical method by J. Medveď in spectrochemical laboratory of the Slovak Academy of Science. The mentioned samples belong to the group of selected representative granitoid rocks of the West Carpathians (ZK samples), which were collected by B. Cambel and L. Kamenický and from the complex of samples of Malé Karpaty collected by B. Cambel, J. Veselský and V. Kátlovský. It was also analysed a smaller number of samples for futher geologists (D. Hovorka), which is also included in the number of valuated analyses, of which are 234 on the whole. A part of analyses is taken over from the catalogue of D. Hovorka (1972). The mentioned analytic results were statistically evaluated (arithmetic and geometric means and relative standard deviation of the geometric mean) (J. Medveď, 1978).

At present the material of selected represetative samples of granitoid rocks of the West Carpathians (so called ZK samples) is being treated very intensely geochemically-mineralogically and petrographically as well as numerous samples from the Malé Karpaty region are evaluated. The contemporaneous knowledge, which provides characterization of the mentioned, mainly Variscan granitoids makes possible to work out the classification of these rocks from geochemical, petrochemical and petrographic-mineralogical view-points. In the time when the individual statistic data mentioned in tables of the presented work were calculated, neither these data were available nor an international system of classification was accepted and got used and therefore the names of rocks are introduced in the tables of the work, which corresponded to ways of classification, used in that time and not uniform. Therefore in the tables are taken over names of the rocks used by mapping geologists previously. In order to make possible parallelization of rocks mentioned under various names in the tables with names, which are in agreement with the international classification, we present the following parallelization, which is based on the classification of granitoid rocks of the West Carpathians from the group of „ZK" samples, carried out on the basis of appropriate planimetric analyses.

According to these results the granitoid rocks of the West Carpathians are divided into:

1. leucogranitoids: a) leocogranites, b) leucogranodiorites
2. two-mica granitoids: a) two-mica granites, b) two-mica granodiorites
3. biotite granitoids: a) biotite granites, b) biotite granodiorites
4. tonalites: a) leucotonalites, b) biotite tonalites, c) amphibole-biotite tonalites.

In order to compare granitoid rocks of the Bohemian massif and West Carpathians B. Cambel, L. Kamenický, J. Klomínský, M. Palivcová (1980) used the following subdivision, partly in agreement with the division used in this work, as rocks studied in the latest 20—30 years were compared there. The following division was used:

1. leucogranites (aplite granites)
2. two-mica granites and biotite granites (adamelites and leucocratic granodiorites)
3. biotite granodiorites ($\pm$ amphibole)
4. tonalites and amphibole granodiorites ($\pm$ amphibole)
5. durbachites (in the Bohemian massif only)
6. diorites and gabbros associated (in granitoids)

According to the international classification of sorted selected samples of the West Carpathians the first group includes approximately rocks with the following names mentioned in the tables of this article: aplites, pegmatites, aplite-pegmatitoid granites, leucocratic granitoids, granites of type Kralička and further a part of autometamorphic (autometasomatic) granitoids from various mountain ranges.

The second group includes the following analogous groups: muscovite-biotite granites to granodiorites, a part of granitoids and granodiorites from various mountain ranges, a part of granites and granodiorites of Hrončok and Veporide types, a part of autometamorphic granitoids.

To the third group belong analogous rocks mentioned in this work under the following names: biotite granites — granodiorites, biotite granodiorites, granodiorite of Sihla type, granodiorites of Ďumbier type, granodiorites of Modra type.

To a particular group belong: amphibole-biotite quartz diorites and diorites, which are analogous with the group 6 mentioned in the work by B. C a m b e l et al. (1980), in which diorites and gabbros are associated with granitoid rocks.

In the presented work are mentioned also such types as autometamorphosed or autometasomatic granitoids of Prašivá type etc. affected by potassium or sodium autometasomatism. These names were taken over from older works and are requoted, although we know that at present there are discussions whether to consider the genesis of various so called autometamorphosed types as products of normal development of rock differentiation (D. H o v o r k a, 1979).

Such rocks are known in the region of the High Tatra, Low Tatra (Prašivá type), Veľká and Malá Fatra and Vepor crystalline. A particular group are metasomatites from the Malé Karpaty region, where an alkalic higher-thermal potassium metasomatosis, or lower-thermal to hydrothermal sodium metasomatosis is concerned. As under the concept metasomatites we do not understand a uniform alteration of granitoid rocks, belonging to one process, these groups are characterized by considerable geochemical variability, mainly in the contents of trace elements, of which especially some metals have higher contents.

The most wide-spread types of West Carpathian Variscan granitoid rocks are those belonging to two-mica granitoids (group 2) and to biotite granitoids (group 3). Leucogranitoids (group 1) and tonalites (group 4) as well as also quartz-diorites or diorites and gabbros (group 6), according to the work by B. C a m b e l et al., (1980), are much less wide-spread and rather form border zones, nests or streaky macro-bodies and light-coloured rocks-vein bodies taking up a relatively small part of massifs.

Granitoids of the Neoid and Late Variscan cycle of development occur in the Gemerides (areas of Hnilec, Betliar, Poproč, Zlatá Idka and elsewhere). From the Tatraveporide granitoids they differ mostly in mineral and chemical composition.

Gemeride granitoids, according to latest evaluations, are also not forming a group homogeneous in age and petrology. According to J. K a n t o r et al. (1979) the northern Súľová strip of occurrences of so called Gemeride granites belongs to Late Variscan intrusions, whereas the southern strip is of Cretaceous or Jurassic age. As it was already said, in the Spišsko-gemerské rudohorie Mts. also hypabyssal acid rocks altered by dynamic metamorphism exist, which possibly may be assigned to porphyroid sub-surface Early Palezoic magmatism.

The main objective of the presented work is to summarize the fundamental data of the contents and distribution of trace elements B, Ba, Be, Co, Cr, Cu, Ni, Pb, Sc, Sn, Śr, V, Y and Zr in individual types of West Carpathian granitoid rocks. The results have to serve as information about clark contents of the above mentioned elements in rocks grouped according to regional and petrographic-petrogenetic viewpoints. Forming of greater complexes from Variscan granitoid groups gives a very clear survey of geochemistry of these rocks and contents of microelements in them. These data form an important geochemical characterization, which makes possible to differentiate or parallelize individual groups of granitoids mutually, from regional and petrographic viewpoints. The work enables us to make a picture of the variability of granitoid rocks in he West Carpathian region and so to solve important petrologic problems and to clear up analogies and relations of correlation between various types of rocks.

Analytic method

The samples of rocks were homogenized with graphite powder SU 602 in ratio 1 : 1. As electrodes served the carrier electrodes SU 308 and counter-electrodes SG 359 produced by Elektrokarbon n. p. Topoľčany. The spectra of samples were taken down 90 seconds, using spectrograph PGS—2. As exciting source was applied the D. c. arc of anodic polarization of the analytical electrode of intensity 6 A. Analytic lines of determined trace elements were chosen in a way to guarantee the best reproducibility and provability. The selection of comparing elements was made on the basis of the course of relation curves so that these should approach as much as possible the observed elements in their spectrochemical properties. The selected wave lengths of lines of the established elements as well as of comparing elements are mentioned in Tab. 1. The blackening of appropriate spectral lines was measured microphotometrically and converted to values Y (log. I) by aid of calibra-

Table 1. Wave lengths of used spectral lines, preciseness of determination and concentration ranges of trace elements in granitoid rocks. *Explanations:* 1 — Ge, Pd, Eu — comparing elements; s_{rp} — relative standard deviation of analytic determination, where index p means that there are, values calculated with utilization of couples of results obtained from parallel measurement; ΔC^1 concentration range, in which the element contents were found in selected 50 samples; ΔC — concentration range, in which is is possible with the decribed spectrochemical method to determine individual elements.

