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Zinc-lead ore deposit in Lower Triassic (Roethian) dolomites at Bolesław (Olkusz region, Poland)

At the Bolesław mine the Zn-Pb ore bodies occur within the Middle Triassic („ore-bearing") and the Lower Triassic dolomites. It is an exceptional feature in the Silesian-Cracow ore district. The Roethian ore bodies are small and irregular, formed of rich ore surrounded by the aureole of dispersed sulfides, monheimite and barite. They lie preferably in synsedimentary breccias, solution breccias (often superimposed on the previous ones) and collapse breccias. Mineralogical composition of the ore is simple: sphalerite-galena-marcasite with abundant colloidal varieties (mostly brunckite) precipitated during four stages of mineralization at 95-115°C . The ore bodies were formed partly by the replacement, partly by the open space filling, formed due to hydrothermal karstification of the host dolomites.

INTRODUCTION

The occurrence of the intensive ore mineralization in the Roethian dolomites is the characteristic feature of the Bolesław mine in contrary to the other Silesian-Cracow lead and zinc deposits. That mineralization is interesting both from the theoretical and practical points of view, although it displays less significant reach when compared with the most abundant mineralization in the ore-bearing dolomites. The occurrence of the mineralization in the Roethian rocks has been know and described since a long time (C. Kuźniar, 1930; F. Ekiert, 1959; J. Własnowolski, 1964; D. X. Phong, 1971; M. Nieć, 1979). In the intensive discussion on the syn- or epigenetic origin of the Silesian-Cracow lead and zinc deposits the existence of the mineralization described was presented as the argument for their hydrothermal provenance. Moreover, it was assumed that mineralization pointed to the migration paths of the ore-bearing solu-

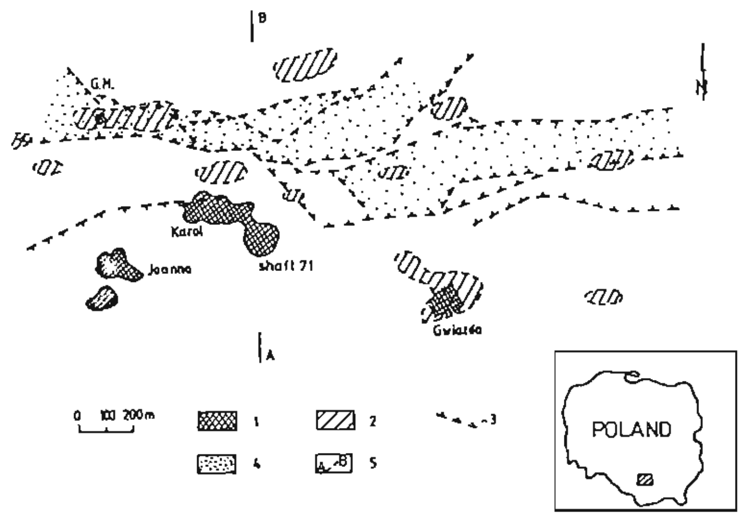


Fig. 1. Location map of ore bodies and mineralized zones within Roethian dolomites at Bolesław mine
1 — ore bodies mined or explored by underground galleries; 2 — mineralized zones explored by boreholes; 3 — main faults; 4 — Bolesław Graben; 5 — cross-section (A—B) on Fig. 2; G. M. — marcasite ore body
Rozmieszczenie znanych ciał rudnych i wystąpień mineralizacji w utworach retu kopalni Bolesław
1 — gniazda rud Zn-Pb rozpoznane wyrobiskami górniczymi; 2 — strefy występowania mineralizacji stwierdzonej w otworach wiertniczych i w odosobnionych wyrobiskach górniczych; 3 — główne uskoki; 4 — rów Bolesławia; 5 — przekrój geologiczny A—B (Fig. 2); G. M.— gniazdo markasytowe

tions ascending from the deep basement to the Middle Triassic rocks, where precipitation of the main ore mass occurred.

The deposit within the Roethian dolomites has been exploited since over 80 years (B. Niedzielski, 1979). The exploitation had been led through years within the so-called nest of the 71 shaft known as the Ulisses field (C. Kuźniar, 1930) and in the adjacent Karol nest, then — in the Joanna and Gwiazda nests (Fig. 1). The mining and drilling works as well as the interpretation of the occurrence of the ore nests and the mineralization showings give the data suggesting the more widespread distribution than the hitherto accepted one. The most interesting problems are the following:

1 — controlling factors of ore bodies distribution;

2 — relation of the mineralization and the adjacent rocks;

3 — mineral composition of the ore bodies; similarities and differences in comparison to the mineralization in the ore-bearing dolomites.

