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PAVEL BAČO*

CONTACT EFFECTS OF CENTRAL VIHORLAT MTS. INTRUSIVE COMPLEX ON THE SURROUNDING SEDIMENTS

(Fig. 1, Tab. 1)

Abstract: The author distinguished several types of contact effects of the Central Vihorlat Mts. intrusive complex on its environment depending on the morphological-structural type of intrusive bodies. The distinguished mineral associations permit to express the intensity of these effects in the form of zonality. The zones are: zone of albite-epidote and amphibole hornfels facies (irregular bodies — type A_1); lower-thermal albite-epidote hornfels facies (dykes and sills — type A_2 bodies); the zone of closest contact of sills and dykes (with sporadical sericite, chlorite, quartz) with A_3 type bodies, and the area of andesite veins with no contact effects. The respective zones and bodies were verified by boreholes.

Резюме: Автор различает несколько типов контактового действия интрузивного комплекса центрального Вигорлата на окружающую среду в зависимости от морфологически-структурного типа интрузивных тел. Различаемые минеральные ассоциации позволили выразить интензивность этого действия во форме зональности. Этими зонами являются: зона фации альбит-эпидотовых и амфиболовых контактовых роговиков (неправильные тела — тип A_1); ниже-температурная фация амфибол-эпидотовых роговиков (дайки и силлы — тела типа A_2); зона самого тесного контакта силлов и дайк (со спорадическим серицитом, хлоритом и кварцом) с телами типа A_3 и область андезитовых жил бес контактового действия. Эти зоны и тела были проверены буровыми скважинами.

Contact-metamorphic and contact-metasomatic effects of intrusive rocks in neovolcanic regions of Slovakia are known above all in Central Slovakia.

Contact-metasomatic effects of granodiorites (Kamenický—Štohl, 1970) are known from the Banská Štiavnica Mesozoic elevation. Even with their low grade of alteration, a varied range of associations, caused by varied composition of the original rocks, was determined.

In connection with the hypabyssal intrusion of Miocene gabbrodiorite in the Kremnické vrchy Mts. (Böhmer—Šímová, 1976), a high-temperature contact-metasomatic skarn zone with a varied mineral association was found. Mesozoic rocks were altered here, probably in the position of xenolites.

Granodiorite porphyry of the Zlatno type had contact metasomatic effects (Mihaliková, 1982) on Mesozoic and Upper Palaeozoic sediments, with the origination of minerals in albit-epidote to pyroxene contact hornfels facies.

Intrusive types in the form of sill bodies and dykes of diorite porphyry composition do not cause contact metasomatic effects (Mihaliková, l.c.) neither in the Štiavnica region, nor in the Javorie Mts.

In the East Slovakia neovolcanic rocks, in the Vihorlat Mts., the Central Vihorlat Mts. intrusive complex was verified by boreholes (Bacsó, 1985).

*P. Bačo, Geological Survey, nat. enterpr., Geological region, Garbanova 1, 040 11 Košice.

This intrusive complex intrudes through subjacent sedimentary environment in the region of the central volcanic zone Morské oko. From the point of view of morphostructure, it is formed by veins, dykes, sill bodies and intrusions with irregular shapes. The veins consist of pyroxene andesite. Dykes and sill bodies have a character of hypersthene-augite and augite diorite porphyries. Intrusive bodies of irregular shapes consist of hypersthene-augite diorite porphyry to augite diorite. More acid and basic intrusive members are present to a lesser extent.

The underlying sedimentary rocks, which are cut by the intrusive complex in the central volcanic zone Morské oko, consist, according to Bacsó, l.c., of rocks of external flysh — of the Magura Nappe. Present and verified are here above all pelitic rocks — claystones, marly claystones interchanging with aleuritic, aleuropsammitic and psammitic rocks — calcite sandstones, muscovite sandstones. Pelitic rocks strongly dominante over psammitic ones, which form thin laminae (in the range X cm to 15—20 cm) in the up to several meters thick claystone strata.

In the southernmost part of the surveyed area the underlying sediments consist of Cretaceous sequences of the Klippen Belt (Samuel. 1985).

Individual morphostructural types of the intrusive bodies display varied contact-metamorphic effects (Bačo. 1985), depending on the surrouding sedimentary environment as well as on their type.

