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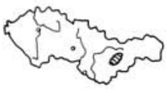
INTRUSIVE COMPLEX OF THE JAVORIE MTS.

(Figs. 1—4, Tab. 1, Photos 1—4)



Abstract: Two fundamental types of intrusive rocks have been distinguished by the petrographic study of the intrusive complex in the area of Javorie:

a) more basic diorite porphyry (in the borehole GK-7)

b) more differentiated type near the village Kalinka (borehole KON-1) represented by quartz diorite porphyry to quartz monzo-diorite accompanied by minor basic and acid differentiates. The basic diorite porphyry represents probably bodies of sill-like type. The more differentiated one near the village Kalinka corresponds in its form probably to an intrusive stock. It is accompanied by an aureole of intense hydrothermal alterations with a charactestic zonality. The zonality of hydrothermal alterations reflects distribution of temperature zones after emplacement of the intrusion. Overlaping of high-temperature associations (the zone of biotitization) with lower temperature associations can be explained by a backward migration of temperature zones during cooling of the intrusion.

The intrusion near Kalinka is characterized by indications of polymetallic mineralization of the porphyry type.

Резюме: Петрографическим изучением интрузивного комплекса в области Яворие были расчленены два основные типы:

а) более базитовый диоритовый порфир (скважина GK-7)

б) более дифференцированный тип близ с. Калинка (скважина KON-1) который представляет кремнисто-диоритовый порфир до кремнистого монзодиорита сопроводящим более базитовыми и кислыми дифференциатами. Более базитовый диоритовый порфир представляет тела вероятно пластового типа (силль). Более дифференцированный близ с. Калинка своим оформлением отвечает вероятно интрузивному штоку. Он сопровожден контактовой зоной интензивних гидротермальных изменений и характеристической зональной структурой. Зональность гидротермальных изменений отразывает распространение температурных зон после размещения интрузии. Перекрытие высокотемпературных ассоциаций (в рамках зоны биотитизации) нижейшими температурными ассоциациами может быть объяснено возвратной миграцией температурных зон во время стынутия интрузии.

Интрузия близ с. Калинка отличается индициами полиметаллической минерализации порфирового типа.

We devote this work to the memory of Dr. Ján Valach, who stood at the beginnings of geological investigation and exploration of the area studied and only premature departure did not permit him to realize his intentions and to participate in contemporary progress in knowledge of the area.

Introduction

The intrusive complex of Javorie represents a part of the polygenic volcanic structure, development of which was taking place throughout the

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Neogene. The stratovolcanic character of the surficial structure was confirmed by the works of R. Kettner (1939) in the area of the southern slopes of the mountains, by works carried out in the area of the northern slopes by E. Krist— M. Koděra (1956), and by regional mapping during the compilation of the geological map 1:200 000 (M. Kuthan et al., 1963). The mentioned authors pointed to some forms of vein and neck type as probable communication channels of andesite volcanism. M. Kuthan (1956), who carried out more detailed studies in the area west of Detva (Rohy-Švost- Kapolna) came to the conclusion about the presence of a larger number of bodies of the vein and neck type, on the basis of which he supposes a larger number of eruptive centres or relics of several volcanoes in this area.

The first author, who found surficial exposures of deeper intrusive bodies during prospection works in the years 1962-1965 was J. Valach (1966). In the wider area of the village Kalinka he described bodies of small intrusions of variable composition: pyroxene diorite porphyrites, facies of gabbrodiorite, hornblende pyroxene diorite porphyrites, and more acid granitoid differentiates. In the area of intrusions and zones of hydrothermaly altered rocks with occurrences of secondary quartzites he found anomalous content of the elements Cu-Bi-Mo-(Sn) in soils.

New data on the character of the intrusive complex were brought by mapping (V. Konečný in the years 1972-1979) and structural boreholes GK-7 (V. Konečný — A. Mihálikova, 1972) and KON-1 (V. Konečný — A. Miháliková, 1977), which we present in this work.

Character of surrounding environment

The intrusive complex occurs in intravolcanic position in the frame of the volcanic structure (Fig. 1) and also in subvolcanic level, i.e. in the frame of the pre-volcanic substratum, often using the boundary of underlying rocks to the volcanic complex.

The pre-volcanic substratum in the wider area of the Javorie mountains is formed by crystalline schists (gneisses, paragneisses, migmatites, amphibolites) and granitoid rocks, which are part of the Kráľova hoľa complex of the Veporide crystallinicum. The remnants of the envelope group in the wider area are formed by Permian and Mesozoic (Triassic, Jurassic) rocks.

Continuation of the structural—tectonic units of the Veporides, submerging below the volcanic complexes at their eastern margin, is confirmed by geophysical works and structural boreholes (O. Fusán et al., 1971). Rocks of the pre-Tertiary basement are cropping out amidst products of Neogene volcanism also in form of isolated exposures (islands), which represent the apical parts of elevation structures of the basement. Most significant are the exposures of the basement near Pliešovce, Lieskovec and Ábelová.

In the central part of the mountains, underlying the stratovolcanic structure, rocks of the Veporide crystallinicum are attested by borehole GK-7 (near the village Stará Huta) in the interval 1515,30 — 1564,30 m, represented by migmatized gneisses, amphibolites and layers of marmorized carbonates. The complex is intensively affected by dynamic metamorphism, mylo-