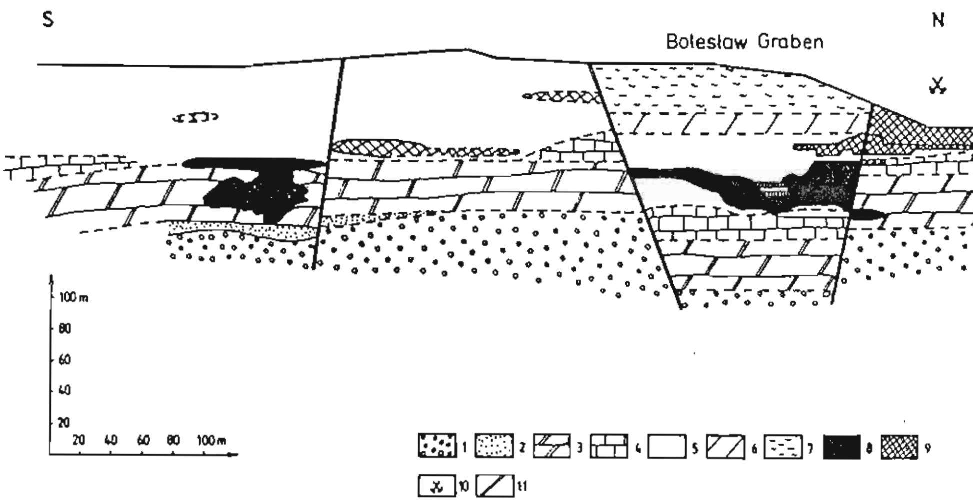


Fig. 2. Section (A—B) across Bolesław ore deposit according to mining data

1 — Permian conglomerates; 2 — Lower Buntsandstein; 3 — Roethian dolomites; 4 — Gogolin Limestones; 5 — ore-bearing dolomites; 6 — Diplopora Dolomites; 7 — Keuper clays; 8 — sulfide ore bodies; 9 — oxidized (galmei) ore bodies; 10 — abbandoned open pit; 11 — faults; mining galleries and boreholes are ommited

Przekrój geologiczny (A—B) przez złoże rud kopalni Bolesław, zestawiony na podstawie danych z wyrobisk górniczych

1 — zlepieńce permskie; 2 — pstry piaskowiec niższy; 3 — dolomity retu; 4 — wapienie gogolińskie; 5 — dolomity kruszconośne; 6 — dolomity diploporowe; 7 — iły kajpru; 8 — rudy siarczkowe; 9 — rudy utlenione (galmany); 10 — kopalnia odkrywkowa galmanu; 11 — uskoki; pominięto wyrobiska górnicze i otwory wiertnicze

THE DEPOSIT IN THE ROETHIAN AND ITS RELATION TO THE STRUCTURE OF THE BOLESŁAW DEPOSIT

The folded and faulted limestones and slates recognized as the Lower Carboniferous represent the oldest rocks stated in the Bolesław region. They are discordantly covered with the horizontal Permian conglomerates of thickness of 120-230 m underlying the Lower nad Middle Triassic sediments. The Keuper sediments appear only in the tectonic grabens being there preserved. The Quaternary sediments form a thin discontinuous cover of thickness reaching 10 to 20 m. They are 50 m thick only in the Przemsza paleovalley erosionally cut in places till the bottom of the Middle Triassic sediments.

The Triassic sediments lie nearly in tolal horizontally. Their dip does not exceed some degrees. Only locally it is possible to observe the large-scale radial bending of the layers. Faults are the predominant tectonic feature. The latitudinal tectonic graben of Bolesław of the width of 150-250 m about 50 m deep represents the main teetonie elements there. Numerous dislocations, transversal and oblique to the graben, cause the blocking strueture of the Triassic sediments which results in the mosaie structure (Fig. 1).

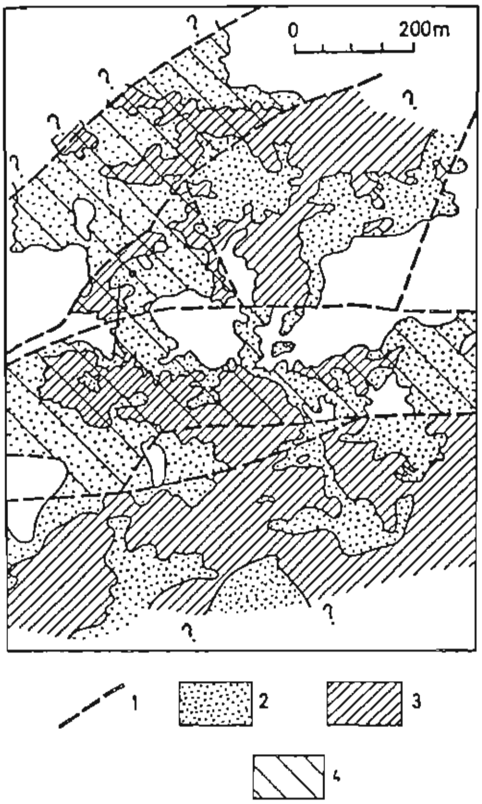


Fig. 3. Map of the part of ore body within ore-bearing dolomites about 15 m over the top of Gogolin Limestones

1 — faults; 2 — ore grade 2.5 to 5% Zn; 3 — ore grade over 5% Zn; 4 — sulfide ore

Mapa fragmentu złoża w dolomitach kruszconośnych ok. 15 m powyżej ich spągu

1 — uskoki; ruda o zawartości: 2 — 2,5-5% Zn, 3 — powyżej 5% Zn; 4 — ruda siarczkowa

The zinc-lead deposit occurs in the ore-bearing dolomites (95% of reserves) and partly — in the Roethian dolomites (Fig. 2). Small ore concentrations occur also in the Gogolin Limestone and the Diplopora Dolomites. The mineralization showings of no industrial significance have been also discovered in the Lower Triassic sediments, the Permian conglomerates and in the Carboniferous sediments.