Element	Wave length in nm	s_{rp}	ΔC_i	ΔC
Ba	233,52	0,105	100—2550	100—3000
Be	234,86	0,097	<3—15	3—300
B	249,77	0,112	<10—100	10—1000
Pb	283,30	0,093	12—150	3—300
Sn	317,50	0,091	<3—18	3—300
Cu	324,75	0,100	8—74	3—300
Ge^1	265,11			
V	318,39	0,116	3—135	3—1000
Sc	335,37	0,113	3—23	3—300
Ni	341,47	0,059	<3—18	3—1000
Zr	343,82	0,166	87—540	10—1000
Co	345,35	0,071	<3—14	3—1000
Y	371,02	0,134	4—82	3—1000
Pd^1	342,12			
Cr	425,43	0,084	<3—56	3—1000
Ba	455,40	0,105	23—1500	3—1500
Sr	460,73	0,089	9—620	3—1500
Eu^1	459,40			

tion curves of emulsion, which were constructed with application of results obtained from preliminary curves (E. Plško, 1969) for the interval of wave lengths 300, 350 to 450 nm. The analytical calibration curves were constructed in coordinates Δ Y against log. C. The samples of granitoids were taken off twice, calibration standards three times and from the obtained parallel results the geometric centre was taken. The preciseness of determination of individual elements expressed by relative standard deviation (s_{rp}) was calculated from the results of parallel measurements at 50 granitoid samples with changing content of one or other element and is given in Tab. 1. The used method of calculation of determination precisencess is described in the work by E. Plško (1973). In Tab. 1, besides other data, is mentioned also the concentration interval ΔC_i, in which were found the contents of individual elements in analysed granitoids and finally the concentration range ΔC, in which it is possible to determine the individual elements by the described spectrochemical method.

The lower limit of interval $\triangle$C represents practically the attainable detection limit. The correctness of analytic results was controlled by analyses of standard reference materials USGS[1] G—2 (granite), GSP—1 (granodiorite); CRPG[2] — GA (granite), GH (granite); ZGI[3] — GM (granite); IGEM[4] — „Ryžik" (granodiorite); ANRT[5] — Dr—N (diorite). Establishing of trace elements in standard reference materials was carried out in various times (from 1970 to June 1980), almost after each set of 40 samples. From the obtained values of microelement contents in individual standard reference materials were calculated the average $\bar{x}$ values, which were compared with the recommended C_0 values, mentioned by F. J. Flanagan (1969, 1973) and IGE, Moscow (1973). The average $\bar{x}$ values as well as the recommended C_0 values are quoted in Tab. 2.

Treatment of results

For the individual distinguished types of granitoid rocks (from more basic to acid and taking into regard rocks affected by autometamorphic and metasomatic processes) the average contents of trace elements, expressed by arithmetic and geometric means were calculated. Further on, the relative standard deviation of the geometric mean (of dispersion of logarithm values of element contents) was calculated. All these statistical data are mentioned in Tabs. 3—7. The mean contents expressed by geometric means can be calculated from distribution histograms provided that lognormal distribution of microelements is also at these analyses, in which a part of the results is below the detection limit. In groups with a small number of samples histograms could not be constructed and therefore the geometric means were in a part of these samples, when the number of contents below detection limit

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2 — Centre de Recherches Pétrographiques et Géochimiques (France)
3 — Zentrales Geologisches Institut (GDR)
4 — Institut geol. rud. mestorozhdenii, petrografii i geoch. AN USSR
5 — Association Nationale de la Recherche Technique (France)

Table 2. The correctness of determination of trace elements in granitoid rocks, controlled with analyses of standard reference materials G—2, GH, GF, Ryžik and Dr—N. (The contents are in $g.t^{-1}$). *Explanations:* n — number of analytic data; $\bar{x}$ — arithmetic mean; C_o — recommended value (F. J. Flanagan, 1969, 1973; and IGEM Moscow, 1973).

Stand. ref. material	Index	B	Ba	Be	Co	Cr	Cu	Ni	Pb	Sc	Sn	Sr	V	Y	Zr
G-2	$\bar{x}$	<10	1807	<3	4,7	8,6	10,1	4,4	27,5	4,7	<3	500	38,1	12,2	298
n=10	C_o	2	1950	2,5	4,9	9	10,7	6,4	28,7	3,9	1	479	37	12,2	316
GSP-1	$\bar{x}$	<10	1407	<3	7,4	10,5	33,2	8,2	56,7	8	9,4	252	59	28,1	485
n=8	C_o	3	1360	0,8	7,5	13,2	35,2	10,7	52,4	9,2	6,5	247	52	36,1	544
GA	$\bar{x}$	29	810	4,2	7,9	8,8	10,7	5,8	28,8	8,1	4,1	297	35,5	19,6	130
n=6	C_o	26	850	4	5	10	14	7	26	7	4	305	36	18	140
GH	$\bar{x}$	<10	23	6	<3	3,5	9	3	45,5	3,2	8,8	9	3	70,5	162
n=6	C_o	3	22	6	1,5	6	12	3	50	3,5	10	10	5	70	160
GM	$\bar{x}$	12	330	4,3	3,5	10	9,8	6,1	30	5,2	4,5	125	11	23,8	151
n=6	C_o	13	328	4,4	3,5	10	13	7,5	30	5,1	4,6	133	11	26	145
Ryžik	$\bar{x}$	20	1380	4,3	10	32	43	10	117	11	7	590	91	17,8	174
n=4	C_o	27	1300	4,5	13	39	57	14	150	15	7,6	460	96	19	157
DR-N	$\bar{x}$	16	500	3,5	32	22,5	43	19,1	62	42	7	440	207	25,1	126
n=4	C_o	14	360	3,3	35	45	52	16	75	32	6	400	225	20	131

Table 3. Average contents of B, Ba, Be and Co in granitoidrocks of the West Carpathian (in $g.t^{-1}$). *Explanations:* n — number of analytic data; a_p — arithmetic mean; g_p — geometric mean; $s_{r\lambda}$ — relative standard deviation of geometric mean

Type of rock	n	B			Ba			Be			Co		
		a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
1. MALÉ KARPATY													
BRATISLAVA MASSIF													
Musc.-biotit. gr. to granodior.	40	10,3	9	0,58	642	601	0,42	3,9	3,8	0,31	3	5,5	—
Aplites, pegmat. and aplit.-pegrm. gr.	20	11,3	10,7	0,42	332	176	2,54	5,1	4,8	0,44	<3	<3	—
Biotite.-amphibole. quartz diorites	3	14,3	14	—	2497	2456	—	<3	<3	—	18,3	18,2	—
Biotite.-amphibole. diorites	7	11,1	9,9	0,61	1118	884	0,98	<3	<3	—	22,8	18,9	0,84
MODRA MASSIF													
Biotite ggranodiorites	20	18,5	16,3	0,67	759	720	0,43	<3—7,4		—	3,3	3	0,29
Autometamoprh. granitoids	4	39	36	—	792	743	—	<3	<3	—	3,6	3,5	—
Metasomat. gr.	12	17	14,6	0,90	1518	1261	0,91	<3—8,3		—	<3—4,2		—
Biotite.-amphibole. quartz diorites	4	15,3	15,2	—	2200	1998	—	<3	<3	—	18,2	17,8	—
2. POVAŽSKÝ INOVEC													
Biotite. gr. to granodiorites	5	19	18	0,28	618	614	0,10	4	3,9	0,06	~1,6	~1,5	0,29
3. SUCHÝ A MALÁ MAGURA													
Granites to aplite.-pegmatite. gr.	4	15,5	14,3	—	199	152	—	6,1	5,3	—	3,1	3,1	—
4. ŽIAR													
Granodiorites to granite	3	15,3	15	—	937	931	—	4	3,9	—	~2,5	~2,5	—
5. TRIBEČ													
Quartz diorites to granodiorites	3	13,7	13	—	793	789	—	<3	<3	—			
Leucocratic granitoids	4	19,6	19	—	832	825	—	<3—3		—	<3	<3	—
6. MALÁ FATRA													
Granodiorites	10	3—19			1143	1000	0,78	<3—4		—	11,3	10	0,65
Granites	2	11	10,9	—	600	572	—	<3	<3	—	<3	<3	—
Pegmatites	2	19	16,7	—	1845	1842	—	<3	<3	—	<3	<3	—

