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Nappe with the amphibolite facies metamorphites in the Inner Western Carpathians — its position, origin and interpretation

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Покров с метаморфическими породами амфиболитовой фации внутренних Западных Карпат, его позиция, возникновение и интерпретация

Совместно с вышезалегающими анхиметаморфизованными породами добшинской группы досреднекарбонские метаморфические породы амфиболитовой фации метаморфизма внутренних Западных Карпат представляют аллохтон. Означаем его как „клатовский покров". Самыми распространёнными досреднекарбонскими породами покрова являются амфиболиты, парагнейсы и в меньшинстве даже антигоритовые серпентиниты и кристалические карбонаты. Предполагаемые горные породы представляют метаморфически перекристализованный протолит океанического дна, в составе которого в большом количестве принимал участие и материал коры континентального типа. Метаморфическая перекристализация нижнепалеозойских членов клатовского покрова произошла в зоне трансформного разлома или в почве обдукованного офиолитового комплекса.

Nappe with the amphibolite facies metamorphites in the Inner Western Carpathians — its position, origin and interpretation

Together with overlying anchi-metamorphites of the Dobšiná group (Carboniferous), the pre-Middle Carboniferous metamorphites of amphibolite facies of the Inner Western Carpathians (the Gemericum) form the allochthon — which is designated as the "Klátov nappe". The most wide-spread pre-Middle Carboniferous members of the nappe are gneisses and amphibolites, to a lower degree also antigorite serpentinites and crystalline carbonates. They have originated via metamorphic recrystallization of the ocean-floor protolith; the material of continental crust represents a considerable amount in its composition.

In the zone of transform fault or in the basement of obducted ophiolite complex there has taken place the metamorphic recrystallization of the most probably Early Paleozoic nappe members.

The Western Carpathians are in the north-southern direction divided as follows: a) Outer and Inner; or b) Outer, Central and Inner. In the sense of the latter division (Mock, 1978), the Inner Western Carpathians comprise the units which occur and/or are generated south of the "Margecany — Lubeník lineament".

Also during the period when the concept of the nappe structure of the Outer and Central Western Carpathians was dominant, the area of the Inner Western Carpathians was considered to be autochthon with eventual local shifts of partial units. It was not until the 70-ies when D. Andrusov (1968) illuminated some older concepts claiming the allochthonous position of the Inner Western Carpathian units and he designated them "Gemericum" (contrary to older usage of "Gemerides"). The assignment of Paleozoic units occurring south of the Margecany — Lubeník lineament to the Gemericum has been generally accepted. Also the place of origin as well as the tectonic assignment of certain Mesozoic units appearing in the present relief south of the given lineament remain still a nagging question work (Kozur — Mock, 1973, Maheľ, 1975, 1983).

According to P. Grecula (1973), the Early Paleozoic of the Gemericum originally divided into two superpositional groups, the Gelnica and Rakovec groups, forms the group with the same development as that of the Gelnica and Rakovec ones (Upper Ordovician — Devonian?). These lithofacial developments are regarded as the partial nappes (Grecula — Varga, 1979), and the above-mentioned authors (l. c.) placed the Rakovec partial nappe on the basis and the Gelnica nappe into its overlying layers. The allochthonous character of the Gemericum as a unit has recently been emphasized by B. Leško — I. Varga (1980). The problem of the structure of the Gemericum has not been definitely solved, also at present, certain authors (Bajaník — Vozárová — Reichwalder, 1981) support the idea viewing the Gelnica group on the basis and the Rakovec group within its overlying layers. Also M. Maheľ (1983) considers the most part of Paleozoic rock complexes to be autochthonous.

The Gelnica group (nappe) is represented by volcanic — sedimentary sequence of the flysch type. Pelitic — micropsammitic sediments (schists, sandstones) are dominant, with locally present abundant silicites and limestones partly ankeritized to sideritized are in small amounts. Quartz porphyres (and quartz keratoporhyres) and corresponding volcanoclastics are dominant volcanic members. As for the Rakovec group (nappe), within the lower part of the sequence weakly-metamorphosed clastogenous members (quartz-sericite phyllites) are dominant. The upper part is abundant in basic volcanites and volcanoclastics, amongst sedimentary members — sericite chlorite and sericite — quartz phyllites. Also small bodies of basic intrusives are known to appear.

Metamorphic recrystallization of Early Paleozoic rock complexes is considered to be a consequence of Late Caledonian, and/or Bretonian phase of folding and metamorphism (Kamenický, 1968), or a product of Alpine metamorphic-recrystallization processes (Varga, 1973), and/or a

product of polymetamorphic Late Caledonian, Bretonian and Alpine processes (Fusán, 1968, in Maheľ — Buday et al., 1968).

