GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATHICA, 36, 5, BRATISLAVA, OCTOBER 1985, PP. 589—596

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SCHEELITE-GOLDBEARING MINERALIZATION AT THE SOUTHERN SLOPES IN THE WESTERN PART OF THE NÍZKE TATRY MTS.

Abstract: It has been found by geological-investigation works at the southern slopes in the western — Ďumbier part of the Nízke Tatry Mts. that scheelite occurring here in several stages of ore mineralization, was not formed during one process of ore mineralization but there is a repeated polyphase development from the Early Paleozoic to Upper Cretaceous. The oldest is the bedded type of scheelite (strata and time bound). The geological environment of W-mineralization occurrences is mainly formed by gneisses and migmatites of unknown age. They are distributed together with the further mentioned rocks in a narrow zone within an antiform structure. It is about 1 km wide, 20 km long and in 90 % formed by gneisses and migmatites. The rest is represented by weakly metamorphosed Late Paleozoic volcanoclastic rocks and Triassic quartzites. The favourable structural distribution of basement rocks and their deep reach were a suitable communication for the rising heat front in Alpine epoch and mineralization solutions connected with it.

Резюме: Геологические исследования на южных склонах западной — дюмбьерской части Низких Татр показали, что шеелит, встречающийся здесь в нескольких стадиях рудной минерализации, не был образован во время одного процесса рудной минерализации, но наблюдается повторное полифазовое развитие с раннего палеозоя до верхнего мела. Самым старым является слоистый тип шеелита (ограничен слоем и временем). Геологическую среду местонахождений вольфрамовой минерализации составляют преимущественно гнейсы и мигматиты неизвестного возраста. Они распределены вместе с далее приведенными породами в узкой зоне в пределах антиклинальной структуры. Она шириной около 1 км и длиной 20 км, из 90% составлена гнейсами и мигматитами. Остаток представляют слабо метаморфизованные позднепалеозойские вулканокластические породы и триасовые кварциты. Благоприятное структурное распределение подстилающих пород и их глубокая досягаемость были подходящим средством для повышающегося теплотного фронта в альпийской эпохе и минерализационных растворов с ним связанных.

In this contribution we are dealing with the occurrence of scheelite mineralization in crystalline rocks of the Western Carpathians focused on the area of the Nízke Tatry Mts.

Scheelite was described first in Slovakia from crystalline rocks of the Malé Karpaty Mts. by Zepharovich (1859). A survey of older established ore mineralizations from crystalline rocks of the West Carpathians is mentioned by Kantor (1965 — according to the manuscript report by Kantor — Eliáš, 1962). From neovolcanics at the deposits Vyhne and Banská Štiavnica scheelite is described by Koděra (1962).

Hvožďara (1981), setting out from comparison of scheelite mineralizations in the Austrian Alps with new occurrences of scheelite (occurrences found by

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prospection works from the year 1964), distinguishes 4 generations of scheelite in the West Carpathian region. On the basis of the performed prospection works in Slovakia it may me stated that scheelite in crystalline rocks of the West Carpathians is found everywhere, however, it has not been verified in industrial concentrations.

The area investigated most in details from the West Carpathian region, from the viewpoint of scheelite mineralization, are the southern slopes of the western — Ďumbier part of the Nízke Tatry Mts. Here, after scheelite mineralization was found by K a n t o r — E l i á š (1962), we began to deal with scheelite mineralization more thoroughly after finding out of regional extension of scheelite in heavy mineral concentration (P u l e c, 1976; 1977a; 1977b). Already the first more detailed works in the area of Jasenská Kyslá in the year 1978 (mining exploration is being carried out now) showed the possibility of finding of W-Au mineralization in the Nízke Tatry Mts. also of economic importance. In the area of the Gelfúsová dolina valley we found scheelite mineralization in 7 metres layer in borehole Ge-1 where the average content of tungsten was 1.59 % W (P u l e c, 1979).

After termination of geological-investigation works in the area of Jasenská Kyslá in the year 1980 (P e c h o — P u l e c et al., 1980) the members of Dionýz Štúr Institute of Geology in Bratislava sought for scheelite mineralization in the perspective zone from Sopotnička to the spring area of the Vajskovská dolina valley. The occurrence of scheelite mineralization was attested mainly in the axial part of the Špiglová structure at total length of 18 km and width of 400—1200 m with interruption of the mineralized zone at surface in the section between the Bukovská dolina valley and Ráztocká hoľa in the western part of the area under study. In the name of these investigation works a series of new knowledge on the occurrence o fscheelite mineralization as well as a rich fragmental material from the veinstuff of W-Au mineralization from the whole area pursued by prospection has been obtained, which provided us important information on genetic types of scheelite mineralization. On the basis of this knowledge we have come to the opinion that scheelite formed in several stages of mineralization and its development is polyphasic.

