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ON SOME SULPHIDIC MINERALIZATIONS IN THE VEPORIDE CRYSTALLINE FROM RATKOVSKÉ BYSTRÉ AND REVÚCA AND THEIR ISOTOPIC COMPOSITION

(Fig. 1—3)

Abstract: The article includes a geological-deposital characterization of quartzose pyrrhotite-pyrite (± chalcopyrite) mineralization from the Veporide crystalline. Lenticular, impregnational, in places distinct veiny ore types contain sulphur with δS^{34} from — 0,6 to —15,9 ‰. At the localities Revúcke Kúpele and Ratkovské Bystré — Filier δS^{34} varies between —10,3 and —15,9 ‰. In this regard they display some analogy with the pyrite deposits of the Malé Karpaty and Nízke Tatry Mts. The possibility of a similar genesis combined with younger metamorphic-mobilizational processes is discussed. At the locality Bystrianska dolina valley the isotopic composition of sulphur is close to that from meteorites.

Резюме: В статье описана геология и дана характеристика месторождений с кварц-пиротин-пиритовой (± халькопиритовой) минерализацией находящихся в вепорском массиве метаморфных и магматических пород. Линзообразные, вкрапленные типы руд имеют выразительно жильную форму и содержат серу δS^{34} от —0,6 до —15,9 ‰. В месторождении Ревуцкие купеле и Ратковске Быстре-филиер δS^{34} колеблется от —10,3 до —15,9. В этом смысле есть известная аналогия с колчеданными месторождениями горных цепей Малые Карпаты и Низкие Татры. Авторы разбирают проблему генезиса и влияние младших метаморфно-мобилизующих процессов. В месторождении Бистрианска долина содержание изотопов серы близко метеоритическому.

Geological — depositional characteristics

The area in which the described sulphide ore localities are situated belongs to the southeastern part or the Vepor zone of the Central West Carpathians. According to the conception of A. Klinec (1966, 1973) and the results of M. Chovan (1972) this area is formed by rock units assigned to the following lithologically different complexes:

1. Hron complex (A. Klinec 1966) as the deepest structure element is represented by garnet mica schists with intercalations of amphibolites, serpentinites and graphitic quartzites in the described area (fig. 1). The rocks of this complex are highly folded, the majority of schistosity planes are dipping to the south to southeast (A. Klinec 1966, M. Chovan 1972). According to A. Klinec (1966) the products of basic magmatism are syngenetic with other parametamorphites of this complex. Its age has not been surely cleared up so far (a pre-Paleozoic or Early Paleozoic age is considered).

2. Kráľova hoľa complex (A. Klinec 1966), as the stratigraphically higher structure element it was thrust over the garnet mica schists of the Hron complex as a particular unit perhaps in the period of the Alpine folding. It comprises augen gneisses (directed porphyroblastic granites), slightly directed biotitic granodiorites, biotitic granodiorites to quartz diorites and various kinds of migmatites (fig. 1). To this suite are also assigned small bodies of hornblendites and amphibolites (outside the map area) (A. Klinec 1966, M. Chovan 1972). The granitoid rocks of this complex contain many xenoliths and septa of older rocks as well as blocks of migmatites. The age of this magmatism is generally dated back to the Variscan cycle.

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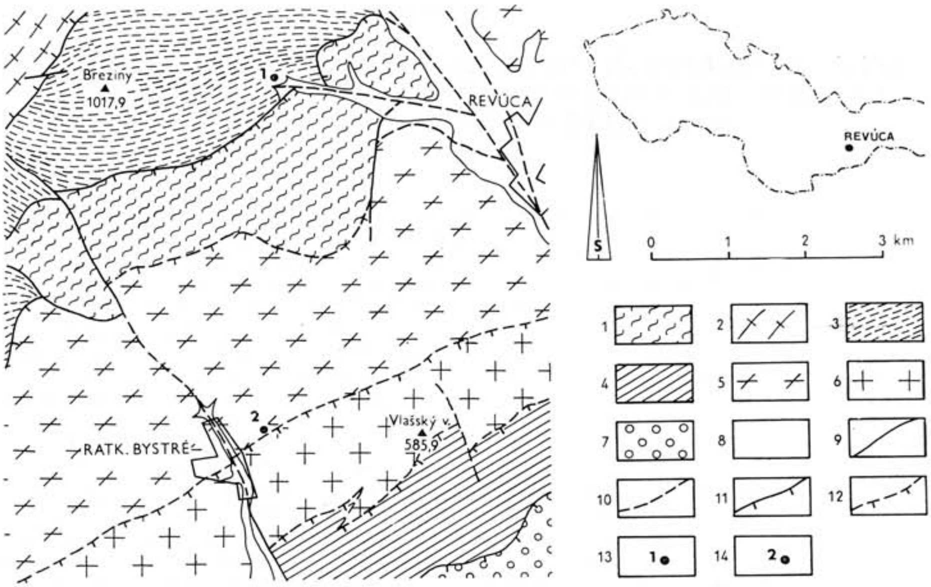