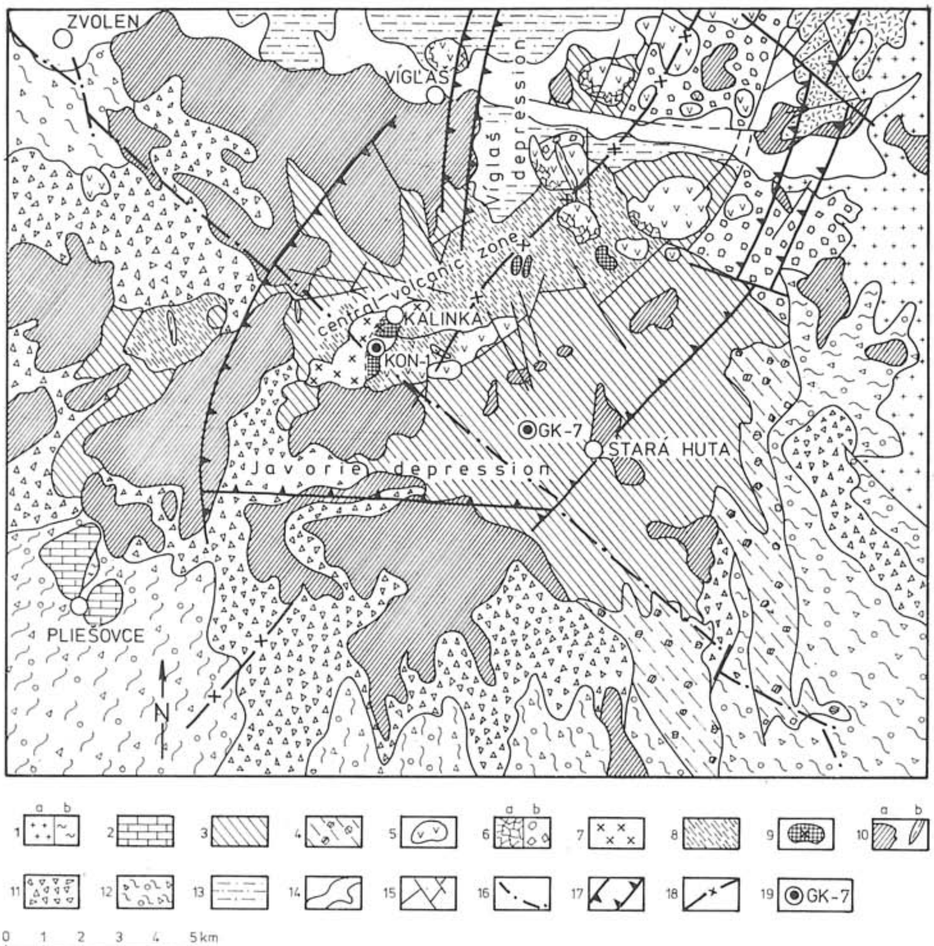


Fig. 1. Structural scheme of the Javorie Mts (V. Konečný, 1980)

Explanations:

1,2—underlying rocks

1—crystalline complex of Veporides: a) —granodiorite, granite, b) —gneisses,

2—Mesozoic complex — Triassic, Jurassic (quartzites, dolomites, limestones),

3—12—Neogene volcanic and intrusive rocks of Javorie Mts.

3—lava flows and hyaloclastite breccias of pyroxene basaltic andesites — Blýskavica formation,

4—reworked hyaloclastite breccias and conglomerates,

5—extrusive bodies of pyroxene—hornblende andesites —Rohy formation,

6—a) —coarse extrusive breccias; b) —coarse epiclastic breccias —Rohy formation,

7—intrusive complex of Javorie Mts. (quartz diorite porhpyry and quartz diorite),

8—hydrothermally altered (propylitized) volcanic rocks mainly of the Blýskavica and Rohy formations,

9—secondary quartzites,

10—lava flows and dykes of pyroxene andesites with hornblende — Javorie formation,

11—pyroclastic and epiclastic breccias — Javorie formation,
12—epiclastic breccias and conglomerates — Javorie form,
13—Pliocene sediments,
14—Quaternary fluvial sediments,
15—faults,
16—Kunešov-Lysec volcanotectonic zone,
17—margins of volcanotectonic depressions (faults identified in structure of fundament by gravity measurements),
18—Javorie-Poľana volcanotectonic zone,
19—boreholes.

nitization and partly diaphthorization. A. Klinec — O. Miko (in V. Konečný — A. Miháliková, 1972) consider it as continuation of the Kráľova hoľa complex.

The exposures of biotite granodiorites to granites (Vepor type) (D. Hovorka in M. Kuthan, 1963) together with crystalline schists occur in outcrops of the brook Madačka near Ábelová.

To the Králova hoľa complex probably also phyllonites similar to diaphthorites of the Veporides from the area of the exposures near Pliešovce belong (O. Fusán, 1971). The envelope group is formed by Triassic to Jurassic rocks, which occur in surficial exposures near Pliešovce (SW margin of the mountains). The Lower Triassic includes epimetamorphosed quartzites with layers of conglomerates and quartz—sericite schists or chlorite schists. Higher up are lying Middle to Upper Triassic dolomites, overlain by white to pink limestones considered as Jurassic (O. Fusán et al., 1971).

Triassic rocks (quartzites and quartz sandstones) are at the southern margins of the mountains, verified by boreholes near Hor. Tisovník.

The northern, Kraklová zone (separated by the Pohorelá fault line from the southern Kráľova hoľa zone) is formed by granitoids and crystalline schists and represents the substratum of the Zvolensko—Slatinská kotlina depression and of the northern margins of the Javorie mountains. Part of the envelope group are Permian rocks, attested in the facies of arcoses and shales overlying the crystallinicum in the area of the Zvolensko—Slatinská kotlina depression (M. Pulec, 1966) and in the form of quartz porphyries occurring in surficial exposurs near Lieskovec.

From the present state of knowledge it results that the environment of the intrusive complex underlying the stratovolcanic complex are rocks of the Veporide crystallinicum (so far the only information in this direction was provided by the borehole GK-7).

The further environment, in which the intrusive complex occurs are the lower parts of the volcanic structure of Javorie (Figs. 1, 2). The lower part of the volcanic structure is formed by a buried stratovolcanic complex, which is attested in the underlier of younger formations by the structural borehole GK-7 in thickness 924 m. The lower structure is formed by alternating lava flows and volcanoclastic rocks of pyroxene and hornblende—pyroxene andesites, with layers of epiclastic rocks and pyroclastics of more acid hornblende—biotite andesites in the upper part. The buried stratovolcanic complex is pierced by numerous dykes of hornblende andesite. Direct data for the age of the lower part of the volcanic structure are missing, we suppose its formation in the time of the Lower Badenian. The dyke of hornblende andesite at depth 783,0 in borehole GK-7, which pierces the stratovolcanic complex and therefore is evidently younger, is dated by K/Ar metod to 15,7 $\pm$ 1 mil.y. (V. Konečný — G. P. Bagdasarjan — D. Vass, 1969).

In overlier the Blýskavica formation of thickness about 300 m follows, formed by alternating lava flows of intermediate to basalt andesites with layers of hyaloclastite breccias. The formation forms the upper part of filling of the volcanotectonic depression, development of which was taking place syngenetically with effusive activity. The dimensions of the depression oriented in NE-SW direction designated as Javorie volcanotectonic depression were delimited on the basis of gravimetric measurements (V. Konečný — J. Lexa — J. Šefara, 1978). The age of the formation

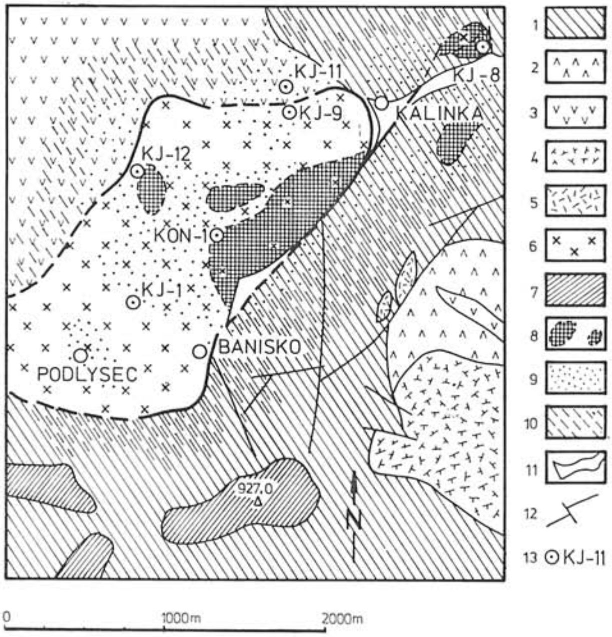


Fig. 2. Scheme of geologic structure of the area near Kalinka village

Explanations:

1—hyaloclastite breccia and lava flows of basaltic andesite — Blýskavica formation tion
2—pyroxene andesite with hornblende
3—hornblende andesite
4—dacite (pyroxene, hornblende, biotite)
5—rhyodacite (hornblende biotite, quartz), 2 — 5- Rohy formation
6—quartz diorite porphyry
7—pyroxene andesite with hornblende — Javorie formation
8—secondary quartzites
9—argillization
10—propylitization
11—Quaternary alluvial deposits
12—faults
13—boreholes

has so far been determined on the basis of one radiometric dating by K/Ar method to 15,6 ± 0,6 mil.y. (V. Konečný — G. P. Bagdasarjan — D. Vass, 1969).