On Early Paleozoic groups (nappes), discordantly in autochthonous (subautochthonous) position, there appear sediments and basic volcanites of Middle and Upper Carboniferous to Permian. Mesozoic members of the Inner Western Carpathians are assigned, at the same time, into several tectonic units.

Metamorphites of higher grade

Complexes of metasediments and metaeruptives in the Inner Western Carpathians (and namely Paleozoic complexes) have in the past been generally and definitely assigned among metamorphites which have originated in the greenschist facies conditions (Kamenický, 1968, Kamenický — Krist, 1969, Kamenický, 1969 in Maheľ, 1969, Varga, 1973). Generally accepted scheme of intensity and type of metamorphism of pre-Middle Carboniferous rock complexes in Gemericum is not supported by the results of L. Rozložník (1965) from the area of Dobšiná. This author (l. c.) described a complex of amphibolite facies metamorphites from the mentioned area. The higher grade of metamorphic recrystallization took place in narrow tectonically predisposed zones, due to the effects of granitizing fluids. Among amphibolite facies metamorphites he presented mainly different types of amphibolites and gneisses. Totally different views on the genesis of pre-Middle carboniferous rock complexes in the Dobšiná area were held by L. Kamenický — M. Marková (1957) and J. Ilavský (1957). The former authors (l. c.) distinguished "hornblende gabbro" in the area of Dobšiná. They described it as magmatically preferrentially oriented intrusion of diabase magma, and "amphibole-biotite diorite" which they regarded as later differentiate of the mentioned basic magma which was cooling after the release of pressures. In the view of J. Ilavský (l. c.) the origin of amphibolites can be explained by assimilation of diabase. He considered diorite the product of assimilation of Carboniferous greywackes by granite intrusion.

In recent years, the rocks of higher metamorphic recrystallization grade have been introduced by J. Popreňák et al. (1973) from the area of Rudňany. Their main characteristics (composition, position) and arguments in favour of their metamorphic origin can be found in the work of D. Hovorka et al. (1979). Metamorphites of similar type were described also from the area of Vyšný and Nižný Klátov (Dianiška — Grecula, 1979) and other areas (Bajaník — Hovorka, 1981, Hovorka et al., in print).

Apart from the characteristics of the main rock types comprised in the metamorphite complex of amphibolite facies and their geological position, recent years have brought some attempts to interpret mainly the temperature conditions of the origin of the mentioned rocks via the study of coexisting metamorphic minerals (Hovorka — Spišiak, 1981, Bajaník — Hovorka, 1981, Hovorka et al., in print, Spišiak — Hovorka, in print). These studies also provided evidence for the Variscan metamorphic recrystallization of the discussed rock complex. Also radiometric age determinations of the rocks under consideration (Cambel et al., 1980, Bajaník et al., 1981, Kantor, 1981) point to the Variscan metamorphic recrystallization to have taken place. Although the limitations due to the used method and the character of the used analyzed mineral are considerable, and they also cause that the results suffer from the accuracy (differences in determining the age of gneisses and amphi-

bolites), yet, the metamorphic processes are undoubtedly pre-Middle Carboniferous.

Rock filling

Although there are known in detail different rock types in dependence on the degree of natural, and/or artificial outcrop in different areas where the rocks of amphibolite facies occur, yet, the main rock filling is identical for the whole characterized complex.

Paragneisses are the main rock type in the upper part of the discussed complex, while laterally and vertically they are alternated by metabasites. Their main mineral association: quartz — plagioclase (An_{18-30}) — biotite ± garnet ± amphibole ± muscovite, is often hydrothermally destructed. On the basis of geochemical criteria (Hovorka — Spišiak, in print), original sediments of paragneisses corresponded to pelitic — psammitic sediments and they also did not show geochemically mature character (rocks close to greywackes). Plagioclase biotite paragneises locally pass into quartz-rich types of paragneisses. Rocks of this group have mostly porphyroblastic structures with porphyroblasts of plagioclase and garnet, banded textures are frequent. High portion of plagioclase porphyroblasts (and at the same time, low mica contents) cause that sections perpendicular to the rock schistosity shows macroscopically massive appearance of these rocks. Also in such cases microscopical development of mineral association provides the evidence for its metamorphic-recrystallization origin. In the case of gneisses, to a lower degree also in amphibolites, there can be seen zones of intensive Na-metasomatosis (albitization), which is older than the siderite-sulphide mineralization wide-spread in the discussed areas. Local presence of nests and irregular positions of mineral associations of granitic pegmatites, and albite-quartz nests which are probably the result of mobilization and segregation during metamorphic recrystallization. Chemical composition of the main types of gneisses can be found in Table 1.