Characterization of genetic types of scheelite mineralization

1. According to the up to present results of investigation works we may say that the first — oldest group of scheelite in the Nízke Tatry Mts. are bedded types (strata and time bound) most probably genetically bound to hydrothermal activity of paleovolcanics.

For genetic consideration of pyrite occurrence we take for important finding of scheelite mineralization in borehole R-2 in the Bukovská dolina valley where scheelite does not occur in form of epigenetic quartz veins but is bound to the parental rock-migmatites. In section 22.0—31.0 m scheelite is found in thin strips in direction of bedding schistosity and represents primary mineralization in the metamorphosed volcanic-sedimentary complex. A similar occurrence of scheelite in thin strips in migmatites is also at outcrop (locality SR-4), in the new forest path cut above the brook Ramžené.

For considering the age of banded and eyed migmatites and gneisses, in which

are most scheelite ores, we take for very important establishing of their position in the area of Polianka (Bukovská dolina valley). Here a complex of high-grade metamorphosed gneisses and migmatites with scheelite mineralization occurs in the axial part of the Špiglová structure (the s_1 — surfaces of migmatites are steeply dipping). On them the low-grade metamorphosed volcanogenic-sedimentary complex of Devonian age is lying (determination according to Planderová, 1984). These Early Paleozoic low-grade metamorphosed products verified also by drilling works are not containing scheelite mineralization of bedded type visible macroscopically.

We found rich fragmental material from bedded types of scheelite mineralization at the locality Ramžené (SR-1, left tributary of Sopotnica) where scheelite is found in the metamorphosed volcanic-sedimentary complex in the shape of variously thick bands-regenerated in the process of later Variscan or Alpine tectonometamorphic processes. So here scheelite forms, besides characteristic bedded types, also porphyroblasts, coarse-grained aggregates of scheelite grains and crystals elongated in direction of bedding schistosity and also transversal joint fillings.

Metamorphic alterations of the complex of migmatites and gneisses, in which the bedded scheelite ores are found, were taking place in several stages. We consider the complex of high-grade metamorphosed rocks (gneisses-migmatites) as oldest, probably even pre-Paleozoic.

2. We assign to the second group scheelites, which are the product of palingenic regeneration with Variscan granite-forming processes (A) and scheelites bound to Variscan granite-forming ore mineralization processes (B).

From general metallogenetic view of the origin of ores of various formations (still without scheelite) the Variscan epoch is most important in the Nízke Tatry Mts. Formations of ores distinguished by Andrusov—Koutek—Zoubek (1951), ore veins and ore formations distinguished here by Kravjanský (1959), Hak (1959; 1962), are dated in this period. A part of the authors supposes that these ore formations were later recrystallised or mobilised during the Alpine tectonometamorphic processes. Close relation of the veins and stockworks with scheelite and gold-bearing mineralizations connected with the Variscan epoch is pointed out by Ilavský (1981), who puts their origin into connection with metamorphic reworking of the volcanogenic-sedimentary series, probably of Paleozoic age, which originally contained ores of the scheelite-gold-bearing formation. He ranges to the Variscan ore complex several hydrothermal veins but does not mention the share of these granitoids in hydrothermal origin of scheelite-gold-bearing mineralization.

Close relation of the scheelite-gold-bearing mineralization to Variscan granitoids is indicated by Gubač (1983) on the basis of geochemical prospection (soil metallometry). According to him the hydrothermal solutions were scheelite formed and at greater distance elements and ores of the outer zone occur (Pb, Zn, Cu and farther Sb).

Linking of scheelite with the Variscan granitization mineralizing process may be proved by he presence of scheelite in pegmatites and granitoids. In them scheelite is found in form of particular grains of various size. So, for instance, in the Špiglová dolina valley scheelite crystallised at the contact of pegmatite with banded migmatites. This pegmatite is of Variscan age according to the analysis by Ar^{40}–K^{40} method carried out by Kantor (1981) (326 mil. y.).

3. To the third group we range scheelites, which were regenerated in the process of Alpine tectonometamorphic processes from the first two generations (A) and scheelites linked with Alpine ore mineralization processes (B), which are genetically bound to Alpine intrusions.

