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# FLUID REGIME OF TECTONIC STRUCTURES AS THE MAIN FACTOR OF GEOCHEMICAL AND METALLOGENETIC SPECIALIZATION OF GRANITOIDS

*(Figs. 3)*

Abstract: Notably varied rare alkaline elements contents in granitoids are defined by the regime of development of tectonic zones, where granitoids are formed, and do not depend on their petrochemical composition and formation type. The uniform geochemical specialization of polyformation granitoidal series is observed in tectonical structures with the stable regime of development.

Резюме: Значимо различные содержания редких щелочных металлов в гранитоидах обусловлены режимом развития тектонических зон, в которых формируются гранитоиды и не зависят от их петрохимического состава и формационной принадлежности. В тектонических структурах с устойчивым режимом развития отмечается сквозная геохимическая специализация полиформационных гранитоидных серий.

Investigation of rare alkaline elements distribution in granitoids revealed their significant differences even in similar petrographic varieties of rocks belonging to one and the same formation type.

Formation type is thought to be association of granitoids, steadily repeated in space and time (Кузнецов, 1973). Three types of such associations (formation types) are considered here: granodiorite-adamellitic, granitic and leucogranite-alaskitic.

Granodiorite-adamellitic association of granitoids belongs to sodium-potassium class of alkalinity and is presented by bipyroxene amphibole-biotite and garnet-biotite granodiorites, adamellites granites and leucocratic granites.

Granitic formation type is presented by association of granitoids similar to the above mentioned according to alkalinity class. It includes amphibole-biotite and biotite granodiorites, adamellites, granosyenites, granites, bimicaceous and leucocratic granites.

Leucogranite-alaskitic association of granitoids belongs to more potassium class of alkalinity and includes biotite granites, leucocratic biotite granites, alaskites and muscovite granites.

Saldyrma series of Eastern Kazakhstan is standard for granodiorite-adamellitic formation type; Kalba complex of Eastern Kazakhstan and Kaldyrma complex of Central Kazakhstan are standard for granitic formation type, Akchatau complex of Central Kazakhstan and Monastyri complex of Eastern Kazakhstan are standard for leucogranite-alaskitic formation type (Попов и др., 1975; Ермолов и др., 1977; Лопатников и др., 1982; Магматические комплексы . . ., 1983).

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The data on rare alkaline metals and potassium were generalized for 110 massifs of Late Riphean and Phanerozoic from a number of provinces of the USSR: Northern, Eastern, Central Kazakhstan, Southern Tian-Shan, Tuva, Urals, Sajan, Eastern Zabaikalje, Southern Pamir, Primorje, Gornyi Altai. For 95 of them original data were taken; and for 15 massifs — published data.

About 4000 determinations for K, Li, Rb, Cs were used in the study. Arithmetic mean contents of these elements were calculated for each massif according to four groups of main granitoidal varieties, which present main phases in massifs and completely reflect their geochemical peculiarity: 1) tonalites, granodiorites, adamellites; 2) granosyenites; 3) granites; 4) alaskites, leucocratic biotite granites. Subsequent comparison of average values for K, Li, Rb, Cs was done for varieties of granitoids similar in composition and belonging to one and the same formation, but with different structural position.