A higher member of the succession are products of the Rohy formation represented by domatic extrusions and intrusions of pyroxene— hornblende andesites with biotite to dacites and subordinately by extrusions of rhyodacites. The intrusive—extrusive activity is connected with development of the Vígľaš volcanotectonic depression. (V. Konečný — L. Dublan, 1975) in the area of Vígľaš-Klokoč-Detva. At the periphery of some domatic extrusions are accumulated coarse chaotic breccias formed in the course of the extrusive process. The domatic extrusions were dated by fission track method to 15,9 ± 0,8; 15,2 ± 0,8; 15,4 ± 0,9 mil.y. (I. Repčok, 1978).

The upper volcanic structure of stratovolcanic type designated as the Javorie formation is situated in overlier of the intrusive complex. The formation is formed by lava flows of pyroxene andesite and hornblende pyroxene andesite and builds up the apical parts of the mountains with volcanoclastic rocks. The volcanic products are lying on the denuded surface of older structure. Radiometric dating of lava flows by K/Ar method provided the ages 10,0 mil.y. and 11,1 ± 0,4 mil.y. (G. P. Bagdasarjan — L. Dublan — V. Konečný — E. Planderová, 1977).

The intrusive complex near the village Kalinka occurs amidst hydrothermally altered volcanic rocks. J. Valach (1966) states that „small intrusions are surrounded by hydrothermally altered rocks", not discussing nearer the relations of age to the succession of volcanic rocks. According to the same author the intrusions as well as zones of hydrothermally altered rocks and occurrences of secondary quartzites are bound to dislocation zones of NE direction.

The volcanic complexes within the Javorie and Vígľaš volcanotectonic depressions were subjected to hydrothermal alterations in chlorite—carbonate or epidote—chlorite facies, which are characterized by areal extent. In zones of hydrothermally altered rocks bodies of secondary quartzites with variegated association of secondary minerals occur; sericite, kaolinite, pyrophyllite, diaspore, alunite, zunyite, further haematite, pyrite, ilmenite, rutile, nacrite, brookite, described in detail first by J. Valach, 1966.

The bodies of secondary quartzites and zones of argillization are closely associated with intrusions (area of Kalinka) on the one hand but also occur particularly within propylitized rocks (in the area of the Vígľaš depression near the village Klokoč). A. Mihálik — V. Konečný — J. Valach (1975) put the hydrothermal alterations, products of which are polyzonal profiles of propylitized and silicified rocks from chlorite—carbonate or epidote—chlorite facies through sericite—quartz facies, the facies of argillized quartzites to the facies of pure monoquartzites into connection with reverberations of intrusive activity in the area of Kalinka.

In the last time M. Marková — J. Štohl (1978) carried out detailed characterization of mineralogical associations of secondary quartzites, established some new minerals (topaz, dickite) and confirmed zunyite. The mentioned authors distinguished characteristic facies; quartz—alunite, of pure silicites, argillized silicites, quartz—topaz and quartz—suplhur—alunite. They consider these associations as product of low—temperature processes of solfatara type and draw the conclusion that they need neither genetically nor in time be connected with the aureole of high—temperature alterations, which were described by J. Valach (1966) at the periphery of diorite intrusions in the area of Kalinka and by V. Konečný — A. Miháliková (1977) in borehole KON-1.

Structural—geological position

From structural view—point the intrusive complex is located in the area of the Javorie volcanotectonic depression (V. Konečný — J. Lexa — J. Šefara, 1978), the beginning of formation of which is connected with development of the Blýskavica formation (Fig. 1).

On the basis of interpretation of gravimetric measurements (L. Zbořil — V. Konečný — M. Filo, 1971 and V. Konečný — J. Šefara — L. Zbořil, 1973) the course of a dislocation zone of NE-SW direction was delimited in underlier of the stratovolcanoes of Javorie and Poľana, designated later as the Javorie and Poľana volcanotectonic zone (V. Konečný — J. Lexa — J. Šefara, 1978).

The course of this zone corresponds with the axial part of the Javorie volcanotectonic depression and Vígľaš depression. The position of the intrusive complex falls to the area of crossing of the mentioned volcanotectonic zone with the course of a transversal dislocation system of NW-SE direction (L. Zbořil — V. Konečný — M. Filo, 1971) (Fig. 1).

On the basis of surficial exposures the intrusive complex near the village Kalinka extends over an area of about 5 km^2. Its environment in the lower level are products of the lower volcanic structure and higher up at the level of denudation cut it occurs amidst rocks of the Blýskavica formation and intrusive—extrusive bodies of pyroxene—hornblende and hornblende andesites parallelized with the Rohy formation (Fig. 2).

On the basis of present-day knowledge the intrusive complex does not reach the upper volcanic structure represented by the stratovolcanic complex of the Javorie formation.

An age of 13,2 $\pm$ 0,8 mil.y. was determined by fission track method on biotite (I. Repčok, 1978). An age of 16,2 mil.y. was obtained by K/Ar method for plagioclase (J. Kantor, 1979).

Formation of the intrusive complex near Kalinka, according to present—day knowledge, falls to the period after the origin of the Blýskavica formation and intrusive—extrusive bodies of the Rohy formation and before development of the upper volcanic structure of the Javorie formation.

The borehole GK-7, which was situated about 1,5 km SE of the village Kalinka (Fig. 3) (at the subvolcanic level, verified intrusive bodies of diorite porphyries; in the interval 1168— 1500,2 m and in the interval 1564,3 — 1590,0 m) the borehole was finished in the last body. The upper body is situated at the boundary of the substratum and the volcanic complex, the lower body, separated from the upper one by the complex of the Veporide crystallinicum, is situated within the substratum.