The ore complex bound to the orogenic stage of the Alpine epoch has no representative in the prospection area. Vein rocks of lamprophyre character (kersantites) are present only, found by K l i n e c (1983) in the Vajskovská dolina valley in the area of Zadné Kotliská and Pálenice.

In crystalline rocks of the Ďumbier zone serpentinised amygdaloidal rocks were found already earlier in the Mesozoic of Trangoška development, to which, however, no metallogenetic activity of more important character is attributed. In spite of that a great metallogenetic importance is ascribed to the particular tectonometamorphic development of crystalline rocks, which we shall mention further, during the Alpine epoch and also the occurrence of Fe-Cu-Pb-Zn ores in the Middle Triassic of the folded Mesozoic. Formation of these ores is put into connection with Upper Cretaceous tectonomagmatic and tectonometamorphic processes (S t a n k o v i č, 1962). Formation of veins of antimonite ores at the southern slopes of the Nízke Tatry Mts. in the Ďumbier crystalline complex is placed into the Alpine epoch by M. Slavkay (1971).

The occurrence of scheelite in the third group and its linking with the Alpine ore mineralization processes, which are genetically bound to Alpine intrusions cannot be excluded from this view of metallogenessis in the Nízke Tatry Mts. Relation of young-Alpine granitoids to formation of scheelite is mentioned from the West Carpathian region in the area of Rochovce by I v a n o v — P u l e c (1979).

With mineralogical-paragenetic evaluation (B e ň k a — S u c h ý, 1983) these parageneses were distinguished: carbonate, pyrite-arsenopyrite, chalcopyrite-tetraedrite, antimonite with berthierite (?), quartz-gold-tellurium-bismuth and quartz-scheelite. The authors consider tungsten mineralization at the ore veins in this part of the Nízke Tatry Mts. as one of the youngest on the basis of mineralogical-geochemical observations.

After purposeful geological investigation, focused on clearing up of the environment of W-ores occurrence in the Nízke Tatry Mts., it was stated that this is mostly bound to a narrow long zone, which has many particular features when compared with the wider area. A part of this publication is devoted to its location, description of structural marks, lithological and chronological content and position in the central zone of the Carpathians just for the mentioned reason.

Finally we also put the discovered features of distinct destruction of the present-day relief into connection with the particularities of the structural plan of the area and its active modelling up to the latest period. Greatest concentration of scheelite ores from the whole Nízke Tatry Mts. area is bound to their Ďumbier part. Inside it on their southern side is a zone of crystalline schists, prevailingly distinctly metamorphosed. On the northern side of this E-W stretched strip, at their contact with granitoids, is a zone about 1 km wide and 18 km long. Concerned is the length in strike at the surface in the section mainly built up of crystalline rocks. We suppose that it continues towards the west and east, but there — in Mesozoic complexes its course is of different character.

Within this zone — in the section Sopotnička—Bukovská dolina valley, through Biela voda, Kyslá, Lomnistá dolina valley, Vajskovská dolina valley, Trangoška to the Bocianka valley, south of Vyšná Boca, two strips of Triassic quartzites, shales and carbonates are observed in the almost whole its course. In the eastern half of the zone they are oriented within the antiform structure to its northern and southern wing. In the area of the Vajskovská dolina valley — Trangoška both wings are inclined to the north. The smaller western half is characterized by distinct manifestation of transversal fractures and upthrusts of NW-SE direction, consequently the two strips of quartzites are inclined to southeast. The crystalline rocks are the dividing elements between the quartzite strips at all length of strike of the zone (including Trangoška).

A further feature of this zone is its dissection by numerous longitudinal fractures. They are accompanied by mylonitization and formation of narrow diaphthorite strips as well as the presence of "elements wedged in crystalline rocks" from higher levels (Mesozoic—Paleozoic). The zone contains mainly stromatitic and ophthalmitic migmatites, gneisses and amphibolites of unknown age. Granitoids are also present. They form together 90 % of rocks of the zone. The rest are Early and Late Paleozoic weakly metamorphosed products (metasediments and metavolcanics) and Triassic rocks, prevailingly quartzites.

Between all the above mentioned types of the zone are close relations and features of conformable position. This fact together with great similarity of mylonites and diaphthorites to metasediments on the one hand and to metavolcanics on the other hand renders their field, but also laboratory distinguishing difficult.

The most abundant occurrences of scheelite mineralizations are bound to migmatites at these places where their s_1 — surfaces are of perpendicular (vertical) or steep position. A suitable ore-locating factor is also crossing of steep (vertical) fractures and the presence of amphibolite bodies (topomineral influence).

