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THE METASOMATIC ZINC DEPOSITS OF THE POMORZANY MINE (CRACOW—SILESIAN ORE DISTRICT, POLAND)

(5 Figs and Pl. I—IV)

Metasomatyczne złoże rud cynku z kopalni Pomorzany (rejon śląsko-krakowski)

(Pl. I—IV i 5 fig.)

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Abstract: Based on the observations in the mine workings the zinc portion of the Pomorzany mine is described. The metasomatic origin of the deposit is demonstrated by geological structures, by macrostructures inherited from paleosome, and by microscopic examinations. The ore body reveals several processes: dolomitization, ore replacement, and karstification. It appears that the karst lead and zinc part of the deposit was formed after that of the metasomatic ore body.

Key words: metasomatic Zn—Pb ores, Cracow—Silesian region, Poland.

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Treść: Przedstawiono opis złoża cynku kopalni Pomorzany. Jego budowa geologiczna, makrostruktury rud oraz ich mikroskopowe cechy świadczą o metasomatycznym pochodzeniu omawianego złoża. Złoże ujawnia wpływ dolomityzacji, metasomatycznego zastępowania oraz procesów krasowych. Stwierdzono również, że brekcjowe złoże cynkowo-ołowiowe utworzyło się w wyniku procesów krasowych, po powstaniu metasomatycznego złoża cynku.

INTRODUCTION

In the Pomorzany Mine, two types of deposits are observed: 1 — the banded and spotted zinc ores similar to those described by Bogacz et al. (1973), Smolarska (1968), and Sobczyński, Szuwarzyński (1974) from the Chorzów area, and 2 — the lead — zinc ores in solution collapse breccias. This paper deals only with the first type, i.e., the metasomatic ore body and its relation to the breccia type. The problem concerning the karst ores will be a subject of the forthcoming paper.

GEOLOGICAL SETTING

The Pomorzany ore deposit is located in the carbonate rocks of Lower Muschelkalk (Anisian). The Triassic and Permian sediments overlap transgressively the folded and eroded Paleozoic basement. The host rock is an ore-bearing dolomite — a neosome produced by dolomitization of limestone and recrystallization of the early diagenetic dolostone (for references see Bogacz et al. 1975). The main volume of the ores coinicides with lowermost part of the dolomite bodies. The bottom part of the deposit described here is found in the ore-bearing dolomite which corresponds to so-called interformational conglomerate of the Gogolin Beds (Table 1).

Table — Tabela 1

Stratigraphic position of the examined fragments of ore bodies
Pozycja stratygraficzna badanych fragmentów złoża na tle schematycznego profilu dolnego wapienia muszlowego

<table>
<tr><td rowspan="4">Lower Muschelkalk</td><td>Karchowice Beds</td><td></td></tr>
<tr><td>Terebratula Beds</td><td></td></tr>
<tr><td>Gorażdże Beds</td><td></td></tr>
<tr><td>Gogolin Beds</td><td>Wellenkalk III
Inter-Wellenkalk Beds
Wellenkalk II
Conglomerate horizon
Porous Limestone
Limestone with Pecten and Dadocrinus (higher part)
Wellenkalk I
Limestone with Pecten and Dadocrinus (lower part)</td></tr>
</table>

stratigraphic-position of the ore bodies

The carbonate host rocks are essentially horizontal and are cut by numerous faults among which the latitudinal ones are the most important. They produced the main horsts and grabens. The Pomorzany ore body occurs generally in a large graben and is separated from the Olkusz deposit by a horst structure. In the tectonic zones, the deposit is cut and displaced together with rigid blocks of surrounding rocks.

The ores are scattered in form of a nest-like bodies throughout the mass of the ore-bearing dolomite. The horizontal extent of most nests is much greater than the vertical one. Some of them take a regular, isometric shape; others form tabular lenses. The latter ones usually consist of banded and spotted ores, whereas the nestlike ore bodies comprise mineralised breccia. These breccias represent the solution-collapse type analogous to those observed in the neighbouring Olkusz deposit (Sass-Gustkiewicz, 1974, 1975). The banded and spotted ores resulted from the replacement of carbonate rocks by ore minerals. These metasomatic ores constitute a minor part of the Pomorzany deposit.

SURROUNDING ROCKS

The sourrounding carbonate rocks differ in their structures and textures. Several types of dolomites, limestones, and dolomitic limestones have been distinguished. In the vertical profile, we can observe a transition from one to the other structural type of limestones affected by the variation of depositional environment. The character of the rock structures and their variability points to their formation in a shallow sedimentary basin.