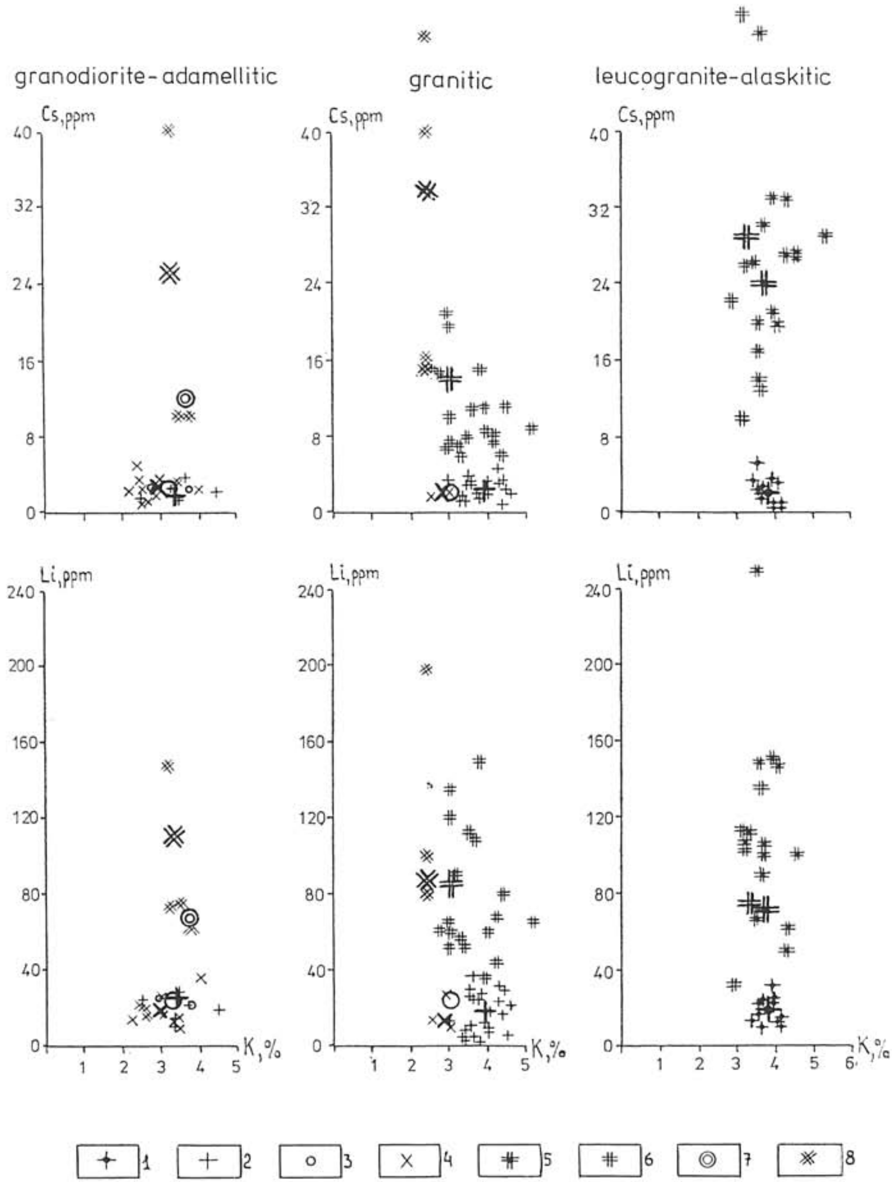
Tectonic position of granitoids results from their confining to the structures of the particular regime of development in period preceding granite generation. The experience in metallogenic investigations, indicating to the decisive importance of types of ore-bearing structures for generation of endogenic deposits varied in composition, necessitates consideration of tectonic regime in zones of granite formation (Херасков, 1958, 1963; Смирнов, 1961; Твалчрелидзе, 1960). Metallogenic investigations, carried out in our institute, established the predominant confinement of lithophile elements deposits to rather definite tectonic structures characterized by geoanticlinal type of development (Волочкович, 1960; Алтухов и др., 1968).

The author used the following main indications for typization of tectonic structures according to the character of their development: 1) predominant tendency of tectonic movements; 2) character and scale of preorogenic magmatism. This work considers granitoids from most contrast tectonic zones, selected according to these main features. One type includes zones of predominant subsidence with intensive and widely developed geosyncline magmatism, including ophiolitic one.

Eugeosyncline downwarps are most typical representatives of such structures. The other type includes tectonic zones developing in the regime of predominant upwarpings with weak magmatism in period preceding to orogenic granite development. These are structures like stable upwarps with clearly defined geoanticline character of development.

Thus, average values of K, Li, Rb, Cs in granitoids similar in composition, belonging to the same formation but different in structural-tectonic position were compared to reveal geochemical peculiarity of granitoid (Figs. 1, 2). Three groups of rocks were compared in granodiorite-adamellite formation type: 1) tonalites, granodiorites, adamellites; 2) granosyenites; 3) granites. Granites and granodiorites were compared in granite formation type. Granites and alaskites, leucocratic biotite granites, were compared in leucogranite-alaskite formation type. Average values of rare alkaline metals were plotted on diagrams of re-

Fig. 1. Distribution Cs, Li and K in the granitoids of the granodiorite-adamellitic, granitic and leucogranite-alaskitic formation types. Granitoids from tectonic zones, developing in the regime of predominant subsidence, accompanied with geosyncline magmatism.




*Explanations:* 1 — alaskites, leucocratic granites; 2 — granites; 3 — granosyenites; 4 — tonalites, granodiorites, adamellites. Granitoids from tectonic zones, amagmatic at the preorogenic stage, being developed in the regime of predominant upwarpings: 5 — alaskites, leucocratic granites; 6 — granites; 7 — granosyenites; 8 — tonalites, granodiorites, adamellites. Small symbols — average contents for massifs; large symbols — average contents for petrochemical types of granitoids belonging to a particular formational type and structural-tectonic position.

lationships between them and potassium. It is evident that similar varieties of granitoids have different rare alkaline metals concentrations in each formation type with similar contents of potassium. They form strongly isolated fields of points in Li—K, Cs—K, Rb—K coordinates. The same is observed for all varieties of granitoids in each formation type. Comparison of average values of K, Li, Rb and Cs contents in the same granitoids varieties belonging to the

