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RADIOMETRIC DATING OF METAMORPHITES OF AMPHIBOLITE FACIES FROM THE RUDŇANY DEPOSIT, SPIŠSKO-GEMERSKÉ RUDOHORIE MTS.

(Figs. 1—3)

Abstract: From the siderite deposit of Rudňany are recently mentioned eruptive rocks from granodiorites to ultrabasic and rocks of amphibolite facies. They reach the Carboniferous, are characterized by intensive hydrothermal and metasomatic alterations. The genesis and mutual relations have been little cleared up so far.

The metamorphism into amphibolite facies is uncommon in the epimetamorphosed Spišsko-gemerské rudohorie Mts. Its age ranging has been questionable till now. By the argon method the ages of 324, 320 and 281 mil. y were proved at amphiboles from amphibolites. These results disprove the views on the Alpine age of metamorphism and are an evidence of its Variscan age.

Резюме: В последнее время из области сидеритового месторождения Руднян, приводят эруптивные породы с гранодиоритов до ультраосновных и породы амфиболитовой фации. Доходят до карбона, отличаются интенсивными гидротермальными и метасоматическими изменениями. Генез и взаимные отношения до сих пор мало объяснены.

Метаморфоз в амфиболитовую фацию в эпиметаморфизованном Спишско-гемерском рудогории не обыкновенный. Его возрастное зачисление было до сих пор спорное. Аргоновым методом были на амфиболах из амфиболитов установленные возрасты 324, 320 и 281 мил. лет. Эти результаты опровергают мнения касательно альпийского возраста метаморфоза и являются доказательством его варийского возраста.

Introduction

The Rudňany deposit is the most important of the siderite formation in the Spišsko-gemerské rudohorie Mts. (SGR). As a perspective source of iron ores the local vast vein system and its neighbourhood attract the attention of geologists. In the last years the interest in this locality was raised by finding a rock complex, which on the contrary to the common type of Paleozoic rocks is characterized by a higher grade of metamorphism — into amphibolite facies.

In the works of the older authors almost exclusively were mentioned from the Early Paleozoic to Carboniferous complexes of the Spišsko-gemeské rudohorie mts. mineral associations coinciding in the facies of green schists. An exception was formed until lately by the paper of L. Rozložník (1965) about the geological conditions of the Dobšiná area only. The author pointed to the existence of various types of gneisses and amphibolites, which originated by metamorphism of Paleozoic rocks belonging to the Rakovec group.

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Metamorphites of amphibolite facies from Rudňany were mentioned by D. Hovorka et al. (1979). With establishing of the existence of gneisses and amphibolites in the Spišsko-gemerské rudohorie Mts. the problem of dating of the period arose, when the mineral associations of amphibolite facies originated.

Whereas in the area of Dobšiná the upper boundary of the age of metamorphites is given by their presence as pebbles in Upper Carboniferous conglomerates, the situation in Rudňany was problematic.

The presented work has the objective to provide data to the mentioned problem, which were obtained by radiometric dating by the argon method.

Geological conditions

Until lately it was supposed about the Early Paleozoic, Carboniferous and Permian from the Rudňany area that they have practically the same development as analogous formations mainly from the northern part of the Spišsko-gemerské rudohorie Mts. Certain differences in opinions existed between the authors, mainly on assignment of some metabasites (diabases and their volcanoclastics) to the Rakovec group or to the Carboniferous.

The situation essentially complicated by publishing of the results, obtained by Geological Exploration workers in valuation of exploratory works from the area of the Zlatník vein in the northern part of the Rudňany ore field (K. Mandáková et al., 1971).

Structually this part is interpreted as vault, which originated with active effects of deep intrusive bodies. In genetic connection with them are intensive metamorphic — metasomatic processes of the bodies proper and their surroundings, so also the origin of ore locating structures linked with them.

K. Mandáková et al. (l. c.) mention a very variegated palette of intrusive rocks:

Granodiorites, quartz diorites, amphibole diorites, gabbroid rocks with transitions into amphibolites to amphibolic schists, ultrabasics (?).

According to the mentioned authors in the Zlatník structure are largely represented also various metasomatic products of the above mentioned eruptive rocks:

amphibole-biotite- chlorite rocks, carbonate — serpentine — talc, carbonate-talc-chlorite, carbonate-talc-quartz- chlorite with fuchsite (listvenites), etc.