A considerable variability of structures can be also observed in the ore-bearing dolomite. This is caused by the fact that some of the structures were inherited from paleosome. Figs. 1 and 2 are good examples of such inheritance. The same rock structures can be seen on both sides of the metasomatic contact of limestone and ore-bearing dolomite. However, the continuation of structures from one to the other rocks is not always precise. For examples 1 — coarse crystalline, organogenic limestones and some of the spotted ones were altered to spotted dolomite, and 2 — grey, smooth limestones to coarse crystalline, partly laminated dolomite.

The structures of the ore-bearing dolomite are more varied than those of the limestones. This is probably resulted from several processes involued in the metasomatosis such as: dolomitization, recrystallization, and dissolution. However, most of the well-developed structures of paleosome are reflected in the ore-bearing dolomite neosome (Table 2).

Table — Tabela 2

Petrographic description of surrounding rocks
Petrograficzna charakterystyka skał otaczających

Structure/texture of rocks	Limestones	Dolomites
1	2	3
Homogenous, fine-grained	Grey, smooth, microsparitic limestone, partly clotted, recrystallized microfossills are visible	Homogenous grey dolomite. Microscopically: equicrystalline, idiotopic, (or xenotopic), locally porous. Ore minerals fill the intercrystalline spaces. Recrystallization of dolomite is partly observed.
Coarse-crystalline organogenic	Grey, corse-crystalline, partly spotted limestone. Carbonate fossils (mainly Crynoides) are observed in fine-crystalline matrix. Features of recrystallization and dolomitization.	Grey, coarse, crystalline dolomite, with stylolites. Microscopically: composed of hypidiomorphic crystals of dolomite (0,05—0,16 mm). Often the dolomite grains mimic the shapes of Crynoides, features of recrystallization. Stylolites common.
Laminated and/or banded	Light grey limestone with dark laminae. Composed of micritic or microsparitic carbonate materials, lamination is accentuated by the presence of micritic laminae separated one from another by microsparitic one and clay minerals. Scattered dolorhombs point to initial stages of dolomitization.	Light grey with dark laminae. Microscopically: coarse crystalline, idiotopic dolomite. The iron hydroxides underline the outline of dolomite rhombohedra. Non-transmitted minerals are also accumulated in the outher zones of dolomite grains.
Recurring, spongy-like		Grey, coarse-crystalline, rhytmically-porous dolomite. Spongy-like structure appears as porous, alongated zones, parallel to each other.
Spotted	Spotted limestone is light grey with darker laminae and irregular spots. Usually in the inner part of spots coarse crystalline calcite is visible. Microscopically: microsparitic, non equigranular limestone, in some places clotted. Irregular micritic clots, or micritic laminae and	Spotted dolomite is grey with lighter irregular spots, which sometimes show porous inner parts. Microscopically: coarse--crystalline rock, hipidiotopic with finer-crystalline areas. The porous zones are middle-crystalline xenotopic, affected by recrystallization. Numerous cavities are partly filled with

1	2	3
	numerous recrystallized microfossils are present. Dolomitic rhombohedra are accumulated near clay intercalations and stylolites. This type of limestone was found in the vicinity of limestone/dolomite contact, or in boundary zone between organogenic and light gray, smooth limestone.	idiomorphic crystals of dolomite, showing typical zone structure. Sometimes the pores are filled with sphalerite.
Spotted-lump	Spotted-lump limestone is light-grey with darker spots and is characterized by irregular interfaces. Microscopically: micritic, partly microsparitic rock contain disseminated crystals of dolomite. Lumpy structure appear as irregular, rounded spots, filled with coarse crystalline calcite. Calcite partly replaced by dolomite.	Spotted-lumpy dolomite is grey with irregular lighter spots. Microscopically it is middle-crystalline dolomite with coarse crystalline spots. Features of recrystallization are common. Stylolites filled with iron-hydroxides separate coarse and middle-crystalline parts of rock.
Intraformational conglomerats	The conglomerate is composed of grey, micritic limestone pabbles cemented by lighter, coarse-crystalline organodetritic (mainly Crynoides) limestone. Matrix contains a few clastic grains of quartz and rounded barite concentrations.	Conglomerate composed of grey, coarse-crystalline, non equigranular dolomite which forms pabbles cemented by finecrystalline limestone. Both rocks are in some places affected by recrystallization.

THE CONTACT RELATION OF THE ORE-BEARING DOLOMITE AND LIMESTONE

The contacts between the ore-bearing dolomite and limestone appear to be similar to that described by Bogacz et al. (1972) in Trzebionka Mine and by Mochnacka, Sass-Gustkiewicz (1978) from the Olkusz deposit. These are irregular and cross-cut the bedding planes. The contact is well-marked and accentuated by differences in colour and texture of rocks. Often it is additionally accentuated by some amounts of clay minerals. In some cases, however, there occurs a gradual transition from the ore-bearing dolomite to limestone. But the boundaries between the two rocks are always of cross-cutting character.