Fig. 1. Simplified geologic map of area SE from the village Revúca (according to A. K l i n e c and M. C h o v a n 1972), localities described in paper are marked. Explanation: 1 — biotitic migmatites, 2 — eye gneisses (oriented porphyroblastic granites), 3 — garnetic mica-schists, 4 — biotitic and chloritic phyllite and mica-schists, 5 — weakly oriented biotitic granodiorites, 6 — biotitic granodiorites to quartz diorites, 7 — light arcoses and graywackes expressively schistose, 8 — Quarternary, 9 — supposed faults, 10 — observed tectonic contact of nappe character, 12 — supposed tectonic contact of nappe character, 13 — locality Revúcke Kúpele, 14 — locality Ratkovské Bystré-Filier.

3. Hladomorná dolina group (A. K l i n e c — I. L e h o c k ý — S. V r á n a 1962), formed by biotitic and chloritic phyllites to mica schists, tectonically lying on granitoids of the Kráľova hoľa complex (fig. 1). The tectonic contact is obscured by younger granitization processes. In rocks of this group abundant apophyses of leucocratic granites are recorded in the described area. The Hladomorná dolina group is considered as Early Paleozoic in age (P. S n o p k o v á in A. K l i n e c (1966) and stratigraphically equivalent approcimately to the Gelnica group of the Gemerides.

4. Zone of epimetamorphosed arcoses, greywackes and conglomerates (Permian?) builds up the southern part of the described area (M. C h o v a n 1972) and these rocks are thrust over the Hladomorná dolina group. They are considered as a part of the Late Paleozoic envelope of the Veporides (fig. 1).

The locality R e v ú c k e K ú p e l e is situated 2 km NWW of the quarter of the town Revúca of the same name, in the valley of the Dolínsky potok brook. The ore mineralization was found in garnet mica schists here, not far from their tectonic contact with migmatites. In the past it was verified by a short adit. The ore mineralization is found at a dislocation striking E-W, dipping northward as well as in its immediate vicinity. The schistosity of the surrounding garnet mica schists is coincident in strike with this dislocation, however, predominantly dipping to the south. In the ore material impregnational ore types and ores of cast pyrite type of poor quality predominate, in which pyrrhotite and quartz are dominant (M. P e t r o 1963).

Pyrrhotite crystallized after quartz and is the most abundant ore mineral at the locality. Quantitatively it is represented as much as quartz, in places predominating over it. It forms disseminated grains up to 2 mm in size, dense networks of irregular veinlets and larger allotriomorphic grained aggregates. During its precipitation it replaced intensely all rocks minerals except quartz.

In pyrrhotite often a younger pyrite-marcasite aggregate occurs in the shape of irregular veinlets, rarely in the shape of concentric zonal forms. It originated due to a higher sulphur supply in the mineralization process.

Chalcopyrite is rarely observed in close connection with pyrrhotite, in the shape of thin veinlets, of isolated irregular grains up to 0,1 mm in size and allotriomorphic grained aggregates of lesser dimensions. It started to crystallize in the concluding phases of pyrrhotite crystallization but in the majority of cases after it only.

Tetrahedrite is still less frequent than chalcopyrite. It has been found only microscopically, in the shape of isolated grains up to 0,1 mm in size.

The last mineral of the succession is the very little spread ankeritic carbonate.