Amphibolites are another substantially present rock type and in the directions towards the basis of the complex they are becoming dominant. Specifically, it is the rocks of the association: amphibole + plagioclase ± garnet. They are mostly fine to medium-grained, markedly schistose and quasi-massive, homogeneous and slightly (locally) banded. Bands are formed by plagioclase-quartz aggregate. In the case of amphibolites, several types can be distinguished. Their varied mineral associations are mainly due to lithological and chemical differentiation of educt. Pyroxene garnet, epidote and epidote-zoisite amphibolites were identified. The latter represent more-or-less the transition to the rocks of greenschist facies. It is interesting that the spatial occurrence of the given types is usually differentiated which can be best seen in the area of Dobšiná. Centric structures are characteristic for garnet amphibolites. By increase of quartz content, amphibolites gradually pass into amphibole gneisses. According to presently used geochemical discrimination criteria, original volcanics were similar to ocean-floor tholeiites by their composition (Hovorka — Spišiak, in print).

The study of chemical composition of main mineral phases of amphibolites and paragneisses (amphibole — garnet — biotite — plagioclase) with the aid of electron microprobe (Hovorka — Spišiak, 1981, Spišiak — Hovorka, in print) as well as calculated distribution coefficients of Fe, Mg and Ca in mineral pairs (l. c.) in amphibolites and paragneisses allow to reconstruct the origin of these mineral associations (rocks) in the conditions of

low-temperature parts of amphibolite facies (T = 530—620 °C). This finding, together with characteristic vertical and lateral alternation of the mentioned and other rock types, in this way document the temperature conditions under which the whole discussed complex has originated.

Ultramafites appearing in the form of small to fine bodies (hundreds of meters to cm dimensions) in the gneiss — amphibolite complex are its characteristic rock member. They have the character of antigorite serpentinites (Dobšiná — Tešnárky, Rudňany, Klátov, Bukovec). Spinel peridotites were original rocks. Meta-ultramafites appear either directly in gneisses and amphibolites as small, often isometric bodies (ultramafic balls), or as larger lenses on the contact with the Rakovec group. In the first case they were a part of the complex before its metamorphic recrystallization and were metamorphosed together with the complex (the formation of blackwall). Similar evidences if any at all, claiming the pre-metamorpfic presence of ultramafites in the pre-underlying part of the complex, are still missing, They are overprinted with intensive tectonometamorphic and hydrothermal alteration. In the tectonic transport of the metamarphic complex of amphibolite facies were tectonized ultramafic bodies incorporated into tectonic discontinuities not

Chemical composition of the Klátov nappe main rock types

Table 1

	1	2	3	4	5	6
SiO_2	47,96	46,22	49,42	67,20	60,86	39,34
TiO_2	1,14	2,31	1,83	0,63	1,05	0,17
Al_2O_3	16,19	12,51	13,66	14,26	13,24	1,81
Fe_2O_3	1,74	5,06	2,96	0,88	2,87	6,69
FeO	6,64	9,04	10,69	4,13	6,76	2,71
MnO	0,12	0,22	0,24	0,10	0,14	0,07
MgO	9,86	7,10	7,01	2,80	3,77	36,67
CaO	10,22	11,55	6,42	1,80	2,80	0,87
Na_2O	2,28	3,40	2,51	2,72	2,68	0,10
K_2O	0,35	0,44	1,07	2,45	1,84	0,10
P_2O_5	0,15	0,19	0,19	0,10	0,49	0,10
H_2O-	0,34	0,34	0,32	0,14	0,22	6,61
H_2O+	2,86	1,65	3,87	2,75	2,54	11,02
Suma	99,72	100,03	99,64	100,04	99,26	100,05
V	174	220	336	128	—	89
Cr	331	205	83	48	—	1610
Co	15	76	8	12	—	89
Ni	69	127	10	17	—	1690
Li	34	—	33	38	—	—
Rb	8	—	23	75	—	—
Cs	2	—	2	5	—	—
Sr	185	—	262	170	—	—
Ba	50	—	400	380	—	—
Zr	38	—	354	84	—	—

1 — Rudňany, drill Ry-IV-Z/393,5 m: augen anmphibolite, 2 — Košická Belá, drill SGR-V-9/9,4 m: epidote amphibolite (Dianiška — Grecula, 1979), 3 — Rudňany, drill Ry-Z-58/21,0 m: banded garnet amphibolite, 4 — Rudňany, drill Ry-Z-58/40,3 m: plagioclase paragneiss, 5 — Dobšiná, biotite-plagioclase paragneiss (Rozložník, 1965), 6 — Dobšiná — Tešnárky: antigorite serpentinite (Hovorka — Ivan, 1981, FD-103)

only in the complex itself, but also in the overlying rocks of the Dobšiná group (Dobšiná, Mlynky, Mišíkova skala, Gretla, Rudňany, Košické Hámre). On favourable tectonic structures, when overlying hydrothermal processes took place, the bodies of metaultramafites represented primary concentrators of Ni, and Co of hydrothermal vein occurrences of arsenides of nickel and cobalt (the "Dobšiná type", Ivan — Hovorka, 1980, Hovorka — Ivan, 1982).

