Geological Quarterly, Vol. 37, No. 4, 1993, p.485-500

Wiesław OLSZYŃSKI, Stanisław SPECZIK

Ore mineralization of Lutynia (SW Poland)

Basing on the mineralogical, geochemical and thermo-barogeochemical studies two major stages of ore mineral formation may be distinguished at Lutynia. The first stage composed mostly of Fe-Ti oxides is related to pre-Variscan regional metamorphism of volcanic-sedimentary pile. The second stage represented by As, Fe, Cu, Pb and Zn sulfides is connected with thermal and metasomatic influence of Kłodzko — Złoty Stok Variscan granitoids on adjacent rocks. The occurrence of reaction skarns and mineralogical composition of ores that include both Fe-As and Pb-Zn sulfides suggest, that they may be related to the same metallogenic event as the Złoty Stok skarn type mineralization, and may represent its farther, low temperature replacement type manifestation.

GEOLOGICAL OVERVIEW

The Lutynia Pb-Zn vein type deposit is situated on the western slope of Góry Złote Mts., between the village of Lutynia and the state road from Lądek Zdrój to Złoty Stok. Geologically it is a small northeastern fragment of the large geological structure of the Kłodzko — Orlica dome (F. Pauk, 1953), known also as the Kłodzko or Śnieżnik dome (H.Teisseyre, 1973). The major geological feature in the northeastern part of the Kłodzko dome, the authors are interested in, is the Variscan Kłodzko —Złoty Stok syenitic massif, that underlies an area of about 120 km^2 (Fig. 1).

Kłodzko — Złoty Stok massif crosscuts various in age (Precambrian to Lower Carboniferous) and degree of metamorphism tectono-lithological structures. The thermal and metasomatic influence of the Kłodzko — Złoty Stok intrusion is especially pronounced on its western contact, where extensive zone of granitization is observed. SW contact with Góry Bardzkie Mts., and SE, and NE borders with the rocks of the Lądek — Śnieżnik metamorphic unit are influenced mostly by thermal activity

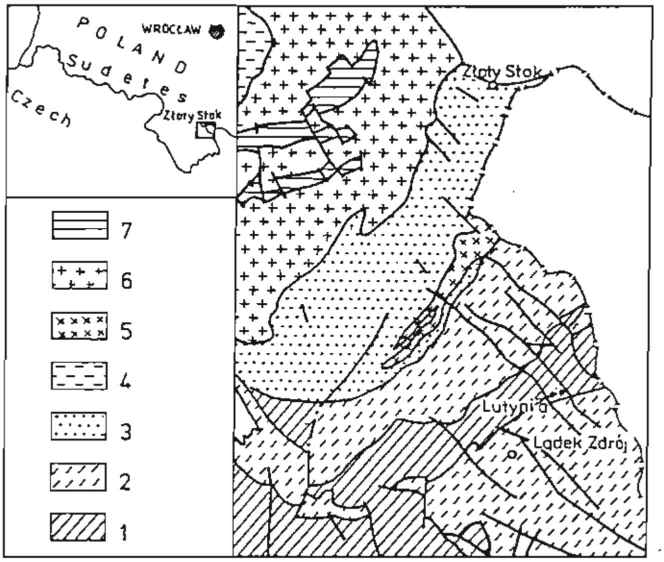


Fig. 1. Geologic sketch-map of the study area

1 — Stronie Series; 2 — granite gneisses series; 3 — blastomylonite series; 4 — Carboniferous rocks of the Góry Bardzkie Mts.; 5 — Jawornik granitoids; 6 — Kłodzko — Złoty Stok granitoids; 7 — skarn related rocks

Szkic geologiczny badanego obszaru

1 — seria strońska; 2 — seria gnejsów granitowych; 3 — seria blastomylonityczna; 4 — skały karbońskie Gór Bardzkich; 5 — granitoidy jaworniekie; 6 — granitoidy kłodzko-złotostockie; 7 — skarnoidy

(B. Wierzchołowski, 1976). To the north, the core of Kłodzko — Złoty Stok granitoids as well as its metamorphic and sedimentary surrounding are separated from Fore-Sudetic Block by major tectonic structure — Marginal Sudetic Fault.

The Lutynia deposit is situated about 8 km far from SE border between Kłodzko — Złoty Stok granitoids and Lądek — Śnieżnik metamorphic rocks, namely within the Stronie Series (K. Smulikowski, 1973). Typical profile of Stronie Series includes: mica schists, two-mica paragneisses, quartzites, marbles, erlanes, amphibolites and amphibolite schists. It represents mostly the low temperature sector of the amphibolite mineral facies (K. Smulikowski, 1979). Close to the investigated area, the metamorphic complex contains also two small granitoid bodies. Granodiorite and tonalite from Bielice (B. Wierzchołowski, 1966) and tonalite, adamellite and granodiorite of Jawornik massif (J. Burchart, 1960).