From the lithological point of view, the most favourable environment for the origination of contact-metasomatic processes in the studied area are marly and carbonaceous sediments of the Klippen Belt Cretaceous verified by the boreholes RH-5 and RH-7. However, in this environment were found only intrusive bodies of the A_4—A_3 type (Tab. 1). Dykes and sill bodies consist of pyroxene andesite to diorite porphyry, rarely with accessory amphibole. On the contact of these bodies the surrounding rock is brecciated. It is partly re--crystallized, the manifestation of which is the enlargement of calcite grains. These rocks are sporadically cross-cut by epigenetic veinlets filled by calcite and quartz, with sulphide pyrite-pyrrhotite mineralization. Polymetallic mineralization is scarcely also present, though this is already of hydrothermal character.

Bodies of pyroxene diorite porphyries to diorites of the types A_1—A_4, i.e. dykes, sills, irregular intrusions, intruded into the environment of rocks of the Magura Palaeogene.

In the surroudings of the borehole RH-26, A_4 type bodies intruded into sedimentary rocks subjacent to the volcanic complex. They are represented by vein bodies of pyroxene andesite porphyries. Their false thickness is small and even in the closest surroundings contact metamorphic effects cannot be observed. According to Bacsó et al. (1978), these intrusive bodies are no directly genetically connected with the intrusive complex of the central volcanic zone Morské oko.

At a greater distance from the parent intrusion, the occurence frequency of dykes and sill bodies reaches the values 2—5 and their individual thickness is up to 18.5 m. Glass often takes part in the composition of the matrix of the bodies. These intrusive bodies belong to the type A_3 (Tab. 1) and they were proved in the area of the boreholes RH—9 and RH—13 (Fig. 1). They affect their surroundings only in closest contact, where the rock is brecciated.

Table 1

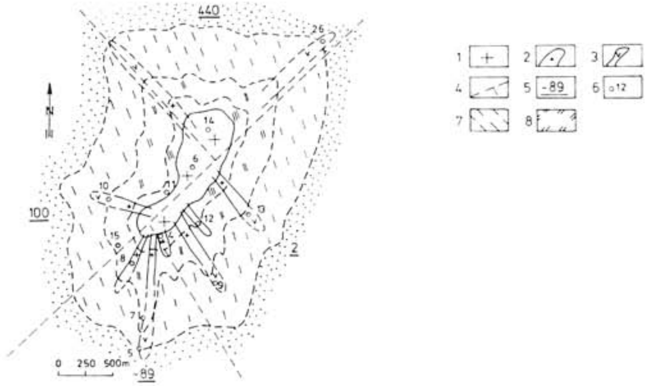
Types of intrusive bodies

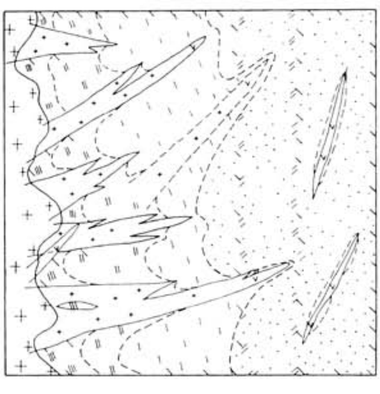
Borehole No.	RH-4	RH-12	RH-8	RH-10	RH-7	RH-5	RH-9	RH-13	RH-26
Borehole depth (m)	1.178,5	1.204,5	1.201,2	987,6	1.121,1	1.115,6	1.000,0	769.5	744.5
Above sea level height of underlying rocks (m)	—16.4	2.3	—63.9	98.7	—92.9	—108.9	—1.2	18.2	442.2
Verified thickness of underlying rocks (m)	585.1	561.0	458.7	402.5	398.6	295.9	489.6	273.5	370.7
Number of verified intrusive bodies	13	7	18	10	2	3	2	5	2
Maximal false thickness of intrusive bodies (m)	72.9	142.7	100.0	85.10	19.7	5.8	18.5	15.3	12.4
Minimal false thickness of intrusive bodies (m)	0.5	0.8	0.5	0.5	0.3	2.4	1.9	0.5	4.5
Type of intrusive bodies	A_1	A_2			A_3				A_4

It comes to more intensive blackening and solidification. From the mineralogical point of view, only certain re-crystallization of the calcite cement takes place in the psammitic-arenaceous parts. In pelitic rocks — claystones nearest to the contact not very intensive origination of sericite, chlorite and quartz takes place. Though, already in this stage of contact metamorphism it is possible to observe signs of dehydratation of the original mineral association, e.g. illite — sericite. These rocks are often cross-cut by epigenetic veinlets filled mainly by calcite, quartz and sporadically by sulphides of hydrothermal stage.