Carbonates are present in the facies of crystalline limestones and dolomites, associating mostly with amphibolites. They form the layers which attain the thickness of several cm to several m. Original clastic admixture at metamorphic recrystallization gave rise to tremolitic amphibole, garnet, mineral of clinozoisite-epidote group, plagioclases and others. They were identified in Dobšiná (P. Rozlozsnik, 1935, L. Rozložník, 1965), Rudňany (Kusák — Hurný, 1981), Klatov (Dianiška — Grecula, 1979). Due to successive hydrothermal processes they are sometimes altered into ankerite and siderite, respectively.

The group of seldom rock members of the metamorpfite complex under consideration includes also the layers of monomineral pyroxene rocks and pyroxene amphibolites from the area of Dobšiná described by P. Rozlozsnik (1935). Layers of tremolite schists, and/or rocks with fibre-like terminating amphibole, discovered by L. Rozložník (1965), most probably represent (uralitized) derivatives of pyroxene rocks. The group of rarely occurring rocks comprises also garnet-pyroxene rocks described by L. Rozložník (l. c.) within the area of Dobšiná. They have also been discovered recently at Langenberg near Dobšiná (Hovorka — Spišiak, in preparation).

In concluding the characteristics of the most wide-spread rock types of metamorphite complex of amphibolite facies, it must be emphasized that the mentioned rock types are intensively tectonically, but mainly hydrothermally-metasomatically altered namely in ore fields at Rudňany and Dobšiná. For that reason, it is difficult to identify their originally metamorphic character in places.

Geological position

Amphibolite facies metamorphites occurrences in the Inner Western Carpathians are concentrated exclusively in the north-Gemeride zone. This is the designation of the zone of individual structural-tectonic development which connects the contact of the Inner Western Carpathians represented by the Gemericum — and the units of the Central Western Carpathians — the Veporicum and Tatricum.

Until now, the following areas of occurrence of amphibolite facies metamorphites are knon from the north — Gemericum zone (Fig. 1): Rejdová — Táfliová, Dobšiná, Mlynky, Rudňany, Slovinky, Kojšov, Klátov. In the mentioned areas, the rocks at the same time assigned among metamorphites of amphibolite facies, were identically regarded as the part of Early Paleozoic Rakovec group.

The main geological characteristics of the mentioned occurrences are in all cases considerably similar. The most typical common feature is the morphology of the given rock complex. It represents tabular bodies attaining the maximum thickness of the first hundreds of meters. Their underlying layer is usually the Rakovec group in the development of chlorite-sericite phyllites. The contact is tectonic; the contact zone is indicated by strong tectonic mixing and there are localized lense-shaped bodies of antigorite serpentinites. The overlying layers of gneiss-amphibolite complex are within the most of mentioned