There is virtual disagreement among geologists concerning the age of rocks composing the Kłodzko dome (J. Don, 1964; J. Ansilewski, 1966; N. Bakun-Czubarow, 1968; A. Żelaźniewicz, 1976; K. Smulikowski, 1979). The agreement concerns only Variscan granitoids. Kłodzko — Złoty Stok granitoids were dated with K-Ar method (T. Depciuch, 1972), revealing age of about 301–304 my. Granitoids from Bielice revealed very similar age of 290±30 my, both using K-Ar (J. Borucki, 1966) and FT methods (K. Jarmołowicz-Szulc, 1987). The age of Jawornik granitoids is older about 335 my, as suggested by J. Borucki (1966).

Isotopic K-Ar dating may with some limitations suggest 382 my, for blastesis of biotite from Gierałtów gneisses, Lower Devonian (N. Bakun-Czubarow, 1968). The low grade metamorphic maxima related to Variscan granitoids occurred most probably about 330±15 and 300–310 my ago (K. Jarmołowicz-Szulc, 1987).

Studied samples were collected both from limited natural outcrops but mostly from old workings, diggings as well as from mine dumps, that are situated on eastern bank of the river Lutynia. Therefore, they were preferentially abundant in rocks coming from salbands, apophyses and rock fragments locked within the veins, relative to pure vein content. This was however an advantage for this investigations as it allowed to recognize a metasomatic influence of processes responsible for vein formation on country rocks.

PETROGRAPHIC CHARACTERISTICS

The zone intimately associated with the investigated veins is composed of fairly blastomylonitic rocks slightly differentated in their composition. There are mostly quartzite and quartz-muscovite schists with minor amphibolites, and skarn-type rocks. The gradual transition of quartzites and amphibolites into skarn-type rocks is observed within the salbands. Far from the quartz veins the blastomylonitic character of country rocks diverses.

QUARTZ-MUSCOVITE AND QUARTZITE SCHISTS

These rocks are often laminated and in places distincly foliated (Pl. I, Fig. 4). However, the random and massive textures are also observed. Close to veins the texture is to some extend blastomylonitic. Generally these rocks are very fine-grained with some coarse-grained pseudoveinlets and quartz nests elongated parallelly to the foliation (Pl. I, Fig. 5). These forms are generally younger than the main deformations, and in places they are also cataclased and healed by younger quartz generations.

Quartz blast with mosaic light extinction and abundant suture structures amounting from 50 to 90 vol. % dominate in mineral composition of these rocks. Other rock components are micas (mainly muscovite, decolorized biotite and chlorite), K-feldspars, plagioclases and graphite with minor cordierite, garnet, vesuvianite, epidote and carbonates.

The most common component of these rocks beside the quartz is graphite that in some thin sections reaches up to 15 vol. %. In less cataclased rocks graphite is evenly dispersed throughout the rocks. Tiny graphite scales are enclosed between quartz blasts or are contained within the quartz. In blastomylonitic or carbonitized varieties the graphitic material is often concentrated in thin black laminae or in feather like textures (Pl. I, Fig. 6).

Both K-feldspar and sodic plagioclase (up to 10 vol. %), are strongly sericitized, with twinning textures strongly deformed by cataclasis. The sericitized pseudomorphs often contain graphitic dust, opaque oxides and tiny mica flakes. Among micas muscovite dominates (up to 20%), followed by decolorized biotite that locally is also replaced by epidote. Two varieties of chlorite have been recognized, one related to biotite chloritization and the second — hydrothermal, especially abundant in salbands or in rock fragments locked within the vein. Other components as garnets, cordierite, vesuvianite are preferentially concentrated in salbands, when present in larger quantity giving skarn type appearance to the rocks, that may by classified as reaction skarns (M. T. Einaudi, D. M. Burt, 1982).

Garnet forms large isometric blasts up to 3–5 mm often with concentric or spiral internal texture illustrating its formation parallelly to the relaxation of tectonic stress. It often contains spirally oriented intergrowths of ore minerals. Cordierite, up to 10% (in some thin sections), similarily to almandine forms larger oval or conical blasts (1 to 2 mm) that grow at the expense of other minerals. This process often disrupts laminated texture of the rock (Pl. I, Fig. 7). Cordierite is to various extent replaced by pinite. Vesuvianite was found occasionally while small epidote grains are a common component in rock fragments locked within the veins. In this case the amount of epidote increases up to 10 vol. %.

AMPHIBOLITES AND AMPHIBOLITE SCHISTS

Lenticular or irregular bodies of amphibolites are a common component of generally quartzitic lithological profile at Lutynia. In megascale the contacts between amphibolites and quartzites and quartzite schists are sharp, however in microscope transitonal zones with increased amount of amphibole in mostly quartzitic rocks have been encountered. There are two textural varieties of amphibolites: weakly foliated massive amphibolites and slightly more foliated amphibolite schists. They have the same composition that include: slightly oriented common hornblende up to 50 vol. %, actinolite, K-feldspar, acid plagioclase, cordierite, sphene and occasionally slightly uralitized pyroxene. Common hornblende is often replaced by actinolite. Both feldspars are strongly sericitized and kaolinitized.

In salbands or in amphibolite fragments locked within the veins amphibolite schists often contain quartz, up to 10 vol. %, and secondary fresh blasts of pyroxene up to 10 vol.%. Quartz and feldspars often form here laminae within the amphibolites.

