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DISTRIBUTION OF ZK SAMPLES IN GRANITOID PLUTONS AND MASSIFS OF THE WEST CARPATHIANS

(Tab. 1, Fig. 1)

Granitoid massifs take up nearly 12 % of the surface of the West Carpathians. The individual massifs can be grouped into larger units with the character of plutons on the basis of common features. These are indicated with the letters A, B, C, D, E in the attached sketch. The bodies proper of the plutons are built up of the following main types of granitoids:

1. aplite — pegmatite granites
2. two-mica and biotite granites
3. biotite granodiorites
4. tonalites to amphibole — biotite granodiorites

As the mentioned types of granitoids were not indicated in a uniform way with mapping, distribution of the types in individual massifs is indicated with numbers in the sketch.

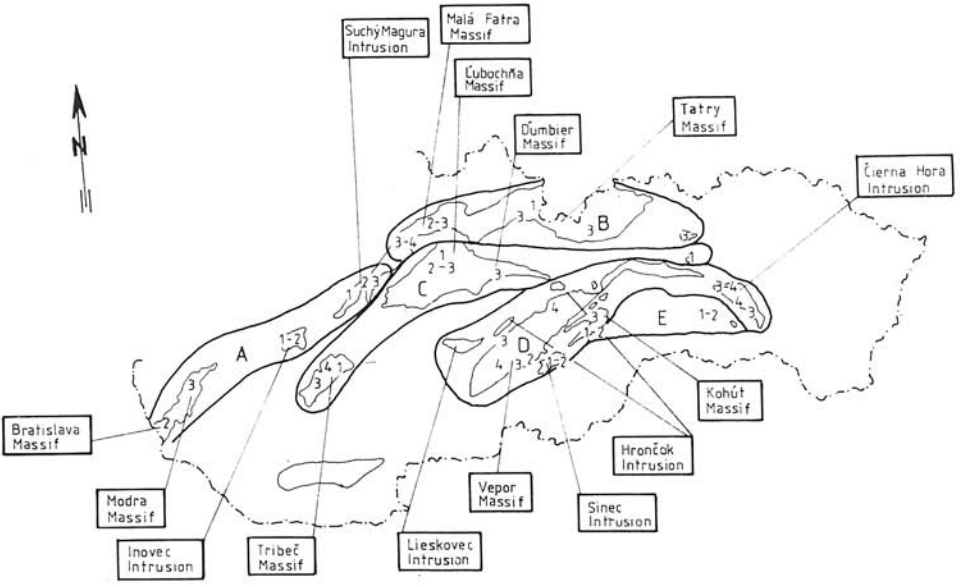

Fig. 1. Dislocation of ZK samples of the Carpathian granitoids.

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West Slovakian granitoid pluton

In three core mountains of western Slovakia, in the Malé Karpaty Mts., Inovec and Strážovské vrchy mountains (in the Suchý and Malá Magura) granitoids are found, which have several common features. On the basis of the geological position mutual connection may be supposed in them. When also the individual massifs are of found in direct continuation, caused by younger tectonics, they form one wing of fan-like intrusion.

Malé Karpaty Mts.

The core mountains of the Malé Karpaty belong to the external zone of the core mountains and are found in its southwestern termination. They form a meganticlinal horst bourdered from the southwestern side by a system of faults, at which it is gradually sinking to a depth of several thousands metres. From the northwestern side it has its Mesozoic mantle, the Krížna and Choč nappes.

The crystalline core is built up mainly of granitoids, which occur in two massifs – the Bratislava and Modra massifs. Between them a zone of crystalline schists with rich basic volcanism – the Pezinok – Pernek crystalline is transversal to the course of the mountains. The crystalline schists are also found at the northwestern periphery of the Bratislava massif and on both sides of the Modra massif.

The granitoids are late-orogenic. In contrast to the Modra massif, the Bratislava massif is more leucocratic and richer in pegmatites and aplites. The most acid members are concentrated to the northwestern part of the massif and therefore we suppose here the overlying part of the body. In the environs of Bratislava also amphibole diorites occur, from which some bodies can be considered as intrusive, other, however, show distinct features of granitization and assimilation of metamorphosed basic volcanics by the influence of granite intrusion. The distribution of individual ZK samples is to be seen in map enclosure No. 2. Generally it may be said that the individual samples fall into the differentiation order of Variscan Tatride granitoids, the majority of them, however, belong to leucocratic granites.

On the basis of I/S classification of B. W. Chappell and A. J. R. White, 1974 and of strontium isotopes (B. Cambel – I. Petrík, 1982) both massifs are of similar origin. It is evident from the work by B. Cambel – V. Veselský, 1981 that the model ages of Malé Karpaty Mts. granitoids and their minerals (biotite, muscovite, amphibole), determined according to K/Ar method, provide values varying from 300 to 360 mil. y. in unaltered granitoids according to the histogram mentioned in this work. In the work of G. P. Bagdasarian et al. (1982) by help of strontium isotopes the following age of granitoids was determined by the isochrone method: for the Bratislava massif 347 ± 4 mil. y. (initial ratio of isotopes $^{87}Sr/^{86}Sr = 0.7076$) and for the Modra massif 324 ± 18 mil. y. ($^{87}Sr/^{86}Sr = 0.7075$). From the ratio of isotopes the crustal origin of rocks results, influenced by younger submarine tholeiite – basaltoid effusions comming from the mantle. This idea is also confirmed by the conclusions deduced from I/S classification of B. W. Chappell – A. J. R. White, 1974.

Inovec Mts.

The Inovec core mountains are of very complicated tectonic structure. The general course corresponds to the course of the arc of external cores of the Tatrides, however, represents the most pushed out crystalline complex among the core mountains. They have their Late Paleozoic and Mesozoic mantle and also nappes. J Kamenický (1956) described pebbles of diaphthorized crystalline schists in the Carboniferous and so proved the preceding diaphthoresis of crystalline schists.