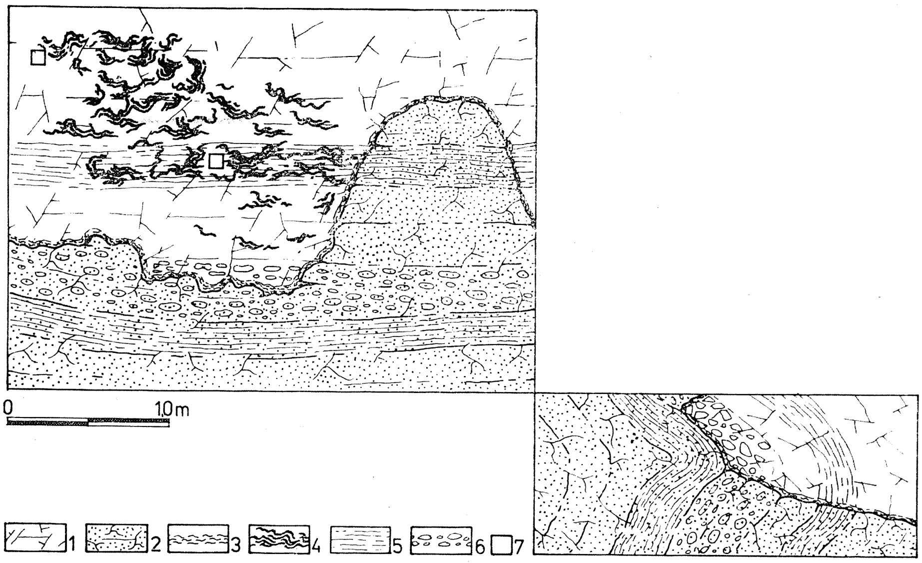

Fig. 2. Cross section of a portion of ore body near the metasomatic contact of ore-bearing dolomite with limestone. 1 — ore-bearing dolomite, 2 — limestone, 3 — clays, 4 — banded and spotted ores, 5 — laminated rocks, 6 — conglomeratic rocks, 7 — examples show on photographs

Fig. 2. Przykład wykształcenia złoża w pobliżu metasomatycznego kontaktu dolomitów kruszconośnych z wapieniami. 1 — dolomit kruszconośny, 2 — wapień, 3 — iły, 4 — ruda o strukturze warstwowanej i plamistej, 5 — skały o strukturze laminowanej, 6 — skały o strukturze zlepieńcowej, 7 — przykłady struktur rudnych przedstawione na fotografiach

The geometrical configurations of the contacts over short distances are very irregular, even when the contact is nearly horizontally. In some cases the limestone-dolomite boundary is wavy (Figs. 1 and 2), in others it is thooth-like (middle part of Fig. 1). In the lower part of the main dolomite body, there is an intermediate zone of incomplete dolomitization. In this zone are some alongated relics of limestones, parallel to the bedding planes.

One can see that this zone (Fig. 1, left side) is transformed into a tabular dolomitic body developed on both sides of the bedding surfaces of the paleosome. The dolomite body is isolated from the under- and over-lying limestones by thin black layers of clay minerals. The presence of these two clay screens has brought about a forced horizontal flow of dolomitizing solutions which resulted in the formation of a tabular body.

Both these facts: 1 — the cross-cutting contact of the sedimentary interfaces, and 2 — the presence of unaltered relics of limestones point to the metasomatic origin of the ore-bearing dolomite (compare Bogacz et al. 1972 and 1975).

THE METASOMATIC ORE BODIES

As it has been said before the metasomatic ore-bodies assume mostly a tabular shape. Their horizontal extention is several tens of meters, up to hundreds of meters, while their vertical extent ranges from 0.5 to 3 meters. This quite regular shape is disrupted in a few places by a rapid increase of thickness which has formed local nests of banded and spotted ores. The height of these nests exeeds many times the average thickness of the tabular body and may even reach 30 meters.

The tabular, horizontally disposed ore bodies if observed from nearby are irregular. Their boundaries cross the sedimentary bedding planes of surrounding rocks. This is the result of the selective replacement of the ore-bearing dolomite. Consequently, the bottom of the metasomatic ore bodies coincides with the bottom of the ore-bearing dolomite.

The metasomatic ore bodies are not uniform in their inner composition. They contain irregular accumulations of massive sphalerite ores surrounded by weak impregnetions of sphalerite with preserved fragments of barren dolomite. Usually, there are some differences between the character of the bottom and the roof of the ore body. In the roof zone, the concentrations of ore minerals decrease step-like with distance from the ore body, while the bottom is sharply defined and accentuated by the presence of clays. Figures 1, 2 and 3 illustrate some selected fragments of a metasomatic ore body.