Two types of the ores, i.e., sulfide and oxidized (galmei), occur in the ore-bearing dolomites. The sulfide ores compose about 50% of the reserves.They occur in the lower parts of the deposits, mostly in the tectonic grabens. Their composition is very simple. Sphalerite (in the crystalline form or in hemi-colloidal varieties), galenite and iron sulfides (mainly marcasite) represent the main ore minerals accompanied by calcite in the marginal parts of the ore bodies. The oxidized ores (galmei) occur in the elevated parts of the deposit, mainly in the wings of the Bolesław Graben. Main minerals there are the followings: smitsonite, hydrated iron oxides, cerusite and relics of sulfides, mainly of galena.

The shape of the deposit in the ore-bearing dolomites strongly depends on the cut-off grade applied. With a decrease of cut-off grade the less mineralized parts of ore-bearing dolomites may be recognized as ore, and the continuity of the deposit increases. The richest deposit parts (over 5% of Zn) cover an area of about 38%, while

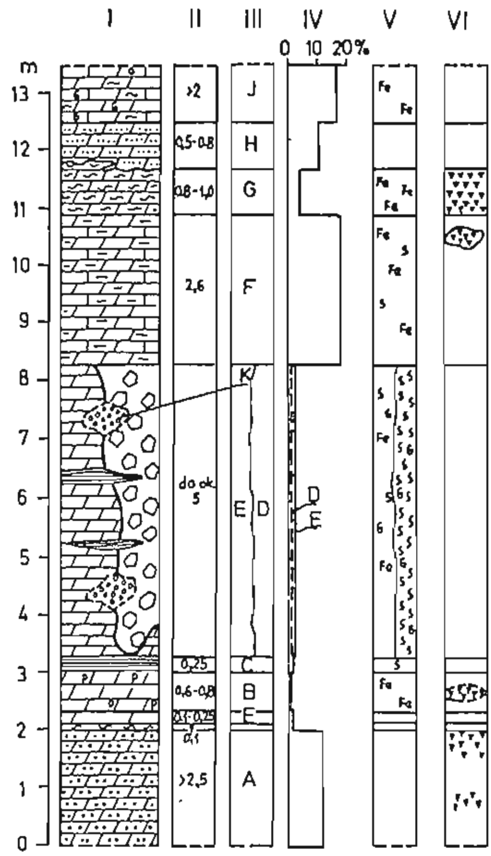


Fig. 4. Lithologic profile of Roethian dolomites at 255 m level of Bolesław mine

I — lithologic profile; II — thickness in m; III — rock types: A — oolitic dolomites, B — „spotted" dolomites, C — marly dolomites thin- bedded, D — bedded synsedimentary dolomite breccia, E — laminated marly dolomites, F — limy dolomites, G — marly dolomites, H — sandy dolomites, J — limy dolomites with mollusc shells and foraminifers, K — „pocket" breccia (nest breccia); IV — porosity; V — mineralization: Fe — iron sulfides, S — sphalerite, G — galena; VI — barite

Profil dolomitów retu odsłoniętych na poziomie 225 kopalni Bolesław

I — profil litologiczny; II — miąższość w m; III — typ litologiczny: A — dolomity oolitowe, B — dolomity „plamiste", C — dolomity margliste płytkowe, D — brekcja dolomitowa „ławicowa", E — dolomity margliste laminowane, F — dolomity wapniste, G — dolomity margliste, H — dolomity piaszczyste, J — dolomity wapniste z małżami i otwornicami, K — brekcja gniazdowa; IV — porowatość; V — mineralizacja: Fe — FeS_2, S — sfalerytowa, G — galenowa; VI — baryt

the ore of 2.5% of zinc — 66%. The ores displaying the content above 1.5% cover about 82% of the area. With the lowest metal contents the deposit has the form of the discontinuous, irregular layer with nest enriehments.

An opinion on fault controlled ore formation has been widely accepted (T. Gałkiewiez, 1977). It did not consider varied cut-off grades applied for sulfide and oxidized ores. Cut-off grade higher for the oxide ore than for the sulfide one, makes mappable ore contours broken on fault lines and oxide ore bodies diseontinuously presented on the elevated fault wings.

Applying the same criteria to both the sulfide and oxidized ores when contouring the deposit, one can state the continuous character of the deposit on the both sides of the fault (Fig. 3). The faults are, therefore, either younger that the mineralization itself or renewed after its formation.

The deposit within the Roethian dolomites displays a significant nested eharacter (Fig. 5) even with the lowest economic criteria. There oceur in general the sulfide ores. Only the highest parts of some nests are in the weathering zone there.