The intrusion is pierced by dykes of hornblende andesites, which intrude

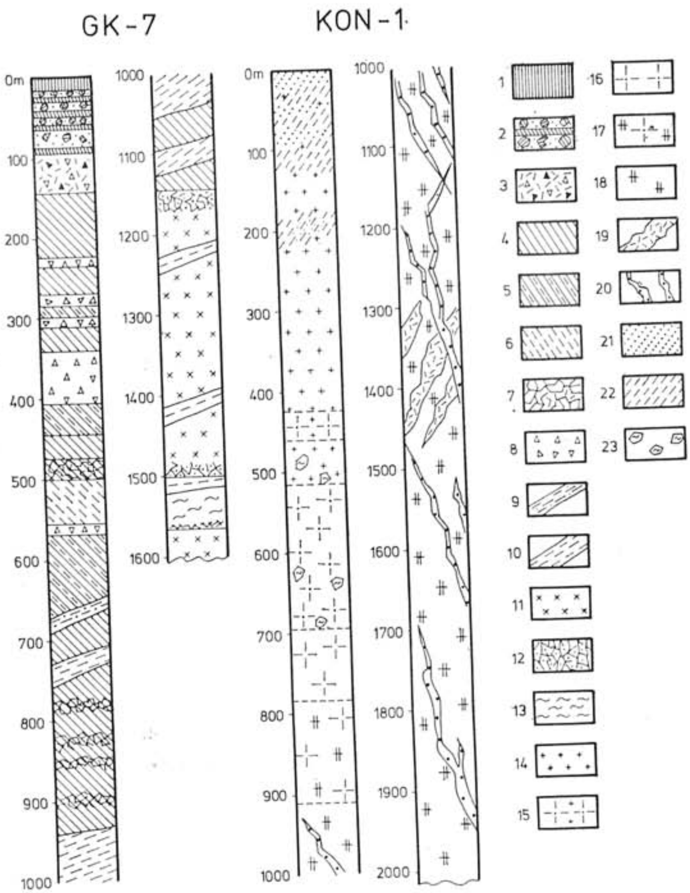


Fig. 3. Lithological profiles of the structural boreholes GK-7 and KON-1.

Explanations:

1—pyroxene andesite—Javorie formation
2—hyaloclastite breccias and lava flows of basaltic andesites-Blýskavica formation
3—epiclastic and pyroclastic breccias of pyroxene andesite with hornblende and biotite
4—pyroxene andesite
5—pyroxene andesite with hornblende
6—hypersthene andesite
7—lava breccia
8—epiclastic breccias
9—dykes of hornblende-biotite andesite
10—dykes of hornblende andesite
11—diorite porphyry
12—intrusive breccia of diorite porphyry
13—migmatitized gneisses and amphibolites-Kráľova hoľa komplex of Veporides
14—quartz diorite porphyry
15—quartz diorite porphyry to quartz diorite
16—quartz diorite

17—quartz diorite to quartz monzodiorite
18—quartz monzodiorite
19—basic differentiate
20—acid differentiate-aplite
21—argillization
22—quartzization
23—xenoliths of underlying rocks (gneisses)

also into the lower stratovolcanic structure, thus are evidently younger. A dyke of hornblende andesite piercing the lower stratovolcanic structure at the depth of 783,0 m (as mentioned above) was dated to 15,7 $\pm$ 1 mil.y. These facts make us suppose that the intrusive complex near Kalinka and the intrusions attested by borehole GK-7 are probably not of the same age. The intrusions in borehole GK-7 are probably older and their formation falls to the period after the origin of the lower structure and of the hyaloclastite complex of the Blýskavica formation and before intrusive activity of hornblende andesite.

The form of intrusions

For evaluation of the type of form of intrusions data of only several boreholes are available, not permitting to solve the problem unambiguously.

a) The diorite intrusion verified by the borehole GK-7 in the interval 1168—1500,2 m was emplaced between the pre-volcanic substratum (formed by Veporide crystallinicum) and the overlying volcanic structure (Fig. 3). In the upper part of the intrusion at the contact with the overlying volcanic structure in the interval of 1168—1141 m is a zone of breccias formed by fragments of pyroxene andesite, hornblende pyroxene andesite, basaltic andesite and diorite, which are enclosed in the diorite body. At the base of the body in the interval of 1493,0 — 1503,0 m is again a zone of breccias formed predominantly by fragments of rocks of the substratum enclosed in diorite.

Similarly the lower body in the interval 1564,3 — 1590,0 m situated within the substratum has in the upper part a zone of breciation with rocks of the substratum.

As only data from one borehole are available, the form of the body cannot be solved unambiguously. We assume that the most probable type of form are concordant bodies of sill-like type, indicated by the tendency of using the lithological boundary between the substratum and the overlying volcanic complex and the absence of structures characteristic of forcible intrusions or of the process of „magma stopping".

b) The intrusive complex near the village Kalinka is by a denudation truncation uncovered in a series of exposures amidst propylitized rocks of volcanic complexes (Fig. 2). Its border in SW direction has not been completely solved so far. The intrusive complex is prevailingly formed by quartz diorite porphyries to quartz diorites, subordinately more acid and more basic differentiates are present, which J. Valach (1966) described as individual small intrusions. On the basis of mapping and technical works we come to the conclusion that there is a more extensive intrusion or intrusive complex with more differentiated facies in marginal parts.

In the upper part of the intrusion and at its margin are discontinuous widened zones of argillization (encroaching on the surrounding rock complexes) and bodies of secondary quartzites. The immediate contact with surrounding rocks is not uncovered. At the northern margin of the intrusion zones of intrusive breccias and transition into a finer—grained development of groundmass have been found in boreholes. The borehole KON-1 situated about 1,5 km SW of the village Kalinka (area of Banisko) verifies the intrusive body in the whole extent of 2020 m.

On the basis of present—day knowledge we suppose that the intrusion is a body with vertical continuation and its form probably corresponds to a stock.

Petrographic characterics

For the first establishing of intrusive bodies in the wider area of Kalinka, defining of their main petrographic types as well as rocks of the volcanic complex, further for determining of the types of hydrothermal alterations and their mineralogical content are indubitably the pioneer and extraordinarily meritorious works carried out in this area in the years 1962—1965 during prospection—geological mapping by Dr. Ján V a l a c h.

He was the first to point to processes of alkalic metasomatism (which in his opinion resulted in formation of monzo—diorite types of rocks) and to processes of biotitization and actinolitization in intrusive bodies. He understood correctly connection of hydrothermal alterations (represented by zones of propylitization, argillization and silicification) with reverberations of intrusive activity. His finding of higher concentrations of Sn-Bi-Mo(Cu), associated with bodies of secondary quartzites and intrusive bodies, further establishing of occurrences of alunite played an important part in activation of further geological investigation in this area.

Dr. J. V a l a c h took part in person in localization of structural boreholes GK-7 and KON-1.

The diorite porphyry in the borehole GK-7 (V. K o n e č n ý — A. M i h á l i k o v á, 1972) (Fig. 3.) is a massive rock of greyishblack colour, equigranular to porphyritic texture, with phenocrysts of hornblende and plagioclase. The rock is affected by hydrothermal processes, tectonically disturbed, the sliding planes are often smoother and coated with carbonates and weak impregnations of pyrite.