Fig. 2 represents a section through the marginal part of the ore body. The following rock structures can be distinquished in the limestone and in the ore-bearing dolomite: laminated, spotted, and recurring spongy. The contact between the limestone and the ore-bearing dolomite is of a metasomatic type. All the sedimentary structures continue from limestone to dolomite without any changes at the cross-cutting boundary between them. Along this contact, some amounts of clay minerals were accumulated. Small, irregular, sphalerite and marcasite nest-like bodies are developed exclusively in the ore-bearing dolomite and terminate a the contact with the limestones.

In the laminated layer of the ore-bearing dolomite, there banded ores have been formed (Pl. I, Fig. 1). Above them, in the layers of spotted dolomite, there are concentrations of spotted ores (Pl. III, Fig. 3). In both cases, the ores reflect the petterns of the host rocks. The concentrations of massive ores are surrounded with impregnation haloes. Of these two ore minerals, the sphalerite is older than the marcasite. The latter fills the open spaces resulting from the metasomatosis and also replaces the sphalerite.

Let us return to Fig. 1. Above the zone of incomplete dolomitization, described earlier in this section, in the complex of ore-bearing dolomites, there is the marginal part of a typical tabular ore body. Its thickness ranges widely but decreases towards the distal end (on the right of the picture). In spite of its tabular shape, the ore body is not bedding controlled.

The ore body consist of two different, overlapping, horizontally disposed elements. The upper one is composed of metasomatic ores and the lower one is made up of the internal sediments. As usual, the roof of the metasomatic ore body has an irregular shape that cross-cuts the bedding, but the small sedimentary structures are repeated, resulting in banded and spotted ores. Their distribution is visible in Fig. 1. The uppermost part of the metasomatic ore body is a zone of irregularly disposed impregnations.

Between the rich, massive ores and the impregnation zones, there is a gradual transition. The sample shown on Pl. I, Fig. 2, shows the transition zone in which the banded ores are of low concentration. The laminated dolomite is impregnated by sphalerite grains. The bedding planes are solutionally widened, producing narrow, sheet-like open spaces. These voids are incrusted by light brown and dark brown sphalerite. The distribution of ore minerals suggests that the solutionally enlarged voids were the places from which the replacing solutions have spread outwards into the host rock (compare also Bogacz et al. 1973 and Dżułyński, Sass-Gustkiewicz 1977).

The bottom of the metasomatic ore body rests on the internal sediments. Their thickness differs according to the irregularities of the irregular bottom surface. This surface shows a typical karstic morphology with solutionally rounded forms covered by black residual clays. The internal sediments consist of detrital grains of the surrounding carbonates, clastic and euhedral sulfide grains and residual clays. The sediments also contain fragments of dolomite and metasomatic ores. The internal sediments show a lamination that often reveals soft-rock-deformations. The amount of ore minerals is great enough to call them stratified sedimentary ores.

The above presented twofold ore body has been affected by two different ore forming processes, i.e. metasomatosis and dissolution joined with internal karstic accumulation. The nearly horizontal bottom of the metasomatic ore body suggests that the dissolution of underlying rocks preceeded very slowly and together with the deposition of internal sediments, which protected the metasomatic ore body from collapse. However, the presence of metasomatic ore fragments in the internal sediments indicates that the karstic processes developed after the emplacement of metasomatic ores. This relationship is evidenced more obviously in the following pictures (Fig. 3) that show a section through the central part of the ore body. The complex of the Gogolin limestones (lower part) and the ore-bearing dolomites (upper part) lies horizontally. As usual, the contact between the two types of rocks cuts across the bedding planes, which are more clearly marked in limestones than in dolomites. In the ore-bearing dolomites, the irregular concentrations of metasomatic ores can be observed. They represent the same type of banded ores described above, composed mainly of sphalerite followed by marcasite.

Beneath the ore body, there are two elongated in the vertical direction breccia zones. The smaller one (on the right in Fig. 3) is developed in limestone beds only and the overlying dolomite strata are not disturbed nor even fractured. The bigger one (on the left of the picture) involves also the ore-bearing dolomites, thus in the breccia, we can find clastic fragments of the overlying metasomatic ore body. The spaces between the large breccia fragments are filled with small clastic particles of the surrounding rocks and the internal sediments. Both breccia zones are a type of solution-collapse breccias with an uncollapsed roof. There is a lateral transition from the proper breccia to the unbrecciated dolomite layers through breccia with little displacement and rotation of blocks which is typical of collapse structures (compare Sass-Gustkiewicz 1974). Moreover, the surface of the limestones shows signs of dissolution.