Continuation to Tab. 3

Type of rock	n	B			Ba			Be			Co		
		a_p	g_p	Sr_λ	a_p	g_p	Sr_λ	a_p	g_p	Sr_λ	a_p	g_p	Sr_λ
7. VEĽKÁ FATRA													
Biotite. granodior.	3	11,6	10,5	—	700	634	—	<3	<3	—	6,3	6,1	—
8. HIGH TATRA													
Granodiorites	12	12,6	11	0,71	770	698	0,59	<3	<3	—	3,3	3,3	0,13
Autometamorph. gr.	3	11	10,6	—	633	616	—	3	3	—	<3	<3	—
Aplite.-pegmatite. gr.	2	10	10	—	41	34	—	<3	<3	—	<3	<3	—
9. LOW TATRA													
Gr. of Kralička type	3	28,5	27,4	—	582	565	—	3,7	3,7	—	<3 —	3,2	—
Granodior. Ďumbier type	7	10,4	7,8	1,12	632	484	0,97	3,2	3,2	0,06	4,7	4,6	0,92
Autometamorph. gr. Prašivá type	7	20,5	17	1,01	914	820	0,67	4,2	4	0,36	<3	7	—
Leucocrat. gr.	4	20,7	18,5	—	477	472	—	<3	<3	—	<3	<3	—
10. BRANISKO													
Aplite.-pegmatite. gr.	2	16,3	16	—	420	417	—	<3	<3	—	<3	<3	—
11. ČIERNA HORA													
Granodiorites	5	10	9,8	0,28	1215	1111	0,61	<3	<3	—	6,3	6,1	0,36
12. VEPOR CRYSTALLINE													
Granodior. of Sihla type	7	8,5	8	0,48	1414	1404	0,12	<3	<3	—	7,1	6,8	0,43
Granodior. and gr. Hrončok, Vepor. type	17	17,6	16,7	0,40	840	754	0,64	6	5	0,72	3,1	2,9	0,45
Leucocrat. gr.	6	<3 —	10	—	773	735	0,39	<3 —	3,5	—	<3 —	10	—
13. SPIŠSKO-GEMERSKÉ RUDOHORIE													
Gemeride granitoids	14	388	193	2,59	153	113	1,24	7	6,5	0,55	<3	<3	—

Table 4. The average contents of Cr, Cu, Ni and Pb (in $g.t^{-1}$) in granitoid rocks of the West Carpathians. *Explanations:* 1_{Pb} — Pb was determined in granitoid rocks of the Malé Karpaty and Malá Fatra only. The others as in Tab. 3.

Type of rock	n	Cr			Cu			Ni			Pb[1]		
		a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
1. MALÉ KARPATY													
BRATISLAVA MASSIF													
Muscovite.-biotite. gr. to granodiorites	40	12,8	9,9	1,00	6,9	6	0,67	4,7	4,4	0,46	18	16,6	0,48
Aplitites, pegmat. and aplit.-pegm. gr.	20	<3	— 19	—	<3	—7,1	—	<3	— 6	—	28,4	25,5	0,60
Biotite.-amphibole, quartz diorites	3	18,6	16,5	—	14,1	12,5	—	5,3	5,1	—	16,6	16,5	—
Biotite-amphibole. diorites	7	142	50	3,22	27,4	16,5	1,74	34,8	16,3	2,43	20	18,6	0,46
MODRA MASSIF													
Biotitic granodiorites	20	17,6	14,7	0,77	7,4	6,6	0,66	6,9	6,6	0,41	14	13	0,52
Autometamorphosed granitoids	4	30	24,3	—	8,3	7,8	—	4	3,9	—	—	—	—
Metasomatic granites	12	30,2	25,2	0,88	8,7	7,9	0,56	5	4,6	0,60	—	—	—
Biotite.-amphibole. quartz diorites	4	33,9	33,2	—	26,5	25,9	—	9,3	8,1	—	25,3	23,4	—
2 POVAŽSKÝ INOVEC													
Biotite. gr. to granodiorites	5	<3	<3	—	<3	<3	—	3,4	3,4	0,15	—	—	—
3. SUCHÝ AND MALÁ MAGURA													
Granites to aplit.-pegmat. gr.	4	5,7	5,6	—	6,4	5,9	—	4	3,9	—	—	—	—
4. ŽIAR													
Granodiorites to granites	3	3,7	3,7	—	<3	<3	—	3,6	3,5	—	—	—	—
5. TRIBEČ													
Quartz diorites to granodiorites	3	24,3	21,9	—	21,3	15,9	—	9,9	9,8	—	—	—	—
Lecocratic granitoids	4	6,9	6,7	—	7,6	7,6	—	<3	<3	—	—	—	—
6. MALÁ FATRA													
Granodiorites	10	22,6	18,5	0,86	7,3	5,1	1,42	11	9,2	1,00	20,3	19,6	0,31
Granites	2	24,4	24,3	—	6,6	6,6	—	3,8	3,8	—	—	—	—
Pegmatites	2	<3	<3	—	3,5	3,5	—	<3	<3	—	55	53	—

Continuation of Tab. 4

Type of rock	n	Cr			Cu			Ni			Pb[1]		
		a_p	g_p	Sr_λ	a_p	g_p	Sr_λ	a_p	g_p	Sr_λ	a_p	g_p	Sr_λ
7. VEĽKÁ FATRA													
Biotite granodiarites	3	10,4	7,7	—	13,5	12,8	—	7	7	—	—	—	—
8. HIGH TATRA													
Granodiorites	12	12,4	11,6	0,43	6	5,4	0,64	3	2,7	0,52	—	—	—
Autometamorphosed granites	3	9,7	9,6	—	6	5,9	—	4,3	3,9	—	—	—	—
Aplite-pegmatite granites	2	<3	<3	—	<3	<3	—	<3	<3	—	—	—	—
9. LOW TATRA													
Granites of Kralička type	3	4,5	4,4	—	5,8	5,5	—	<3	<3	—	—	—	—
Granodiorites of Ďumbier type	7	29,9	29,2	0,26	8,3	6,9	0,90	8,7	8,7	0,24	—	—	—
Autometamorph. gr. of Prašivá type	7	17	16,8	0,13	5,5	4,7	0,86	4,9	4,8	0,40	—	—	—
Leucocratic granites	4	<3 — 5,2		—	6,9	5,7	—	<3	<3	—	—	—	—
10. BRANISKO													
Aplite-pegmatite granites	2	<3	<3	—	4,4	4,4	—	<3	<3	—	—	—	—
11. ČIERNA HORA													
Granodiorites	5	24,1	23,4	0,29	9,5	8	1,00	6,9	6,3	0,64	—	—	—
12. VEPOR CRYSTALLINE													
Granodiorites of Sihla type	7	21,3	20,8	0,25	6,3	6,1	0,36	8	7,7	0,31	—	—	—
Granodior. and gr. of Hrončok and Vepor types	17	10,5	8,1	1,18	6,1	5,4	0,67	4,9	4,7	0,24	—	—	—
Leucocratic granites	6	24	22,3	0,49	5,1	4,8	0,48	<3 — 5		—	—	—	—
13. SPIŠSKO-GEMERSKÉ RUDOHORIE													
Gemeride granitoids	14	<3 — 18		—	5	4,5	0,59	<3 — 8,3		—	—	—	—

Table 5. Average contents of, Sc, Sn and Sr (in $g.t^{-1}$) in granitoid rocks of the West Carpathians. Explanations as in Tab. 3