REACTION SKARNS

As a reaction skarns there were classified rocks, with increased amount of skarn type minerals that intimately associate with veins. Corresponding to two major country rock types, there are two types of reaction skarns distinguished. The first with granoblastic texture is composed of actinolite with large fresh diopside crystals (Pl. I, Fig. 8) and sphene, with minor amount of K- and alkali-feldspars. The second is composed of quartz with increased amount of skarn type minerals, i.e. almandine, cordierite, vesuvianite and carbonates.

ORE MINERALIZATION

The occurrence of mineralization at Lutynia is connected with a zone of cemented tectonic breccia that is associated with a large tectonic fracture trending NW–SE towards the Lądek Zdrój. This fracture is steeply 80° dipping NE, with thickness of the associated zone of breccia varying from 20 cm up to 4 m. The wall rocks are mostly quartz-muscovite-graphite schists with minor described earlier other rock types. The breccia is cemented mostly with quartz and minor calcite. The gangue minerals form individual veins, veinlets, however, lenticular bodies and druses are also common.

Two varieties of quartz are recognized. Older mostly milky quartz is connected with outer parts of breccia and wall rocks. This variety is only slightly mineralized. The dark gray younger quartz associates with ore mineralization. This quartz often displays banded-zonal texture with borders of individual quartz envelopes underlined by graphite inclusions (Pl. I, Fig. 9). Several quartz generations could be recognized, with older ones being mostly cataclased and healed by younger quartz generations. The amount of calcite increases towards the inner parts of larger individual veins.

In the larger veins quartz is often idiomorphic with crustification-type textures what may suggest crystallization in open spaces. The size of quartz crystals varies from parts of millimeters in small veinlets (found in salbands) to several centimeters in inner parts of larger (up to 1 m) veins.

The ore mineralization is associated with veins, tectonic breccia as well as with wall rocks adjacent to breccia zone, where its mineral composition varies considerably. Two stages of ore formation were recognized at Lutynia. The ore minerals of the first stage occur mostly in wall rocks and in rock fragments locked within mineral content of the breccia zone. Ore mineral paragenesis of this stage consists of pyrrhotite, pentlandite, magnetite, ilmenite, ilmenorutile, pyrite with minor chalcopyrite. Minerals of this paragenesis are oriented parallelly to the lamination or are nearly unevenly dispersed throughout the country rocks (Pl. II, Fig. 10).

In mineral succession, the first crystallizing sulfide mineral was pyrrhotite with lenticular intergrowths of pentlandite (Pl. II, Fig. 11). It is followed by chalcopyrite, ilmenite and pyrite. The individual crystals of this paragenesis are idio- and hipidiomorphic. The mode of occurrence of the first stage mineralization suggests its origin due to regional metamorphism of sedimentary-volcanic pile that was enriched in nickel and to lesser degree in copper. The pre-Variscan age of these processes seems to be preferable, however it is not excluded that both processes represent older and younger Variscan stages. Within the breccia zone minerals of the older stage are often corroded or even replaced by minerals of the younger Variscan stage. Especially abundant are here sympthoms of sulfurization manifested by pyrrhotite replacement by pyrite, melnikovite-pyrite and carbonates (Pl. II, Fig. 12).

Minerals of the second stage occur predominantly within the veins and inside the breccia zone. However, they were also found in wall rocks and salbands, that show sympthoms of skarn development. In general they could be divided into two generations. The first one with higher temperatures of formation and the second one originated mostly in lower temperatures. However, this could be an oversimplification as the mineral paragenesis of the stage II were formed in continuing process, from skarn type conditions, i.e. arsenopyrite, pyrite and chalcopyrite mineralization to lower temperatures represented by tennantite, sphalerite and galena.

This continuing drop of temperature was associated by relaxation of tension, which resulted in cataclase of stage minerals I as well as the first mineral generation of the younger Variscan paragenesis. In some polished sections also sphalerite and galena are brecciated and healed with younger sphalerite and galena. The fractures in arsenopyrite, pyrite as well as in ore minerals of stage I are healed preferentially by tennantite and sphalerite. The later minerals form often a dense network of microveinlets within larger pyrite-arsenopyrite aggregates (Pl. II, Fig. 13).

Ore minerals of generation I are idiomorphic — arsenopyrite, partly pyrite, or hipidiomorphic chalcopyrite. They are generally smaller (< 1 mm) than the minerals of generation II. Some idiomorphic galena crystals are reaching up to 1 cm in diameter. When associated with calcite galena is mainly idiomorphic, in association with quartz it has more irregular forms. In such case galena is filling open spaces between dark gray quartz crystals (Pl. II, Fig. 14).

Galena is locally partly replaced by cerussite. A. Muszer (1988) reports additionally the occurrence of hypergenic covellite, goethite and lepidocrocite at Lutynia.

FLUID INCLUSIONS AND MICROPROBE STUDIES

Fluid inclusions are abundant in entire investigated material. They occur in all quartz varieties, in calcite and also in sphalerite. Two-phase gas-liquid inclusions dominate but polyphase inclusions with solid daughter and trapped crystals are also common. One-phase, liquid inclusions are relatively rare, they may be former two-phase inclusions that lost their hermecity. Because of multistage pattern of gangue minerals crystallization characterized by drop of temperature associated by tectonic activity, the majority of inclusions show features characteristic of the secondary ones. Dark grey quartz crystals with zonal banding contain primary inclusions in each quartz envelope.