The locality R a t k o v s k é B y s t r é — F i l i e r i s situated 400 m NE of the community Ratkovské Bystré, in a small brook at the valley bottom. There is an occurrence of pyrrhotite-chalcopyrite mineralization, which we have found during field work (M. P e t r o in M. C h o v a n — M. P e t r o 1972). The ore mineralization is found in migmatites with neosome predominating (M. C h o v a n 1972), forming a block within the mass of fine — to medium-grained biotitic granodiorites. Between both the mentioned rocks is a distinct tectonic contact striking NE-SW, dipping SE. In the vicinity of the occurrence the rock is highly tectonically disturbed and healed by quartz veins, which are striking 280° with a dip of 45°N at the locality. Their thickness attains several decimetres. The ore lenticle at the locality is striking 235°, dipping 70°NW. Its thickness varies up to 2 m. Towards the west it may be observed only at a short distance because the area is covered with scree. Its eastern termination is tectonic. The ore mineralization is mainly concentrated it the quartz lenticle, in the shape of younger veinlets, massive clusters and impregnations as well as in the surrounding migmatites in close vicinity of the lenticle, where it forms prevailingly impregnations and small veins.

According to M. P e t r o (l. c.) the oldest and mostly spread mineral of the succession is quartz, which represents a particular-quartz mineralization period.

As the first mineral of the second — sulphidic period pyrite is mentioned. It is

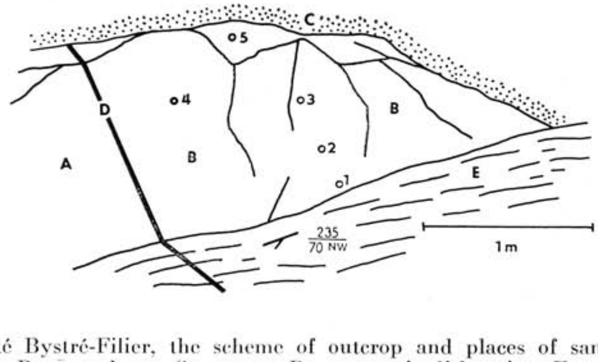

Fig. 2. Ratkovské Bystré-Filier, the scheme of outcrop and places of sampling. A — migmatite, B — ore lense, C — scree, D — tectonic dislocation, E — brook.

relatively little spread, forming isolated grains and small allotriomorphic grained aggregates, highly corroded by younger pyrrhotite.

Pyrrhotite crystallized after pyrite and is the most abundant ore mineral at the locality. It forms veinlets, disseminated ores and clusters in quartz as well as isometric grains developed on schistosity planes of the wall rock, having the character of impregnations. These impregnations are often so intense that even loop-network structures originate. In contrast to other occurrences, in the pyrrhotite of this place almost no pyrite-marcasite aggregate has been observed.

Chalcopyrite is more abundant than pyrite but less than pyrrhotite. It may be observed in the shape of veinlets up to 2 mm thick in joints, which intersect all older minerals of the ore mineralization here. It also forms isolated small grains and aggregates of lesser dimensions.

Locality Ratkovské Bystré — Bystrianska dolina valley, situated 1,5 km west of the community. Its surroundings comprises granites with locally occurring migmatites. In the past a quartz-sulphidic vein striking 30; several decimetres thick was mined in two adits. The following minerals are present (M. Petro 1972); assigned to one, quartz-sulphidic period and to three mineralization subperiods.

The oldest and mostly spread nonmetallic mineral is quartz, often affected by intermineralization tectonics.

Pyrite is the oldest sulphidic mineral and the first mineral of the second mineralization subperiod. It forms allotriomorphic grained aggregates as well as hexahedral metacrysts in quartz.

Pyrrhotite is less abundant than pyrite. It forms allotriomorphic grained aggregates, in which often polysynthetically extinguishing grains are observed. Corroded relicts of older pyrite are often found in it.

The pyrite-marcasite interproduct is abundant. For the major part it originated primarily in the mineralization process when it often completely replaced pyrrhotite.

Chalcopyrite is a relatively rare mineral of the second mineralization subperiod. It forms isolated disseminations, smaller aggregates and irregular veinlets. It already started to crystallize in the concluding phases of pyrrhotite crystallization.

Ankerite carbonate is the principal mineral of the third subperiod, which started by pyrite crystallization after little distinct intermineralization tectonics having affected the older mineralization. After ankerite crystallization of a lesser amount of chalcopyrite took place.