Type of rock	n	Sc			Sn			Sr		
		a_p	g_p	Sr_λ	a_p	g_p	Sr_λ	a_p	g_p	Sr_λ
1. MALÉ KARPATY										
BRATISLAVA MASSIF										
Muscovite.-biotite. gr to granodiorites	40	7	5,9	0,69	4,9	4,2	0,66	255	237	0,55
Apites, pegmat. and aplite.-pegm. gr.	20	<3 —	4,6	—	7,9	6,6	0,91	104	61	2,16
Biotite.-amphibole quartz diorites	3	26,4	25,7	—	4,8	4,6	—	1347	1291	—
Biotite granodiorites	7	41,6	35,4	,76	5,5	5,1	0,61	1088	859	0,99
MODRA MASSIF										
Biotitic granodiorites	20	7,7	7,6	0,22	<3 —	5	—	876	843	0,31
Autometamorphosed granitoids	4	4,9	4,7	—	7,9	6,6	—	452	445	—
Metasomatic granites	12	4,9	4,4	0,53	11,9	11,6	0,22	462	398	0,86
Biotite.-amphibole. quartz diorites	4	15,7	12	—	4,3	4,2	—	1572	1477	—
2 POVAŽSKÝ INOVEC										
Biotite. gr. to granodiorites	5	4	3,9	0,15	3,5	3,4	0,24	131	112	0,93
3. SUCHÝ AND MALÁ MAGURA										
Granites to aplite.-pegmatite. gr.	3	3,3	3,3	—	14,4	13,1	—	197	186	—
4. ŽIAR										
Granodiorites to granites	3	6,2	6,2	—	<3	<3	—	1160	556	—
5. TRIBEČ										
Quartz diorites to granodiorites	3	14,3	14	—	7,7	7,4	—	700	699	—
Leucocrate granitoids	4	<3 —	3	—	6,9	6,4	—	193	187	—
6. MALÁ FATRA										
Granodiorites	10	10	9,7	0,29	<3 —	12	—	475	447	0,50
Granites	2	3,9	3,9	—	<3	<3	—	460	459	—
Pegmatites	2	<3	<3	—	<3	<3	—	230	227	—

Continuation of Tab. 5

Type of rock	n	Sc			Sn			Sr		
		a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
7. VEĽKÁ FATRA										
Biotite granodiorites	3	9,3	8,8	—	10,4	9,8	—	518	518	—
8. HIGH TATRA										
Granodiorites	12	4,6	4,5	0,32	8,4	7,8	0,52	545	541	0,12
Autometamorphosed granites	3	3,9	3,9	—	<3	<3	—	440	440	—
Aplite-pegmatite granites	2	<3	<3	—	<3	<3	—	38	34	—
9. LOW TATRA										
Granites of Kralička type	3	3,7	3,7	—	7,3	7,3	—	437	432	—
Granodiorites of Ďumbier type	7	6,8	6,6	0,28	9,8	9	0,57	355	308	0,84
Autometamorph. gr. of Prašivá type	7	4,5	4,3	0,30	8,9	7,1	1,12	392	386	0,21
Leucocratic granites	4	<3 —	3,6	—	7,9	6,7	—	161	146	—
10. BRANISKO										
Aplite-pegmatite granites	2	<3	<3	—	<3	<3	—	295	295	—
11. ČIERNA HORA										
Granodiorites	5	8,5	8	0,50	8,9	8,5	0,41	570	546	0,38
12. VEPOR CRYSTALLINE										
Granodiorites of Sihla type	7	8	7,3	0,60	9,5	8,9	0,49	585	578	0,17
Granodior. and gr. of Hrončok and Vepor types	17	5,7	5,2	0,53	8	6,7	0,75	219	150	1,81
Leucocratic granites	6	7	6,1	0,70	<3 —	7	—	286	276	0,34
13. SPIŠSKO-GEMERSKÉ RUDOHORIE										
Gemeride granitoids	14	<3 —	5,6	—	33,3	26,6	0,96	113	50	2,57

Table 6. Average contents of V, Y and Zr (in $g.t^{-1}$) in granitoid rocks of the West Carpathians. Explanations as in Tab. 3.

Type of rock	n	V			Y			Zr		
		ap	gp	Srλ	ap	gp	Srλ	ap	gp	Srλ
1. LITTLE CARPATHIANS										
BRATISLAVA MASSIF										
Muscovite-biotite gr. to granodiorites	40	17,9	15,6	0,75	16,3	16	0,43	154	142	0,53
Aplites, pegmat. and aplite-pegm. gr.	20	< 3 —	4,6	—	< 3 —	13	—	< 10 —	50	—
Biotite-amphibole quartz diorites	3	200	199	—	30	29,7	—	130	126	—
Biotite-amphibole quartz diorites	7	192	153	0,96	28,7	26,8	0,45	142	129	0,53
MODRA MASSIF										
Biotitic granodiorites	20	53	52	0,23	25	22	0,71	200	195	0,24
Autometamorphosed granitoids	4	62	59	—	12,2	11,9	—	155	154	—
Metasomatic granites	12	40	27	1,99	19,4	18,2	0,44	97	87	0,65
Biotit.-amphibol. quartz diorites	4	184	182	—	19,5	18,4	—	99	98	—
2 POVAŽSKÝ INOVEC										
Biotit. gr. to granodiorites	5	8	6,4	1,16	26,2	25,8	0,17	101	97	0,34
3. SUCHÝ AND MALÁ MAGURA										
Granites to aplite-pegmat. gr.	3	4,5	4,3	—	9,5	7,2	—	37,8	36	—
4. ŽIAR										
Granodiorites to granites	3	27	27	—	25,4	25	—	160	155	—
5. TRIBEČ										
Quartz diorites to granodiorites	3	103	103	—	49,6	47,8	—	244	243	—
Leucocrate granitoids	4	17,6	17	—	7,7	6,8	—	87	87	—
6. MALÁ FATRA										
Granodiorites	10	64	60	0,39	15	14	0,48	186	179	0,32
Granites	2	27	27	—	10	10	—	115	114	—
Pegmatites	2	24	18	—	< 3	< 3	—	74	47	—

Continuation to Tab. 6

Type of rock	n	V			Y			Zr		
		a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
7. VEĽKÁ FATRA										
Biotite granodiarite	3	71	66	—	9,8	9,8	—	228	227	—
8. HIGH TATRA										
Granodiorites	12	36,6	36	0,26	14,6	13,6	0,47	160	157	0,20
Autometamorphosed granites	3	20,2	20	—	10	9,8	—	74	73	—
Aplite.-pegmatite granites	2	4	3,9	—	<3	<3	—	<10	<10	—
9. LOW TATRA										
Granites of Kralička type	3	<3	<3	—	36,3	35,8	—	33	30	—
Granodiorites of Ďumbier type	7	53	52	0,23	46	23,2	2,41	135	126	0,47
Autometamorph. gr. of Prašivá type	7	41	34	1,00	9,2	8,4	0,59	126	110	0,91
Leucocratic granites	4	4	4	—	8,2	7,3	—	31	21	—
10. BRANISKO										
Aplite.-pegmatite granites	2	3,7	3,7	—	4	4	—	60	59	—
11. ČIERNA HORA										
Granodiorites	5	81	78	0,38	19,5	16	1,08	232	218	0,48
12. VEPOR CRYSTALLINE										
Granodiorites of Sihla type	7	80	78	0,26	28,4	21	1,42	225	223	0,12
Granodior. and gr. of Hrončok and Vepor types	17	19,6	15	1,39	27,5	18,8	1,62	168	151	0,80
Leucocratic granites	6	27	18	1,58	7,5	6,3	0,37	138	126	0,54
13. SPIŠSKO-GEMERSKÉ RUDOHORIE										
Gemeride granitoids	14	<3 — 14,5		—	36,8	32,5	0,61	65	57	0,69

Table 7. Average content of trace elements (in $g.t^{-1}$) in individual types of granitoid rocks of the West Carpathians.