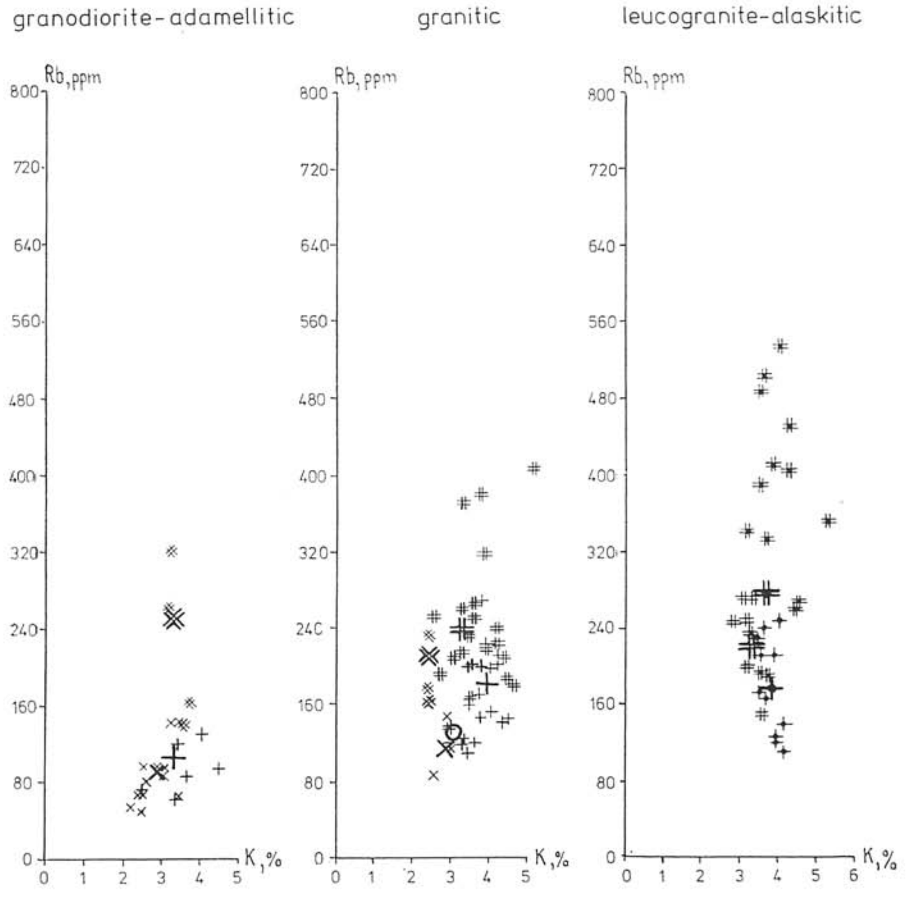



Fig. 2. Distribution Rb and K in the granitoids of the granodiorite-adamellitic, granitic and leucogranite-alaskitic types. Symbols see in Fig. 1.

analogous formations with, the help of non-parameter Wilcockson' criterion showed closeness for average potassium contents and significant differences for their trace element contents. Increased contents of rare alkaline elements were established in granitoids from tectonic zones which had been developing in regime of predominant upwarpings and magmatites being practically absent at the preorogenic stage. Granitoids with minimum content of these elements are spacially related to tectonic zones of predominant downwarpings and intensive geosyncline magmatism. The same varieties of granitoids, belonging to different formation types but generating in analogous tectonic zones yet similar in average contents of Li, Rb, Cs. The same similarity of average rare alkaline metals values is noted for granitoids different in composition but belonging to the same formation and having the same tectonic position. There are differences between them but little and insignificant in comparison with differences between groups.

Intergroup differences of granitoids are even more clearly determined when comparing relationships K/Cs and Rb/Cs. Fig. 3 shows that granitoids of both groups produce strongly isolated fields, which may be designated by limiting values of indicator relationships. Limiting values for granitoids of granite and leucogranite-alaskite formation types are similar and equal to 6000 for K/Cs and 40 for Rb/Cs independent on their petrochemical composition. Thus, the range of lower values of these ratios includes granitoids spatially confined to tectonic zones developing in regime of predominant upwarpings. Limiting values of indicator ratios are lower for granitoids of granodiorite-adamellite formation type being equal to 4000 and 18 correspondingly.

Thus, rare alkaline metals behave themselves as non-coherent elements, distribution of which is not correlated with change of main petrogenic components. This is especially distinct for Cs and Li.

This mode of distribution of rare alkaline metals points to geochemical specialization of not only individual massifs or even complexes of granitoids, but their polyformational series, generating in similar (according to regime of development) tectonic structures. This empirically defined regularity is best explained on the basis of hypothesis on double nature of granites. According to many investigatores (Коржинский, 1952, 1968, 1972; Кузнецов, 1964; Кузнецов — Изох, 1969) large volumes of granitoid magma in crust are generated by means of transformation and subsequent melting of crust substratum influenced by substance and energy supplied by rising granitized solutions. Origin of these solutions is associated with processes of substance differentiation in deep zones of the Earth's crust and mantle. Two types of endogenic solutions, participating in crust granite formation — crust and juvenile-crust ones — should be distinguished with different levels of concentration of rare metals, including alkaline metals.

Crust solutions, according to Лутц (1965) may be generated during eclogitization of rocks in the Earth's crust at the boundary with mantle. Eclogitization or basification reaction are no isochemical. They are accompanied with removal of lithophile elements, alkaline metals, with big ionic redii, first of all. Level of concentration of rare alkaline metals in such metamorphogenic deep-crust solutions should be conditioned by the average content in the crust, equal to: Li — 32 ppm, Rb — 150 ppm, Cs — 3.7 ppm (Виноградов, 1962). Granitoids appear to be formed in tectonic zones of predominant descending movements with participation of such solutions. Average values of lithium, rubidium and cesium in these granitoids are actually near to their clarke concentrations in the Earth's crust.