As indicated above, some sections of the zone are characterized by subhorizontal or moderate dip at s_1 — surfaces. For instance, the section in the middle part of the Lomnistá dolina valley and the Struhár ridge. There localities are, however, situated farther (more southerly from the axis of the antiform structure). The section in the area of Biela voda is also characterized by a moderate dip of s_1 — surfaces. There however, the E-W course of the zone is disturbed by transversal fractures of upthrust character dipping southeast 30°—40°—60°.

A remarkable structural discordance between migmatites on the one hand and quartzites, phyllites on the other hand was observed at the Polianka ridge. On erected (vertical position of s_1 — surfaces) migmatites are lying the above mentioned metasediments with flat dip of 30° to the north. The established relation is not exceptional in the Nízke Tatry Mts. So far, however, it has been recorded between crystalline and Mesozoic complexes. In the frame of structural arrangement of the zone — it is an untypical case, but important as metasediments are dated palynologically as Early Paleozoic, Devonian to Lower Carboniferous products (determination and assignment by P l a n d e r o v á, 1984). The zone is dissected by transversal fractures into blocks-sections, inside which vertical movement was manifested to a various extent. In sunken blocks as is the section between Biela voda and the Bukovská dolina valley — (Polianka

ridge) higher structural elements are preserved — Early Paleozoic. The sections vaulted in horsts, e. g. the area of Jasenská Kyslá, are characterized by the presence of migmatites, which represent the lower levels of the structure. On such a dissection of the zone also the occurrence of W-ores is depending. The sunken blocks characterized by a greater share of Paleozoic and Mesozoic units have usually no more important accumulations of ores at the surface.

Many of the mentioned features of the zone indicate that there is a great cicatrix of deep reach. We suppose that it formed in the Mediterranean or Subhercynian phase as a consequence of compression and following releasing of pressure in rocks of the crystalline basement. We assume that the existence of this deep-reaching cicatrix offered a suitable communication for ascent of the heat front and mineralization connected with it also in the Alpine epoch. The observed dependences support the hypothesis of a deep source of ore mineralization or of such a deep process, which was the "unifying factor" in formation and location of scheelite mineralization, regardless of the character of the primary source.

An analogous structure has not been found in crystalline rocks of the central zone so far. It is not by chance that it is found amidst the most distinctly altered rocks. It may be connected with the rising tendency of the end of the Mesozoic era and then in the Tertiary.

To the end of the Tertiary a further anomalous development was taking place in this area. The Ďumbier part of the Nízke Tatry Mts. was enormously rapidly uplifted against the surrounding area. So the unequal state of rock mass distribution resulted in formation of a destruction structure — to formation of a gravitational nappe. It was established on the basis of the analysis of a cosmic satellite photograph. Its root part is represented by the zone just analysed. The movement of rocks masses was from north to south, the front of nappe is located even to the area of Strelníky. The detailed analysis of this structure is the subject of a particular article (in press). From the viewpoint of the above analysed structures of the zone the fact is important that its original arrangement and original position of ores are deformed by development of this destruction structure.

Conclusion

As a result of geological-prospection works and special investigation methods we have obtained new knowledge in a relatively short time, which we summarize as follows.

The occurrence of scheelite-gold-bearing mineralization, mainly in the axial part of the Špiglová structure, has been confirmed. It has been established that in the Nízke Tatry Mts. scheelite is found in several stages of ore mineralization, was not formed in one process of mineralization, but there is a repeated polyphasic development from the Early Paleozoic to Upper Cretaceous. Scheelite occurs in three generations here. The bedded type of scheelite (strata and time bound) is the oldest. With its formation the Variscan epoch was distinctly manifested and terminal formation of the ore structures was in the Alpine epoch. Its present-day occurrence is mainly bound to epigenetic hydrothermal veins.

The geological environment of the remarkable occurrences of W-minerali-

zation in the Nízke Tatry Mts. is mainly formed by gneisses and migmatites of unknown age. They are distributed together with further mentioned rocks within an antiform arrangement in a narrow long zone. This is 1 km wide, 18 km long and 90 % formed by gneisses and migmatites. The rest are Early and Late Paleozoic weakly metamorphosed volcanoclastic and Triassic quartzites.

The rocks of the zone are distinctly disturbed by deep-reaching longitudinal fractures and transversal fractures, dissecting it into rising or sunken blocks.

The analysis of structural elements of the zone leads us to the basement. So the favourable structural arrangement of basement rocks and its deep reach became a suitable communication for the rising heat front and mineralizing solutions connected with it in the Alpine epoch.

Translated by J. Pevný

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Manuscript received January 17, 1985