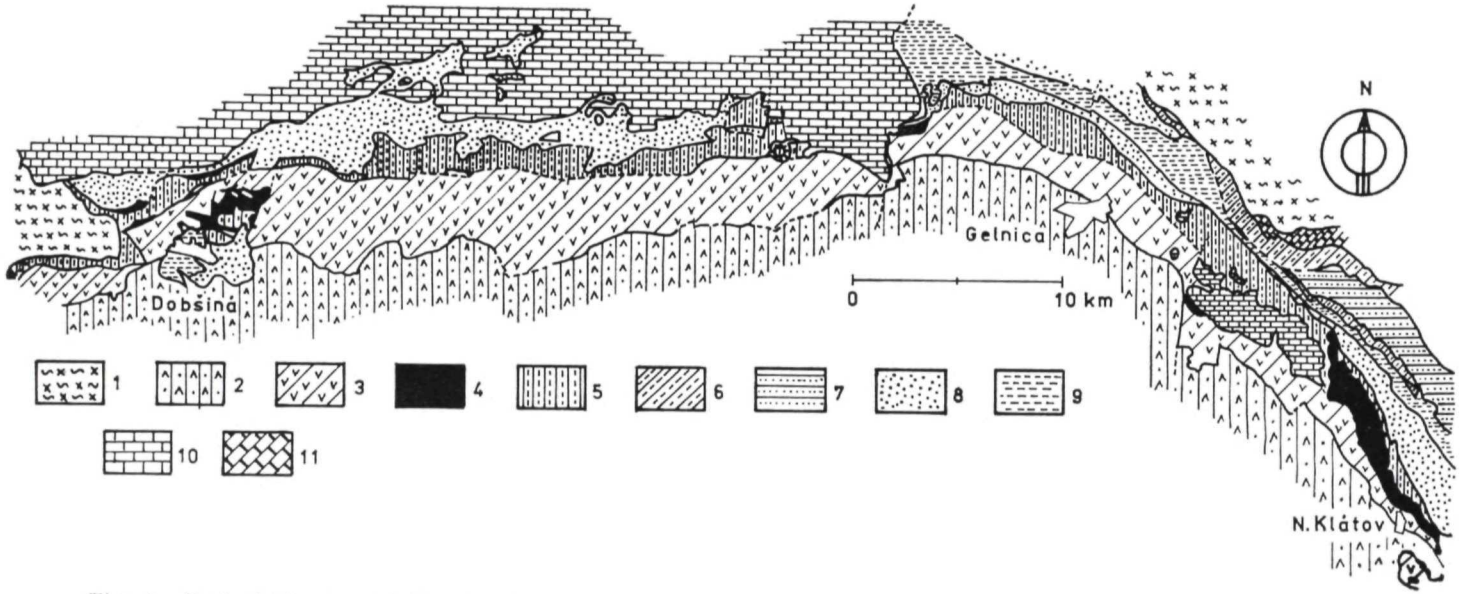

Fig. 1. Geological map of the northern part of the Inner Western Carpathians (compiled on the base of Bajaník's, Grecula's, Mahel's, Snopko's and others geological maps). 1 — Pre-Carboniferous units of the Central Western Carpathians, 2 — Gelnica Group, 3 — Rakovec Group, 4 — Klátov Group, 5 — Dobšiná Group (except of the Ochtiná Beds), 6 — Ochtiná Beds, 7 — Črmel Group, 8 — Krompachy Group, 9 — Lower Triassic of schistose development, 10 — North Gemeric Mesozoic in carbonate rock development, 11 — Mesozoic envelope of the Central Western Carpathians, core mountains

occurrences, formed by coarse-grained anchimetamorphosed metaclastics of the Dobšiná group (Carboniferous). Most of the pebble material of polymict conglomerates to breccias are formed by rocks of the direct underlying layers (gneisses, amphibolites; Rozložník, 1965, Vozárová, 1973). The presence of sandstones and greywackes can also be seldom noticed in the overlying layers of the complex under consideration. On the basis of abovementioned facts, the position of the rocks within Dobšiná group in the overlying metamorphites of amphibolite facies, can by designated paraautochthonous.

The present morphological form and areal distribution of amphibolite facies metamorphites represents the final result of several Hercynian and Alpine folding phases which have effected them. Besides lithological and geological-tectonic factors, its position and localization was effected by the difference in physical and mechanical properties of the rock complexes involved. In comparison with greenschist facies rocks of the Rakovec group, gneisess and amphibolites behave as a rigid body.

According to L. Rozložník (1965), this has found reflection in the geological structure of the Dobšiná area. Occurrences of discussed metamorphites are concentrated in narrow zones of reverse fault type of NE—SW direction (Fig. 2), appearing in the middle of the Rakovec group rocks. The zones express the imbricate structure of the area which has formed as a result of compensation of Alpine N—S compressional motions (l. c.). L. Rozložník (l. c.) considers the relief reverse fault of the discussed complex through the rocks of the Rakovec group in the area N of Dobšiná, to be a special case. The reverse fault plain, with respect to the morphology occupies relatively flat position, only slightly dipping to the S, and in that way, amphibolite facies metamorphites, together with overlying Dobšiná group, are exposed on the area reaching several km^2. Their position in regional tectonic depression saved them from erosion (Rozložník, 1965). The whole rock complex under consideration is strongly tectonically limited. The E and W terminals are provided by faults of the shift character, the S and N terminals are represented by outcrops of overthrust plane — the Georgi and Kor-

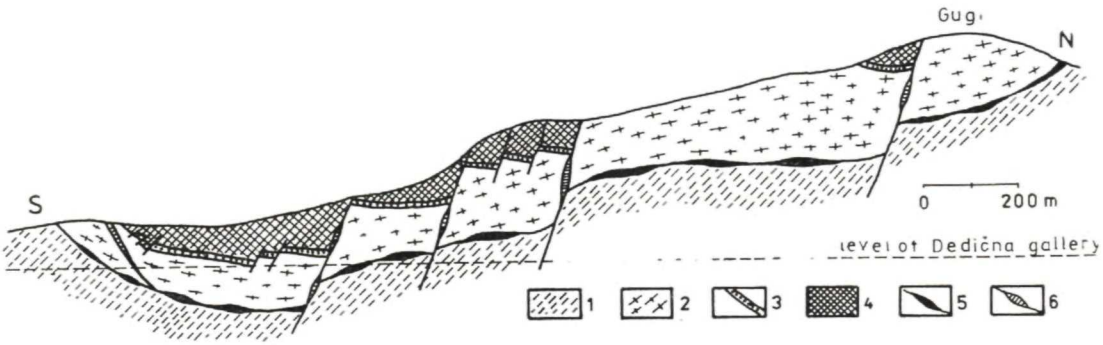

Fig. 2. Schematic geological cross section northward of Dobšiná. 1 — Rakovec group, 2 — metamorphites of the amphibolite facies (Klatov Group), 3 — conglomerates, 4 — pelitic schitic schists and limestones (3 + 4 Upper Carboniferous of the Dobšiná Group), 5 — metaultramafites associated with amphibolite facies (Klatov Group) metamorphites, 6 — metaultramafites tectonically protruded into overlying rock sequences