Element	Diorites (n=7)			Quartz diorites (n=10)			Granodiorites (n=67)			Granites (n=67)		
	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
B	11,1	9,9	0,61	14,5	14,1	0,27	10,1	9,2	0,38	14,2	13,3	0,43
Ba	1117	884	0,98	1867	1608	0,72	908	832	0,52	533	475	0,61
Be	<3	<3	—	<3	<3	—	<3	<3	—	3,9	3,7	0,39
Co	22,8	18,9	0,84	16,5	14,9	0,57	5,2	5	0,31	<3	<3	—
Cr	142	50,4	3,22	26,9	23,6	0,67	14,9	13,7	0,52	11,4	10,2	0,60
Cu	27,4	16,5	1,74	8,3	7,5	0,57	6,6	5,7	0,74	4,8	4,5	0,41
Ni	34,8	16,3	2,43	22	18	0,88	6,4	6	0,43	4,1	4	0,23
Sc	41,6	35,4	0,76	18,5	15,8	0,75	7,5	7,2	0,34	4,5	4,3	0,32
Sn	5,7	5,1	0,61	5,2	5	0,41	4,9	4,5	0,49	5	4,5	0,58
Sr	1088	859	0,99	1243	1133	0,54	577	525	0,54	231	202	0,68
V	192	153	0,96	165	158	0,34	55	53,2	0,28	12,6	11,1	0,65
Y	28,7	26,8	0,45	32	28,3	0,64	20,2	17,3	0,74	15,6	14	0,59
Zr	142	129	0,55	152	139	0,53	187	182	0,26	104	97,3	0,43
Pb[1]	20	18,6	0,46	21,6	20,1	0,46	16,9	15,9	0,41	17,9	16,6	0,48

Element	Autometamorphosed gr. (n=14)			Leucocratic granites (n=8)			Aplites, pegamatites, aplitepegmat. gr (n=27)			Gemeride gr. (n=14)			Metasomatic gr. (n=12)		
	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$	a_p	g_p	$s_{r\lambda}$
B	21	18,6	0,64	20,2	18,7	0,47	13,6	13	0,35	437	193	2,59	17,9	14,6	0,89
Ba	780	721	0,48	673	659	0,23	305	260	076	157	113	1,24	1555	1261	0,91
Be	<3	<3	—	<3	<3	—	<3	<3	—	7,1	6,5	0,54	<3	<3	—
Co	<3	<3	—	<3	<3	—	<3	<3	—	<3	<3	—	<3	<3	—
Cr	16,6	15,8	0,38	8	7,6	0,37	<3	<3	—	<3	<3	—	30,8	25,2	0,88
Cu	6,6	6	0,53	6,4	5,9	0,48	<3	<3	—	5	4,5	0,59	8,7	7,9	0,56
Ni	4,5	4,2	0,47	<3	<3	—	<3	<3	—	<3	<3	—	5,1	4,6	0,60
Sc	4,3	4,3	0,25	<3	<3	—	<3	<3	—	<3	<3	—	4,8	4,4	0,53
Sn	5,4	4,1	1,08	5,1	4	1,00	<3	<3	—	33,4	26,6	0,96	11,8	11,6	0,22
Sr	428	423	0,16	208	195	0,44	124	109	0,67	112	50	0,57	482	398	0,86
V	36,5	34,1	0,44	12	10,7	0,61	5,2	4,5	0,70	<3	<3	—	49,2	27	1,99
Y	10,4	9,9	0,38	7,6	6,8	0,59	<3	<3	—	36,4	32,5	0,61	19,5	18,2	0,44
Zr	111	107	0,33	73,3	61,2	0,82	19,6	16,2	0,85	65	57	0,69	98,6	87	0,65
Pb[1]	—	—	—	—	—	—	39,9	36,8	0,50	—	—	—	—	—	—

permitted, calculated from logarithms of concentration values. The above mentioned statistical data were also calculated in groups with smaller number of samples and therefore these are of informative character only. When in some group of samples the content of the established element was below

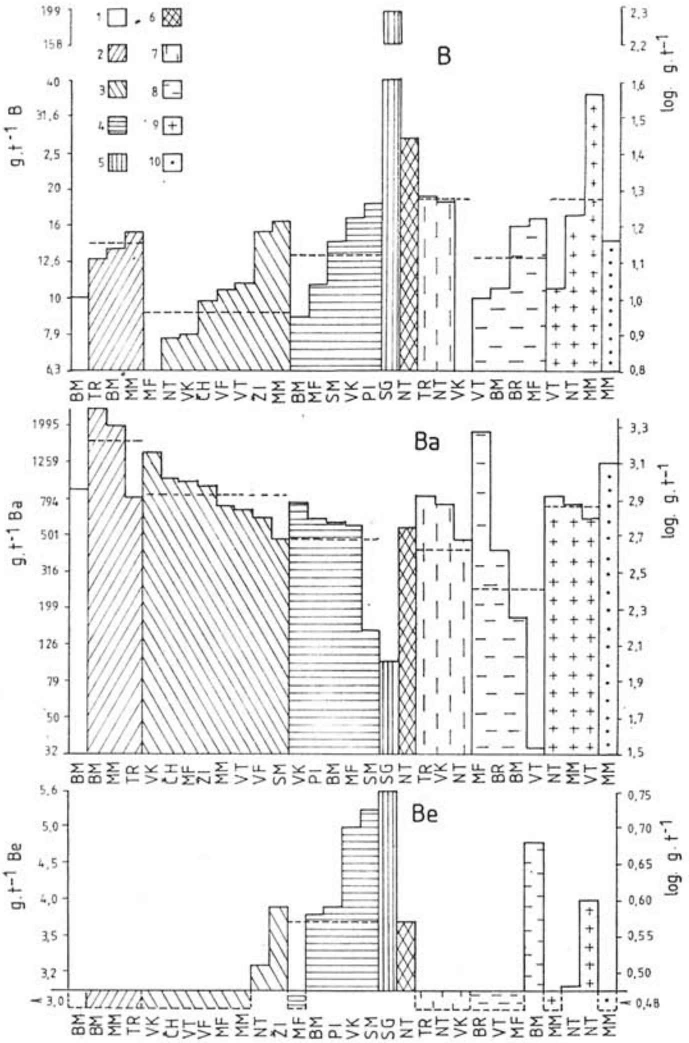


Fig. 1. Representation of B, Ba and Be in studied types of the West Carpathian granitoids. *Explanations:* 1 — diorites; 2 — quartz diorites; 3 — granodiorites; 4 — granites; 5 — Gemeride granites; 6 — granites of Kralička type; 7 — leucocratic granitoids; 8 — pegmatites to aplite-pegmatite granites; 9 — autometamorphosed granitoids; 10 — metasomatic granitoids; BM — Bratislava massif; MM — Modra massif; PI — Považský Inovec; SM — Suchý and Malá Magura; ŽI — Žiar; TR — Tribeč; MF — Malá Fatra; VF — Veľká Fatra; VT — High Tatra; NT — Low Tatra; BR — Branisko; ČH — Čierna hora; VK — Vepor crystalline; SG — Spišsko-gemerské rudohorie.

detection limit, the mentioned value of the range of contents is „less than the detection limit and the maximum content value of element". The microelement contents are also evaluated graphically (Figs. 1—5). In statistical calculations (of geometric mean, relative standard deviation of geometric mean) it was set out from the works by L. H. Ahrens (1954), S. Ďurovič (1959), E. Plško (1973), B. Cambel — L. Kamenický — J. Medveď (1979) and others.

Tab. 7. is compiled so as to make possible to compare, whether some elements are increasing or decreasing with basicity or rock (with its degree of differentiation) and how they behave in processes of autometomorphism or metasomatism. On the basis of data in Tab. 7 it may be stated that trace elements Ba, Co, Cr, (Cu), Ni, Sc, (Sr), V, (Y) and Zr are bound to more basic types (diorites, quartz diorites to biotite granodiorites). Their contents usually decrease (except Cu, Sr and Y) toward acid types (granites, leucocratic granites, autometamorphosed granites, aplites + pegmatites + aplite pegmatite granites and Gemeride granites), in some cases (e.g. at V, Sc, Ni and Co) very distinctly. To the contrary, B, Be, Sn and Pb increase in reverse order, i.e. in acid granite types. A certain exception is formed by autometamorphosed granitoids or metasomatic types of the Malé Karpaty, which are closer to more basic types of granitoids in contents of trace elements and enriched in some metals, the bearers of which are supercritical or hydrothermal solutions (Cu, Sn, Ni, Ba, Cr). This geochemical feature can be a diagnostic mark confirming autometamorphic and/or metasomatic processes affecting the terminal development of rocks.

To the contrary of other West Carpathian granitoid rocks, the highest concentrations of elements typical of acid magmas (B, Be, Sn) are characteristic of Alpine Gemeride granites, which, however, have also the lowest Ba and Sr contents. The statement that Variscan or Caledonian—Variscan grantoids have no typical metal-bearing features, as shown in the low content of B, Be, Sn, F and in the high contents of Ba and Sr, was achieved already earlier (L. V. Tauson — B. Cambel — V. D. Kozlov — L. Kamenický, 1974, 1977; V. Kátlovský — L. Kamenický — R. Marschalko — J. Medveď, 1974).