The most important feature of these inclusions is that they are very small, the majority of them do not exceed 20 μm. This caused some problems with homogenization, and made it impossible to carry out a chemical analysis of the remnant liquid. Moreover, in some inclusions the presence of liquid carbon dioxide, halides and solid phases were stated by optical means. The majority of solid phases are opaque, what may suggest the presence of ore minerals. The volumetric amount of gas phase in gas-liquid inclusions is principally small. However, they homogenized generally in higher temperatures. This may in part suggest a high salinity of remnant liquid.

Homogenization temperatures were measured at the microscope heating stage in silicon oil. This allowed very high accuracy of determined temperature of ±1°C, however this limited our measurements to inclusions that homogenized below 300°C. Pt/Pt-Rh 10%, thermocouples were employed. The best reproducible results were obtained with respect to all quartz varieties. The values of the achieved temperatures of homogenization are varing from very high > 300°C for outer parts of veins and metasomatically altered salbands (Pl. II, Fig. 15a) to 120°C for the youngest quartz

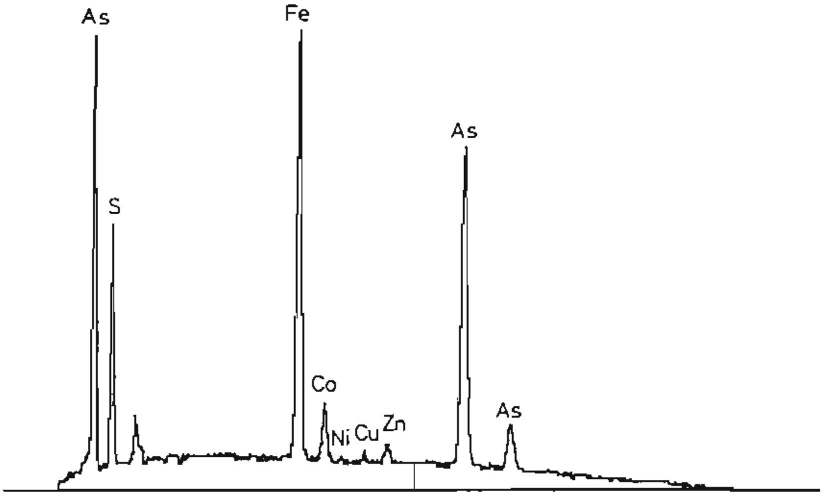


Fig. 2. Composition of arsenopyrite as revealed by microprobe studies
Skład arsenopirytu na podstawie badań mikrosondą

generations. Two temperature (*Th*) optima may be recognized. The first one comprising the majority of the obtained results is relatively high-temperature from 220 to 260°C (Pl. II, Fig. 15b). It is related partly to milky quartz and in part to autigenic quartz that associate with salbands and fragments of country rocks locked within the veins and veinlets. The second optimum comprises inclusions that homogenized in temperatures from about 150 to 180°C, and is characteristic of dirty-gray quartz associated with the sphalerite-galenite mineralization. Because of very small size of inclusions in sphalerite only one reproducible homogenization was achieved. This inclusion homogenized in 156°C (Pl. II, Fig. 15c).

The obtained temperatures are much higher than expected. The light colour of sphalerite as well as earlier opinions about the origin of these veins made an impression that they were formed from a very low temperature hydrothermal fluids.

Trace elements characteristic of ore minerals were obtained with an use of an *ISM 84 OA* scanning microscope coupled with energy-dyspersive Roentgen microprobe *AN 10/85 S Link System*. The accelerating potential was 20 kV. The results suggest that the investigated minerals contain generally very low amount of admixtures. Pyrrhotite, as a rule, reveals an increased amount of Ni, also when it does not contain pentlandite intergrowths. Arsenopyrite similarity to arsenopyrite of Złoty Stok is recognized due to an increased amount of Co (Fig. 2), and varying but smaller admixture of Ni, Cu and Zn. Sphalerite commonly bears cadmium but it does not reveal traces of iron. The amount of Ag in galena is very small. Therefore, because of the reported chemical content of Ag in the Lutynia ores, it may be suggested that Ag is related to tiny veinlets of tennantite.