The presence of the mentioned mineral associations as well as also the frequent occurrence of chromspinelides, Ni- minerals, fuchsite etc. testify that metasomatites originated from gabbroid to ultrabasic rocks. The authors derive the origin of these metasomatites from exocontact action of granitoid rocks.

J. Popreňák et al. (1973) deny the vault structure of the Rudňany ore field and its direct genetic relation to the development of ore structures.

They also briefly touch the problem of intrusive rocks. In contrast to K. Mandáková et al. (l.c.) they emphasize, that in the whole profile of „intrusive" rocks can be observed sedimentary structures, banding, alternation of finer and coarser fractions, intercalations of shales as well as gradual transitions from shales into psammites to coarse-clastic rocks.

Their observations are not in accordance with the data mentioned by K. Mandáková et al. (l.c.) and call forth doubtfulnesses about the intrusive character of gabbroid rocks in Rudňany. They suppose that in the given case „plutonization of original Early Paleozoic and Carboniferous clasto-and volcanosediments is concerned".

Similarly as granitization in the Spišsko-gemerské rudohorie Mts., J. Popreňák et al. (1. c.) put also the metamorphic processes, resulting in the origin of „gabbroid rocks" in Rudňany into connection with the Alpine orogene in time.

Although J. Popreňák et al. (1. c.) in some regards sketched a new scheme of the geological development of the Rudňany area, their arguments are only indicated and partly based on proved factographic material. This concerns mainly the character of eruptive and metamorphosed rocks, their mutual linking and relations of metasomatites to the mentioned types of rocks and to hydrothermal processes, owing to which the Rudňany deposit originated.

In this view is a contribution the article of D. Hovorka et al. (1979) about metamorphites of the amphibolite facies from the Rudňany area. The authors present a brief characteristic of the geological position of metamorphosed rocks, a relatively detailed description of mineralogical-petrographical relations and closing with a discussion about metamorphic processes and their age.

Whilst K. Mandáková et al. (1971) mentioned the complex of quartz diorites, gabbros to ultrabasics and various types of metasomatites as complicated intrusion, which penetrated into Early Paleozoic to Carboniferous rocks, D. Hovorka et al. (1979) stress their concordant position in Carboniferous sequences.

The difference in conception of the geological structure is evident from the geological sections (Figs. 1, 2) representing the geological profile through the middle part of the Zlatník vein.

One is from the work by K. Mandáková — L. Drnzíková — J. Hudáček (1971). A further section was published by D. Hovorka et al. (1. c.). It represents the section through the same place as the foregoing one and as author of the profile is mentioned J. Hudáček (1970).

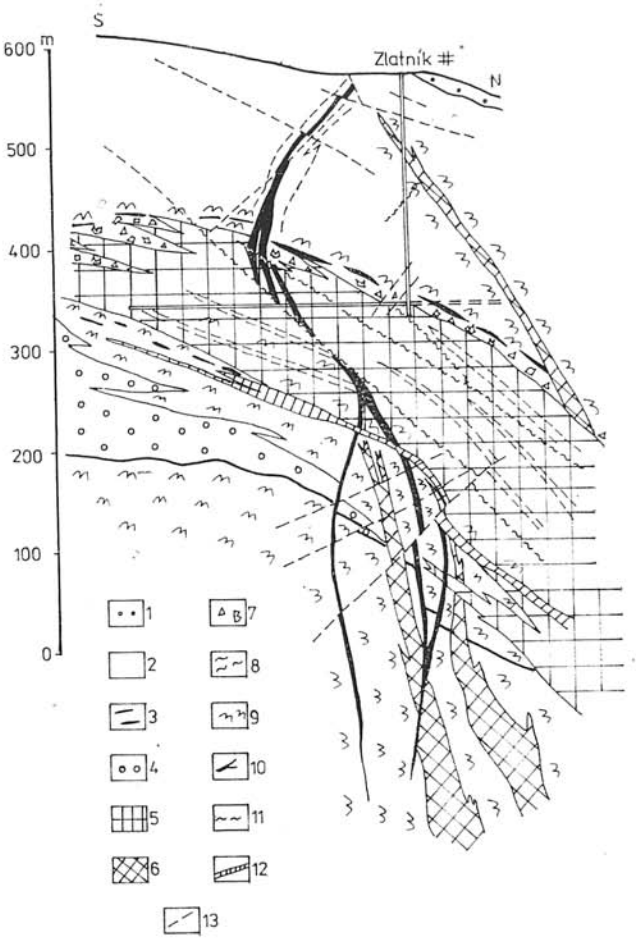
It results from the enclosures that the different interpretation does not concern only eruptive or metamorphosed rocks, petrographic designation of rocks, but also stratigraphic competence of rock complexes. As e. g. in the section of K. Mandáková et al. (1. c.) the base of the Carboniferous are the Bindt-Rudňany conglomerates, below which is the Rakovec group, in the section of D. Hovorka et al. (1. c.) these conglomerates are designated as graphite shales and the whole complex below them as the Carboniferous. These differences also show complicatedness of the problem.