In general, the lowest microelement contents were established in aplites, pegmatites and aplite-pegmatite granites, with the exception of Pb, concentrations of which are highest in part of these rocks. An exception is Ba in pegmatites of the Malá Fatra, with a very high content (1842 $g.t^{-1}$) in contrast to aplites, pegmatites and aplite-pegmatite granites of the Bratislava massif, High Tatra and Branisko, (contents of which are varying from 41 to 420 $g.t^{-1}$). It is necessary to remark, however, that pegmatites of the Malá Fatra are rich in potassium feldspars, and in these pegmatitoid granitoids hydrothermal deposits of barite of vein character occur.

With autometamorphic processes (potassium metasomatism) Ba contents usually increase in affected granitoid rocks. As an example the higher Ba content (820 $g.t^{-1}$) in granites analogous to the Prašivá type in contrast to Ba content (484 $g.t^{-1}$) in Ďumbier type granodiorite may be mentioned. In autometamorphic or metasomatic processes, in the Modra massif or Považský Inovec Mts., the affected rocks are distinctly enriched in Ba, what is probably connected with observed increase in potassium near the contact of granitoids

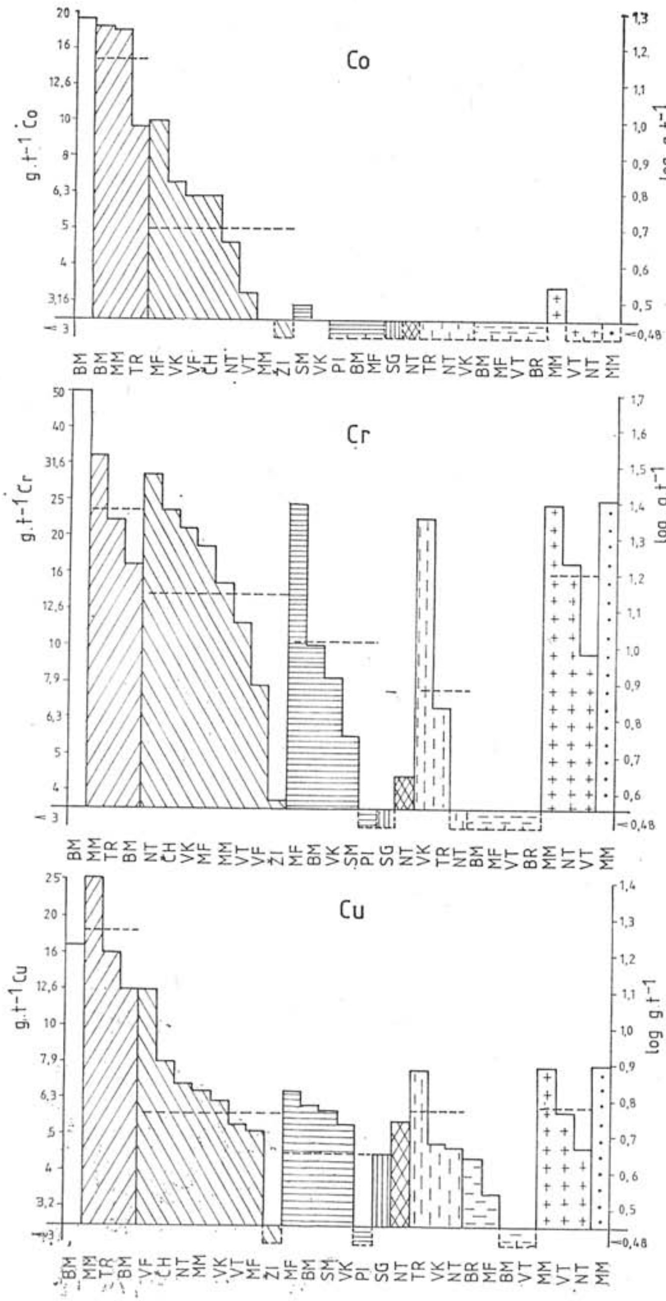


Fig. 2. Representation of Co, Cr and Cu in studied types of the West Carpathian granitoids. Explanations as in Fig. 1.

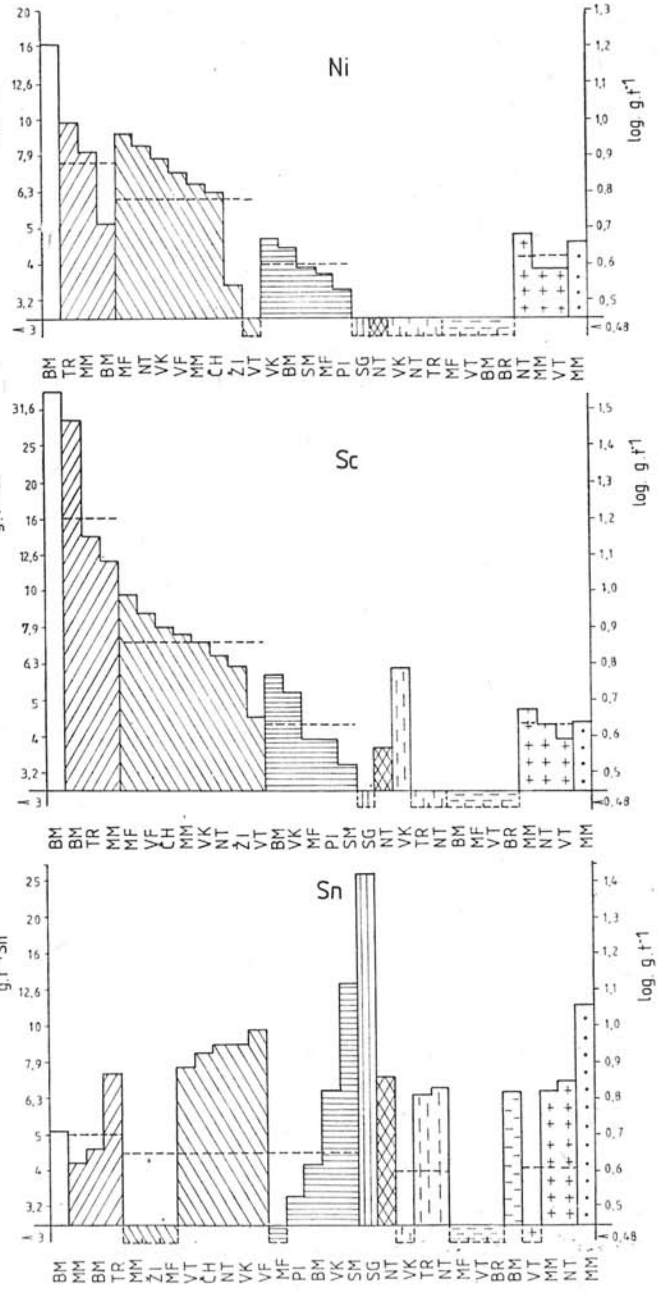


Fig. 3. Representation of Ni, Sc and Sn in studied types of West Carpathian granitoids. Explanations as in Fig. 1.

with surrounding rocks of the schistose crystalline. Between metasomatic granitoid rocks of the Modra massif and Považský Inovec Mts. are, however, differences in contents of some trace elements, due to the different character of metasomatic processes.