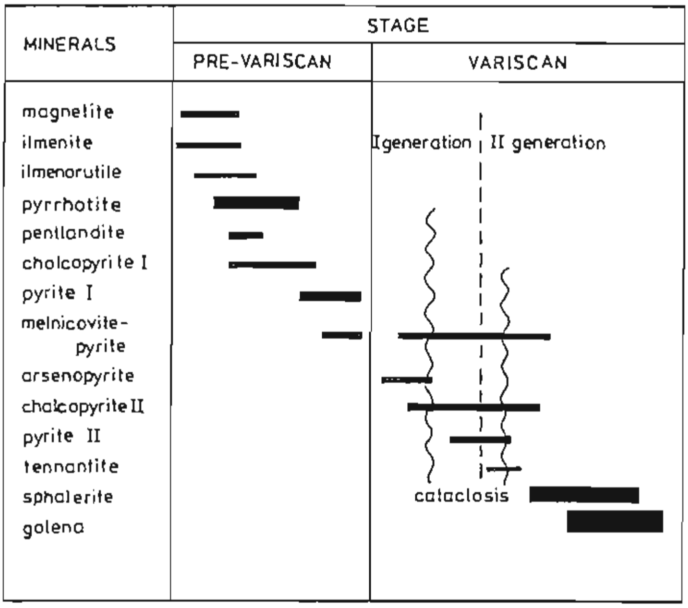


Fig. 3. Table of ore mineral succession
Tabela sukcesji minerałów kruszcowych

DISCUSSION

It is suggested that the ore mineralization of Lutynia was formed in a two-stage process (Fig. 3). Stage mineralization I composed of magnetite, pyrrhotite, pentlandite, ilmenite and pyrite was formed during the pre-Variscan metamorphism of sedimentary-volcanic pile. This mineralization is similar to mineralization found elsewhere within the metamorphic cover of the Kłodzko — Złoty Stok southern and southeastern border, i.e. Marcinów, Orłowiec (M. Mastalerz, 1988; A. Muszer, 1988). Stage mineralization I is confined to country rocks and their fragments locked within the vein material. The age of metamorphic processes is debatable (I. Wojciechowska, 1988; K. Smulikowski, 1979; J. Oberc, 1987) but authors recognize pre-Variscan age of this mineralization.

The stage mineralization II is related to thermal and metasomatic influence of the Kłodzko — Złoty Stok syenites on the country rocks. In Lutynia these processes were promoted by active tectonic fractures. As suggested by complicated pattern of breccia zone infilling mineralization was formed in continuing process, characterized by drop of temperature and several episodes, of brecciation. High temperature mineral generation that was formed in part in temperatures exceeding 300°C consist of arsenopyrite, pyrite, chalcopyrite, milky quartz and occurs mostly in salbands and outer parts of breccia zone. The amount of liquid and gas phases on that etape of mineral evolution seems to be relatively low. Prior and also parallelly to ore minerals there were formed garnets, diopside, actinolite that gave salbands and parts of breccia zone skarn-related appearance.

Minerals of younger generation, i.e. sphalerite, galena, tennantite, dark gray quartz, chlorite, and calcite were formed starting from medium temperature ranges 220–260°C, but mostly in lower temperatures 150–180°C. The amount of volatiles and sulfur increases during these processes what resulted in sulfurization of pyrrhotite. As suggested by domination of idio- and hipidiomorphic crystals, of both ore minerals and quartz, these processes took place relatively slow and often in open spaces. As suggested by K. Jarmołowicz-Szulc (1987) the metamorphic influence of Kłodzko — Złoty Stok granitoid lasted not less than 10 my. Minerals of both stages are variously replaced by supergene cerussite, covellite and iron hydroxides. Minerals of stage I and representing generation I of stage II are cataclased and healed by tennantite and sphalerite. Also the automorphic crystals of galena often display sympthoms of cataclase and later cementing.

In previous descriptions of Lutynia ore mineralization, it was generally thought, that it represents a very low-temperature hydrothermal type mineralization. The results of this study may suggest that Lutynia ores show profound similarities and links with the Złoty Stok skarn type mineralization. Thus, it is envisaged that it may represent its spatial replacement type manifestation.

Acknowledgements. Sincere thanks are expressed to Drs. A. Barczuk, A. Kozłowski, P. Zawidzki and Mrs E. Starnawska MSe. for help and aid in conducting laboratory investigations. Cordial thanks are extended to Prof. B. Wierzchołowski, who kindly read an early draft of this paper and offered very helpful comments.

Translated by Stanisław Speczik

Instytut Geologii Podstawowej
Uniwersytetu Warszawskiego
Warszawa, al. Żwirki i Wigury 93
Received: 22.02.1993

REFERENCES

ANSILEWSKI J. (1966) — Petrography of the gneiss area of the Bialskie Mts. (in Polish with English summary). Geol. Sudetica, 2, p. 121–260.

BAKUN-CZUBAROW N. (1968) — Geochemical characteristics of eclogites from the environs of Nowa Wieś in the region of Śnieżnik Kłodzki. Arch. Miner., 28, p. 243–382, no. 1.

BORUCKI J. (1966) — Preliminary results of absolute age determination (K-Ar) of the Lower Silesian granitoidic rocks (in Polish with English summary). Kwart. Geol., 10, p.1–19, no. 1.

BURCHART J. (1960) — On the Jawornik granitoids (Eastern Sudetes) (in Polish with English summary). Arch. Miner., 22, p. 237–348, no. 2.

DEPCIUCH T. (1972) — Absolute age of (K-Ar) granitoids from the Kłodzko — Złoty Stok area and the Niemcza Zone (in Polish with English summary). Kwart. Geol., 16, p. 103–112, no. 1.

DON J. (1964) — Góry Złote i Krowiarki jako element składowy metamorfiku Śnieżnika. Geol. Sudetica, 1, p. 79–117.