Isotopic composition of sulphur and its interpretation

The mineralizations in the south-eastern part of the Veporide crystalline belong to little investigated ones from the deposital and mineralogical-geochemical view. So far also data on isotopic ratios have completely been missing. The aim of our investigation was to present their fundamental characterization.

Isotopic ratios of sulphur were measured on modified mass spectrometer MI-1305 of Soviet production. We used SO_2 obtained from monomineralic fractions. For the separation of minerals we are thankful to Mrs. Z. Trstenská and Mr. D. Zaťovič, for SO_2 extractions to Mrs. V. Wiegerová and for mass spectrometric measurement to Ms. E. Spišáková. The results of analyses are given in Tab. 1 in per-mille deviation to the meteoritic standard according to relation:

$$\delta S^{34}/‰ = \frac{S^{34}/S^{32} \text{ of sample} - S^{34}/S^{32} \text{ of standard}}{S^{34}/S^{32} \text{ of standard}} \times 1000$$

Table 1

Locality	No	Mineral	S^{32}/S^{34}	δS^{34} (‰)
1. Revúcke Kúpele	611	pyrrhotite	22,452	−10,34
	1195	pyrrhotite	22,512	−12,99
	1194	pyrrhotite	22,579	−15,89
2. Ratkovské Bystré — Filier	1168 (3)	pyrrhotite	22,481	−11,60
	1166 a(2)	pyrrhotite	22,491	−12,05
	1167 a(1)	pyrrhotite	22,496	−12,25
	1169 (4)	pyrrhotite	22,524	−13,50
3. Ratkovské Bystré — Bystrianka	601	pyrrhotite	22,544	−14,39
	1167	pyrite	22,460	−10,69
	1166	chalcopyrite	22,487	−11,87
	600	pyrite	22,233	− 0,59

From the locality of Revúcke Kúpele we analysed 3 pyrrhotite samples, characterized by a considerable enrichment in isotope 32, with δS^{34} ranging from − 10.3 to − 15.9. The mineralization occurs in the oldest and deepest, Hron complex of this area (A. Klinec 1966).

Pyrrhotites from the locality Filier near Ratkovské Bystré are also characterized by high concentrations of light sulphur. The established diapason of variations is, however, somewhat narrower here: The δS^{34} values varied between − 11.6 and − 14.4 ‰.

For sulphur from chalcopyrite from the same locality the value $\delta S^{34} = -11.9$ and for pyrite − 10.7 ‰ was measured.

The competent per mille deviations for the coexisting pyrite — pyrrhotite pair:
pyrite = − 10.7
pyrrhotite = − 12.2

The common trend for a higher concentration of light isotope in pyrrhotite with fractioning is preserved. The difference in δS^{34} values equals 1.5.

In the coexisting pyrrhotite-chlcopyrite couple an insignificant difference in δS^{34} has been found only: pyrrhotite = − 12.05, chalcopyrite = − 11.87 ‰, which may be caused by a later origin of chalcopyrite as testified by the conditions observed under the microscope.

As mentioned before, the sulphidic mineralization of Ratkovské Bystré-Filier occurs in a block of migmatites submerged in biotitic granodiorites, probably of Variscan age.

At the locality Ratkovské Bystré-Bystrianska dolina valley the sulphur from pyrite approaches meteoritic sulphur in its isotopic composition ($\delta S^{34} = -0{,}6$ ‰), conspicuously differing from both the mentioned mineralizations.

According to the investigations of one of the authors (M. P.) a distinct epigenetic, vein, hydrothermal mineralization is concerned. The isotopic composition of sulphur — as far as we may it consider as representative — is not contradictory to such an origin, nor to deriving it from a deep magmatic source.

The sulphidic sulphur from the localities Revúcke Kúpele and Ratkovské Bystré-Filier should be, however, with equal assumptions, considered as uncommon by its isotope ratios.