The granitoids occur mainly in the central part of the mountains. They are biotite and two-mica granitoids, which cause migmatization in their mantle. In the Železnica valley and northeastern surroundings of Podhradie smaller bodies of aplite — pegmatite granites are found. Near Modrovka leucocratic two-mica granites occur. A smaller occurrence of granitoids is in the northern area of Hlohovec.

The Inovec core is divided into two different parts by the Hrádok fault, separated from each other by the zone of phyllonitized crystalline schists. North of the fault are found diaphthorized migmatites, mica schists and amphibolites or orthogneisses.

Crystalline cores of Suchý and Malá Magura

The mentioned crystalline cores are part of the Strážovské vrchy mountains, mainly built up of the mantle and nappe Mesozoic. Two morphologically independent parts of the crystalline rocks form two flanks of the fan — like intrusion. The southwestern and eastern borders of the crystalline cores are of fault character.

The granitoids occur in both crystalline units. Acoording to M. Ivanov (1957) three successive intrusive phases are represented, of hybrid biotite granodiorites, biotite to two-mica granodiorites and aplite — pegmatite granites. Mutual relation between these phases are well evidenced by penetration of younger phases through older phases. The choice of ZK samples is relatively small, however, characterizes the mentioned main intrusive phases.

The above mentioned crystalline cores 3 core mountains show several common features in granitoids intrusions, in relatively abundant representation of leucocratic granitoid varieties and especially of aplite — pegmatite granites, in location of these leucocratic facies at the northwestern periphery of granitoid bodies and in orientation of crystalline schists. These properties indicate a common genesis and trend to tongue-like shape of the intrusion, which is inclined to northwest and so forms a wing of the fan-like intrusion of the granitoid pluton. In the Malá Magura area, it may be considered as the more southern lying wing of the intrusive fan.

North Slovakian pluton

Comparing the crystalline cores of Malá Fatra, Vysoké Tatry and Branisko Mts., several distinct common features may be stated in the granitoid bodies:

a) similar shape of intrusive bodies with tongue-like forms sloping north;
b) similar material composition and differentiation range of granitoids;
c) axial depression in eastern and western termination.

It may be concluded that they belong to one orogenic granitoid core of the fan of intrusive pluton, which has locally indicated presence of opposite wing in the Vysoké Tatry and Malá Fatra areas only. L. Kamenický supposes that in the central part of the granitoid wing in the Vysoké Tatry Mts. the intrusive body was thrust far over the fore-land. There we can also conclude that the metamorphites of the Variscan cycle are underlain by an older sequence with different composition of lithological members but also metamorphism. Mica schist rocks at the contact of these two cycles correspond to Variscan diaphthorites (G. Gorek, 1959).

The original homogeneous intrusive body was divided by younger faults or fault systems and shifts of various amplitude into the mentioned three cores. In the synclinal part of the fan the root part of the pluton has to be supposed. From the directions of the individual segments of the intrusive body an arc-like course as early as the Variscan orogeny may be concluded. This arc, however, cannot be identified with the present-day arc, even with its present position.

Malá Fatra Mts.

The core mountains of Malá Fatra form a meganticlinal horst of arc-like course, bordered by tectonic faults from the southern and southeastern sides. The termination at the eastern side of the core is also of fault character. Here the crystalline rocks are at direct contact with the nappe Mesozoic. The crystalline core is enveloped by the mantle Malá Fatra group, at which along the northwestern periphery the Krížna and Choč nappes are lying. West of the core proper the anticline of Kozol with the Permian and Lower Triassic is situated.

The crystalline complex is mainly built up of granitoids. The metamorphosed sedimentary complexes occur in the southwestern part. Schistosity is dipping NW, i. e. below the intrusive massif. At the contact with crystalline schists granitoids are of hybrid character. In the mantle of granites is a wide zone of migmatite and imbibed gneisses.

The granitoid intrusion of Malá Fatra is inhomogeneous. The oldest intrusive phase corresponds to the Ďumbier type of granodiorites on the basis of analogy. In it a relatively younger magmatic intrusion occurs, called the Magura type (M. Ivanov, — L. Kamenický, 1958). This causes metasomatism in the preceding type and autometamorphism inside the body proper. Such altered types of granitoids are designated as Prašivá type of granites or autometamorphosed marginal zone of the granitoid intrusion in other mountain ranges.

Vysoké Tatry Mts.

The crystalline core of the Vysoké Tatry Mts. extends in an area of nearly 520 km^2. Strong granitoids (445 km^2) are prevailing. Metamorphosed sediments are found only in the southwestern part of the core between the Jalovecká

and Račková dolina valleys (75 km^2). The core mountains form a post – Paleogene meganticline of E–W direction, bordered by the Subtatric fault from south. The detaily folded metamorphosed series form a cupola-shaped form with greatest vaulting at the mount Baranec. The majority of metamorphosed sediments correspond to the Cambrosilurian and Upper Proterozoic cycle. The orthogneisses were not formed by metamorphism of intrusive rocks (G. G o r e k, 1959). According to the mentioned author granitoids are late-to post--tectonic, forming a homogeneous tongue-shaped body intruding from north to south. It is reflected in different metamorphism of underlying and overlying metamorphosed groups and in distribution of granitoid types. The differentiation and autometamorphism were shown in overlying direction from the body.

According to G. G o r e k three main types of granitoids may be distinguished in the intrusive body:

1. Quartz diorites to biotite granodiorites, medium-grained with hypidiomorphic, rarely porphyritic texture. Modal composition varies within the range: plagioclase 39–68 %, quartz 19–39 %, potassium feldspars 1–15 %, biotite 2–12 %, muscovite 0–4 % and accessories 0.2–2 %. The share of An component of plagioclases varies between 22–30 %. Quartz is undulatory. From accessories magnetite, apatite and zircon are typical.