EINAUDI M. T., BURT D. M. (1982) — Introduction-terminology, classification and composition of skarn deposits. Econ. Geol., 77, p. 745–754, no. 4.

JARMOŁOWICZ-SZULC K. (1987) — Geochronology of the Variscan intrusions (in Polish with English summary). Kwart. Geol., 31, p. 531–542, no. 4.

MASTALERZ M. (1988) — Charakterystyka łupków grafitowych okolic Marcinkowa. In: Wybrane zagadnienia geologii złoż Polski Zachodniej. Mat. Konf., p. 98–101. Wyd. UWr. Wrocław.

MUSZER A. (1988) — Charakterystyka mineralizacji hydrotermalnej w rejonie Lutyni. In: Wybrane zagadnienia geologii i mineralizacji metamorfiku Śnieżnika. Mat. Konf. Nauk., p. 100–105. Wyd. UWr. Wrocław.

OBERC J. (1987) — Palaeozoic movements in south-western Poland (in Polish with English summary). Kwart. Geol., 31, p. 523–530, no. 4.

PAUK F. (1953) — Poznamky ke geologii Orlickych Hor a Kralickeho Śnieżniku. Vest. Geol. Ustr. Ust., no 5.

SMULIKOWSKI K. (1973) — Les roches metamorphiques du Mont Śnieżnik et de la region de Lądek. In: Revue des problemes geologiques des zones profoundes de l'ecorce terrestre en Basse Silesie, p.77–102. Wyd. Geol. Warszawa.

SMULIKOWSKI K. (1979) — Ewolucja polimetamorficzna krystaliniku Śnieżnika Kłodzkiego i Gór Złotych w Sudetach. Geol. Sudetica, 14, p. 7–79, no. 1.

TEISSEYRE H. (1973) — Geology of the Śnieżnik Mountain Group. In: Revue des problémes géologiques des zones profondes de l'écorce terrestre en Basse Silésie, le quide a la XV-e Session de l'AZOPRO. Wyd. Geol. Warszawa.

WIERZCHOŁOWSKI B. (1966) — Bielice granitoids in Sudetes and their metamorphic mantle (in Polish with English summary). Areh. Miner., 26, p. 509–647, no. 1–2.

WIERZCHOŁOWSKI B. (1976) — Granitoids of the Kłodzko-Złoty Stok Massif and their contact influence on the country rocks (petrographic characteristics) (in Polish with English summary). Geol. Sudetica, 11, no. 2.

WOJCIECHOWSKA I. (1988) — Zarys budowy geologicznej północnej części metamorfiku Śnieżnika. In: Wybrane zagadnienia geologii i mineralizacji metamorfiku Śnieżnika. Mat. Konf. Teren., p. 10–16. Wyd. UWr. Wrocław.

ŻELAŹNIEWICZ A. (1976) — Tectonic and metamorphic events in the Polish part of the Orliekie Mts. Geol. Sudetica, 11, p. 101–169, no. 1.

Wiesław OLSZYŃSKI, Stanisław SPECZIK

ZŁOŻE LUTYNIA JAKO PRZYKŁAD STREFOWEGO ROZMIESZCZENIA METALI W SKAŁACH OSŁONY MASYWU KŁODZKO-ZŁOTOSTOCKIEGO

Streszczenie

Wyniki badań mineralogicznych, geochemicznych i termobarogeochemicznych rud pochodzących ze złoża Lutynia (fig. 1) sugerują ich dwustadialną genezę. Złoże związane jest z brekcją wypełniającą strefę nieciągłości tektonicznej, która przecina skały serii strońskiej reprezentowanej tu przez łupki kwarcowo-grafitowe, kwarcyty i amfibolity (tabl. I, fig. 4). Brekcja tektoniczna została scementowana przez hydrotermalny kwarc, kalcyt i związane z nimi minerały kruszcowe. W skałach otaczających wykształcił się miejscami salband zawierający oprócz minerałów kruszcowych minerały skarnowe.

Minerały I stadium, przedwaryscyjskiego: magnetyt, ilmenit, ilmenorutyl, pirotyn, pentlandyt, chalkopiryt I oraz piryt I, powstały w trakcie metamorfizmu regionalnego serii osadowo-wulkanicznej (tabl. II, fig. 10, 11; fig. 3). Minerały II stadium, waryscyjskiego: arsenopiryt kobaltonośny (fig. 2), piryt II, chalkopiryt II,

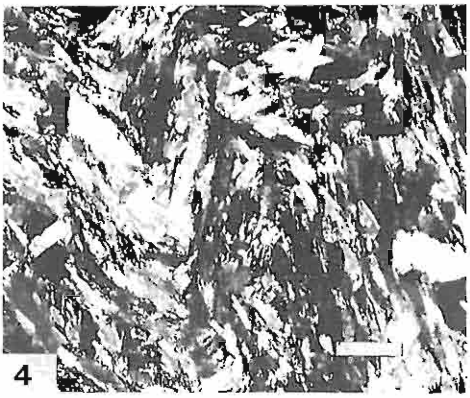
sfaleryt, tenantyt i galenit (tabl. II, fig. 12–14; fig. 3) związane są z termicznym i metasomatycznym oddziaływaniem skał masywu kłodzko-złotostockiego na otoczenie. Najwcześniej powstające minerały paragenezy waryscyjskiej tworzyły się w temperaturach znacznie przekraczających 300°C; główna masa minerałów kruszcowych powstała w średnich i niskich zakresach temperatur (tabl. II, fig. 15a–c).