According to modern ideas, mantle is the source of juvenile solutions enriched with lithophile elements, including rare alkaline metals. As it follows from the investigation of alkaline elements distribution in rocks of upper mantle,

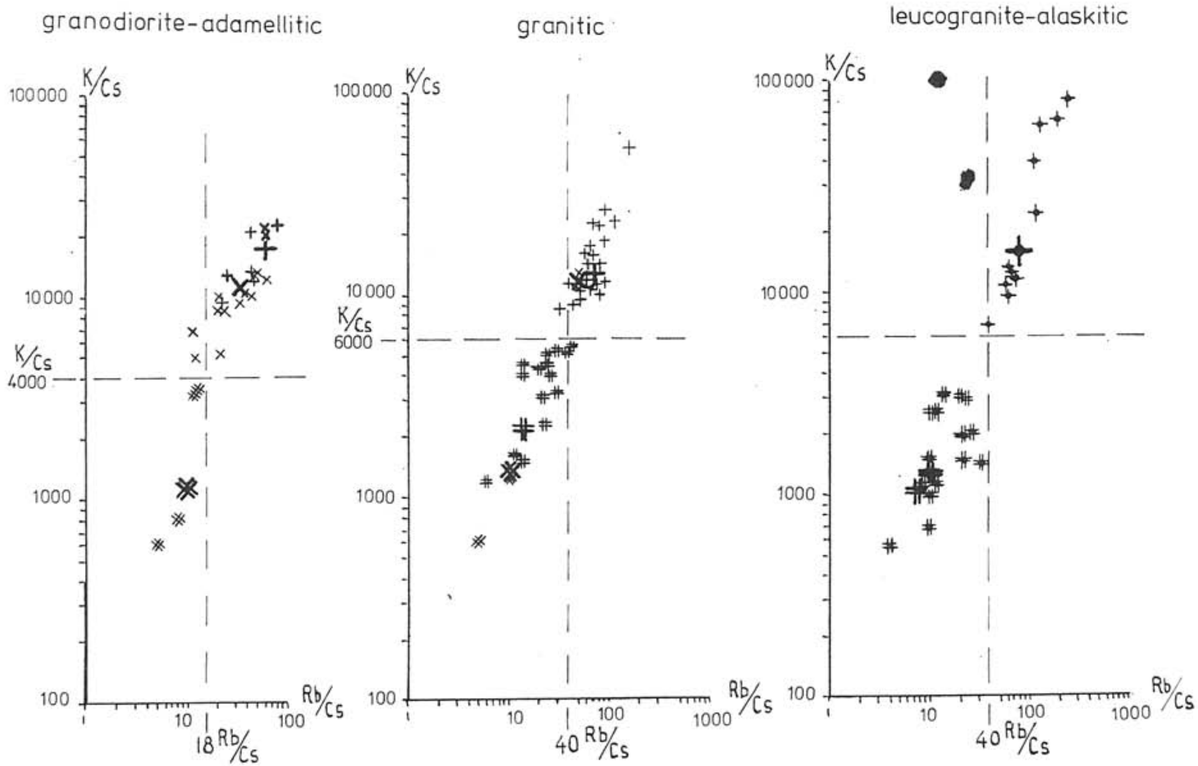



Fig. 3. Relationships K/Cs and Rb/Cs in the granitoids of the granodiorite-adamellitic, granitic and leucogranite-alaskitic formation types. Symbols see in Fig. 1.

content of all alkaline metals successively increases with depth (Gangadharam, 1969; Harris — Middlemost, 1971; Лутц, 1975; Лутц и др., 1977).

Concentration of rare alkalines in deepest mantle magmatic rocks such as kimberlites and potassium basalts is comparable with their content in granitoids from structures like stable upwarpings. This indicates that alkaline metals content in upper mantle is sufficient for generation of high alkaline mantle fluids.

Process of mantle acid leaching was suggested by Лутц (1975) as mechanism determining extraction of these elements from mantle substratum. This mechanism is determined by the following. Significance of reduced forms of all volatiles in gas-fluidal phase increases with depth increase in mantle. According to thermodynamic calculations (Маракушев — Перчук, 1972) and direct investigation of gaseous inclusion in mantle rocks (Лутц, 1975), their composition is hydrogen-methaneous and thus acidic. Such composition of mantle fluids should result in leaching of bases. According to the principle of acid-basic interrelation (Коржинский, 1959), elements with more basic properties, like alkaline metals, are most easily leached. Such juvenile solutions enriched with rare alkaline metals appear to be directly responsible for granitoid magmas generation with increased concentration of rare alkalines.