The oldest building element of the Rudňany ore field is the Rakovec group of Devonian age. It consists of chlorite-sericite phyllites with intercalations of metamorphosed volcano-clastics of basic volcanics.

According to D. Hovorka et al. (1. c.) the Upper Carboniferous begins with polymict conglomerates of Bindt-Rudňany type. From the southern, near-shore part are mentioned minute-to fine-grained greywacke conglomerates from their overlier. In the central part of the Rudňany field their

equivalent are graphite-sericite schists with intercalations of metavolcanoclastics of basic volcanics and above them the so-called gneiss-amphibolite complex.

Above the gneiss-amphibolite complex in the central part the upper („intraformation") conglomerates are found, which are locally passing into grey sandstones. They are overlain by a complex of alternating dark graphite-sericite schists with layers of metavolcanoclastics.



Fif. 1. Geological section through the central part of the Zlatník vein, (K. Mandáková, L. Drnzíková, J. Hudáček, 1971).

1. Permian (conglomerate development). 2. Graphite schists, sandstones and rocks of diabase volcanism. 3. Antracite seams. 4. Carboniferous conglomerates of Bindt—Rudňany type. 5. Diorites, 6. Veins of ultrabasic rocks. 7. Contact breccias of diorite body. 8. Metasomatites of exocontact zone. 9. Rakovec group — Early Paleozoic. 10. Ore veins, siderite — barite — sulphide. 11. Ore veins —quartz ankerite — specularite. 12. Ore veins ankerite — calcite — quartz sulphide (Co + Ni). 13. Tectonic dislocations.

In the southern part of the Rudňany area gneiss-amphibolite layers are not developed. Above greywacke sandstones is resting directly the upper conglomerate layer, which according to D. Hovorka et al. (1. c.) evolved gradually from the underlier. A. Vozárová (1973) also called attention to gradual transition of the Bindt-Rudňany complex in the area under study. The higher part of the Carboniferous is represented by alternating layers of graphite-sericite schists and metavolcanoclastic material.