The above-mentioned breccia zone shows a certain assymetry in the distribution of limestone and ore-bearing dolomite beds on both sides of the breccia zone. Because of the lack of disturbance in the overlying dolomite and because the same layers of limestones are traceable on the same level on both sides of breccia, the assymetry cannot have been affected by any vertical displacement. This relationship must have been caused by a prior assymetric configuration of the metasomatic contact between the limestones and the dolomites that promoted the dissolution processes. Thus, the presence of ore fragments in the solution collapse breccia indicates that the karstic processes developed after the emplacement of sphalerite and marcasite in the banded ores.

INHERITED AND/OR DIFFUSION ORE STRUCTURES

Between the ore structures, there is a group of large-scale structures that show a striking similarity to the macrostructures of the host rocks. To explain this similarity, a specific layer was selected in which a transition from limestone through ore-bearing dolomite to the ore is visible over a short distance. Four main types of structures were differentiated, that is: banded, repeated spongy-like, spotted, and organogenic occuring as well in limestones, in ore-bearing dolomite as in ores (compare Table 2). The pictures in Plates II and III show two macrostructures: repeated spongy-like and spotted which were observed in all these rocks.

Microscopic examinations have led to the conclusion that the main reason for the recurrence of these structures during all the steps of metasomatism was the differences in solubility. Hence, we may conclude that some of the macrostructures were inherited from the paleosome (see also Bogacz et al. 1973).

Apart from the doubtlessly inherited ore structures there are the banded and spotted structures which do not reflect the primary structures. They developed probably independently of the structures of the host rocks. It may be added, at this point, that Bogacz et al. (1973) describing sphalerite metasomatic banded ores in Trzebionka Mine has pointed to the "irregularities and deviations from primary patterns" among the inherited structures.

Comparison of these irregularly banded ores with the rhythmic ore structures obtained by Pospelov (1973) from experiments on the formation of the so called "fissureless veins" reveals a close similarity. These experimental rhythmic ore structures were affected by a reverse diffusion of components, which similarly to the wave phenomena are subjected to diffraction, interference, and wave deflection in the stream of diffusion. Because diffusion is an important factor in the spreading of mineralizing solutions, it seems reasonable to assume that the structures obtained from experiments are comparable with these observed in a real ore body and that the irregularities and deviations from the primary structures might be explained as a result of diffraction, interference, and deflection of waves during the reverse diffusion of the mineralizing solutions.

The coexistance of inherited and non-inherited structures in one simple ore-body is in agreement with the observations made in many other typical metasomatic ore deposits and can be explained in terms of the paradoxes of metasomatosis.

MICROSCOPIC EXAMINATION OF THE METASOMATIC ORES

The sphalerite [1] ore replaces a metasomatically altered, coarse crystalline dolomite. The ore consists of idio- or hipidiomorphic grains of dolomite (0.05—0.3 mm) and sphalerite. The sphalerite occurs in form

[1] For simplicity's sake, ZnS occuring in all types of accumulations has been named sphalerite. It is known however (Chu-Tuan-Nha, Kubisz 1973) that ZnS from Polish Zn—Pb deposits contains sometimes up to 10% of hexagonal wurtzite. Detailed mineralogical examinations are not the aim of this paper.

of dispersed grains or irregular aggregates. Usually, the size of sphalerite and dolomite crystals is similar or the former is somewhat smaller. (Fig. 4—1).

According to microscopic observations of thin sections, a few steps of successive replacement of dolomite by sphalerite can be distinquished. In the first step, the sphalerite grains are distributed around the larger grains of dolomite or form rings around the dolomitic aggregates. The next stage was the formation of sphalerite nests containing dolomite crystals within their meshes. The last stage appears to be the massive sphalerite aggregates containing single, well-developed centrally located dolorhombs (Fig. 4—2, 3 and Pl. IV, Fig. 4). Similar microstructures of sphalerite are observed in the vicinity of vugs incrusted by sphalerite (Pl. I, Fig. 2).

The sphalerite occuring as dispersed grains belongs to the oldest generation — I. It originated concurrently with the recrystallization of dolomite or a little later; this is suggested by the coarse crystalline idiotopic structure of dolomite containing sphalerite I. The massive aggregates of sphalerite are composed of sphalerite II. Both, I and II generations of sphalerite examined in transmited light are gray, light brown with high refractive index, isotropic or partly anisotropic. Sphalerite II occurs in completely recrystallized ore-bearing dolomite. It consists of well developed dolorhombs. Staining methods using alizarin red S and potassium ferricyanide reveal irregular ankeritic zones of dolomite crystals. The dolorhombs show replacement by sphalerite II.

In the porous parts of the rock (e. g. in spotted and spongy dolomite), the sphalerite occurs as a filling of pores. The dolomite crystals growing in the open spaces have a typical concentric zonation. The outer zones are ankeritic (unlike the dolorhombs forming the ore-bearing dolomite in which the ankeritic zones are the ones before the last). The different forms of dolomite crystals seem to correspond to the different stages of dolomitization. The crystals of dolomite I are low-iron whereas the dolomite II crystals filling open spaces contain the outer ankeritic zones.