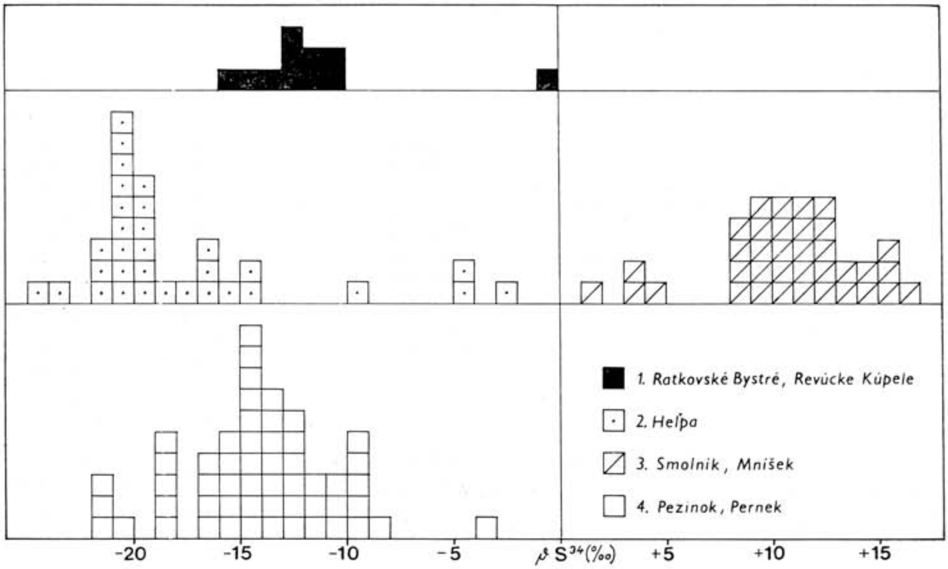

Fig. 3. Histograms of δS^{34} values for massive sulphides deposits in the West Carpathians.

For more important pyrite deposits of the West Carpathians isotope characteristics were published by one of the authors (J. K.).

The sulphidic sulphur from the deposits Smolník and Mníšek nad Hnilcom, from stratiform ore mineralizations in the Cambro-Silurian suite of the Gemerides, is enriched in heavy isotope when compared with sulphur from meteorites. The values δS^{34} vary mainly within the range from +8 to +16 ‰ (J. Kantor — M. Rybár 1970).

The stratiform pyrite-pyrrhotite deposit of Heľpa is lying in the Hron complex of the Nízke Tatry Mts. It is marked by light sulphur with a δS^{34} maximum around —20 ‰ (J. Kantor et al. 1971).

A similar isotope distribution has also been found at the Malé Karpaty pyrite deposits of stratiform type from Pezinok and Pernek. The diapason of δS^{34} variations ranges from —8 to —22 ‰ (J. Kantor in B. Cambel — J. Kantor 1972, J. Kantor 1974).

The histograms of δS^{34} values for the mentioned deposits are given in fig. 3.

In its isotopic composition of sulphidic sulphur the ore mineralizations from Revúcke Kúpele and Ratkovské Bystré markedly differ from sulphides of the deposits Smolník-Mníšek nad Hnilcom. They display, however, considerable analogies with the deposits from Heľpa and Pezinok-Pernek.

This analogy need not relate only to the isotopic composition but also to genetic conditions and relationship to the basic, submarine volcanism, also in spite of the fact that basic rocks are well developed in the Malé Karpaty Mts., less near Heľpa and rudimentarily in the area of Revúca and Ratkovské Bystré.

At the deposits near Heľpa and Pezinok-Pernek pyrrhotite is present in the hexagonal and monoclinic structural type (J. Kantor — J. Ďurkovičová 1973, 1973 a). Relics of hexagonal pyrrhotite in monoclinic one have also been found in ore mineralizations from Filier near Ratkovské Bystré and Revúcke Kúpele. On the contrary, at typical hydrothermal veins in the Spišsko-gemerské rudohorie Mts. exclusively the monoclinic, usually a lower-thermal type is represented (J. Ďurkovičová — J. Kantor 1975).

Conclusions

The ore mineralizations of the area under study are noteworthy in their enrichment in light sulphur. In this regard they resemble the pyrite deposits from Heľpa in the Nízke Tatry Mts. and from Pezinok-Pernek in the Malé Karpaty Mts. We may also admit that primary stratiform ore mineralizations are concerned, which could have been partly or completely remobilized due to superimposed tectonic and magmatic processes. In every case more detailed investigations are requirable to verify these assumptions.

Translated by Jozef PEVNÝ.

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Review by B. CAMBEL.