Microscopically the rocks is porphyritic, with holocrystalline development of groundmass of microhypidiomorphic to microallotriomorphic character. The groundmass is formed by idiomorphic tables of plagioclase, prismatic grains of hornblende, allotriomorphic grains of quartz and grains of magnetite. In plagioclasses two generations are distinguished: idiomorphic tables with dimensions 0,37 mm × 0,2 mm and allotriomorphic grains attaining dimensions 0,06 mm × 0,04 mm. The scheme of idiomorphism has the following trend: hornblende → plagioclase (1) → plagioclase(2) → quartz.

Composition of plagioclase varies in the range An_{40}-An_{50}. Maximum dimensions of phenocrysts are 3,10 mm × 2,16 mm. The phenocrysts are fresh besides the interval 1345,20 — 1380,70 m where they are replaced by calcite. Sporadically replacement by adular is observed.

Hornblende is tabular, dimensions 2,50 mm × 0,50 mm and 2,2 mm × 1,1 mm, belongs to common green hornblende. The phenocrysts are intensely altered and replaced by calcite and chlorite. At the margin the hornblende is opacitized.

Pyroxene (monoclinic) is entirely sporadical, replaced by chlorite.

Glomeroporphyritic clusters are formed by plagioclase and by hornblende with plagioclase.

Accessories are represented by apatite and magnetite.

Secondary minerals — which represent products of hydrothermal alterations, are formed by calcite, chlorite, adular, limonite.

Modal composition:

Groundmass	38,50 %
plagioclase	33,40 %
hornblende	26,60 %
ore minerals	1,50 %
	100 %

Chemical characterization of diorite porphyry in borehole GK-7 is given by chemical analyses (see Tab. 1).

Information on variations of petrographic composition, hydrothermal alterations, their zonality and ore mineralization of the intrusive complex near the village Kalinka is provided by the structural borehole KON-1. (Fig. 3).

According to the results of this borehole, the intrusion is of a distinctly porphyritic character in the upper part of the profile, lower it gradually passes into equigranular texture with increasing depth. The upper part of the intrusion is affected by intense hydrothermal alteration with formation of secondary quartzites and association of clay minerals (argillization).

On the basis of petrographic study the following facies were distinguished:

0 — 337,0 m	hydrothermally altered rock of diorite porphyry type.
337,0 — 422,0	quartz diorite porphyry
422,0 — 448,0	transitional type between quartz diorite porphyry and quartz diorite
448,0 — 460,0	quartz diorite
460,0 — 520,0	quartz diorite porphyry
520,0 — 702,0	porphyritic quartz diorite
702,0 — 789,50	quartz diorite
789,50 — 926,50	transitional type between quartz diorite and quartz monzodiorite (modal orthoclase 10 — 15 %)
926,50 — 2021 m	quartz monzodiorite/with monzonitic texture (modal orthoclase 20 %).

Quartz diorite porphyry

The rock is greyishgreen (propylitized) equigranular, with distinct fine—porphyritic phenocrysts of plagioclases and pyroxenes. Pyrite forms fine—grained impregnation and filling of small veins.

The texture is porphyritic with microallotriomorphic development of groundmass, which is formed by allotriomorphic grains of orthoclase and quartz (grain size 0,15 mm × 0,10 mm). Besides primary minerals also secondary minerals are present: sericite, actinolite, kaolinite.

Table 1

Chemical composition of intrusive rocks of the Javorie Mts.

	1	2	3	4	5	6	7	8	9
SiO_2	48,35	52,76	46,96	51,60	52,75	56,05	56,53	48,79	60,02
TiO_2	1,12	1,12	1,32	0,57	0,29	0,56	0,83	1,40	0,30
Al_2O_3	16,70	17,21	16,40	16,76	16,37	17,32	15,66	14,68	14,79
Fa_2O_3	4,23	4,83	8,43	4,98	8,90	4,80	2,52	15,30	5,79
FeO	5,17	5,17	5,05	4,19	0,49	2,87	4,74	—	—
MnO	0,15	0,18	0,21	0,14	0,11	0,14	0,11	0,33	0,04
MgO	4,34	3,51	6,09	2,77	4,18	3,83	3,08	7,65	1,31
CaO	8,68	7,70	5,80	7,65	5,94	6,87	7,01	9,65	2,38
Na_2O	2,00	3,26	2,40	2,24	2,05	3,22	3,06	1,66	3,00
K_2O	1,04	0,91	0,80	1,08	1,99	2,24	2,92	0,82	5,82
P_2O_5	0,10	0,21	0,12	0,06	traces	0,15	0,04	0,11	0,09
H_2O^+	3,66	1,02	1,02	6,66	0,48	0,80	0,15	0,49	—
H_2O^-	1,44	0,91	0,91	1,72	0,38	0,14	2,31	—	0,40
S	0,14	0,09	0,09	—	5,77	—	0,75	—	5,68
SO_3	—	—	—	—	—	0,61		0,04	0,39
CO_2	3,16	1,31	—	—	—	—	—	—	—
sum.	100,28	100,19	100,42	100,42	99,70	99,66	99,71	100,92	100,01

Explanations:

1—Diorite porphyry from the borehole GK-7, depth 1222,0 m. Analysed by E. Jirásková, GÚDŠ.
2—Diorite porphyry from the borehole GK-7, depth 1272,0 m. Analysed by E. Jirásková, GÚDŠ.
3—Diorite porphyry from the borehole GK-7, depth 1267,2 m. Analysed by E. Jirásková, GÚDŠ.
4—Diorite porphyry from the borehole GK-7, depth 1311,0 m. Analysed by E. Jirásková, GÚDŠ.
5—Quartz diorite porphyry from the borehole KON-1, dept 390,10 m. Analysed by Ing. V. Šutarová, GÚDŠ.
6—Quartz diorite from the borehole KON-1, depth 780,50 m. Analysed by Ing. V. Šatúrová, GÚDŠ.
7—Quarz monzodiorite from the borehole KON-1, depth 1649,30 m. Analysed by Ing. V. Šutarová, GÚDŠ.
8—Basic differentiate of coarse — grained pegmatite character quartz monzodiorite from the borehole KON-1, depth 1428,0. Analysed by E. Feriančiková, GP (Geological Survey) Turčianské Teplice.
9—Acid differentiate-aplitic porphyry from the borehole KON-1, depth 770,3 m. Analysed by Ing. V. Šutarová, GÚDŠ.
10—Quartz monzodiorite (modal composition page).

Explanations also for diagram figure 4.

Plagioclase (An_{36-40}) forms idiomorphic tables 3,1 mm × 1,1 mm maximum (average 1,3 mm × 0,6 mm). At joints it is sericitized and kaolinized.

Pyroxenes (augite, hypersthene) are altered into actinolite and opacitized. Dimensions are 4,4 mm × 1,7 mm maximum (average 3,7 mm × 1,5 mm).

Hornblende is intensively actinolitized.