Mineralizacja kruszcowa złoża Lutynia wykazuje związki z mineralizacją w Złotym Stoku i może być traktowana jako przestrzenny ekwiwalent procesów złożotwórczych zachodzących w osłonie syenitowego masywu kłodzko-złotostockiego.

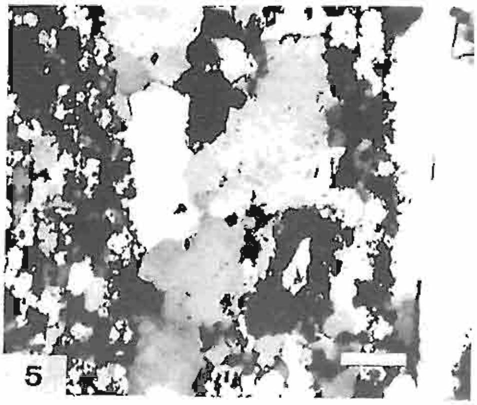
PLATE I

Fig. 4. Deformed lamination in quartz-muscovite-graphite schists
Zaburzona laminacja w łupku kwarcowo-muskowitowo-grafitowym
Fig. 5. Recrystallized quartz,pseudoveinlet in salband
Zrekrystalizowany kwarc, pseudożyłka w salbandzie
Fig. 6. Strongly carbonized and sericitized salband, with parallel graphite laminae
Silnie zserycytyzowany i skarbonatyzowany salband z równoległymi laminkami grafitu
Fig. 7. Cordierite blast disrupting parallel texture of the rock
Blast kordierytu zaburzający równoległą strukturę skały
Fig. 8. Diopside in reaction skarn
Diopsyd w skarnie reakcyjnym
Fig. 9. Inner part of small vein; calcite (c) and quartz (q) with zonal texture
Wewnętrzna partia małej żyłki; kalcyt (c) i kwarc (q) z budową zonalną