Thus, geochemical specialization of granitoids in respect to rare alkaline metals correlates with regime of tectonic structures development, which they are spatially associated with. As it takes place, there is through geochemical specializations determining geochemical peculiarity of individual massifs or even complexes of granitoids, but of their polyformational series. This indicates that each tectonic regime appears to be characterized by rather definite and stable fluidal regime, specifically by different degrees of rare metals concentration, including alkaline ones. So, deep granitizing solutions are not only initiators of crustal granite generation but they define the initial level of rare elements concentration in granitoid magma. This explains existence of two groups of granitoids and each of them is characterized by strongly distinguished values of rare alkaline metals depending on tectonic position of granitoids and independent on their composition and formational belonging.

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# VARISCAN GRANITOIDS OF THE WEST CARPATHIANS IN THE LIGHT OF GEOCHEMICAL—PETROCHEMICAL STUDY

*(Figs. 3)*

Abstract: In the paper West Carpathian granitoids are briefly characterized from the point of view of their geological occurrence, age relations and metamorphosis. Characteristics of main petrographical and geochemical features, macrochemical composition, trace elements behaviour, including REE and of some isotopic ratios is given. Some results of modelling a macrochemical composition (by means of mixing program GENMIX), as well as trace elements are presented on an example of the Malé Karpaty Mts. On the basis of these results, the authors present a view on differentiation of granitoid magma by Rayleigh crystal fractionation of mineral assemblage: bio + plg + Qz ± K-feldspar + + accessory minerals from parental magma of tonalite-granodiorite composition.

Резюме: В статье коротко характеризованы гранитоиды Западных Карпат с точки зрения их геологического проявления, отношений возраста и метаморфизма. Дается характеристика основных петрографических и геохимических признаков, макрохимического состава, поведения элементов-примесей, включая редкоземельные элементы, и некоторых изотопных отношений. На примере Малых Карпат приводятся некоторые результаты моделирования макрохимического состава (при помощи смешивающей программы GENMIX), а также элементов-примесей. На основе этих результатов авторы представляют мнение о дифференциации гранитоидной магмы фракционной кристаллизацией Рэлея минеральной ассоциации: биотит + плагиоклаз + кварц ± калиевый полевой шпат + акцессорные минералы из исходной магмы тоналит-гранодиоритового состава.

The geochemical-petrological investigation of Late Paleozoic granitoid massif of the West Carpathians taking place already for several years at the Geological Institute of the Slovak Academy of Sciences and Department of Geochemistry and Mineralogy of the Faculty of Natural Sciences at the Comenius University in Bratislava has brought a series of new results. The objective of our contribution is to summarize the obtained results, to try for an interpretation and to point to some problems. The problems of interpretation are mainly caused by the insufficient number of isotopic data and data of REE contents in all varieties of granitoids, but are mainly lying in complicatedness of the proper geological occurrence of West Carpathian granitoids. The mostly bad uncovering of the terrain and complicated tectonic situation render clearing up of intrusive mechanizms and linkings, contact effects on the surroundings, several-phases character of intrusion or contingent zonality of the massifs difficult. The allo-

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chtonity of whole mountain massifs of crystalline rocks supposed by some authors, caused by the Alpine orogeny also forces to be careful in connection of the massifs into comagmatic groups, differentiation orders or larger batholiths.

Variscan magmatic activity was manifested in the West Carpathians by intrusion of several, not large, particular granitoid plutons, often subsequently separated tectonically. At present these form with their metamorphic mantle the cores of the so called core mountains. The schistose crystalline rocks were metamorphosed regionally to lower grades already before the intrusion, but the main metamorphic effects are connected with granitoid plutonism of the Variscan orogeny. In some plutons (Malé Karpaty Mts., Kohút and Sinec bodies of the Veporides) the resulting contact metamorphism caused by granitoid intrusion is also proved. The age of regional meatmorphism of gneissose-amphibolite crystalline rocks is considered as Early Paleozoic (Cambel, 1962). In the most investigated area of the West Carpathians (Malé Karpaty Mts.) this age is confirmed by Rb/Sr dating with whole rock isochrone: $387 \pm 38$ mil. years, initial ratio 0.7100 (Bagdasarjan et al., 1983) and in the whole region of the West Carpathians it is also confirmed by model ages obtained by K/Ar mtehod (Cambel et al., 1980; Cambel–Veselský, 1981). Dating of contact-metamorphic biotite from metapelites by the mineral isochrone: biotite — whole rocks showed the age of contact metamorphism, which in the frame of error is identical with Rb/Sr age of granitoid intrusion ($347 \pm 4$ mil. y., Bagdasarjan et al., 1982).

In the gneissose-amphibolite crystalline complex of the Malé Karpaty Mts. metamorphic zones were characterized and distinguished on the basis of mineral associations (Broska—Janák, 1984; Korikovskij et al., 1984). The highest - temperature regional periplutonic zone is the staurolite-chlorite zone with temperatures of 490–508 °C according to the garnet-biotite thermometer. The immediate contact effect of the intrusion was manifested by formation of the superimposed highest - temperature staurolite-sillimanite zone with temperature 550–560 °C (Korikovskij et al., l. c.) to 593 °C (Cambel et al., 1981 a; Perčuk et al., 1983). Depth of intrusion probably corresponded to 350 MPa. The Modra granodiorite massif of the Malé Karpaty Mts., on the contrary, ascended to a higher level corresponding to pressure 150 MPa (Korikovskij et al., 1984).