Modal composition (after colouring tests)	
phenocrysts	32,50 %
plagioclase	
plagioclase in groundmasse	23,80 %
quartz	8,50 %
orthoclase	1,0 %
dark minerals	
(hornbl. pyroxenes)	11,20 %
	100,00 %

Quartz—diorite porphyry to quartz diorite

(Transitional type in the interval 422—443 m)

The rock is equigranular, dark—grey, with small phenocrysts of plagioclase, hornblende and pyroxene. Pyrite forms fine impregnation. The texture of rocks is porphyritic—hypidiomorphic. Development of groundmass is hypidiomorphic to allotriomorphic. The groundmass is formed prevailingly by idiomorphic tables of plagioclase with dimensions 0,20 mm × 0,20 mm, allotriomorphic grains of quartz and orthoclase of average size 0,10 × 0,10 mm and needles of actinolite. The portion of groundmass in composition of rock is lower than in case of quartz diorite porphyry.

Plagioclase ($An_{36\text{-}40}$) forms idiomorphic tables of average size 1,5 mm × 1,1 mm, with albitic and Carlsbad twinning, relatively fresh.

Hornblende is altered into actinolite and biotite. Phenocrysts attain 1,1 mm × 0,6 mm on average.

Pyroxenes (hypersthene, augite), average size 1,5 mm × 0,6 mm, intensely actinolitized and partly biotitized. Dark minerals are also replaced by pyrite. Accesories: zircon, apatite, magnetite.

Quartz diorite

In the interval 448 — 460 m the rock acquires an equigranular character. The texture is hypidiomorphic, formed by plagioclase, ortoclase and dark minerals (Plate I., Photo 1.).

Plagioclase (An_{34-40}) forms idiomorphic tables with albitic and Carlsbad twinning, size 1,5 mm × 0,6 mm to 1,3 mm × 0,50 mm.

Orthoclase and quartz form grains with allotriomorphic character, filling up the space between tables of plagioclase with idiomorphic character.

Pyroxene (augite, hypersthene) from idiomorphic grains with dimension on an average 1,3 mm × 0,5 mm, prevailingly altered into actinolite and partly also into biotite. From the depth 448 m pyroxenes are intensely biotitized.

Hornblende forms idiomorphic tables of average size 1,3 mm × 0,5 mm, intensely actinolitized and biotitized. Actinolite forms fibrous sheaf—like forms, which are filling up relicts after hornblende. Pleochroism is α = yellow, β = yellowishgreen, γ = light = green, $c/\gamma = 12°$.

Biotite (primary) is only sporadical in form of small grains 0,11 mm × 0,10 mm enclosed in orthoclase and quartz.

Accesories -are represented by zircon, apatite, magnetite, pyrite Modal compositions (after colouring tests)

Plagioclase	49,10 %
dark minerals	15,90 %
orthoclase	9,80 %
quartz	18,50 %
opaque minerals	5,70 %
	100,00 %

In the interval 460,0 — 520,0 m the intrusion is grained of porphyry character, as its inhomogenous character illustrates. In the interval 520,0 — 702,0 m the rock of diorite type continues locally with porphyritic—hypidiomorphic texture.

From the depth of 780,50 m the intrusion acquires transitional character between quartz diorite and quartz monzodiorite with increasing content of orthoclase. The boundary between the quartz diorite and quartz monzodiorite is conditional.

Quartz monzodiorite

The rock of this type represents the lowermost section of the borehole profile (interval 926,50 — 2021 m). It is characterized by inhomogenous character, with basic and more acid differentiates (Photo 3 and 4, Plate I.) and orthoclase content about 20 %.

The texture is hypidiomorphic, monzonitic (Phate I. Photo 2), formed by large grains of orthoclase (2,2 mm × 2,0 mm) with hypidiomorphic — allotriomorphic character, which enclose poikilically idiomorphic tables of plagioclase and dark minerals.

Plagioclase (An_{34-40}) forms idiomorphic tables in average of 1,5 mm × 0,3 mm, relatively fresh. From the depth of 1708 m sericitization is observed.

Orthoclase—forms hypidiomorphic to allotriomorphic delimited grains, attaining 2,2 mm × 2.2 mm on an average. Orthoclase poikilitically encloses all minerals except quartz. Perthitic textures are observed mainly in sections where the rock aquires pegmatite character. The content of orthoclase was established by colouring tests to 20 %.

Pyroxenes (augite, hypersthene) attain 1,1 mm × 0,4 mm on an average Hypersthene is characterized by intense pleochroism α = light-reddishbrown, β = yellowishbrown and γ = bright-green, 2V = 64°. Augite forms idiomorphic tables 0,8 mm × 0,4 mm on an average. Pleochroism α = light — green β = light — yellowish — green, c/γ = 44 — 47. Besides rare exceptions augite is intensively altered into actinolite and partly into biotite.

Hornblende -forms rods attaining 1,9 mm × 0,4 mm, is intensively altered into actinolite and biotite.

Biotite-forms grains 0,20 mm × 0,10 mm on an average, attaining greater dimensions with depth (at the depth of 1639 — 1655 m dimensions are 3 mm × 0,20 mm) with increasing percentual representation. Besides primary biotite also biotite of hydrothermal origin is observed, forming flaky aggregates as pseudomorphs after former dark minerals (pyroxene, hornblende). It is also found in form of fillings of hair joints and individual flakes in variable amount together with chalcopyrite.

Accesories-are represented by apatite, zircon, sporadically orthite (at depth 1871 — 1939)

Modal composition (after colouring tests)

Plagioclase	42,85 %
orthoclase	20,17 %
quartz	12,39 %
dark minerals	24,59 %
	100,00 %

At lower levels the intrusion is pierced by small veins of aplite character of average thickness 2 — 4 cm.

The texture is aplitic, the rock is formed by allotriomorphic grains of quartz (size 0,6 mm × 0,4 mm) and orthoclase (0,7 mm × 0,3 mm), which form mutual graphic intergrowth. Original plagioclases are replaced, relicts are preserved only. Dark minerals are mainly represented by biotite, primary as well as hydrothermal. Hydrothermal biotite forms pseudomorphs after hornblende and biotite.

Basic differentiates — form thicker veinlets and penetrations with irregular coarse and unsharp blurred delimitation (mainly in the section 1330 — 1480 m.). The texture is poikilophitic, prevailingly formed by dark minerals, enclosing poikilitically plagioclases and ore minerals. (Plate I, Photo. 4).

Pyroxene (hypersthene, augite) are relatively fresh. Hypersthene forms grains of hypidiomorphic delimitation, which attain the sizemof 2,2 mm × 1,1 mm to 2,4 mm × 0,8 mm. At joints they are slightly actinolitized and biotitized.

It forms about 38 — 40 % in composition of rock. Grains of hypersthene enclose poikilitically small plagioclases (less than 0,08 mm × 0,04 mm). Augite forms hypidiomorphic grains, which attain 2,8 mm × 1,5 mm and form about 5 — 10 % of rock composition.

Biotite is represented sporadically only.