2. Granodiorites to granites with manifestations of autometamorphism. These types change the character from biotite to two-mica granodiorites with microcline and myrmekite to two-mica granodiorites to granites with distinct autometasomatism. Modal composition of the former varies as follows: plagioclase 46.9–57 %, K – feldspars 6.5–19 %, quartz 23.5–27.4 %, biotite 5.7–7.8 %, muscovite 2.7–4.5 % and accessories 0.4–1.5 %, the latter: plagioclases 35.5–46 %. K – feldspars 14.2–36 %, quartz 22–27.5 %, biotite 6.5–8.8 %, muscovite 2–7.3 % and accessories 0.8–1.5 %. In plagioclases a more acid albite hem occurs. Potassium feldspars correspond to microcline, indicating a lower temperature of crystallization.

3. Granitoids of the marginal pegmatite – aplite zone. They are found in the overlying marginal part of the intrusive body. They are of variegated composition. The most external part is formed by white muscovite aplite granites. In these rocks plagioclases are more acid, albite – oligoclases and albites.

According to D. H o v o r k a, (1979) autometamorphosed granites/granodiorites are a differentiation product of biotite plagioclase granodiorite/tonalite by crystallization of K-feldspars from residual melt without migration of potassium in the frame of West Carpathian massifs.

J. B u r c h a r t (1968) stated by aid of Rb/Sr method of geochronological investigation the Variscan age of granitoids (290–315 mil. y.), representing a time when rocks arrived the state of a closed system, thus, as a matter of fact, ending of their evolution. In paragneisses of Goryczkowa he records traces of older isotope equilibrium, perhaps corresponding to Caledonian metamorphism.

All ZK samples belong to the group of the above mentioned granodiorites to granites with manifestations of autometamorphism of variable intensity. Extremely acid aplite – pegmatite granites obviously correspond to similar rocks from the Branisko core or from other core mountains.

Branisko Mts.

This core mountains represent a typical horst with distinct fault borders at the western and eastern sides. The faults are filled up with breccias. The height of relative vertical shift of blocks to each other exceeds 1000 m. The core has an own Late Paleozoic mantle from the Carboniferous and Permian (at the northern periphery) and partly also mantle Mesozoic. It is composed of two various parts. The northern corresponds to continuation of the Vysoké Tatry Mts. crystalline complex and the southern to continuation of the Nízke Tatry Mts. crystalline complex. Granitoids of the northern part of Branisko Mts. are of similar position and differentiation as Vysoké Tatry granitoids.

As already mentioned in the introduction to the North Slovakian pluton, distinct common features of granitoid bodies of the Malá Fatra, Vysoké Tatry and Branisko Mts. exist.

Central Slovakian pluton

In the central part of the Inner Carpathians there is grouping of core mountains, in which also close mutual relations may be observed. They are the crystalline cores of the Nízke Tatry, Veľká Fatra, Tríbeč, Žiar and southern part of Branisko Mts. These core mountains are connected with the Tríbeč core mountains and designated as the inner zone of Tatride core mountains. We remark, however, that the crystalline complex of the Tríbeč crystalline core has some characteristics different from other mountains.

Nízke Tatry Mts.

The core mountains of Nízke Tatry are a post-Paleogene meganticline including Tatride and Veporide structural units. Their east-western orientation is in discordant position to Cretaceous structures of the Veporides. The Tatrides and Veporides differ in their structure and granitoid intrusions. To the Central Slovakian pluton only granitoids of the Tatride part of the core mountains bordered by the Čertovica fault line and Hron synclinore from the south belong.

The crystalline core is built up of two heterogeneous units, the Ďumbier granitoid massif proper and an extensive area of metamorphosed sediments, in major part synkinematically migmatized. Their contact is mostly tectonic. In the mantle the Late Paleozoic is represented by small occurrences, also the Mesozoic mantle and nappes are present.

The granitoid massif proper is roughly tongue-shaped with direction of intrusion from north to south. It is heterogeneous as a consequence of assimilation processes, differentiation and metasomatism. Its development was taking place in stages. In the first the so called Ďumbier type of granodiorites intruded, which is highly hybridized at the contact with the mantle. This intrusion differentiated into leucocratic granodiorites including aplites and pegmatites. In further stage there was regeneration of intrusive mechanism with intrusion of the Prašivá type granodiorites to granites with differentiates of leucogranites and from the second generation – aplites and pegmatites. The granitoid intrusions of the Nízke Tatry Mts. were preceded by small intrusions of

utrabasic to intermediate magmas, which were later partly assimilated by granodiorite intrusion. To the Variscan intrusive cycle also small vein and dyke bodies of granite — porphyries and intermediate vein bodies, probably of Permian age, belong.

The area of synkinematically migmatized crystalline schists is without Variscan intrusions. Here acid magmatism is represented by leucocratic orthogneisses, subautochthonous granites of Králička type and metamorphosed rhyolites. Granitoids of Králička type are of variable appearance and genesis, because also their pre-Variscan age cannot be excluded in some types.

From granitoids the samples were taken from hybrid types ZK 3, from Ďumbier types ZK 78, from Prašivá or metasomatic altered Ďumbier types ZK 24, 25, 79, 91 92 and from Králička type granitoids ZK 4, 68.

Veľká Fatra Mts.

The crystalline core of Veľká Fatra has a two-sided structure bordered by fault systems from the eastern and western sides. It consists of the Ľubochňa granite massif (D. K u b i n y, 1958), which forms the underlier of the mantle and nappe Mesozoic. In granitoids septa of crystalline schists are found in the easternmost part only. The massif is built up of the Smrekovica type of granodiorite, in which in the central and deepest uncovered part are Prašivá type granites, with which leucocratic muscovite and two-mica granites occur together. As in other Tatride massifs, pegmatites and aplites are present in two groups: of light and pink colours. Regarding to the fact that the Prašivá types occur inside the Smrekovica type (equivalent of the Ďumbier granodiorite of the Nízke Tatry Mts.), D. K u b i n y assumed a relatively younger intrusion there.