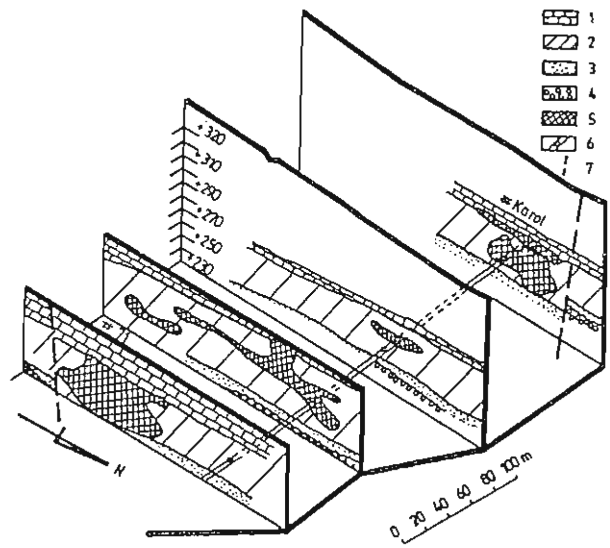


Fig. 5. The shape of 71 shaft and Karol ore bodies according to borehole and mining data
1 — Gogolin Limestones; 2 — Roethian dolomites; 3 — Buntsandstein; 4 — Permian conglomerates; 5 — sulfide ore (ore bodies); 6 — main gallery; 7 — faults
Forma złoża w gniazdach szybu 71 i Karol na podstawie danych z wyrobisk górniczych i wierceń dołowych
1 — wapienie gogolińskie; 2 — dolomity retu; 3 — pstry piaskowiec; 4 — zlepieńce permu; 5 — rudy siarczkowe (ciała rudne); 6 — przekop udostępniający; 7 — uskoki

In comparison to the ore-bearing dolomites there occurs a higher percentage of the colloidal zinc sulfide varieties, especially of brunckite and marcasite. Calcite, being a common barren mineral in the ore-bearing dolomites, remains subordinate in the Roethian rocks in contrary to the abundant barite mineralization forming distinct aureoles around the sulfide ore nests (B. Niedzielski et al., 1975). The occurrence of monheimite (Fe, Zn)CO_2 (B. Bąk, M. Nieć, 1978, 1981) is characteristic in some parts of the deposit.

MINERALIZATION DISTRIBUTION IN ROETHIAN DOLOMITES

Zones of mineralization occurrence in the Roethian dolomites are presented in Fig. 1. Best known are the following nests: the already exploited nests of the 71 shaft, the smaller and adjacent to the previous one Karol nest, the Joanna and Gwiazda nests. Due to the mining works they gave a lot of information on the deposit structure. The marcasite nest at the top of the Roethian dolomites within the tectonic Bolesław Graben has been recognized also due to the mining activity.

The ore mineralization appears in the whole Roethian section with different intensity. In some places the bottom parts of the Gogolin Limestones are mineralized,

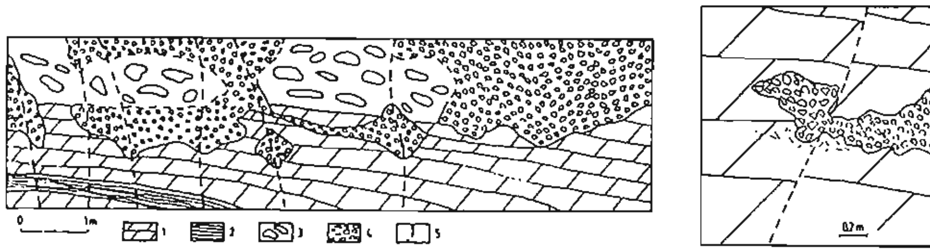


Fig. 6. Mode of occurrence of „pocket" (nest) breccias

1 — coarse-bedded dolomites; 2 — thin-bedded marly dolomites; 3 — bedded synsedimentary breccias; 4 — „pocket" (nest) breccias; 5 — joints and faults

Formy występowania brekcji gniazdowych

1 — dolomity gruboławicowe; 2 — dolomity cienkoławicowe margliste; 3 — brekcje „ławicowe"; 4 — brekcje gniazdowe; 5 — spękania i uskoki