Dykes and sill bodies near the parent intrusion area verified by the boreholes RH—8, RH—12 and RH—10 (Fig. 1) have the character of A_3—A_2 type bodies. The bodies are more frequent, their frequency is more than 7, up to 18, and their individual thickness is up to 142 m. This is manifested also by their contact effects. In sedimentary environment, where these intrusive rocks occur, new mineral associations originate. These in some parts totally substitute the original associations of claystones, what is accompanied by their marked dehydratation. The most important mineral becomes quartz, with the origination of the associations chlorite + sericite + quartz ± plagioclase. The contents of the main components are variable, and the originating associations can be classed with the lowest-temperature areas of the albit-epidote contact hornfels facies. These rocks are solid, very fine-grained, varied in colour — gray, grayish green, brownish. It is possible to observe in them structural signs of the original sediments, i.e. lamination, microtectonic structures etc. The texture of the rocks is micro-grano-lepidoblastic.

The most complicated contact-metamorphic to contact-metasomatic processes occur in the surroundings of the intrusive bodies of the A_1 type. They are thick sill bodies (more than 100 m), of pyroxene diorite porphyries, but mainly irregularly shaped intrusive bodies of diorite composition in which more basic cummulates as well as more acid differentiates are present. Sedimentary environment of this type of intrusive bodies was surveyed by the borehole RH—4 and partly by the borehole RH—12 (Fig. 1).





Type of intr. bodies	Effects of intrusive bodies on surrounding sediments	Graphic depict.
A_4	Area with no effect	
A_3	Thermal effects in the surroundigs of intrusive bodies. Sporadic formation of sericite, chlorite and quartz.	
A_2	Marked thermal effects. Formation of lowest-thermal associations in albit-epidote contact hornfels facies	
A_1	Contact-metamorphic and contact-metasomatic effects. Formation of associations in albit-epidote and and amphibole contact hornfels facies	

Fig. 1. Graphical scheme of intrusive bodies types and their contact effects on surrounding underlying sedimentary environment in the central volcanic zone „Morské oko".

Explanations: 1 — intrusion of irregular shape (diorite porphyrite to diorite) — A_1 type of bodies; 2 — dykes, sills — A_2 type of bodies, number of verified bodies more than 7, individual thickness up to 143 m; 3 — dykes, sills, veins — type of bodies A_3—A_4, number of verified bodies up to 5, individual thickness up to 20 m; 4 — faults; 5 — average above sea level height of Pre-Neogene subjacent rocks; 6 — RH series boreholes; 7 — outer flysch — Magura Nappe; 8 — Klippen Belt.

The newly-formed associations totally substitute the original ones and they reflect the character and conditions of contact metamorphism. On the basis of mineral and partly chemical composition we can class the distinguished mineral associations, according to Winkler (1976), with individual contact hornfels facies as follows:

1. albite-epidote hornfels facies — associations:
tourmaline + chlorite + sericite ± plagioclase
tremolite + chlorite + quartz ± calcite ± actinolite
biotite + quartz ± plagioclase ± calcite ± chlorite

2. amphibole hornfels facies — associations:
tremolite + diopside + quartz ± plagioclase
labradorite + calcite + diopside + quartz + hypersthene

Three basic associations, in which we presume a gradual heightening of temperature and dehydratation grade, were distinquished within the albite-epidote contact hornfels facies. Characteristic is the substantial content of quartz and constant presence of chlorite ± plagioclase. Associations with this common basis are distinguished according to such minerals like tourmaline, amphibole group minerals and biotite, which do not occur simultaneously.

Description of individual associations

Association with tourmaline:

tourmaline + chlorite + sericite + quartz ± plagioclase

The rock is variable in colour; it is greyish-green with dark patches. It is very fine-grained. Its texture is micro-lepidogranoblastic, with more substantial contents of tourmaline nematogranoblastic. An essential component of the rock is newly-formed quartz in allotriomorphic form, further fine-scaled chlorite and sericite. Tourmaline occurs in this environment as a product of contact metamorphism. It is hypidio- to allotriomorphic with brown pleochroism (ω). It is finely dispersed in all rock. The size of cross-sections is up to 0.05 mm. Lamelled plagioclase — oligoclase An_{24} is present sporadically.