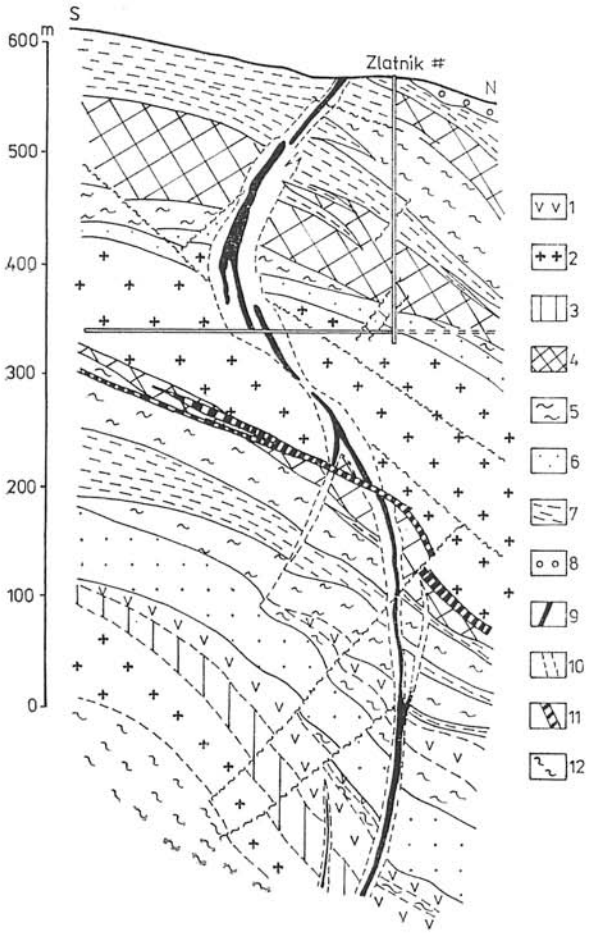


Fig. 2. Vertical section through the Zlatník shaft area (J. Hudáček, 1970).

1. Amphibolites and types of rocks transitional to ultrabasics. 2. Rocks of acid — diorite volcanism. 3. Tuffites of basic and acid volcanism. 4. Diabases and diabase tuffites of the Carboniferous. 5. Chlorite and chlorite- sericite schists. 6. Carboniferous sandy shales and sandstones. 7. Carboniferous graphite schists. 1—7 — Carboniferous. 8. Permian basal conglomerates. 9. Siderite- barite vein (deposit). 10. Hydrothermally altered rocks. 11. Calcite hydrothermal vein. 12. Tectonic dislocations.

The main criterion for stratigraphic assignment of the Rudňany Carboniferous is the fine-grained sandstone horizon (fossil-bearing") with rich Westphalian B—C flora (J. V a c h t l, 1938), which may partly reach also the Westphalian A.

The position of this fossil-bearing horizon in the succession of the Carboniferous sequences is not quite unambiguously mentioned.

In D. H o v o r k a et al (1. c.) the fossil-bearing horizon is quoted once in the underlier and another time as overlying the intraformation conglomerates (cf. p. 486 and Fig. 5).

The thickness of the gneiss-amphibolite complex is very variable. In places it attains up to 100 m, elsewhere, mainly in the southern part of the Rudňany field, it often completely wedges out. The average value is mentioned around 50 m (D. H o v o r k a et al. 1. c.).

In the whole area of Rudňany metamorphites of the amphibolite facies are found in close underlier of the upper conglomerate horizon, which usually is lying about 100—200 m above the lower conglomerate of Bindt-Rudňany type.

At surficial outcrops neither the gneiss-amphibolite complex, nor the upper „intraformation conglomerate" have been found so far. They are known from mine workings and boreholes only. Both are gradually plunging into greater depths toward west along the longitudinal profile of Zlatník.

The upper conglomerate layer is characterized by relatively small thickness up to several tenths of metres. When compared with the basal conglomerate of Bindt-Rudňany development also the size of pebbles is prevailingly less (2—4 cm) and roundness weaker. A weaker metamorphism than in basal conglomerates is mentioned.

There are differences also in petrographic composition of pebbles — in the upper conglomerates pebbles of quartz and quartzites predominate. Only locally fragments of basic volcanic rocks are more abundant.

The character of pebbles in the intraformation conglomerates is directly depending on the petrographic composition of the immediate underlier (D. H o v o r k a et al. 1. c.).

Characterization of rocks of the gneiss-amphibolite complex

According to latest investigations (D. H o v o r k a et al. 1. c.) the gneiss-amphibolite complex is characterized by considerable variability in structures and material composition. Characteristic of it are multiple mutual transitions between metabasites and metapsammites in vertical as well as lateral direction. The mineral variability of this complex is still enhanced by superimposed, hydrothermal alterations practically in the whole ore field.

Amphibolites are characterized by prevailingly schistous structures, banded or lenticular development of millimetres to centimetres thicknesses, with alternation of amphibolite layers with biotite paragneisses.

Amphibole is not optically homogeneous. It is usually found in form of older greenishbrown hornblende, forming the central parts of unhomogeneous grains, whereas the marginal parts are taken up by light-green hornblende of the IInd generation.

From amphibolic rocks are mentioned:

amphibolites s.s., garnet amphibolites, zoisite amphibolites, hornblendites, eyed amphibolites.