Well-developed dolorhombs show the evidences of dissolution which starts from the inner part of crystals. These voids were filled with fine crystals of dolomite or sometimes of sphalerite (see Fig. 4—5 and Pl. IV, Fig. 3). More intensive dissolution and transfer of liquids promoted the enlargement of voids, which were succesively filled with colloform sphalerite of the IIIa generation (Fig. 4—4). As is shown in Fig. 4—4, the aggregates of sphalerite II are covered with thin layers of sphalerite of indistinct structure. The colloform sphalerite III forms the next zone and is built up of alternately repeated bands of light-honey and dark-brown bands of sphalerite. Longitudinal crystals growing perpendicularly to the nucleation surface cut across several bands. The next

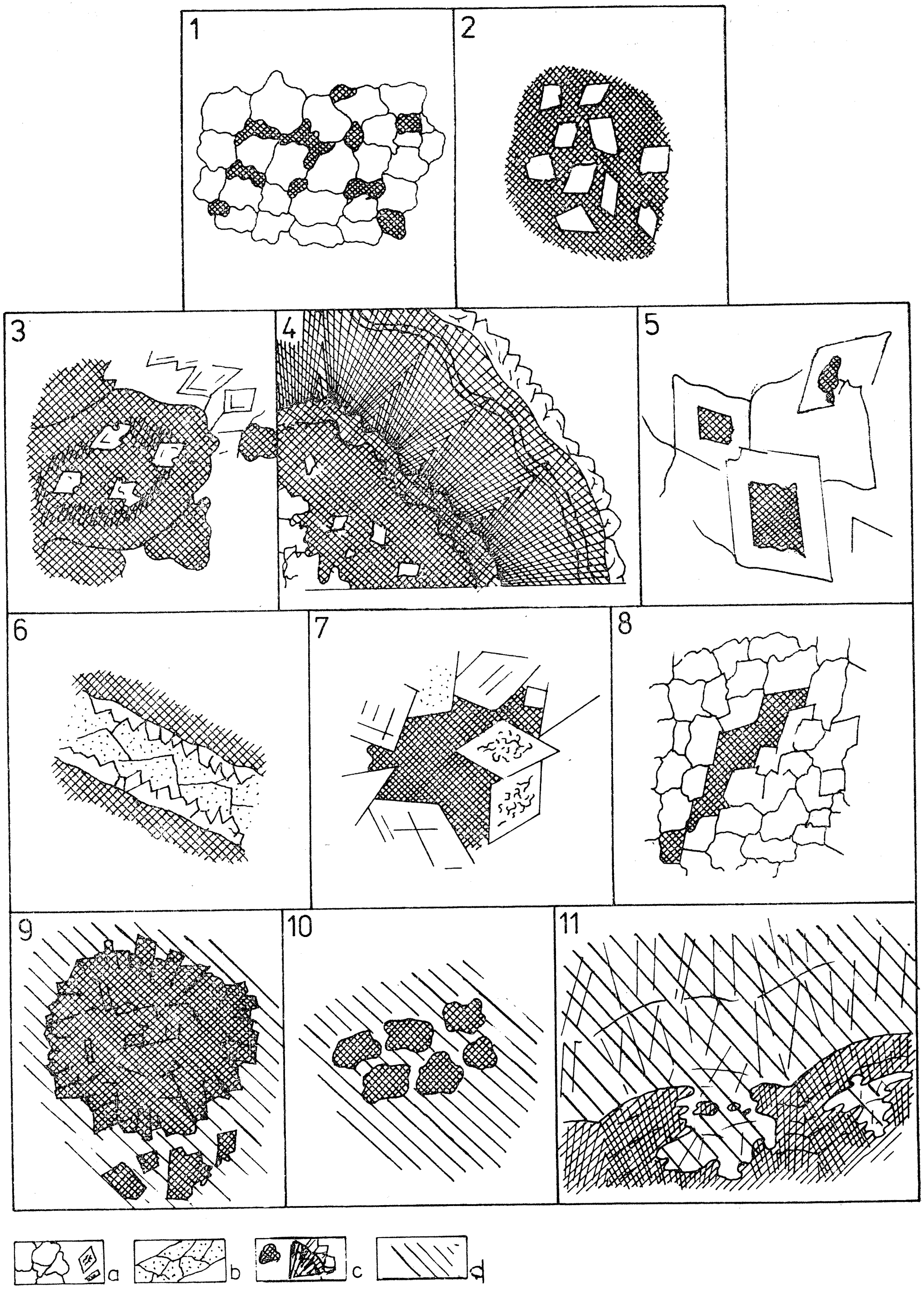

Fig. 4 — Forms of sphalerite (in microscopic scale). a — dolomite, b — calcite, c — sphalerite, d — iron sulfides

Fig. 4. Formy występowania sfalerytu w skali mikroskopowej: a — dolomit, b — kalcyt, c — sfaleryt, d — siarczek żelaza

variety is white, crystalline sphalerite IIIb (Fig. 4—4 and 5, 6). All structural varieties of sphalerite discussed above originated as the filling of open spaces (Fig. 4—4, 5, 6, 7, 8). However, it should be noticed that the aggregates of sphalerite II indicate the traces of recrystallization, and they mimic collomorphic structures (Fig. 4—3).