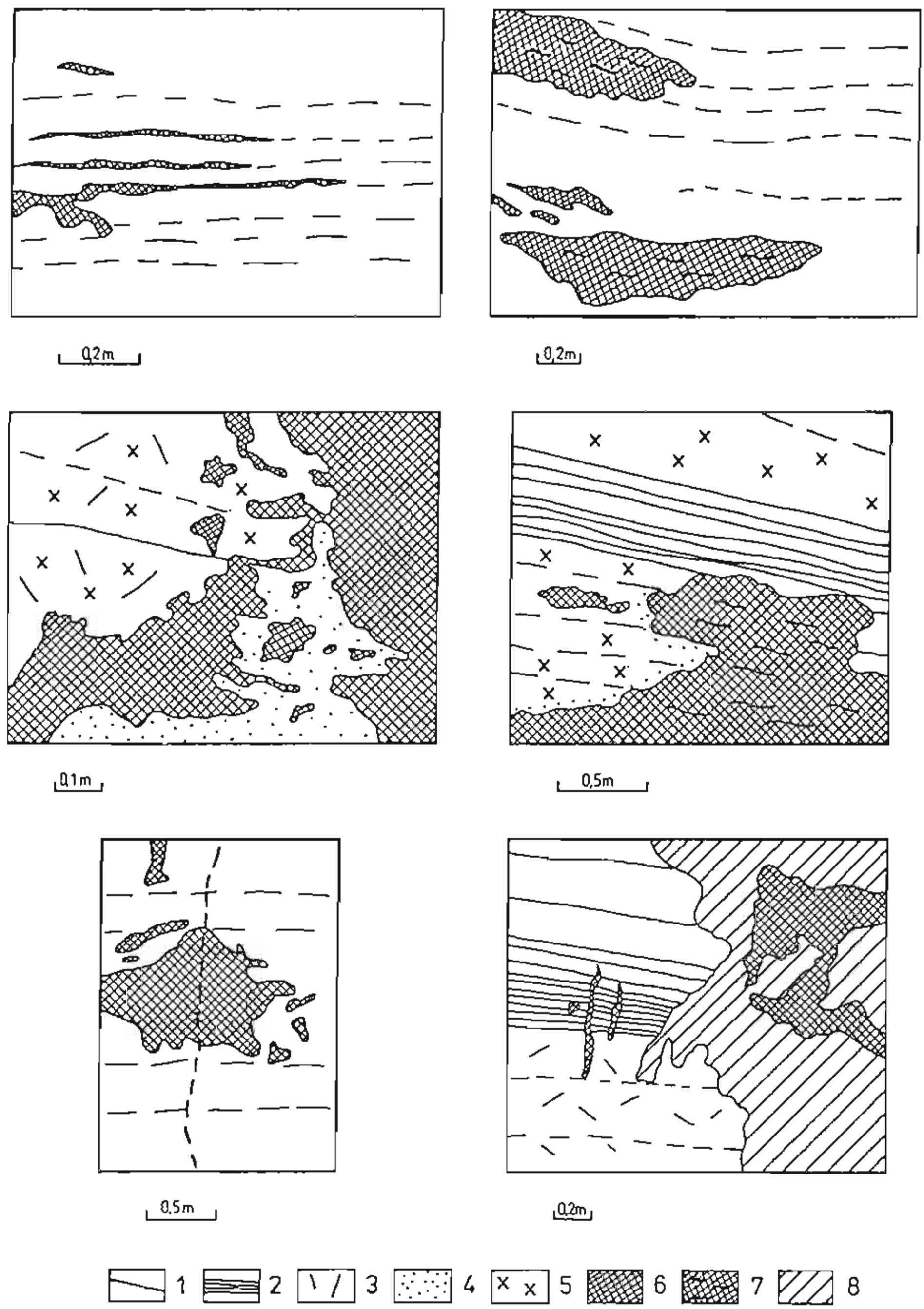
too. No evidence exists, however, on the continuation of the mineralized zones through the Gogolin Limestones to the ore-bearing dolomites. It can be concluded due to the C. Kuźniar data (1930) on the uppermost parts of the nest from the 71 shaft that connections between ore bodies in the Roethian dolomites and the one in the ore-bearing dolomites are limited to the small areas (B. Niedzielski, 1979).

LITHOLOGY OF ROETHIAN DOLOMITES

The early papers concerned the Roethian dolomites as lithologically homogeneous rocks since poor outcrops provided no suffieient information of their heterogeneity. The occurrence of marly dolomites in the lower part and the vesicular limestones in the upper part were noticed. F. Ekiert (1959) observed some intercalations of the oolitic dolomites in the marly ones as well as „intergrowths of brownish and greyish coarse grained, occasionally crystalline dolomite with no resemblance to the typical dolomites". The author quoted regards those rocks as formed in the later dolomitization processes. He noticed also the occurrence of the vesicular limestones, possibly of the weathering origin.

Detailed observations done in the mine and boreholes have pointed to a distinct lithologic variability of the Roethian dolomites.

Basing on the sedimentary cycles observed in the Roethian sediments in the adjacent area S. W. Alexandrowicz (1965) distinguished two sequences A and B there. Each sequenee begins with dolomite marls being followed by marly, oolitic and organodetritic dolomites. Studies done by T. Smakowski (1977) in the Olkusz region have led to the conclusion on shallow water very mobile deposition environment of the Roethian sediments which is evident due to numerous interformational conglomerates. The basin margin lay possibly some kilometers southwards from the mining area. It is difficult to distinguish both sequences (A, B) in the Bolesław mine due to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the significant facial change there. The sedimentation of the B sequence begins there with no distinct marl layer. The marls seem to be replaced by the marly dolomites deposited on thin-bedded, plety ones.

Breccias of not tectonic origin are characteristic for the Roethian dolomites, especially in their lower part. Three breccia types can be distinguished: synsedimentary, solution and collapse breccias (Fig. 6).