The system of ZK samples represents the above mentioned granodiorite types. The direction of differentiation is well characterized by them.

Žiar Mts.

The small core mountains of Žiar are forming a horst bordered by faults from the Turčianska kotlina, Hornonitrianska kotlina and Handlovská kotlina depressions. The crystalline complex is equally as in the Veľká Fatra built up almost only of granitoids, porphyric two-mica granite, autometamorphosed granite (Prašivá type) and leucocratic aplite-pegmatite granite (A. K l i n e c, 1958). The first type is represented by sample ZK 62.

The crystalline schists are found only in the southeastern part of the massif in a small area.

The mantle of the crystalline core consists of the Mesozoic mantle group beginning with Triassic quartzites to conglomerates and of the Krížná and Choč units.

All the mentioned massifs of the Central Slovakian pluton have several common features and because in the area of the Tlstá fold spatial linking is indicated, we can range them into one whole of common genesis. The occurrences of crystalline schists in the Veľká Fatra and Žiar Mts. indicate branching of the pluton into two wings. The aplite — pegmatite type of granites is found in analogous position also in the southern promontory of the crystalline Bra-

nisko core and therefore we also include this part in the Central Slovakian pluton.

Tríbeč massif

The crystalline core of Tríbeč is of character of horst of NE – SW direction, bordered by tectonic faults from the surroundings. It is heterogeneous with the southwestern part built up of diaphthorized migmatites, orthogneisses, amphibolites and gneisses. The crystalline rocks are uncovered in three particular units, of Zobor, Veľký Tríbeč and Razdiel, representing axial elevations. According to E. Krist (1959) metamorphosed sedimentary rocks are found subordinately in the southwestern part of the crystalline complex as septa submerged in granitoids. The Razdiel part of the crystalline complex is built up of gneisses synkinematically migmatized (with essential representation of orthocomponent) and orthogneisses of acid and basic character. They were altered by diaphthoresis into muscovite- chlorite mica schists to garnet – muscovite chlorite mica schists. In diaphthorized leucocratic orthogneisses locally also relict types occur. The basic rocks are locally altered into actinolite-chlorite schists. They are mainly intrusive types.

Granitoids of the southwestern part of the core correspond to biotite quartz diorite or tonalite of medium grain size. Fine-grained types are found at the periphery and in the near – mantle area. The rocks are often hybrid. On the northeastern side of the intrusion marginal leucocratic differentiation facies of biotite granite composition (ZK 42), two-mica leucocratic granite (ZK 41) and prevailing aplite – pegmatite granite to granodiorite (ZK 100) composition is developed. In the central part of the massif, e. g. in the valley northeast of elev. p. Rakytka (598 n) in places metasomatism of fundamental type was taking place. It is represented by chloritization, sericitization and subordinate small pegmatite veins with pink potassium feldspars (ZK 1). Also granite rocks of the Tríbeč mountains are affected by local dynamic metamorphism, mainly at the southern periphery of the intrusion (north of Jelenec) or along dislocation zones.

The treated samples can be characterized as a discontinuous differentiation order, with ZK 1 showing features of autometamorphism. All samples are of magmatic origin. Parallely with the degree of differentiation the share of muscovite, Ab-component of plagioclases and K-feldspars increases. In leucocratic varieties potassium feldspars are represented by microcline.

A petrographic analogy of sample ZK 1 is the Vepor tonalite- Sihla type (ZK 28) and more remote- tonalite from the Čierna hora mountains from the Sopotnica valley (ZK 12). In ZK 28, however, geochronology shows a minimum age of 380 mil. y. whereas in ZK 1 the age is 290 mil. y. The compared two samples are, however, already from the Kráľova hoľa zone of the Veporides.

Vepor pluton s. l.

In this name can be included granitoids of variable character, occurring in three zones of the Veporides, in the Kráľova hoľa zone, where they are most typically developed, in the Kohút zone and small occurrences in the Krakľová zone. Its dimensions are 75 × 22 km. The pluton includes two distinct

groups of granitoid types, the so called Sihla granodiorites to tonalites and Vepor granites to granodiorites s. s. The Hrončok type mentioned in literature is a variation of the Vepor type only. The Ipeľ type is different only by colour of porphyric potassium feldspars, which are pink in contrast to usual light-coloured to white. V. Zoubek (1950) took up an attitude to mutual relation of the main granitoid types, considering them as comagmatic, the more acid Vepor types should be a marginal facies. According to J. Kamenický (1961), on the contrary, the Vepor type is only the Sihla type altered by metasomatism. On the contrary, L. Kamenický (1973) considers the Sihla type as younger magmatic intrusion.

The age of zircons of the Sihla type in sample ZK 28 from Tlstý Javor was determined geochronologically 380 mil. y., (K/Ar analysis of the same rock shows the age of 190 and 219 mil. y.). Model ages of zircons were determined also for the Vepor type in sample ZK 29 (Dobroč — 320 mil. y.) and in sample ZK 26 (Hrončok — 260 mil. y.). According to K/Ar method the model ages are in Dobroč granite 186 mil. y. and in Hrončok granite according to biotite 115 and 98 mil. y. It is necessary to remark that the mentioned age values determined by Pb—U—Th method are related to isotope ratio $^{208}Pb/^{238}U$. The isotope ratios generally show discordant ages in zircons.

The Sihla tonalite has balanced mineral composition and grain size (medium) and characteristic phenomena of alteration. Enclaves of various rock types including amphibolites can be observed. Locally (e. g. east of Kráľova hoľa) it is intensely compressed.

The Vepor granite to granodiorite is more acid and in places more inhomogeneous than the Sihla granodiorite to tonalite. The inhomogeneity is caused by the presence of hybrid parts. Porphyritic feldspars of white and pink colours attain in places the size of several cm. Autometamorphosed varieties with features similar as are known in Prašivá granites are also found.