nélia lineaments (Rozložník, 1965, Hovorka — Ivan, 1981). Both lineaments are noted for strong expressions of destruction, the presence of antigorite serpentinite lenses and successive hydrothermal activity. The study of small-scale tectonic elements of the body testifies to its shift from the S to N (Rozložník, 1965). Spatial and genetic relation of gneiss amphibolite complex with overlying Dobšiná group is characteristic, in which the layers starting with conglomerates with pebbles of the overlying rocks. The continuation of Mlynky zone at the W is the occurrence of amphibolite metamorphites described from the bore-hole BM-1 near Mlynky (Bajaník — Hovorka, 1981). Geological situation is analogical with that in the area N of Dobšiná. With respect to the presence of the rocks of the Dobšiná group in the area NE to E of Mlynky, the complex of highly-metamorphosed rocks seems to continue in the depth in that direction.

In the area of the Rudňany ore-field, the discussed rocks practically do not appear on the surface-data on their geological position are based on mining and prospection works. In fact analogical structure as that in Dobšiná has been verified there. The complex of amphibolite metamorphites facies forms tabular body. Its thickness probably increases towards the N. The contact with underlying layers is tectonic and is formed by chlorite-sericite phyllites, often hydrothermally altered, to a lower degree also graphite phyllites (tectonite?) and green schist. Due to the low degree of knowledge, there does not exist any definite evidence about the presence of ultrabasites in contact zone. The overlying layers of gneiss-amphibolite type rocks are mostly formed by polymict conglomerates, more rarely sandstones. Within conglomerates the clastic material of direct underlying layers is dominant. On the contrary to the conglomerates from Dobšiná, they exhibit higher thicknesses with tendency of fine-grained clastic material towards the overlying layers.

Due to bad exposure and small areal extent, metamorphites of amphibolite facies in Slovinky and Kojšov have been discovered only recently (Bajaník — Hovorka, 1981). They appear close to, or directly on the overthrust plane of younger Mesozoic carbonate sediments on the Rakovec group. In the area of Slovinky, direct overlying layers are built up of polymict conglomerate of the Krompachy group (Permian). The most probable underlying layers in both mentioned areas are formed by chlorite-sericite phyllites, to a lesser degree also by metavolcanoclastics.

The esternmost as well as areally largest occurrence of amphibolite facies metamorphites is represented by the localities in the area of Vyšný and Nižný Klátov (Fig. 3). Its length exceeds 10 km and false thickness on the surface reaches 2 km. In comparison with occurrences in the western part of the North-Gemericum zone it appears as in the reverse position. The overlying layers form sericite-chlorite phyllites of the Rakovec group. The contact is tectonic, phyllites are separated from the complex of higher metamorphosed rocks by a thin position of graphite-sericite phyllites (tectonites ?) and lense-shaped bodies of antigorite serpentinite. The underlying layers are formed by the rocks of the Dobšiná group: graphite-sericite phyllites and dark schists with carbonates (Dianiška — Grecula, 1979).

Discussion and Interpretation

The presence of rocks of higher metamorphic recrystallization grade within the frame of structurally-tectonic unit charac-

terized by generally only a low grade of metamorphic recrystallization (greenschist) represents a phenomenon which is difficult to interpret. Conceptions proposed until now can fall into 4 groups:

1) The origin of amphibolite facies metamorphites via granitization processes in narrow zones of the Rakovec group. Processes are determined by penetration of granitization fluids derived from more intensive hypothetical massif of plutonites in the underlying layers (Rozložník, 1965). The age of metamorphism: Hercynian.

2) The origin of the complex due to compressional movements and the change of p-t conditions of the Rakovec group rocks within Jurassic-Cretaceous. The Rakovec group itself corresponds to the ophiolite suite of oceanic rift which has been deformed and disintegrated into melange during Paleo-Alpine obduction (Dianiška — Grecula, 1979).

3) Metamorphic recrystallization in conditions of amphibolite facies was conditioned by elevated heat flow taking place during the intrusions Late Variscan (Permian) granites of the Gemericum which was active in the rock assemblage situated between two geochemical and heat barriers-positions with abundant graphite schists and graphite quartzites (Hovorka et al., 1979).