The FeS_2 exists as: a) cement of sphalerite grains (Fig. 4—9, 10), b) irregular pore filling, c) in form of aggregates which cover the colloform sphalerite and partly replace it (Fig. 4—11).

A SCHEME OF METASOMATIC PROCESSES

The scheme presented in Fig. 5 shows the development of metasomatic processes in the Pomorzany deposit. Its construction has been based on microscopic examinations of rocks and ores. However, the time relationship of these processes is based on the observation on the macro- and mesoscale.

The metasomatic processes altered the limestone only, because in opposition to other deposits of this region, no early diagenetic dolomite occured here.

The dolomitization of limestones was the first geological process (calcite I — area 1) which affected the origin of dolomitic limestone (dolomite I — area 2). Locally, in the same thin sections, evidences of recrystallization or calcitization of single dolorhombs (calcite II — area 3) were observed. The dolomitization of limestone caused the formation of dolostone, which consists of dolomitic grains only (dolomite I — area 4). The latter stage of the metasomatic processes is the recrystallization of dolomite (dolomite II — area 5). The coarse-grained, idiotopic, partly hipidiotopic dolostone is the result of the above described processes.

Dolomitization is associated with the dissolution of rocks and consequently with the development of caverns. These caverns are then partly filled with the idiotopic dolorhombs, showing concentric structure (dolomite IIa — area 6).

The formation of dolomite I was accompanied by the deposition of the first generation of sphalerite (sphalerite I — area 7). The disseminated iron sulfides (pyrite I) probably were produced at the same time. The successive enrichment in ZnS resulted in the formation of sphalerite aggregates (area 8) located in the idiotopic coarse-graine dolomite. The dolomite rhomboedra occuring in these aggregates seem to be the relics of dolomite, which were not replaced by sphalerite. This is evidenced by the transition zones, showing succesively greater density of the sphalerite aggregates. The well-developed dolorhombs are characterized by