A. Klinec (1976) mentioned the view that the Vepor pluton forms a platy body, which was thrust as a nappe from the Kohút zone of the Veporides to the northern part of the Veporide Krakľová zone. E. Krist (1979) completes this view by observation that in the western part the pluton is well rooted and thrust at little distance along upthrust planes.

From samples, which are quite numerous, is to be seen that they can be grouped into main particular groups, in which signs of regular differentiation may be observed then.

Rimavica pluton

In the southern part of the Veporides along the contact with the Gemerides granitoids occur in a more or less continuous body from Chyžné to Lovinobaňa. There are late-kinematic leucocratic muscovite to two-mica granites to granodiorites with local facies of leucocratic quartz diorite. The age of these granitoids is Variscan as follows from the age of granodiorite from Chyžné (ZK 2) determined by geochronology. By U-Th-Pb method concordant Variscan ages were stated in this case. On the other hand, however, the influence of Alpine tectonics on granitoids is very intensive. Near Rochovce in a borehole was drilled a body of granitoid, the Alpine age of which was determined by K/Ar method. Many authors consider all Rimavica granites as a whole Alpine.

In the mantle of granitoids also Early Paleozoic metamorphosed sediments are found.

From the Rimavica pluton a greater series of ZK samples was taken, characterizing well the development of differentiation.

Turčok massif

In the western part of the Gemeride, in the area between Sirk and Jelšava spa, a massif of medium- grained to finegrained granodiorites to granites, largely mylonitized, is situated. There are several smaller occurrences in the Western part and a continuous, about 4 km long body in the eastern part. The width of the intrusive body is several hundreds metres maximum. In its mantle, on the southern side, epimetamorphosed sediments of the Early Paleozoic of the Gelnica group are found. On the northern side is a tectonic contact with the Upper Carboniferous of the Gemerides. P. Ončáková (1955) assigns the Turčok massif to the Gemeride granites. J. and L. Kamenický (1955) consider it as independent Variscan intrusion in the Gemerides. Granodiorite is represented by one sample ZK 16 only.

Gemeride batholith

In the Early Paleozoic of the Gemerides at the relief surface several smaller massifs and a larger number of small granite bodies of particular character occur. They are the Gemeride autometamorphosed granite (J. and L. Kamenický, 1955). It is also known from several mine spaces. The contact rocks typical of these granite massifs are also found at several places of the Gemerides, indicating the presence of granite apophyses.

On the basis of petrographic study the above mentioned authors supposed that the fundamental type is biotite granite, which should form an extensive body in the Volovec anticlinorium. Toward the mantle the fundamental type passes through two-mica granite into leucocratic muscovite granite. Distinct porphyric types to granite porphyries are also present. Aplite varieties form local parts of intrusive bodies. The opinions of the age of granites often changed. According to latest geochronological investigations a part of granites is of Permian age. Later these granites were influenced by Alpine tectonics so that some samples and types show a Jurassic, Cretaceous to Paleogene age according to K Ar and Rb Sr methods.

An important feature in these granites is metasomatism, which resulted in spatial greisenization and accumulation of Sn-mineralization in the Hnilec area (L. Kamenický, 1953).

From ZK samples taken from borehole HG — 1 in regular height intervals a regular development from more basic type to leucocratic marginal types is visible in all considered components.

In the foregoing passage plutons and massifs of Variscan age were mentioned. When also from the individual massifs not a sufficient number of samples of various granitoid types was available, nevertheless, in ranging of all samples of Variscan granitoids a continuous order of differentiation may be seen. The granitoids are of distinct palingenic origin as stressed by several authors. The intrusions was taking place in several successive phases from the Lower Carboniferous to the Upper Permian.

Particular types of acid magmatites of the West Carpathians

Besides the mentioned Variscan granitoids a series of bodies of acid magmatites including granitoids is occurring at surface in the Central West Carpathians. They are mainly porphyroids and granodiorite porphyrites of the Early Paleozoic of the Ľubietová and Krakľová zones and then a group of metamorphosed acid magmatites – orthogneisses, subautochthonous granites of Králička type and others, the genesis and ages of which have not been solved satisfactorily yet.

Subvolcanic and volcanic acid magmatites of the Ľubietová and Krakľová zones in the Veporides

In the mentioned Veporide zones smaller bodies of acid to intermediate magmatites occur, in which some times the effusive character may be seen well, in another time they have the appearance of fine-grained granitoids, granite porphyries to granodiorite porphyrites. Several authors were dealing with their genesis. V. Zoubek (1963) considers them as equivalents of Permian effusive quartz porphyries, intruding under subvolcanic conditions. Later J. Kamenický (1967) calls attention to the more basic character in contrast to quartz porphyries and does not exclude their origin in the Lower Carboniferous sialic plutonic formation. On the contrary, L. Kamenický (1973), A. Klinec (1974) and A. Vozárová (1979) consider them as equivalents of Early Paleozoic porphyroids of the Gemerides.

They are mostly greyish or greenish medium- to fine-grained rocks, often with porphyric appearance. Larger grains are formed by plagioclase, quartz, biotite and orthoclase. The groundmass is more fine-grained. These rocks are often schistous.

The bodies of granodiorite porphyrites are usually of elongated shape as e. g. in the Veporide Ľubietová zone. They are distributed in a relatively narrow zone more than 60 km long. They are usually underlying slighter metamorphosed crystalline schists. An Upper Silurian to Lower Devonian age of them was established by palynological investigation in the Bacušská dolina valley. The sample ZK 7, analysed geochronologically (U–Th–Pb method on zircon) showed a minimum age of 370 mil. y. The sample is lying on isochrone 505 mil. y. together with porphyroids and some orthogneisses. This datum testifies to a common genesis of the mentioned rocks in the Caledonian era. The mentioned data also correspond to geological observations.