4) The rocks metamorphosed in the conditions of amphibolite facies are not a part of the Gemericum, but they represent the tectonic wedge from the neighbouring structurally-tectonic unit of the Veporicum (conceptions of some authors — not published yet).

In comparison with some other Western Carpathian metamorphic areas, the expressions of metamorphic recrystallization in the conditions of amphibolite facies within the Gemericum exhibit peculiarites which indicate a different mechanism of metamorphic recrystallization. The most important features which should be mentioned and taken into consideration when interpreting the genesis, follow like this:

a) certain affinity of metamorphic

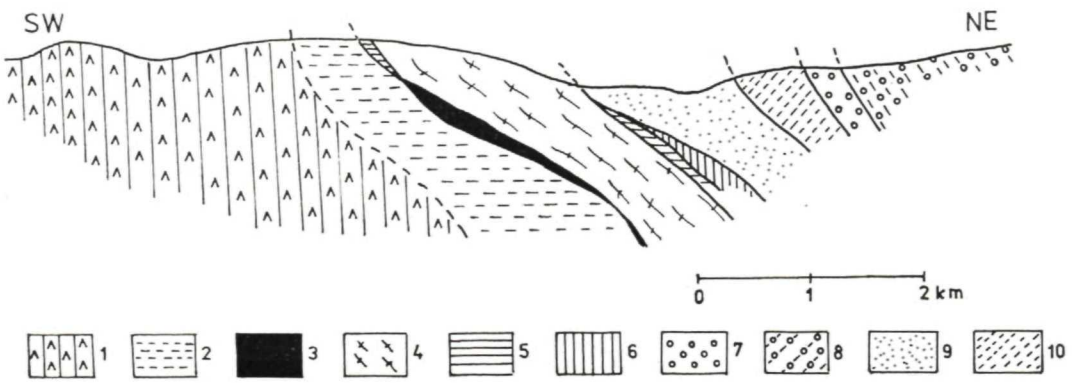

Fig. 3. Geological cross section of the amphibolite facies metamorphites (Klátov area; Dianiška — Grecula, 1979 — adopted). 1 — graphite — sericite schists (tectonites?), 2 — chlorite — sericite schists of the Rakovec group, 3 — metabasalts of the Gelnica group, 4 — amphibolite facies metamorphites, 5 — Gelnica group (metasediments and acid metavolcanics), 6 — Krompachy group (variagated sandstones and shales — Permian), 7 — dark shales with carbonate intercalations (Carboniferous), 8 — conglomerates (Permian), 9 — metaultrabasites, 10 — faults; a — detected, b — supposed

alteration to linear tectonic elements (noticed by Rozložník, 1965), which is expressed by morphological delimitation of metamorphosed complex;

b) discovered features of zoning of the intensity of metamorphic recrystallization within the frame of the given rock complex-from the rocks of typical amphibolite facies to the rocks of lower metamorphic recrystallization grade, locally even to metamorphites of higher-temperature areas of greenschist facies. Although the areal occurrence of metamorphites of the given grades is to certain extent tectonically separated at the present stage of knowledge, it is supposed that the change of the grade of metamorphic recrystallization took place only on small distances;

c) "quasi-statical" character of metamorphic alteration. In comparison with Variscan metamorphites of equivalent grade in the Tatricum and Veporicum, the rocks under consideration are characteristic by only slight role of dynamic phenomena during metamorphic recrystallization of the complex.

d) Narrow areal linkage of metamorphites with ultrabasic material as an undoubt part of the metamorphosed complex.

e) On the contrary to the conceptions presented by I. Dianiška — P. Grecula (1979), lithological and geochemical character of protolith (Fig. 4) does not represent (in the same way as the Rakovec group) a typical ophiolite sequence. It rather corresponds to the material of oceanic crust effected by clastic materials of close block with the continental crust. In the case of the Rakovec group, it can not be assigned to typical ophiolite suite: volcanoclastic are dominating over effusions of basalts, which are of island-arc tholeites trend.

Analysis of the mentioned problems leads to the conclusion that the origin of amphibolite facies metamorphites could be regarded as a result of the effect of elevated heat flow upon the rocks, using well-defined linear element having relation to oceanic crust to penetrate the recrystalling complex.