Association with amphiboles:

tremolite + chlorite + quartz ± calcite + actinolite

In contrast to the previously described association, this one is enriched in minerals of the amphibole group — tremolite and actinolite. We consider this association to be higher-thermal, nearer to the contact. It is evidenced by a higher grade of dehydratation — i.e. the presence of amphiboles, and by a shortage of boron — i.e. the absence of tourmaline.

The rock is of grey to dark greyish-green colour, it is massive, very fine-grained. The texture is micro-nematoblastic, where the contents of quartz and chlorite are more substantial, the texture is lepidogranoblastic. Tremolite is an essential mineral, the average size of cross-sections is 0.1—0.05 mm and its content up to 40 %. It has lath-like habitus and is hypidiomorphic. The orientation in the rock is directionless.

Association with biotite:

biotite + quartz ± plagioclase ± calcite ± chlorite

This is a case of biotite contact hornfelses. The rock occurs above a body of augite diorite porphyry to diorite not reached by the boreholes. It is grayish--brown, very fine-grained, massive. The texture is micro-lepidogranoblastic. Characteristic is the presence of contact-metasomatic biotite (10—15 %). It occours in the form of fine hypidiomorphic to allotriomorphic lath-like grains, in average 0.02 mm in size, with marked yellow-brown pleochroism (γ).

Amphibole hornfels facies:

Essential minerals of the rocks classed with this facies are the minerals of the amphibole group, together with pyroxene group minerals — diopside ± ± hypersthene. The rocks classed with this facies contain the highest-thermal association we have determined, where total dehydratation of the original rock composition took place, and which are nearest to the contact with the irregularly shaped intrusion. We distinguish the following two associations:

1. tremolite + diopside + quartz ± plagioclase: The rock is grayish-green, solid, firm and very fine-grained to massive. The texture is micro-grano- and lepidoblastic. Quartz is an essential component of the rocks. Diopside is present regularly, evenly dispersed. It forms almost isometric grains, up to 0.05—0.08 mm in size. Hypidiomorphic plagioclase — basic labradorite An_{64} is also present. The thin lath-like tremolite (c — 20°) is concentrated into thin bands, but it occurs also isolated in quartz-chlorite matter.

2. labradorite + calcite + diopside + quartz ± hypersthene: The rock is of dark grey colour, very fine-grained, solid. The texture is micro-nematoblastic. One of the essential minerals is quartz in allotriomorphic form. Diopside forms small isometric, sporadically columnar grains. It is dispersed between the grains of quartz or it forms smaller clusters. Tremolite is lath-like, occurring in monomineral clusters. Hypersthene was identified sporadically in the presence of diopside. The size of the cross-sections of individual minerals is up to 0.1 mm, in average 0.05 mm. Sphene is present in accessory quantity, in the form of irregular to isometric grains. The rock, especially in the presence of pyroxenes, is impregnated by opaque minerals — pyrrhotite, magnetite.

Conclusions

The intrusive complex determined and verified by boreholes in the central volcanic zone Morské oko displays varying contact-metamorphic effects depending on the morphological-structural type of individual intrusive bodies.

In the surroundings of irregularly shaped bodies contact metamorphism reached the conditions of albit-epidote contact hornfels facies and on closest contact the conditions of amphibole contact hornfels facies. Dykes and sill bodies had thermal contact effects on the rocks of Magura Palaeogene, with the origination of lowest-thermal associations in albite-epidote contact hornfels facies.

The determined occurrence of individual mineral associations in the boreholes permits to describe schematically the intensity of contact alterations around the central intrusive complex.

On Fig. 1 this intensity is depicted in the form of zonality. The region surveyed by the borehole RH—4 represents a zone where contact metamorphism reached the conditions of albit-epidote and, nearest to the contact, of amphibole contact hornfels facies. At the same time, this is the region of the occurrence of irregularly shaped bodies, i.e. type A_1. The region surveyed by the boreholes RH—12, RH—8 and partly RH—10 represents a zone which corresponds to the conditions of lower thermal regions of albit-epidote hornfels facies. This is as well a region with the occurence of dykes and sills — i.e. type A_2 bodies. The region surveyed by the boreholes RH—5, RH—7, RH—9 and RH—13 represents a zone of thermal effects of sill and dyke bodies in their nearest surroundings, with sporadical origination of sericite, chlorite and quartz. At the same time, this is the region with the occurrence of type A_3 bodies. The region surveyed by the borehole RH—26 is characterized by the occurrence of veins of andesite — A_4 type bodies — which do not display any contact effects on their environment.

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