The synsedimentary breccias are developed on the widespread area.They occur in few bands. Most characterictic are the breccias within the marly dolomites, at about 10–15 m over the Roethian bottom. Their top is parallel to the bedding plane of the superimposed dolomites. Their bottom is irregular and its morphology suggests the erosion of the underlying sediments prior to the breccia formation. The breccia fragments are different varieties of dolomites which either lie below the breccia or in the same stratigraphic position. Occasionally clayish pebbles are seen. The rock fragments are either angular or partly rounded, often twisted and fissured which suggest a transport of the not totally lithified material. Breccias cement displays a variated composition oscillating from the marly dolomitic to the dolomitic one. The lateral transition from the breccia to the dolomite with dispersed rock chips is a characteristic feature. There occur occasionally in the breccia discontinuous interlayers of marls and marly dolomites. The distinct variation in size of the rock fragments (from some milimeters to some tens of centimeters), lack of sorting, gradual transition of the breccia into the dolomite or marly dolomite allow to assume the breccia origin from the mudy-mudstone flows close to the small-scale olistostromes.

Thickness of the synsedimentary breccia is variated, reaching in places some meters.

The solution breccias occur in the dolomites, most frequently — the marly ones, and in the synsedimentary breccia. They form irregular nests or pockets, sometimes in the neighbourhood of the fractures. At the margins of the nests the breccia shows gradual transition into cavernous dolomite composed of rock fragments cemented with the contact cement of sulfides (ZnS and FeS_2) accompanied by the secondary crystalline dolomite and monheimite. The nests of the breccia display different size — from some tens of centimeters to at least over 10 m. They were formed due to the leaching of the dolomite during the ore-formation processes or just before them.

The collapse breccias appear in the neighbourhood of the ore bodies rich in mineralization, mostly at their top, rarely in the wall rock. They are formed of rock fragments and blocks of dolomite (from some centimeters to 1–2 m) cemented either with the ores or with the clayish-marly mass impregnated with sulfides. The gradual

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Fig. 7. Mode of occurrence of ore bodies and their shape

1 — coarse-bedded dolomite unmineralized or with dispersed sphalerite in small quantities; 2 — thin-bedded dolomites; 3 — fractured dolomites; 4 — friable dolomites; 5 — disseminated sphalerite; 6 — sphalerite-brunckite massive ore; 7 — sphalerite-brunckite banded ore; 8 — massive marcasite ore

Formy występowania ciał rudnych w dolomitach i morfologia ich granic

1 — dolomity niezmineralizowane lub słabo impregnowane sfalerytem, grubolawicowe; 2 — dolomity cienkolawicowe; 3 — dolomity spękane; 4 — dolomity rozsypliwe („zmurszałe"); 5 — intensywna impregnacja sfalerytowa; 6 — masywne rudy sfalerytowo-brunckitowe; 7 — rudy j. w. smugowane; 8 — masywna ruda markasytowa

passage has been noticed: from collapse breccia, through fracture breccia (where individual rock fragments are surrounded by fractures and moved from their original position only for a small distance), to strongly fractured dolomites.

MINERALIZATION

Ore accumulation intensity within the Roethian dolomites is variated. Rich parts of ore bodies built nearly of pure sulfides are often surrounded with the wide zones of the dispersed mineralization, the boundaries of the rich ore bodies being sharp.

Mineralization of the dolomites occurred partly due to their impregnation and replacement and partly due to filling of the open spaces resulting from leaching and caverning. Distinct replacement phenomena can be observed in the lower parts of the rich mineralized nests, while in the upper — open space filling contemporary to the ore phase. It seems, therefore, that the dolomite replacement did not occur following the classic rule „volume for volume".

The zinc and lead sulfide occurs often in the synsedimentary breccia as the impregnations in the cement or as the nest accumulations. In the bedded dolomites only some layers are ore-bearing which results in the layered or lenticular form of the ore accumulations (Fig. 7, Pl. I, Figs. 9, 10). No distinct relation between the mineralization intensity and host rock lithology has been found. It seems to be dependant on some local factors invisible at present which were totally erased by mineralization itself. In some cases the bedding planes were the migration paths for the ores since the lenticular and strip sulfide accumulations (Fig. 7) occur there. In the other cases the boundaries of the layers (e.g., of the thin-bedded dolomites) distinctly limit the ore accumulations. Also frequent are the ore boundaries that cross-cut the bedding planes of the dolomites. All those facts point to the differentiated mineralization conditions. No direct relation between mineralization and tectonics has been stated. The faults observed have the post-ore origin. The ores appear in the fractured dolomites only occasionally in the joint fractures. Some relation between mineralization and tectonics, however, may be suggested by trend analysis (M. Nieć, 1979, 1984). Observations made in the Joanna nest (R. Blajda, 1991) suggest the possible relation between the ore bodies and the strike-slip faults of the NW–SE direction. Also in the Gwiazda nest the ore concentration in the neighbourhood of such the faults has been observed.

The most characteristic features of the deposit in the Roethian dolomites are (F. Ekiert, 1959; C. Harańczyk, 1962): occurrence of the hemi-colloidal and colloïdal ZnS varieties (especially of brunckite); fine-grained character of galena and occurrence of its colloidal varieties („boleslawit"; C. Harańczyk, 1962); distinct accumulation of marcasite often forming individual ore bodies; barite mineralization adjacent to the ore nests (C. Harańczyk, L. Szostek, 1970; B. Niedzielski et al., 1975); monheimite presence in the marginal parts of the deposit (B. Bąk, M. Nieć, 1979).