The presence of contact metamorphism accompanied with formation of andalusite-bearing hornfelse spotted schist has been already stated by Cambel (1954).

Another granitoid pluton in the region of the Veporides (Sinec body) with a contact-metamorphic aureole also forms a hornfelse mineral association biotite--cordierite corresponding to pressure less than 100 MPa (Kamenický, 1977). On the contrary, further granitoid bodies (Vysoké Tatry Mts.) have a metamorphic mantle with high-pressure association disthene-sillimanite-staurolite (Kahan, 1968), or are surrounded by migmatite zones (Nízke Tatry Mts.).

The uplift of the core mountains of the West Carpathians to present-day horst structures is the result of the Alpine orogeny. This was confirmed by dating by the method of uranium fission tracks by Kráľ (1977) and Burchart–Kráľ (1982). Dating of uplifts has shown that earliest – in the Upper Cretaceous – the Vepor pluton began to rise (FT age of apatites: 54–84 mil. y.). From the Tatride mountains the Nízke Tatry Mts. massif was rising first (Eocene, 45 mil. y.), later in the Miocene (10—20 mil. y.) the other core mountains were uplifted. These processes also strongly influenced the model ages established by K/Ar method.

The modal (Streckeisen, 1976) and also chemical classification of granitoid rocks (Streckeisen—Le Maitre, 1979) with application of mesonorm provide identical results: the predominating rock types of the Tatrides and Veporides are biotite granodiorites to tonalites (trondhjemites) sporadically containing amphibole and biotite to two-mica monzogranites. These two rock types in from of medium-grained or porphyric varieties are represented in various proportions practically in all massifs.

The West Carpathian granitoids from the view-point of macrochemical composition form a suite limited in composition: the extent of $SiO_2$ content is 60—78 weight %. The average values for tonalite are 66.3 %, biotite granite — granodiorite 71.3 %, leucocratic granite — granodiorite 73.9 % (Cambel—Walzel, 1982). The variations of the individual oxides are characteristic. With increasing $SiO_2$ content only $K_2O$ rises, $Na_2O$ keeps at an approximately equal level and other oxides decrease. The $Na_2O/K_2O$ ratio is typically greater than 1 (Cambel — Vilinovičová, 1981). A considerable part of granitoids is peraluminous. These chemical features are expressed in prevalence of granodiorites over granites and in frequent occurrence of two-mica varieties.

As comagmatism of granitoids in the individual massifs is indubitable, we tried to quantify this relation by the generalized petrological mixing model (Le Maitre, 1979) and interactive program GENMIX (Le Maitre, 1981). The program calculates the proportions of individual minerals in the crystallizing association as well as the fraction of residual melt by solving an equation, for instance:

$$\text{magma 1} = \text{magma 2} + \text{plagioclase} + \text{biotite} + \text{K-feldspar} + \text{quartz},$$

where the entering data are chemical analyses of granodiorite (magma 1), its minerals and monzogranite (magma 2). The example of one solution for granitoids of the Malé Karpaty Mts. is in Fig. 1.

As to trace elements, our granitoids may be characterized as follows. The trace elements correlate with $SiO_2$ as expected: the contents of Sr, Ba, Sc, Co, Cr, Ni and Zr decrease with the degree of differentiation (i. e. elements behave compatibly), Rb, B, Be and partly also Pb contents increase with differentiation (the elements behave incompatibly). For granitoids of the Tatrides and Veporides the extent of rubidium concentrations of 50—160 ppm, rarely higher, is typical. The granites of the Gemerides differ in distincly higher contents: Rb = 200—500 ppm (Cambel et al., 1983). Sr attains maximum in tonalites of the Modra massif of the Malé Karpaty (500—1000 ppm) and Tríbeč Mts. (700—800 ppm). With differentiation it sinks to 200 ppm and in aplites also below 100 ppm. Barium sinks from the maximum values of 1400 ppm even below 200 ppm in aplite types (Cambel — Medveď, 1981).

Solution of differentiation of the concrete granite suite by mixing model by means of GENMIX program is a suitable starting-point for interpretation of behaviour of trace elements. Modelling of Rb, Sr and Ba trends with using of the distribution coefficients and mineral proportions obtained with mixing has confirmed unambiguously that Rayleigh fractional crystallization of plagioclase, biotite, quartz and K-feldspar is able to explain the observed distribution of Rb, Sr and Ba. An example of Sr and Ba distribution together with curves of fractional crystallication is in Fig. 2. In this case the decrease in Ba contents is explicable by fractional crystallization of biotite, later also K-feldspar, the