Modal composition:

Plagioclase	40,80 %
pyroxenes	43,30 %
quartz	12,20 %
opaque minerals	2,60 %
orthoclase	1,10 %
	100,00 %

Remarks to petrology of intrusive complex

The chemical character of the Javorie intrusive complex is indicated by chemical analyses (Tab. I) carried out at the Dionýz Štúr Institute of Geology (GÚDŠ). The intrusion in borehole GK-7, which corresponds to diorite porphyry when compared with classical areas (A. N. Zavarickij, 1950) is situated between the prototypes Pellé and Lassen Peak, whilst the intrusion of quartz diorite porphyry to quartz monzodiorite near Kalinka is situated in the area of the Yellowstone Park prototype.

On the basis of Niggli's parameters the diorite porphyry of borehole GK-7 belongs to diorite magma and the quartz diorite porphyry and quartz monzodiorite to quartz diorite magma (P. Niggli, 1931).

The chemical properties of both intrusions are projected in the triangle according to A. Streckeisen (1967) with application of classification and nomenclature, recommended by IUGS subcommision on the systematics of Igneous Rocks (A. L. Streckeisen et al., 1973).

It results from the diagram (Fig. 4) that the intrusion in borehole GK-7 is situated in the field of diorite and gabbro. The rock is relatively basic and poor in alkalies. The intrusion near Kalinka is located in the field of quartz monzodiorite. Although the whole intrusion in borehole KON-1 near Kalinka falls to this field, according to the petrographic character (monzonitic texture) only the lower part of the borehole profile in the interval 926,5—2020 m corresponds to quartz monzodiorite.

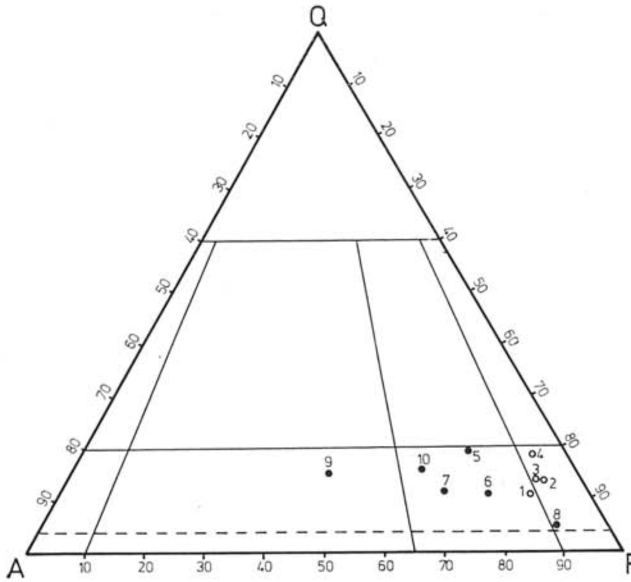


Fig. 4. Diagram QAP according A. Streckeissen et al., 1973

Acid differentiates (aplites) reach the field of quartz monzodiorite and the basic differentiates fall to the field of gabbro. From the diagram their character comagmatic with the main intrusion results (Figure 4). Basic and acid differentiates represent products of terminal differentiation of the main intrusion. Their ascent and emplacement in the upper parts of the intrusion are coincident with the period of more advanced consolidation of the body. Aplitic differentiates are, with regard to more basic ones, relatively younger as they are piercing them.

Hydrothermal alterations and their zonality in the borehole KON-1 (Kalinka)

In the upper part of the borehole to the depth of 490 m the intrusion is affected by intensive hydrothermal alterations, with characteristic zonality.

Argillization and silicification affect the upper part of the body to the depth 370 m. This zone is characterized by a loss of alkalies, then of Mg, Mn, Ca, Rb, Li and by a formation of clay minerals (kaolinite, sericite, pyrophyllite, montmorillonite), further by the presence of chlorite, quartz, alunite. Silicification and argillization are combining with each other but also occur independently.

In the interval:

0 — 16 m argillization with prevalence of pyrophyllite with good technical parametres predominates;

16,5 — 69,5 m silicification with formation of secondary quartzites predominates;

69,5 — 123,0 m argillization and silicification of lower intensity and pyritization which is most intensive in the interval 81 — 106 m. In the quartzitized rock at the same time impregnation of native sulphur is present;

123,0 — 315,0 m intensive argillization with irregular silicification of lower intensity.

Epidotization — joins in the interval 123 — 315 m.

Actinolitization characteristic by alteration of augite, hypersthene, hornblende into fibrous actinolite, which appears from depth of 337 m.

Biotitization joins from the depth 422 m and continues to the end of the borehole. Biotite forms small flakes as pseudomorphs after dark minerals and along joints.

Sericitization-joins again from the depth 1708,8 m and continues to the end of the borehole. Sericite replace plagioclase.

At the depth of 315 m sporadically fluorite is observed. The described zonality clearly shows decreasing thermality from the pneumatolitic—magmatic stage (represented by penetration of aplites and more basic differentiates through the high—temperature stage (actinolitization, biotitization), lower — temperature stage (epidotization, formation of clay minerals, silicification) to the low-temperature stage with segregation of native sulphur and SiO_2, which affects the uppermost part in the centre of the body.

The boreholes situated at the margin (Figure 2) of the intrusive body verified also tourmalinization (borehole KJ-1) in form of needles and aggregates with radial orientation. Together with tourmaline also topaz is present. The borehole KJ-12 at the western margin of the body proved the presence of topaz, tourmaline and fluorite, which represent the high-temperature stage together with continuous biotitization and actinolitization.

In the same borehole in the intervals 37,5 — 109,3 m and 357,6 — 413,3 m potassium metasomatism represented by adular is developed, which is accompanied by an association of minerals as chlorite, calcite, epidote, sericite. quartz. Intense silicification locally results in formation of secondary quartzites with alunite, pyrophyllite, illite. This association with potassium metasomatism corresponds to the low—temperature stage.

The mentioned facts testify to overlaping of two stages: the first—high temperature stage is with decreasing temperature overlapped by associations of the second-low, temperature stage i.e. an example of telescoping as a consequence of backward migration of the temperature zones with cooling of the intrusion. In the beginning stage after emplacement of the intrusion the high—temperature zone was at its periphery and more externally the lower—temperature zones was situated within the surrounding rock complexes (what conditioned their propylitization and nearer to the intrusion formation of argillization zone). With cooling of the body at decreasing temperature backward migration of temperature zones was taking place and originally high—temperature associations (zones of actinolization and biotitization) were overlapped by lower—temperature associations. The zones of argillization and silification of this stage are distributed already within the mantle of the intrusion proper (as confirmed by the results of mapping and boreholes).

Ore mineralization

The intrusion near Kalinka verified by borehole KON-1 shows indications of weak polymetallic mineralization.