Some elements as e.g. Sn, B, Be, Zr, Cr, V, although showing the observed trend to decrease or increase their contents in dependence on basicity or acidity of magma, display considerable variation of contents in the indi-

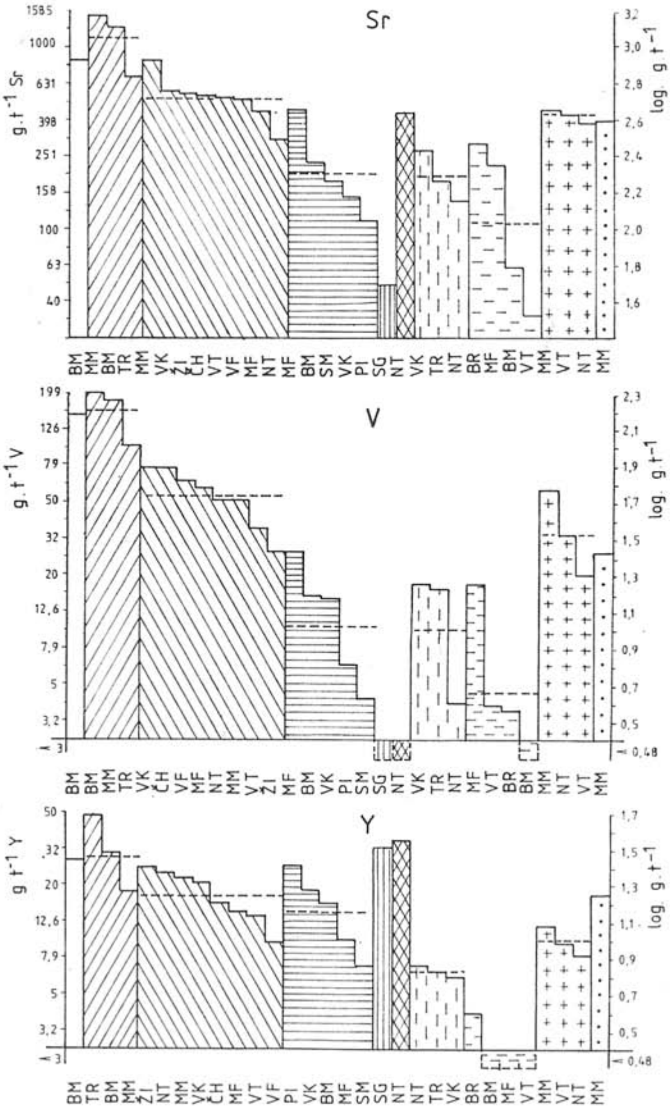


Fig. 4. Representation of Sr, V and Y in studied types of West Carpathian granitoids. Explanations as in Fig. 1.

vidual mountain ranges, also within the same type of rock. Greatest variations, as natural, are in acid differentiates in autometamorphic types of pegmatite-aplitoid granitoids, pegmatites and aplites. So e.g. in the type of leucogranite, according to mountain ranges the variations in contents are as follows: Sn in VK (Vepor crystalline) = <3 in NT (Low Tatra) = 7; Cr in VK = 20 in NT = <3; Zr in VK = 140 in NT = 25; V in VK = 20, NT = 4; B in VK = <3 in NT = 20 (mentioned in $g.t^{-1}$). Attention should be called to the fact, as particularity, that e.g. Be, which is little represented

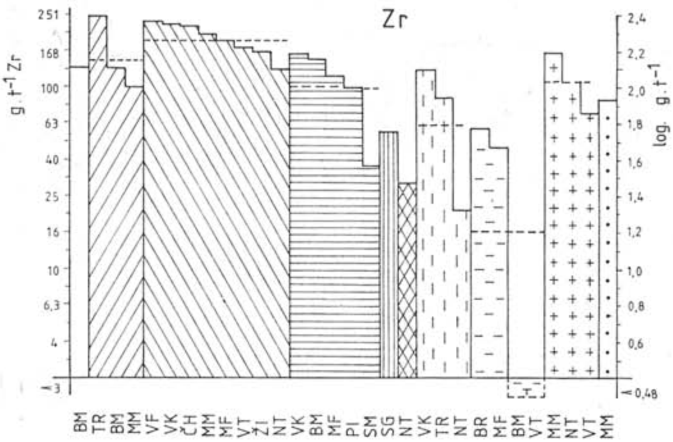


Fig. 5. Representation of Zr in studied types of West Carpathian granitoids. Explanations as in Fig. 1.

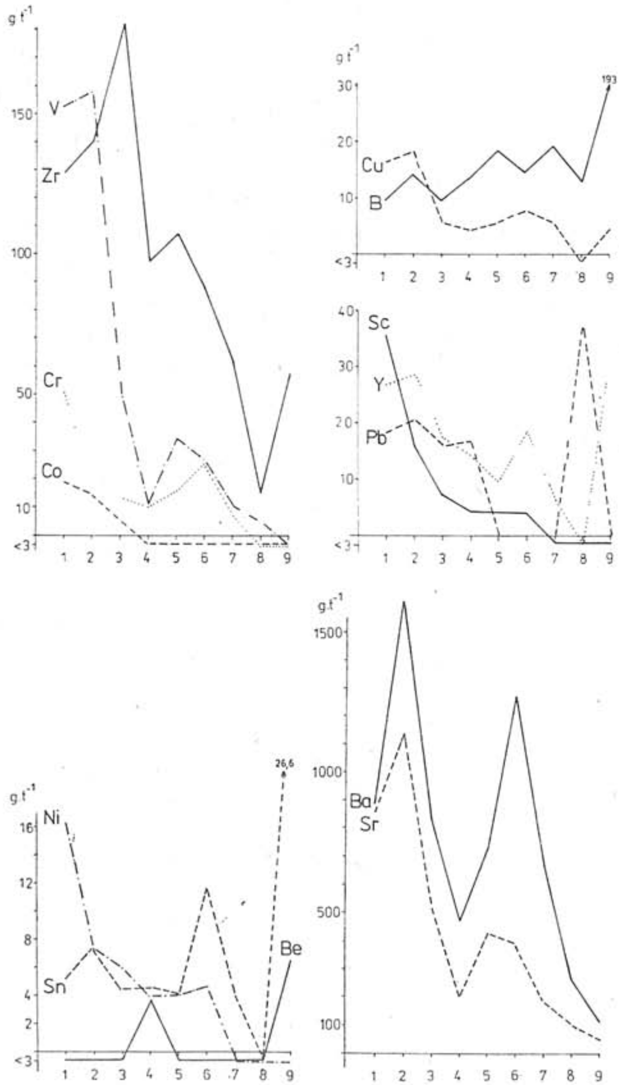
in Variscan granitoid rocks of the West Carpathians (mostly <3), being also unexpected for their acid differentiates, aplites and pegmatites, which have little Be. Only aplitoid rocks and pegmatites of the Bratislava massif have more of it. On the other hand, beryllium is an element indicative for autmoetamorphic alterations or for the last crystallizing stages of magma differentiation, also for two-mica granitoids of the West Carpathians, including the Králička type of rock.

In the frame of the studied group of samples of quartz diorites, granodiorites and granites of the West Carpathians, on the basis of microelement contents (Co, Ni, Sc, V but also B, Be and Sn) it is possible to distinguish the following groups with types of gradually sinking basicity:

a) Group of quartz diorites (4th group according to international classification), the representative of which are biotite quartz diorites (tonalites) of Tríbeč type with content of amphibole. From the observed granitoid rocks Co, Cr, Cu, Ni, Sc, Sr, V, Y and Zr display highest concentrations (see Tab. 7).

b) In the group of basic (biotite granodiorites) (3-rd group of international classification), to which the Sihla, Ďumbier and Modra types may be ranged, the contents of microelements Co, Ni, Sc and V are distinctly lower in contrast to the preceding group.

c) The group of two-mica granodiorites to granites (2nd group of international classification) is characterized by most lowered contents of trace elements Co, Ni, Sc, V and higher contents of B, Be, Sn. This group may include rocks belonging to the Prašivá, Vepor and Hrončok types as well as a large part of granitoids of the Bratislava massif and of Kralička type.



Figs. 6, 7. Comparing graph of geometric means of trace element contents in West Carpathian granitoids. Various types of granitoid rocks are ranged according to their increasing acidity. Values taken over from Tab. 7 (in g.t^{-1}). *Explanations:* 1 — diorites; 2 — quartz diorites; 3 — granodiorites; 4 — granites; 5 — autometamorphic granitoids; 6 — metasomatic granitoids; 7 — leucocratic granitoids; 8 — aplites-pegmatites; 9 — Gemeride granites.

d) The group of leucocratic granitoids (group 1 of international classification) and aplites and pegmatites is characterized by relatively greater differences in microelement contents in these rocks in the individual mountain ranges. The group has low contents of B, Be, Sn, Y and rare earths, very low contents of Co, Ni, Sc, V and relatively low contents of Ba and Sr.