Basing on the field observations on the mining faces as well as on the macro- and microscopic observation of the samples there can be distinguished at last 4 mineralization stages: 1 — sphalerite stage, 2 — blende-brunckite-galena stage, 3 — marcasite stage, 4 — sphalerite-monheimite and barite stages.

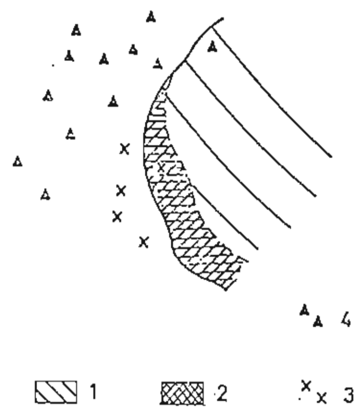

Fig. 8. Scheme of mineral zoning within ore bodies
1 — rich massive sphalerite-galena ore or mineralized collapse breccias; 2 — massive marcasite ore; 3 — disseminated monheimite and monheimite replacing dolomite; 4 — barite aureole
Schemat strefowości mineralizacji w ciałach rudnych
1 — bogata ruda (masywna) sfalerytowo-galenowa lub okruszcowane brekcje zawałowe; 2 —masywna ruda markasytowa; 3 — rozproszona mineralizacja monheimitowa i monheimityzacja dolomitów; 4 — mineralizacja barytowa

The sphalerite mineralization of the first stage has in general metasomatie character and only partly was formed due to empty space filling in the fractures or joints. That process was, however, very rare. Most frequently-sphalerite occurs as fine--grained impregnations in dolomites, invisible macroscopically. The impregnations are responsible for the redish colour of the rock, their occurrence intensity being different — from some percent to nearly pure ore accumulations. Those accumulations are either rocky (with abundant fine caverns) or frable „earthy" ones.

The colloidal forms of zinc sulfide are predominant in the seeond mineralization stage being accompanied by galena. They form colloform accumulations, even stalactite-like or ooid one, or they impregnate the dolomite. Several generations of ZnS and PbS could be distinguished there. The majority of those mineral accumulations seem, however, to be due to the segregation and partial recrystallization processes within the ore mass of colloidal character. In such a situation it is impossible to define a strict boundary between the ores of metasomatic origin and those of space fillings. Replacement phenomena are distinctly observed in the lower parts of the rich mineralized nests and in their margins, while the space fillings are present in the upper portions of the ore bodies. The ores often form there the cements of the collapse breccias (Pl. I, Fig. 11) built of large blocks of the top dolomite only slightly displaced from the original position. The vertical reach of the collapse breccias is in general not distinct and at the distance of some meters this breccia shows transition into the fracture breecia and then — the fractured dolomite. Breccias related to the leaching of dolomite can be also observed on the margins of the rich nests. Those breccias are built of the large dolomite blocks moved from their original position and plunged in the clayish-marly material impregnated with marcasite. The sphalerite accumulations formed in the first mineralization stage undergo brecciation, too.

Marcasite appears in the later mineralization stage. It replaces zinc and lead ores of the preceeding stage. Marcasite is frequent at the margins of the Zn, Pb nests. It forms individual bodies, too. It is often brecciated and mixed with the clayish-marly mass forming cloddy accumulations. Sueh breccia in sometimes eemented with the younger sphalerite. The secondary crystalline dolomite, sometimes together with calcite, occasionally fills fractures in the ore which were formed in the earlier stages.

Minerals of the youngest mineralization stages occur in the peripheric parts of the ore nests and around them. Two types of mineralization can be distinguished — monheimite and barite ones, their mutual relation being unclear due to lack of their co-occurrence.

Monheimite is common in the caverned dolomites accompanying the secondary crystalline dolomite, sphalerite and marcasite. It forms crustifications on the cavity walls (B. Bąk, M. Nieć, 1979). It is accompanied by small amount of gypsum — the youngest mineral in the sequence — and allophane (*op. cit.*).

It is remarkable that monheimite partly replaces the Roethian dolomites around some fractures and caverns in the zone of the width reaching some tens of centimeters. It seems that sphalerite cementing the marcasite breccias belongs to the same mineralization stage.

Barite occurs occasionally, in the peripheric parts of the ore bodies in form of small, irregular nests among the sulfides, being formed due to the filling of the small caverns. It is more frequent in non-mineralized dolomites, outside the ore nests, predominantly — in the strongly fractured or porous dolomites (e.g., oolitic). In that second case it forms thin veinlets filling the fractures or irregular veinlets and small nests formed due to the replacement of the host rock (dolomite). The barite nests reach occasionally the size of some tens of centimeters. The distribution of barite and monheimite mineralization suggests that they form an aureole around the ore nests (Fig. 8).

ORIGIN OF MINERALIZATION

The distribution of the ores in the deposits as well as the forms of their accumulations point to the epigenetic character of the mineralization. The opinion on the hydrothermal origin could be justified.