In the area of Rudňany metapsammites of amphibolites facies are represented by paragneisses, which form transitions into weaker metamorphosed sandy sediments and repeated mutual alternation with amphibolites in many places (D. Hovorka et al. 1. c.).

Most abundant are fine-eyed, ophthalmitic types with eyes of white plagioclases up to size 3—5 mm. Besides that, banded, pearly and macroscopically massive varieties of paragneisses are found.

On the basis of mineral composition are mentioned:

biotite plagioclase paragneisses, garnet-biotite-plagioclase paragneisses, amphibole — biotite plagioclase gneisses, garnet-amphibole-, biotite plagioclase gneisses,muscovite paragneisses.

Age of metamorphism

The first data about the occurrence of amphibolic rocks from the area of Rudňany are from K. Mandáková et al. (1. c.). They are, however, considered as intrusive rocks, influenced and altered by metasomatism by the younger part of granitoid intrusion.

Considerations about the stratigraphic range of intrusive processes are restricted to the mention that these reach also sequences of Carboniferous age. On the basis of the mentioned it would be possible to consider them as Carboniferous or younger.

Essentially more attention was paid to the question of stratigraphic range of metamorphic processes, which were leading to the origin of metamorphites of amphibolite facies in the area of Rudňany, recently by a further group of researches (D. Hovorka et al. 1. c.).

Owing to their activity our knowledge on the geological structure and character of metamorphites of the so called gneiss-amphibolite complex essentially extended.

Although on the basis of the obtained data they consider the possibility of Variscan and Alpine age of metamorphism, they do not come to an unambiguous conclusion in favour of some of them.

A Carboniferous age would be possible on the basis of the occurrence of fragments of gneiss-amphibolite rocks in the upper conglomerate horizon.

On the basis of radiometric ages of some Gemeride granites of the SGR (J. Kantor — M. Rybár, 1979; A. Kovách et al., 1980) and paragneisses from Rudňany, dated by R. Ch. Gukasjan (in B. Cambel et al., 1979) it would be possible to consider also the Permian age of metamorphism.

The suggested parallelization of the upper conglomerates in Rudňany with the Bindt-Rudňany conglomerates in Dobšiná (and so assignment of the amphibolite- gneiss complex in Dobšiná to the Carboniferous), is improbable, in contradiction with the geological situation e.g. in the Heritage adit as well as with radiometric dating of amphibolites from Dobšiná (B. Cambel et al., 1979).

J. Popreňák et al. (1. c.) unambiguously express the Alpine origin of am-

phibolic rocks from Rudňany — similarly as I. Dianiška — P. Grecula (1979) about analogous rocks of the Klátov zone in the east of the SGR. D. Hovorka et al. (l. c.) admit such a possibility for Rudňany — as a higher-thermal member of paired metamorphic zone to South Gemeride glaucophanites.