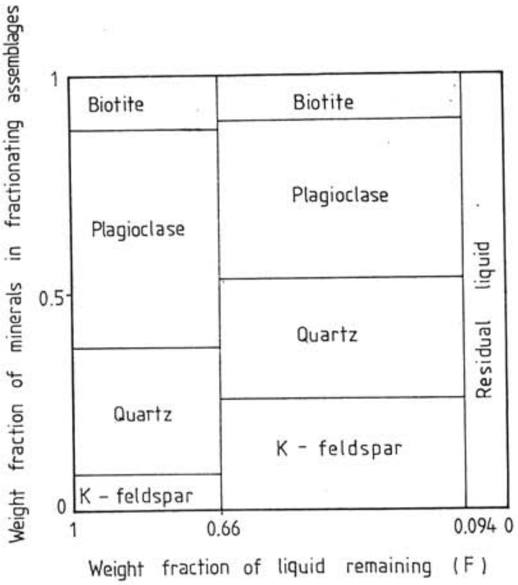


Fig. 1. Crystallization of granodiorite magma of the Bratislava massif of the Malé Karpaty, as modelled by GENMIX program (Le Maitre, 1981). From the parental magma (F = 1) biotite, plagioclase, quartz and K-feldspar crystallize in the first stage in the calculated proportions with formation of monzogranite melt (F = 0.66), which provides syenogranite (F = 0.094) in the second stage by crystallization of the same minerals in changed proportions (Vilinovič — Petrík, in press).

decrease in Sr contents is caused by fractionation of plagioclase and K-feldspar. Modelling has also confirmed the conclusions of McCarthy–Hasty (1976), that equilibrium crystallization of the mentioned minerals does not explain the actual distribution of trace element in rocks. It has also turned out that is probable, the cumulus mineral being plagioclase. This is also testified by high Sr contents (up to 1000 ppm) and the presence of moderate positive Eu-anomalies in whole rock REE distribution patterns.

The most distinct feature of REE distribution in the fundamental types of granitoids (biotite granodiorite to tonalites) are steep REE patterns with distinct prevalence of LREE over HREE practically without Eu-anomaly (Fig. 3). With increasing acidity of rocks negative Eu-anomaly is forming and in the last differentiates is a distinct decrease mainly of LREE. We consider such a trend as the result of fractional crystallization of accessory allanite (LREE), zircon (HREE), or monazite, apatite and titanite together with plagioclase and later with K-feldspar (cf. e. g. Fourcade – Allégre, 1981).

Amphibole-biotite diorites to gabbroids which are present in granitoid massifs in form of enclaves several tens of metres large are not falling into the above-

-mentioned trend of differentiation. According to present opinions these diorite rocks can be a product of anatectic effects of granitoid magma on metabasites — amphibolites, which together with gneisses are part of the metamorphic mantle as well as xenoliths in granitoids. It cannot be, however excluded — and

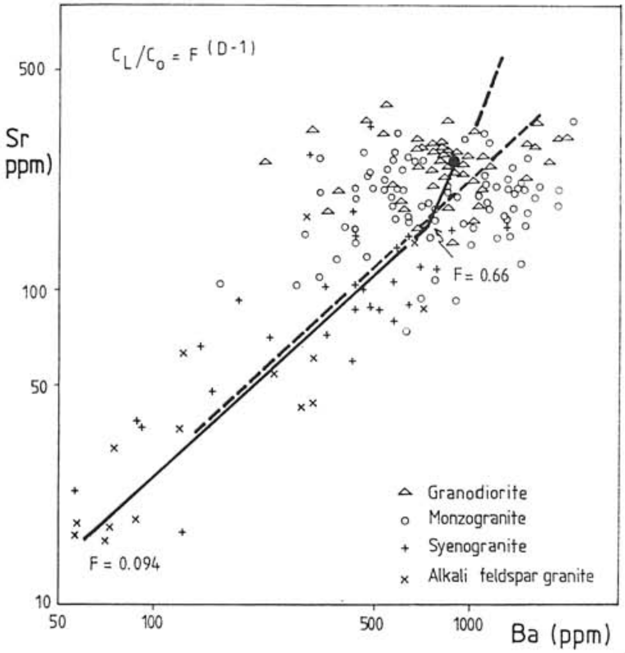


Fig. 2. Sr—Ba relationship for granitoids of the Bratislava massif of the Malé Karpaty Mts. with calculated curves of fractional crystallization.
*Explanations:* Solid lines follow the direction of evolution of liquid compositions, dashed lines follow the evolution of compositions of coexisting solids. Initial composition of magma $C_O$ = 250 ppm Sr, 890 ppm Ba. $C_L$ = concentration of elements in evolving liquid at the given value of F. The states and values of F are taken over from Fig. 1. D is the bulk distribution coefficient of fractionating mineral assemblage calculated assuming distribution coefficients recommended by McCarthy — Groves (1979). Analyst: J. Medveď.

the trace elements, mainly the high content of REE and missing Eu-anomaly testify to this fact — that part of these diorite rocks is a product of basic-intermediate magmatism, which may be in certain relation with granitoid plutonism.