Orthogneisses formed by regional metamorphism of rhyolites, quartz porphyries and their pyroclastics

A typical representative of orthogneisses is the Boca Orthogneiss Formation in the Nízke Tatry Mts. (Kamenický, L. – Kamenický, J., 1982). Orthogneisses are found in the area between Boca and the northern slope of Čertovica. Orthogneisses of similar character occur also in the Ľubietová zone of the Veporides with typical development near elev. p. Čiertaž, then in the Kohút zone of the Veporides, near Muránska huta and finally also in equivalents of the Veporides in the Štubica mountains in a small occurrence at the southeastern slope of elev. point.

Table 1
Charakterization of plutons

Pluton	Massif	Rock type	Geolog. position
West Slovakian pluton postkinematic palingenic intrusion	Bratislava massif	two-mica granite to granodiorite, medium-grained (Bratislava-type) with abundant occurrence of pegmatites	apical part of intrusion
		leucocratic-muscovite-rich granite	marginal overlying part of massif; vein differentiates
	Modra massif	biotite granodiorites medium-grained (Modra type) locally leucocratic	
		autometamorphosed biot. granodiorites	marginal overlying part of massif
	Inovec intrusions	biotite quartz diorite to granodiorite coarse-grained	apical part of intrusion
		aplite-pegmatite granite	apical part of stock
	fan-like intrusion of Suchý and malá Magura western flank	biot. quartz diorite and granodiorite in places syntectic	fundamental type of intrusion
		automet. biot. and two-mica granite to granodiorite	marginal part overlying the intrusion
		aplite-pegm. granites locally syntetic	external part of marginal varieties

in the West Carpathians

Dimension	Mantle	Petrography**	Age*	Remarks
6 × 24 km	phyllites and amphibol. of the Early Paleozoic, near-contact migmatites, gneisses and hornfelses	ZK—48 Rössler quarry, A 1, Bi 12, Pl 47 O 13, Kr 24, M 3 %	K/Ar method shows the main interval of age between 300—360 m. y. Rb/Sr isochrone 347 m. y.	B. Cambel — J. Valach, 1956 B. Cambel — J. Veselský, 1981 G. P. Bagdasarjan et al., 1982
	phyllites and contact schists	ZK—54, road Devín, K. Ves A 1, Bi 4, Pl 39, O 15, Kr 35, Mu 6 %		
12 × 10 km	phyllites, marbles and amphibolites, near-contact gneisses and hornfelses, also schists		Rb/Sr izochrone 324 ± 18 m. y.	G. P. Bagdasarjan et al., 1982
16 × 7 km	biotite and two-mica gneisses			J. Kamenický, 1956
2 × 2 km	ditto and late orogenic migmatites	ZK—63, Duchoňka, A 1, Bi 1, Pl 33, O 29, Kr 32, Mu 4 %		
11 × 4 km	biot. and two-mica gneisses to phyllites at contact migmatized	ZK—104, Liešťany, A 2, Bi 6, Pl 46, O 5, Kr 42, Mu 1 %		M. Ivanov, 1957
		ZK—62, Liešťany, A 1, Bi 5, Pl 40, O 22, Kr 30, Mu 2 %		
		ZK—59, Suchý, A 1, Bi 1, Pl 33, Kr 46, O 10, Mu 9 %		

Pluton	Massif	Rock type	Geolog. position
	eastern flank	ditto as the western branch	
		leucocr. granite to granodiorite musc. to two-mica	overlying part of fundamental type intrusion
North Slovakian pluton	High Tatric massif	biot. quartz diorite (trondhjemite) to granodiorite mediumgrained with transitions to musc.-biot. granodiorite (High-Tatric type)	fundamental body of massif
		automet. biot. and two-mica granites with pink K-feldspars	marginal overlying part of massif
		upper automet. aplite-pegmatite granite zone	external part of autom. varieties
	Branisko massif	syntectic biot. quartz diorite and granodiorite	apical part of intrusion
		autometamorphosed granites	marginal part
	Malá Fatra massif	biot. quartz diorite and granodiorite mostly hybrid	fundamental intrusion
		biot. granodiorites medium-grained, metas. altered	part of fundamental intrusion metas. altered
		autom. biot. and two-mica granites to granodiorites (Magura type)	relatively younger intrusion phase
Middle Slovakian pluton	Dumbier massif	syntect. biotite quartz diorite and granodiorite	variety at contact with mantle

Dimension	Mantle	Petrography**	Age*	Remarks
				A. Klinec, 1953
16 × 6 km	ditto			
48 × 14 km	biot. and two--mica gneisses, quartz gneisses in places with inj. admixture, amphibolites	ZK—46, Šalviov prameň-spring A 2, Bi 18, Pl 50, O 2, Kr 23	J. Burchart, 1970, 1972, Rb/Sr B 304, B 308, M 273, M 311, B 279, 283, M 234, h 311, M, 332, M 293	G. Gorek, 1959, A. Skupinski, 1975
	locally at the northern periphery of the massif	ZK—111, Tichá dolina valley A 1, Bi 5, Pl 35, O 21, Kr 33, Mu 5 %	B. Cambel et al., 1980, 325.5 K/Ar B. Cambel et al., 1980; 208; M 323 K/Ar	
22 km × 100—1000 m				
n100—1000 m × n100—1000 m	biot. and two--mica gneisses, with amphibol., migmatites			L. Kamenický, 1963
n100 m				
38 × 5 km	biot. and two--mica gneisses with amphibol., migmatites	ZK—37, Dubná skala, A 1, Bi 10, Pl 63, Kr 26 %		M. Ivanov — L. Kamenický, 1957
n100—1000 m × 12 km		ZK—36, Dubná skala, A + Mu 2, Bi 11, Pl 45, O 13, Kr 29 %		
24 × 2 km	granitoids of fundamental intrusion			
loc. underlying	orthogneisses, synkin. migm. and gneisses, migmatites	ZK—3, Chopok, A 1, Bi 12, Pl 35, O 21, Kr 31, Mu 1 % (leucocr. var.)	B. Cambel et al., 1977, Chopok, U—Th—Pb, Z 630, 264, 300 m. y.*	D. Kubiny, 1958, J. Koutek, 1931