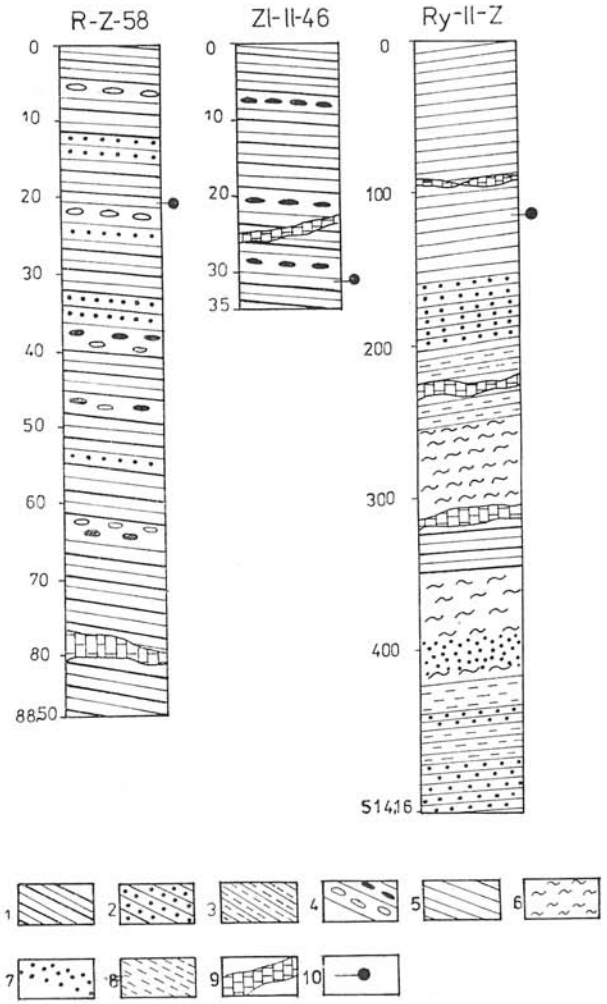


Fig. 3. Schematic profiles of boreholes

1. Amphibolites. 2. Metamorphosed intermediate and basic volcanoclastics. 3. Metamorphosed basic volcanoclastics. 4. Metamorphosed rocks of unclear genesis, locally with macroscopically observed feldspars and biotite (full circle). 5. Compact, in places grained metamorphosed intermediate to basic volcanic rocks. 6. Quartz — graphite and chlorite schists. 7. Sandstones. 8. Metamorphosed basic to ultrabasic rocks. 9. Hydrothermal veins. 10. Analysed samples.

Three samples from the gneiss-amphibolite complex were available to us from the Rudňany area: from boreholes ZL-II-46; RY-Z-58 and RY-II-Z. They represent plane schistose types, in which amphibolites alternate repeatedly with thin layers of biotite gneisses, displaying higher contents of idioblastic garnets. They represent the most common type of amphibolites (D. Hovorka et al. l. c.)

The analysed samples are from subsurface boreholes from the X or XVI horizon from the area of the Zlatník vein. The samples as well as profiles of boreholes, which are schematically illustrated in Fig. 3, were provided by Dr. J. Hurný. We remark that the petrogenesis of the mentioned rocks was not the subject of our work and is investigated by other research at present. Therefore also the designation of rocks in profiles is in agreement with the description presented by the above mentioned author.

From samples almost monomineral concentrates of amphiboles were separated for radiometric dating.

Results:

Number	Sample	K (%)	$^{40}A(10^{-6}Nccm.g^{-1})$	$t(10^6$ y.)
245	ZL-II-46	0,867±0,003	11,797±0,161	320±5
246	RY-Z-58	0,463±0,01	6,384±0,049	324±9
262	RY-II-Z	0,99 ±0,03	11,688±0,039	281±9

The radiometric ages of the first two samples fall to the Carboniferous and display mutually a relatively good agreement. Regarding to the fact that they are samples only little affected by superimposed hydrothermal alterations, it may be supposed that the ages measured are close to the real ages of metamorphism into amphibolite facies. On the basis of them it is possible to exclude unequivocally such a metamorphism in the period of the Alpine orogene. This was proved by one of the authors also for amphibolite-facies rocks from the Rakovec group from the zone Klátov—Košická Belá (J. Kantor, 1980).

The radiometric age of the third sample is distinctly lower and approximately coincides with the boundary between the Carboniferous and Permian. Before finishing detailed geological investigations of the Rudňany area it is not possible to exclude a longer section of time or polyact processes leading to formation of amphiboles. On the other hand also a distinct influence of younger superimposed processes is evident, the character and time sequence of which have not been cleared up sufficiently so far.

Formation of rocks of amphibolite facies in the area of Rudňany obviously took place already during the Variscan epoch after an intensive volcanism and magmatism of basic rocks in the Devonian to Carboniferous.

It is interesting that radiometric ages of the amphibolites here roughly correspond also to a part of intense granitization processes, which were taking place mainly in core mountains.

Total clearing up of all geological questions concerning eruptive rocks and metamorphic processes in the area of Rudňany, however, requires still extensive and detailed investigations.

Besides the already mentioned problem, it will be necessary to pay higher attention to the tectonic analysis, mainly in mine areas and to clear up the question of the position of these rocks in the Rudňany ore district and their lateral relation to the surficial profiles of the Bindt-Rudňany formation. Our radiometric datings are only a small contribution to solving of this important problem. Already now it is, however, evident that considerations of an Alpine metamorphism into the amphibolite facies are not substantiated for the Rudňany area at all.

Translated by J. Pevný.

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Review by B. CAMBEL

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