It should be remarked that groups a, b, c, d have high and gradually sinking B and Sr contents to the cotrary to Gemeride granitoids.

e) The group of Gemeride granitoids is essentially different from the preceding groups of West Carpathian Variscan granitoids according to the content of trace elements. It is characterized by a high content of B, Be and Sn, low content of Co, Ni, Sc, and V (the contents are below the detection limit $g.t^{-1}$) as well as by low Ba and Sr content.

The variability of trace element contents expressed by standard deviations of concentration logarithm dispersion of elements is greatest from granitoid rocks in the Gemeride granites, then in leucocratic granites, metasomatic granitoids of the Modra massif, in diorites and quartz diorites. A less dispersion of trace element contents is observed in fundamental types of rocks building up massifs, in granodiorites, granites as well as in aplitoid and pegmatitoid granites or autometamorphosed granites, which, however, also represent an inseparable part of the fundamental types of West Carpathian granitoid rocks. Variation of microelements in various types of granitoid rocks is ranged according to their basicity, as follows from Figs. 6, 7.

Conclusions

In the presented work the contents of trace elements in 234 samples of granitoid rocks of the West Carpathians are statistically evaluated. For establishing of trace element contents the spectrochemical method was applied, the fundamental parameters of which are described in the work.

On the basis of the contents of trace elements B, Ba, Be, Co, Cr, Cu, Ni, Pb, Sc, Sn, Sr, V, Y and Zr characterization of the fundamental types of granitoid rocks of the individual mountain ranges of the West Carpathians was carried out. The content values of these elements are mentioned in Tables 3—7 and represented graphically in Figs. 1—5. These data make possible a wide parallelization of various rock types from various West Carpathian mountain ranges. This way the possibility is provided to utilize common but also different geochemical features for considerations of genetic competence of petrographically and geochemically different or approached types of rocks. The results confirm competence of Variscan granitoids to one formation of Variscan or Caledonian—Variscan granite plutonism. This plutonism is characterized by a high content of Ba, Sr and prevalence of Na over K, mainly when compared with Neoid Gemeride granites. As leucocratic Late Variscan (post-kinematic) rocks are not forming an association of rocks of various basicity (various range of differentiation) similarly as also syngenetic rocks of Králička type but only leucocratic types, we consider them as rocks types of a homogenous formation of Variscan or Caledonian—Variscan granitoids. They may be considered as Caledonian—Variscan only because there is the assumption that granitization processes probably commenced already to the end of the Silurian and in the Lower Devonian but a particular Caledonian orogene with an own intrusive phase of Caledonian granites has nowhere been proved).

Autometamorphosed and/or metasomatic types of granitoids are characterized by higher contents of these elements which are common for hydro-processes in their supercritical or hydrothermal action. Concerned is mainly the higher content of metallic elements Ni, Cr, Sn, Pb, Cu etc.

In the work is stated that variation of changes of trace element contents is taking place in dependence on basicity of rocks, also in the frame of individual fundamental types of granitoid rocks. It is evident from general comparison of trace element contents that with considerable geochemical homogeneity of granitoid magma of Variscan granitoids the greatest differences in contents are caused by various basicity of rocks, their degree of differentiation or degree of completeness of anatectic remelting or homogenization of palingene magma.

It is seen from the tables and graphical representation of trace element contents that their average contents display a relatively little variability of values. Only a part of aplitoid and pegmatitoid granitoids or diorites form the extreme limit of differences in contents of trace elements between the studied types of Variscan granitoids of the West Carpathians.

A distinctly different geochemical picture display only Gemeride granitoids forming a particular formation.

The work provides important bases for further geochemical and petrogenetic investigation of granitoid rocks of the West Carpathians.

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REFERENCES

AHRENS, L. H., 1954: The longnormal distribution of the elements. Geochim. Cosmochmi. Acta (Oxford), 5, p. 49—73, 6, p. 121—131.

CAMBEL, B. — BAGDASARJAN, G. P. — VESELSKÝ, J. — GUKASJAN, R. CH., 1979: Novyje dannyje opredelenija vozrasta porod Slovakii rubidij-stroncievym i kalij-argonovym metodom i vozmožnosti ich interpretacii. Geol. Zborn. Geol. Carpath., (Bratislava), 30, 1, p. 45—60.

CAMBEL, B. — KAMENICKÝ, L. — MEDVEĎ, J., 1979: Contents of some microelements in bisic metamorphites of the tatroveporides. Geol. Zbor. Geol. Carpath., (Bratislava), 30, 2, p. 131—156.

CAMBEL, B. — KAMENICKÝ, L. — KLOMÍNSKÝ, J. — PALIVCOVÁ, M., 1980: Petrochemical correlation of granitoids of the Bohemian Massif and the West Carpathians. Geol. Zbor. Geol. Carpath., (Bratislava), 31, 1—2, p. 3—26.

ĎUROVIČ, S., 1959: Contribution to the lognormal distribution of elements. Geochim. Cosmochim. Acta (Oxford), 15, p. 330—336.

FLANAGAN, F. J., 1969: U.S. Geological Survey standards — II. First compilation of data for the new U.S.G.S. rocks. Geochim. Cosmochim. Acta (Oxford), 33, p. 81—120.

FLANAGAN, F. J., 1973: 1972 values for international geochemical reference samples. Geochim. Cosmochim. Acta (Oxford), 37, p. 1189—1200.

HOVORKA, D., 1972: Katalóg chemických analýz eruptívnych a metmorfovaných hornín kryštalinika, paleozoika a mezozoika Západných Karpát Slovenska a ich minerálov. Náuka o Zemi. Vyd. Slov. akad. vied Bratislava, 217 p.

HOVORKA, D., 1979: Genéza variských magmatitov Západných Karpát. Geol. práce, Správy (Bratislava), 72, p. 141—148.

IGEM — MOSKVA, 1973: Sertifikat, Analitičeskij standard IGEM — 1002/1007, PIM-1

/peridotit, IGEM — 1004/1006, DIM-1 (diabaz), IGEM — 1003 (granodiorit „Ryžik"). Moskva.
KAMENICKÝ, L. — KÁTLOVSKÝ, V. — MARSCHALKO, R. — MEDVEĎ, J., 1974: Príspevok k charakteristike kyslých magmatitov exotických hornín bradlového pásma a iných tektonických jednotiek Západných Karpát. Mineralia Slovaca (Bratislava), 4, p. 311—321.
KANTOR, J. — RYBÁR, M., 1979: Radiometric age and polyphazic character of gemeride granites. Geol. Zborn. Geol. Carpath. (Bratislava), 30, 4, p. 433—447.
KOVACH, A. — SVINGER, E. — GRECULA, P., 1979: Nové údaje o veku gemeridných granitov. Mineralia Slovaca (Bratislava), 11, 1, p. 71—77.
MEDVEĎ, J., 1978: Analyticko-geochemické štúdium kremičitanových hornín Západných Karpát. Manuskript, archív Geologického ústavu SAV Bratislava, 309 p.
PLŠKO, E., 1969: Bedeutung der Vorkurve bei der Transformation der Schwärzung auf die Intensität der Spektrallinien. Chem. zvesti. (Bratislava), 23, p. 150—158.
PLŠKO, E., 1973: Színképelemzési módszerek statisztikus parametereinek meghatározása üzemi minták alapján. MTA, Kémisi közlemények (Budapest), 39, p. 351—361.
TAUSON, L. V. — CAMBEL, B. — KOZLOV, V. D. — KAMENICKÝ, L., 1974: Preliminary comparison of tin-bearing granites of the Eastern Transbaikalia, the Krušné hory (Bohemian massif) and Spiš-Gemer Ore Mts. (Western Carpathians). Geol. Zborn. Geol. Carpath. (Bratislava), 25, 1, p. 1—24.
TAUSON, L. V. — KOZLOV, V. D. — CAMBEL, B. — KAMENICKÝ, L., 1977: Geochimija i voprosy rudonosnosti olovonosnych gemeridnych granitov Slovakii. Geol. Zborn. Geol. Carpath. (Bratislava), 28, 2, p. 261—267.

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