Present views on geodynamical conditions of metamorphism of oceanic (suboceanic respectively) crust offer in this case the two following models as being the most probable: 1) metamorphism conditioned by obduction of ophiolite plate, and 2) metamorphism in the zone of transform fault. At metamorphism through obducting ophiolite plate, due to its residual heat and that originated from friction, there originates tabular body of metamorphites below the shift plane. In this body, the intensity of metamorphism

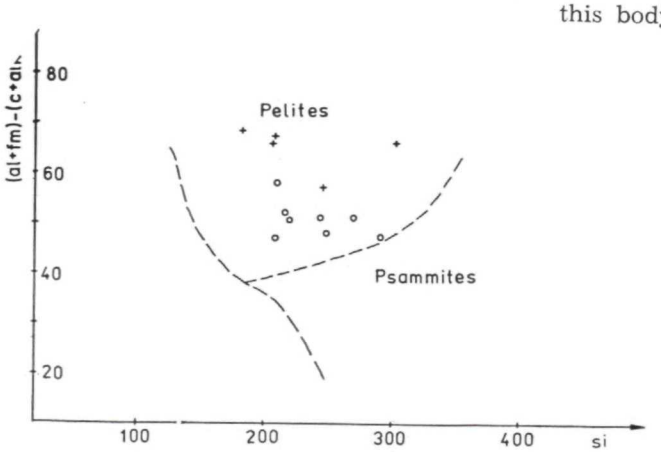

Fig. 4. Projections of the amphibolite facies metamorphite of the Klátov nappe (o) and greenschist facies metamorphites of the Rakovec Group (+). Analytical data in Hovorka — Spišiak (in print); Simonen's diagram (1953)

decrease on a small distance from granulite facies to greenschist facies (Karamata, 1968, Ghent— Stout, 1981, Spray — Roddick, 1980). During tectonic movements the blocks can be separated according to individual facies. In the case of metamorphites under consideration, this way of origin could be indicated by the expressions of higher grades of metamorphic recrystallization (pyroxene amphibolites to monomineral pyroxene rocks).

Metamorphism in the zone of transform fault originates as a consequence of the shifted segments of oceanic ridges contacting with the rocks which are more distant from the ridge and therefore also cooler. In the same ways as in the case of metamorphism at obduction, tabular body is being formed along the fault plane of transform fault. The intensity of metamorphism usually attains only middle grade, while decreasing outwards of the fault (Spray — Roddick, 1981).

The rocks with pyroxenes, discovered also in these conditions, were interpreted as products of Ca-metasomatosis by the authors mentioned above (l. c.). Analogical possibility can not be excluded also in the case of Gemericum metasomatites. Metamorphites originating in the zone of transform faults also exhibit areal relation to ultrabasites penetrating as protrusions along fault planes. The discussed metamorphites got into the structure of continental crust by successive processes of obduction type.

The age of higher-grade metamorphism in the Gemericum is definitely Hercynian (pre-Middle Carboniferons). It is supported also by K-Ar ages of metamorphites and the presence of detrites of amphibolites and gneisses in Middle Carboniferons clastics of the Dobšiná group. The presence of ultrabasic material in conglomerates confirm their genetic relation (Hovorka — Ivan, 1983).

As mentioned above, the protolith of amphibolite facies metamorphites were rocks probably forming in the upper parts of oceanic crust under the effects of clastogeneous material from the block with continental-type crust. In the case that the metamorphites under consideration originated via obduction mechanism, their material has already been in allochthonous positions probably in accretion prism of ocean arc. In the case that metamorphites originated in the zone of transform fault, they have been successively obducted also on the ocean arc (?). The final form as appearing in partial nappe was gained during intensive re-construction of tectonic plan of the Inner Western Carpathians during Alpine age.

Translations by H. Budajová

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Покров с метаморфическими породами амфиболитовой фации во внутренных Западных Карпатах — его позиция, возникновение и интерпретация

ДУШАН ГОВОРКА — ПЕТЕР ИВАН — ЯН СПИШЯК

Для внутренних Западных Карпат (южнее маргецианско-любеницкого линнеамента) домезозойские комплексы представлены метаэффузивами и метаосадочными породами. Степень их метаморфизма отвечает фации зеленых сланцев барровианского типа. В течение последних лет в этой зоне были обнаружены породы значительно более высоких ступеней (Розложник, 1965, Говорка и др., 1978; Дианишка—Грецула, 1978, Говорка—Спишяк, 1980), вплоть до амфиболитовой фации. Эти метаморфические комплексы, совместно с вышележащими слабо метаморфизованными осадками добшинской группы (карбон) образуют аллохтон. Мы называем его „клатовский покров". Самыми распространенными породами дасреднекарбоновых метаморфитов амфиболитовой фации являются гнейсы и амфиболиты, в меньшей степени антигоритовые серпентиниты и кристаллические мраморы. Эти типы пород возникли при метаморфической перекристаллизации как протолита океанического дна, так и материала континентальной коры. В зоне трансформного разлома или в подстилающих комплексах обдуктированных офиолитов произошла метаморфическая перекристаллизация пород вероятнее всего нижнепалеозойского возраста. Клатовский покров в целом не имеет признаков, характерных ддя типичных офиолитов.