Pluton	Massif	Rock type	Geolog. position
		biot. quartz diorite (trondhjemite) to granodiorite, mediumgrained Ďumbier type	main intrusion
		leucocratic. biot. granodiorite to quartz diorite	variety in E part of massif
		biot. granite and granodiorite with porphyroblasts of pink K-feldspars	metasom. altered Ďumbier type
		autom. biot. and two-mica granite-Prašivá type	younger intrusion phase
	Ľubochňa massif	biot. to two-mica granodiorite medium. grained-Smrekovica type, locally autometr. with pink K-feldspars	fundamental intrusion
		leucocr. granite in places granodiorite, muscovite and two-mica	younger intr. in centre of Smrekovica type
	Žiar massif	light-coloured biot. to two-mica granite, porphyritic, medium to coarse-grained-Žiar type	fundamental intrusion
		autometamorph. and dynamic metamorph. Žiar type	central part of intrusion
		aplite-pegm. granite	marginal facies
	Apophyse of Podbranisko	aplite-pegmatite granites	apical part of stock
	Tribeč massif	biotit quartz diorites and granodiorites coarse-grained, Tribeč type	fundamental intrusion

Dimension	Mantle	Petrography**	Age*	Remarks
50 × 3 km		ZK—78, N. Boca, A 2, Bi 14, Pl 55, O 1, Kr 26 %	J. Kantor, 1959, 1964 K/Ar—Ž 270, B 290—305	
n100—1000 m × n100—1000 m				
4 × 4 km		ZK—24, Sopotnica, A 1, Bi 7, Pl 47, O 14, Kr 28, Mu 3		
29 × 8 km discont. exposures	hornfels gneisses, granitoids of fund. intr.	ZK—91, Magurka, A 1, Bi 1, Pl 19, O 41, Kr 36, Mu 2 %	J. Kantor, K/Ar—Ž 280, B 288—305 m. y.	
14 × 5 km discont. exposures		ZK—20, Matejková, A 1, Bi 12, Pl 55, O 6, Kr 26 %		D. Kubíny, 1958
8 × 8 km discontinuos exposures		ZK—90 Lub. dolina valley, A 1, Bi 4, Pl 20, O 34, Kr 38, Mu 3 %		
8—10 × 14 km	gneisses, migmatized gneisses	ZK—62 M. Čausa, A 1, Bi 5, Pl 40, O 22, Kr 30, Mu 2 %		A. Klinec, 1958
n100—1000 m × n100—1000 m				
12 × 6 km discontinuous				
n100 × n100 m	gneisses and migmatiz. gabbro-amphibolites	ZK—55, Podbranisko, A 1, Bi 1, Pl 29, KŽ 32, Kr 35, Mu 2 %		L. Kamenický, 1963
30 × 12 km	gneiss-relicts in granitoids	ZK—1, Rakytky, A 2, Bi 21, Pl 50, Kr 25, Mu 2 %	B. Cambel et al., 1977, U, Th, Pb, Z 200, 285, 295 m. y.	E. Krist, 1960

Pluton	Massif	Rock type	Geolog. position
		biot. granodiorites to quartz diorites, medium-grained	variety of fundamental type
		leucogranite, locally to granodiorite, musc. and two-mica	marginal, overlying differentiates
Vepor pluton	Hrončok intrusion	biotite, light-colour. porphyritic granite-Hrončok type	Permian or Alpine-influenced Vepor type
	Vepor pluton s. s. northern branch of fan-like pluton	syntectic granites and granodiorites or quartz diorites	hybrid parts of main intrusion
		biot. granodiorites to granites often porphyritic-Vepor type	main part of Vepor pluton
		biot. granodiorite to quartz diorite-Sihla type	central part of pluton
		biot. granodiorite to quartz diorite with pink K-feldspars, porphyritic Ipeľ type	autometamorphosed variety
	Southern branch	Ditto and	
		biot. granites and granodiorites, coarse-grained, porphyritic	smaller apophyses in pluton
		biot. granites and granodiorites, often leucocr.	marginal leucocratic facies
	Isolated apophyses in the Lub. and Krak. zones of the Veporides	varieties of quartz diorites, granodiorites to granites, often syntect.	Vyhne, Povrazník, Lieskovec, Bujakovo, Čertovica . .

Dimension	Mantle	Petrography**	Age*	Remarks
16 × 5 km discont. exposures				
2 × 7 km at east periphery		ZK—42, Janová Ves, A 1, Bi 6, Pl 32, O 29, Kr 30, Mu 2 %		
7 × 1 km	late-orog. migmatites, porphyroids	ZK—26, Hrončok, A 1, Bi 7, Pl 34, KŽ 28, Kr 28, Mu 2 %	B. Cambel, et al., 1977, U, Th, Pb, Z 260, Rb/Sr, B 214, K/Ar B 98, Ž 110 m. y.	V. Zoubek, 1966
16 × 4 km	biot. and two-mica gneisses partly migmat. or hornfels	ZK—29, Dobroč quarry, A 1, Bi 14, Pl 40, O 13, Kr 31, Mu 1 %	Dobroč, U, Th, Pb, Z 320 m. y.	V. Zoubek, 1967, A. Klinec, 1976
75 × 22 km				
		ZK—28, Sihla, A 2, Bi 17, Pl 53, O 6, Kr 22 %	B. Cambel et al., Sihla, U, Th, Pb, Z 500, 395, 380 m. y.	E. Krist, 1979
38 × 6 km		ZK—66, Ipeľ. potok brook, A 1, Bi 5, Pl 36, KŽ 28, Kr 28, Mu 2 %		
n1000 × × n1000 m	Vepor type of granitoids, migmatites	ZK—56, Č. Lehota, A 1, Bi 8, Pl 36, O 24, Kr 28, Mu 3 %		L. Kamenický, 1963 A. Klinec, 1976
8 × 2,5 km	biot. and two-mica gneisses mica-schists, amphibol., migmatites			
	gneisses, qu. gneisses, migmatites, amphibolites	ZK—58, Lieskovec, A 1, Bi 5, Pl 50, O 16, Kr 28 %		