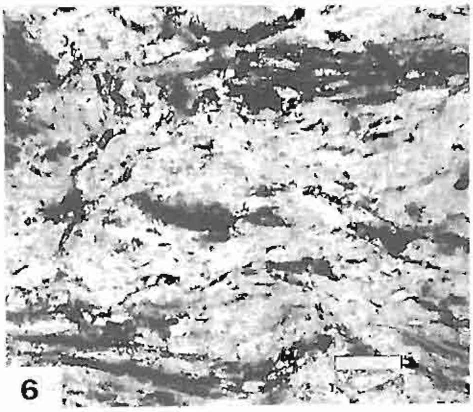
Scale bar 1 mm
Skala 1 mm



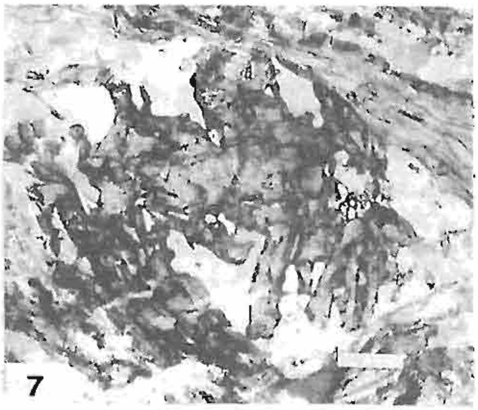
4



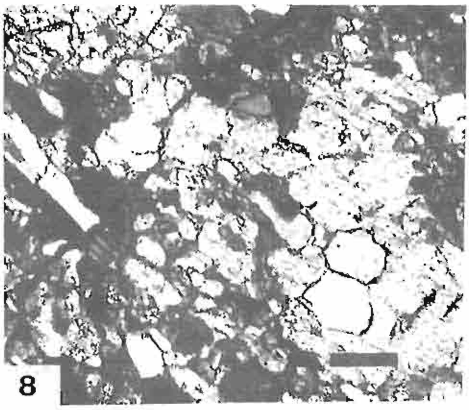
5



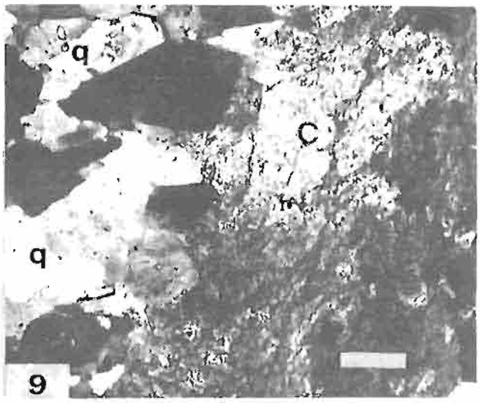
6



7



8

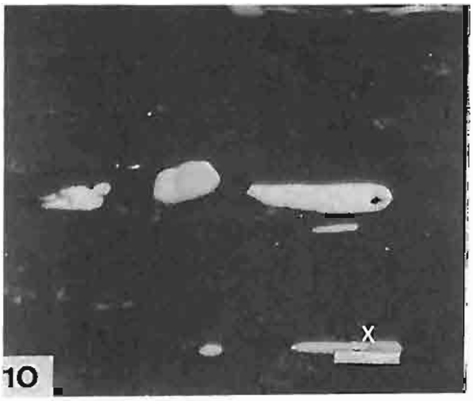


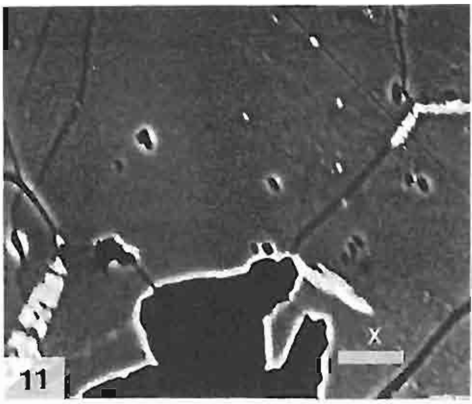
9

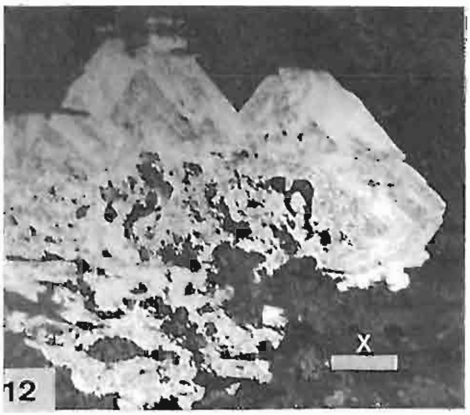
PLATE II

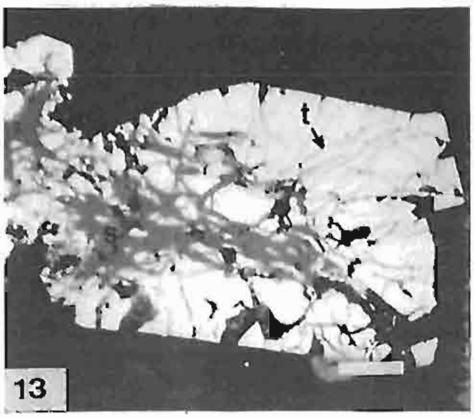
Fig. 10. Parallelly arranged ilmenite crystals
Równolegle ułożone kryształy ilmenitu
Fig. 11. Pentlandite laths in pyrrhotite; microprobe microphotograph
Lamelki pentlandynu w pirotynie; zdjęcie z mikrosondy
Fig. 12. Pyrite growing at the expense of pyrrhotite, with zonal intergrowths of calcite
Piryt wzrastający kosztem pirotynu z zonalnymi przerostami kalcytu
Fig. 13. Cataclased pyrite crystal, healed by tennantite (t) and sphalerite (s)
Skataklazowany kryształ pirytu, zabliźniony przez tenantyn (t) i sfaleryt (s)
Fig. 14. Galena (g) and arsenopyrite at the contact between the vein and wall rock
Galena (g) i arsenopiryt na kontakcie między żyłką a skałą płonną
Fig. 15a–c. Gas-liquid inclusion: a — in quartz with liquid carbon dioxide, *Th* > 300°C, b — in quartz, *Th* 246°C, c — in sphalerite, *Th* 156°C
Inkluzja gazowo-ciekła: a — w kwarcu w ciekłym CO_2, *Th* > 300°C, b — w kwarcu, *Th* 246°C, c — w sfalerycie, *Th* 156°C

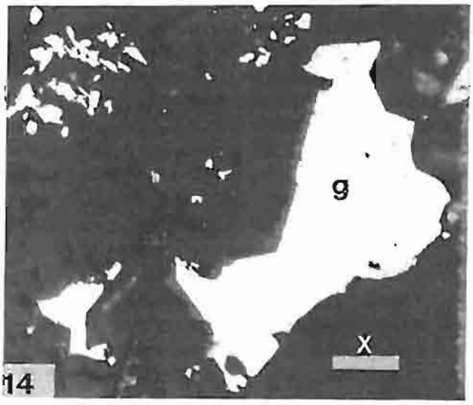
Scale bars: x — 1 mm, y — 10 μm
Skale: x — 1 mm, y — 10 μm

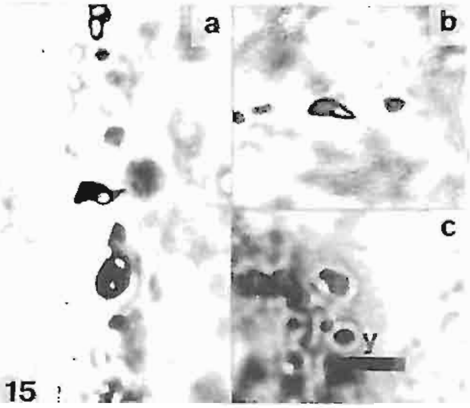












Wiesław OLSZYŃSKI, Stanisław SPECZIK — Ore mineralization of Lutynia (SW Poland)