The West Carpathian granitoids may be so designated as restricted in composition. In this connection it is problematic to range them to some of the petrogenetic series: extrapolation of Peacock's index indicates their competence rather to calcic than calc-alkaline series. Among the West Carpathian Variscan granitoids metaluminous as well as peraluminous types with various per cent representation in the individual massifs are present. As, however, amphibolic members are missing, the model of formation of peraluminous magmas by fractional crystallization of amphibole presented by Cawthorn—Brown (1976) cannot be applied. In deeper parts of the massifs, however the presence of amphibolic varieties cannot be excluded. Peraluminous character is mostly ma-

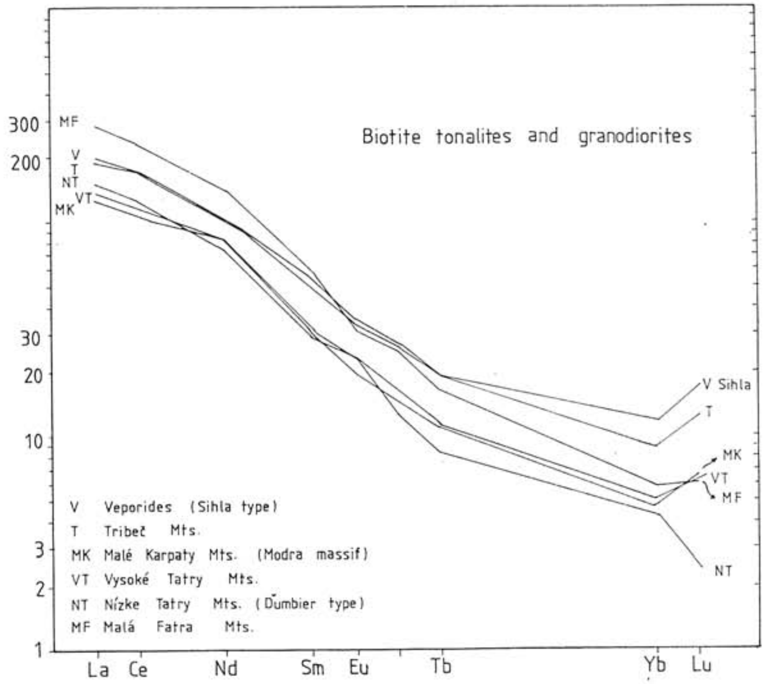


Fig. 3. REE distribution in fundamental rock types (biotite tonalites and granodiorites) of the West Carpathians. Normalized according to Evensen et al. (1978). Analyst. P. Kotas.

nifested by the presence of muscovite + biotite ± sillimanite, in leucocratic varieties and pegmatites by the presence of muscovite + garnet ± tourmaline.

Another of the problems occurring in the study of the West Carpathian granitoids, is the non-unambigous result of I/S classification of Chappell—White (1974) or White—Chappell (1983). The rocks as well as whole massifs posses often characteristics of both types. The only unambiguous representative of S-type granite with explicitly crustal initial ratio $(^{87}Sr/^{86}Sr)_0$ = 0.7195 are Gemeride granites, which are also the youngest intrusions of the Variscan cycle (Kovách et al., 1979). Other granitoids of the Tatrides and Veporides have a much lower initial ratio (0.705 to 0.707) deducing from the results of the Vysoké Tatry (Burchart, 1968) and Malé Karpaty Mts. (Bagdasarjan et al., 1982). From tonalites to almost the most acid varieties these granitoids are of sodium character, inclining to I-type with prevailing mafic mineral biotite. Between $Na_2O$ and $K_2O$ is, however, negative correlation on the contrary to type Australian granitoids. It is possible to mention from world literature several examples of mixed I—S character of granitoids and therefore one can agree with statement of Pitcher (1983), that granitoids of S.E. Australia, on which I/S classification was defined, are mineralogically and chemically quite exceptional. Without doubt a possitive step in the typology of granitoids was Pitcher's (1983) subdivision of I-type into the Cordilleran and Caledonian. It turns out that our Variscan granitoids of the Tatrides and Veporides, namely biotite tonalites and granodiorites correspond in their character mostly to Caledonian I-type. The low magnetic susceptibility at the same time points to their competence to the ilmenite series of Ishihara (1977; 1981).

In solving of the genesis of West Carpathian granitoids it is set out from the conception of anatexis of the metasedimentary series and palingenic origin of granitoid magma (Cambel, 1980). The source rock was probably of greywacke composition, anatexis set in at the boundary of the upper and lower crust (Hovorka, 1979). Further studies based on interpretation of alkalies (Cambel et al., 1981 b) and isotopic relations (Cambel—Petrík, 1982) have, however, shown that the source material must have contained a considerable portion of basic, probably mantle material. This is mainly testified by relatively low initial ratios of Sr isotopes: 0.705—0.707. The way, in which the material with low Rb/Sr ratio was incorporated in granitoid magma, is sought in the mixed-hybrid character of the source material so far, most acceptable is the presumption of anatexis of argillaceous-siliceous and greywacke metamorphites with layers of tholeiite rocks as products of submarine volcanism of mantle origin.

According to the latest results, several granitoid types of the core mountains have a higher initial isotope ratio (0.7150) too, e. g. granitoids of the Králička type in the Nízke Tatry Mts.,what evidences of lithological variability of the rocks from which the West Carpathian granitoids have been formed.

Translated by J. Pevný

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