Pluton	Massif	Rock type	Geolog. position
Bujanovo—Ťahanovce pluton	Bujanovo intrusion	granites, granodiorites, biot. muscovite, to quartz diorites	
	Sopotnica intrusion	quartz diorites	
	Sokol intrusion	„	
	Ťahanovce intrusion	„	
Ľubietová Krakľová zone of subvolcanic magmatites	Isolated apophyses, effusions	granodiorite-porphyrites, granite porphyries ...	Povrazník, Lopej, Braväcovo, Bacúch, Polomka ...
Rimavica pluton	Sinec massif	musc. to two-mica leucogranites and granodiorites	apical parts of intrusion with various varieties
	Revúca massif	ditto	ditto
	Cínobaňa apophyses	ditto	ditto
Gemeride pluton, Variscan	Turčok massif	granodiorite fine-to medium-grained	apical part of intrusion
	Dobšiná apophyse	gabbrodiorite to quartz diorite	apical part of intrusion
	Klatov massif	ditto	

Dimension	Mantle	Petrography**	Age*	Remarks
8 × 3 km	biot. and two--mica gneisses, migmatites, amphibolites			Jacko, 1978
3 × 1 km	ditto	ZK—12, Sopotnica, A 2, Bi 15, Pl 55, O 3, Kr 24, Mu 1 %		
2.5 × 2 km				
6 × 4 km	ditto	ZK 11, Ťahanovce, A 1, Bi 10, Pl 51, O 12, Kr 26 %		
zone 64 km/ n 100 × n1000 m	biot. and two--mica gneisses, mica schists, phyllites, amphibolites	ZK—7, Leňušská dolina valley, A 2, Bi 18, Pl 50, O 5, Kr 25 %	B. Cambel et al., 1977 Leňušská dol. U, Th, Pb, Z 230, 370, 350 m. y.	V. Zoubek, 1969 L. Kamenický, 1973
16 × 6 km	two-mica mica-schists, limestones, graphit. quartzites, amphibol.			M. Kužvart, 1956, J. Kamenický, 1977
24 × 5 km		ZK—67, Lubeník, A 1, Bi 4, Pl 37, O 17, Kr 40, Mu 1 %	B. Cambel et al., 1977, Chyžné, U, Th, Pb, Z 265, 315, 310 m. y.	
n100 × n100 m				A. Biely, 1954
6 × 1 km	phyllites and porphyroids of the Gelnica Subgroup			
5 × 2 km discont. exposures	phyllites, tuffites and diabases of the Rakovec Form. and phyllites of the Gelnica Subgroup		B. Cambel et al., 1980, K/Ar 338.5; 357.7; 258 m. y.	L. Kamenický — M. Marková, 1957; L. Rozložník, 1961
15 × 1.5 km discont. exposures	ditto		B. Cambel et al., 1980 K/Ar, 352.5 m. y.	

Pluton	Massif	Rock type	Geol. position
Gemeride batholith, Neoid-regenerated	Hnilec apophyses and stocks	automet. two-mica granite	apical parts of apophyses and stocks
	Betliar stock	granite porphyry	
	Smolník vein bodies		
	Humel stock Poproč massif	autom. two-mica granite porphyritic Varieties of autom. two-mica granite	

Explanations: *The first value in analysis of zircons by U—Th—Pb method results the isotope ratios 207 Pb/206 Pb; the second from the ratio 207 Pb/235 U, the third 206 Pb/238 U. As most reliable determination of age from ratio 206 Pb/238 U is considered B — biotite, M — muscovite, Z — zircon, Ž — feldspar;** A — amphibole, Bi — biotite, Mu — muscovite, Pl — plagioclase, O — K-feldspar, Kr — quartz.

Generally there are light- coloured, fine- to mediumgrained rocks with distinct parellel structure. The mineral composition consists usually of oligoclase, quartz, ± orthoclase, ± biotite, ± muscovite. An accessory typical besides zircon and apatite is silimanite. In some varieties also microcline is found.

Intrusive bodies of orthogneiss character

As mentioned above, under conditions of regional metamorphism also ultrametamorphism, synkinematic migmatization and simultaneously palingenesis was taking place. The palingenetic melt intruded in form of smaller and larger bodies of subautochthonous synkinematic intrusions. These were called Králička type granite by V. Zoubek in the Nízke Tatry Mts.

Intrusions of relatively greater dimensions are known from the southern surroundings of Muráň. The intrusion penetrated into the overlying so called Bystrá subgroup with abundant syngenetic basic volcanics. It is proved by enclaves of amphibolites in the intrusion body.

Similar types of orthogneisses of intrusive character are also found in the Vysoké Tatry, Tríbeč, Čierna hora Mts. and Ľubietová zone of the Veporides. In the group of ZK samples from the mentioned rocks are a few examples and therefore it is not possible to solve genesis of these rocks in the individual mountain ranges.

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Dimension	Mantle	Petrography	Age	Remark
8 × 3 km discont. exposures	phyllites and porphyroids of the Gelnica Subgroup	ZK—34, Hnilec vrt. A 1, Bi 7, Pl 30, O 32, Kr 27, Mu 3 %	J. Kantor, 1957 K/Ar Betliar 98 m. y.	J. Kamenický — L. Kamenický, 1955
600 × 600 m	porphyroids and phyllites of the Gelnica Subgroup		K/Ar age M 241—141, B 196—105, Ž 128—98 m. y. Rb/Sr 250 and 145 m. y.	J. Kantor — M. Rybár, 1979; Kovách et al., 1980
n10 × n100 m	ditto			A. Klinec, 1959
1 km × 200 m 6 × 1 km	ditto			