In the upper part of the borehole profile is distinct pyrite impregnation (maximum in the section 69,5 — 123 m in the zone of more distinct silicification), lower it passes into small veinlets or network of small veinlets. Polymetallic mineralization (Pb, Zn, Cu) is recorded in low values already from the level of 84,5 m. A more continuous character of moderately higher values of Pb, Zn, Cu concentrations is practically from the depth of 960 m (corresponding with transition into facies of quartz monzodiorite). The mineralogical study carried out by L. Rojkovičová (in V. Konečný — A. Miháliková, 1977) confirmed: galena, sphalerite, chalcopyrite, covellite. The sulphides of Pb, Zn, Cu together with pyrite form the filling of small veinlets (up to 1—3 mm) or small network of veinlets, which penetrate along joints. At the lower levels of the borehole (1253—1787 m) with a higher content of Mo and in this section molybdenite is confirmed. Similarly the presence of cobaltite is confirmed (1984 and 1863,9 m). At lower levels of the borehole ore minerals together with calcite and dolomite (rarely also gypsum and anhydrite) form the filling of small veinlets. In the section 1861,5 — 1985,5 m in a veinlet with galena and sphalerite higher contents of Ag, Sb, Bi are observed, what may point to the presence of sulpho—salts.

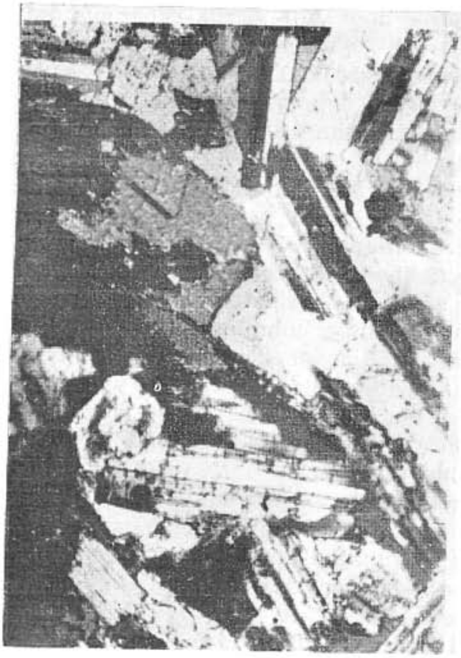
Plate 1

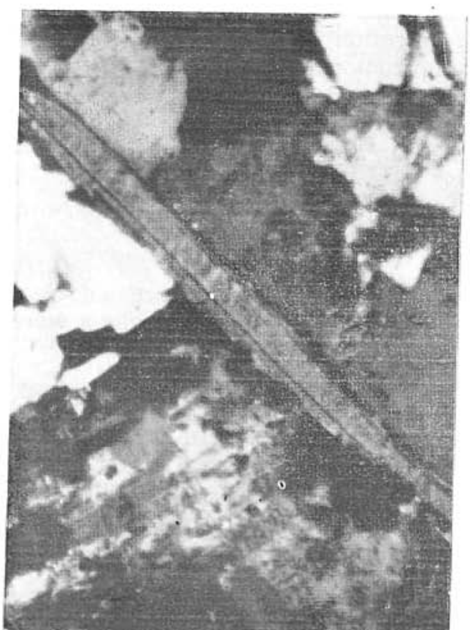
Photo 1. Quartz diorite with hypidiomorphic texture (borehole KON-1, 702 m). Crossed nicols, magn. 36. Photo A. Miháliková)

Photo 2. Quartz monzodiorite with typical monzonitic texture, grain of orthoclase encloses (poikilitically) plagioclase and femic minerals (borehole KON-1, 1718, 60 m). Crossed nicols, magn. 36. Photo A. Miháliková

Photo 3. Coarse-grained differentiate of pegmatite character from monzodiorite with remarkable flakes of biotite (borehole KON-1, 1648,0 m). Crossed nicols, magn, 36. Photo A. Miháliková

Photo 4. Basic differentiate of quartz monzodiorite with poikloophitic texture. Composition prevailingly from pyroxenes, showing poikilitic enclosing of small plagioclases (borehole KON-1, 1420,0 m). Crossed nicols, magn. 36. Photo A. Mihalíková





The ore mineralization in borehole KON-1 does not reach economic importance.

When compared with the model presented by J. D. L o w e l l — J. M. G u i l b e r t (1970) for intrusions of „porphyry copper" type, many analogous features permit to consider ore mineralization in the borehole KON-1 as the porphyry type.

From petrogenetic view -point the bearer of ore mineralization is quartz diorite porphyry to quartz monzodiorite and its form probably corresponds to stock (corresponding with the criterii mentioned by J. D. L o w e l l — J. M. G u i l b e r t, 1970). When compared with model of zonality, it is possible to distinguish the zone of p r o p y l i t i z a t i o n distributed externally from the intrusive body within the surrounding volcanic complexes. The zone of a r g i l l i t i z a t i o n (characterized by association of clay minerals; pyrophyllite, kaolinite, montomorillonite, quartz) with bodies of secondary quartzites is situated at the periphery of the body and partly reaches the surrounding rocks. Within this zone and on its more inner side is the zone of intensive pyritization (in borehole KON-1 in the interval 69 — 123 m). Internally within the intrusive body the zone of b i o t i t i z a t i o n a n d a c t i n o l i t i z a t i o n is situated. Its course is very irregular. Locally at the margin of the body it occurs to the level exposed by denudation, in places of superimposed lower — temperature association of clay minerals and silicification (argillization and silicification) as a consequence of telescoping its original course is deformed and destructed and is found at lower levels of the intrusion. This fact is observed in the borehole KON-1 situated in the central part of the body.

The ore mineralization is spread within the zone of biotitization and reaches to the zone of argillization. Higher concentration of ore mineralization is at lower levels within the facies of quartz monzodiorite.

Though ore mineralization in borehole KON-1 does not attain economic importance, establishing of the presence of the mentioned type of intrusion with porphyry mineralization is stimulating for searching of other bodies of analogous type.

Conclusions

With the petrographic study of the intrusive complex in the area of Neogene volcanic structure of Javorie two fundamental types of intrusions were distinguished:

a) more basic diorite porphyry (in the borehole GK-7)

b) more differentiated type near the village Kalinka (borehole KON-1) represented by quartz diorite porphyry to quartz monzodiorite accompanied by minor basic and acid differentiates.

The more basic diorite porphyry represents probably bodies of sill—like type, which were emplaced between the underlying rocks and volcanic structure. The intrusion is accompanied by hydrothermal alterations of lower intensity with weak pyritization.

The more differentiated type near village Kalinka probably corresponds on its form to intrusive stock and is accompanied by an aureole of intense hydrothermal alterations with characteristic zonal structure: externally from the intrusion the zone of propylitization is distributed within the surrounding volcanic rocks, at the periphery of the intrusion is the zone of argillization extending to the surrounding volcanic complexes. More internally within the intrusion is the zone of biotitization and actinolitization.

The zonality of hydrothermal alterations reflects distribution of temperature zones after emplacement of the intrusion. Overlapping of high-temperature associations (within the zone of biotitization) with lower—temperature associations can be explained by backward migration of temperature zones during cooling of the intrusion.

The intrusion near Kalinka is characterized by indications of polymetallic mineralization of porphyry type.

Translated by J. Pevný

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