The homogenization temperatures of the fluid inclusions obtained by A. Kozłowski are: for sphalerite — 109-114°C, for barite — 95-109°C and for monheimite — 99-103°C.

Analyses of the metal content variations in the nest of the 71 shaft done using the trend analysis (M. Nieć, 1984) lead to an assumption that the mineralization solutions have ascended from the bottom, possibly from the deeper Paleozoic basement through the fracture zones or the fractures accompanying the strike-slip faults.

The pattern of the isarithms of the Zn and Pb content trend surface in 71 shaft (*op. cit.*) suggests the relation between mineralization and fractures of directions of NEE-SWW to NW-SE. The ore-bearing fractures are, however, very rare.

The ore bodies observed on the map are grouped in some distinct zones of SW-NE and NW-SE direction (R. Blajda et al., in press), the fact which seems to be suitable for the future search for the new ore nests.

The ore accumulations were formed either due to the dolomite replacement or to the empty space filling. The empty spaces were the result of dolomite leaching prior to the ore deposition, i.e., due to the hydrothermal karst. The effects of the hydrothermal karst were here less distinct than in the ore-bearing dolomites. The mineralization process occurred in the different stages and some analogy can be found to the stages in the ore-bearing dolomites distinguished by M. Sass-Gustkiewicz (1985). The mineralization in the Roethian dolomites, however, differs from that in the ore-bearing dolomites due to the lack of distinct delimitation of the individual stages. It could be supposed that in the continuous mineralizing process the composition of mineral assemblages precipitated was changing.

The ore nests display zonal structure with the core formed of rich zinc ores surrounded by the cover of the marcasite mineralization and the aureole of monheimite and barite mineralization. The presence of the oxidized minerals in the aureole suggests a mixing between mineralization solutions and the oxygen-rich waters. This conclusion remains in agreement with an increased sulfur content in barite ($\delta^{34}S$ over 10‰) in relation to the sulfides where $\delta^{34}S$ rarely exceeds 10‰ (C. Harańczyk, J. Lis, 1973).

It is not clear why the Bolesław region remains especially privilaged for the occurrence of the ore mineralization in the Roethian dolomites. It cannot be excluded that the mineralization discussed was discovered only there because of the mining activity. This mineralization is rather rare and of low concentration in the Roethian dolomites found in the boreholes in the other parts of the Olkusz area. It is possible that the rich bodies there have small sizes and were not reached by the boreholes. In addition to that — many recognition boreholes are done only to the top of the Gogolin Limestones not reaching the Roethian dolomites at all.

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ZŁOŻE RUD Zn-Pb W UTWORACH RETU W REJONIE BOLESŁAWIA K. OLKUSZA

Streszczenie

W kopalni Bolesław rudy Zn-Pb występują w dolomitach kruszconośnych (trias środkowy) i w dolomitach retu. Dolomity retu są zróżnicowane litologicznie, a występujące w ich obrębie ciała rudne mają formę gniazdową. Tworzą je partie bogato okruszcowane otoczone aureolą mineralizacji rozproszonej, szczególnie intensywnej w dolomitach brekcjowych. Wyróżniono trzy typy brekcji: „ławicowe" — pochodzenia przypuszczalnie osadowego, „gniazdowe" — związane z ługowaniem dolomitu poprzedzającym mineralizację, oraz zawałowe — występujące w stropie dużych gniazd czystych kruszców. Cechą charakterystyczną mineralizacji jest prosty skład mineralny ZnS, PbS i FeS_2. Znaczny jest udział koloidalnych odmian ZnS (brunckitu). Wyróżniono 4 stadia mineralizacji (sfalerytowe, blendowo-brunckitowo-galenowe, markasytowe, sfalerytowo-monheimitowe i barytowe). Monheimit i baryt pojawiają się na peryferii gniazd kruszcowych. Baryt tworzy też wokół nich aureolę. Forma występowania okruszcowania pozwala przypuszczać, że

jest ono pochodzenia hydrotermalnego. Złoże tworzyło się na drodze zastępowania dolomitu, częściowo także w wyniku zapełniania wolnych przestrzeni powstałych na drodze krasu hydrotermalnego.

PLATE I

Fig. 9. Dolomite replaced by zinc sulfides (white) through bedding planes
Zastępowanie dolomitu przez siarczki cynku (białe) wzdłuż płaszczyzn uławicenia

Fig. 10. Tabular zinc sulfide bodies (white) within Roethian dolomites
Zastępowanie dolomitów ławicowych przez siarczki cynku (białe)

Fig. 11. Mineralized collapse breccia, Karol ore body; dolomite blocks lined by zinc sulfides and cemented by massive marcasite-galena ore
Okruszcowanie brekcją zawałową gniazda Karol; bloki dolomitowe obrzeżone siarczkami Zn, scementowane masywną rudą markasytowo-galenową

Fig. 9

Fig. 10

Fig. 11

Marek NIEĆ, Renata BLAJDA, Bohdan NIEDZIELSKI — Zinc-lead ore deposit in Lower Triassic (Roethian) dolomites at Bolesław (Olkusz region, Poland)