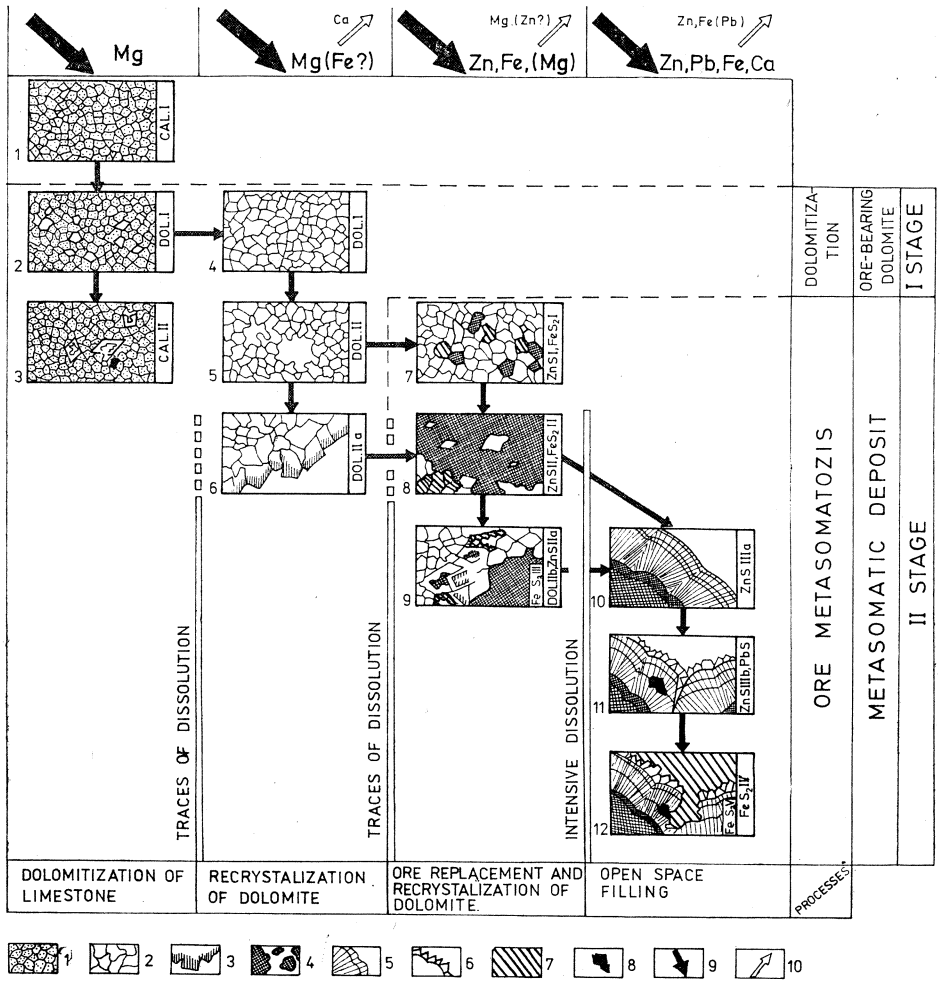

Fig. 5. Scheme of metasomatic processes: 1 — calcite, 2 — dolomite, 3 — ankeritic zones, 4 — disseminated grains and aggregates of sphalerite, 5 — colloform sphalerite, 6 — white crystalline sphalerite, 7 — iron sulfides, 8 — galena, 9 — supplied elements, 10 —removed elements

Fig. 5. Schemat procesów metasomatycznych w złożu. 1 — kalcyt, 2 — dolomit, 3 — strefy żelaziste, 4 — sfaleryt rozproszony oraz w formie impregnacji, 5 — sfaleryt kolomorficzny, 6 — sfaleryt krystaliczny biały, 7 — siarczki żelaza, 8 — galena, 9 — pierwiastki doprowadzone, 10 — pierwiastki odprowadzone.

special resistance to replacement. The dolomite II was formed at the same time. Usually it contains the ankeritic areas in the inner parts of rhomboedra (area 9).

The dissolution was the next important process associated with the metasomatism. It is the dissolution of dolomite rhombohedra that show concentrically banded structure (dolomite IIb) which was partly replaced by sphalerite (area 9). The marcasite III infilling the pores was formed in the same time.

The formation of colloform accumulation of sphalerite (IIIa) followed the recrystallization of sphalerite II. The differences in the structure and colour of the colloform sphalerite and crystalline I and II suggest changes in chemical composition of oreforming solutions (area 10). Within the colloform sphalerite idiomorphic crystals of galena often are visible (area 11), this galena replaces the sphalerite. However, galena occurs in small amounts and does not seem to be typical component of metasomatic ores. In the same picture (area 11), white grains of sphalerite IIIb are shown. They cover the colloform sphalerite IIIa or occur in calcitic veinlets cutting them.

Among the discussed ore minerals, marcasite IV and V are the youngest one (area 12). The marcasite is characterized by radial structures of crystals and strong anisotropy. It also shows the features of replacement.

We mention at this place, that Przeniosło (1974) also suggested the existence of successive gradual transformations of the dolomite which led to the appearance of metasomatic ores.

FINAL REMARKS

As a result of above-described investigations a number of conclusions concerning the composition, development, and the origin of the Pomorzany deposit has been reached. The conclusions are as follows:

1 — two genetic types of deposits can be distinguished:
- — metasomatic ores composed of sphalerite, and
- — filling of empty voids in collapse breccias by lead and zinc minerals.

2 — the host rock is the ore-bearing dolomite. Its epigenetic character has been concluded from contacts with limestones and from microscopic examinations of rocks

3 — the metasomatic ore bodies are mostly stratiform. In some cases, their thickness rapidly increases in many places and at many times

4 — despite the layered form of the metasomatic ore bodies, detailed examination reveals that their irregular shapes crosscut the sedimentary structures

5 — the metasomatic deposits resulted from the following processes succeeding one after the other:
- — dolomitization of limestones,
- — recrystallization of dolomites,
- — replacement of dolomites by ZnS,
- — infilling by ZnS of the open spaces formed during the ore metasomatism

— replacement of dolomites and sphalerite by FeS_2

6 — the metasomatic processes are shown by the inherited structures observed in limestones and ore-bearing dolomite, and in the sphalerite ores

7 — the rhytmic ore structures might have been caused by the diffusional character of flow of the mineralizing solutions

8 — the deposits located in collapse breccias were formed after the emplacement of the metasomatic ores.

translated by H. Czubakowska

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STRESZCZENIE

Złoże kopalni Pomorzany znajduje się w północnej części obszaru olkuskiego. Jest ono jedynym w rejonie śląsko-krakowskim miejscem występowania na większą skalę rud metasomatycznych obok rud brekcjowych.

Podobnie jak pozostałe złoża tego rejonu, złoże Pomorzany jest usytuowane w utworach wapienia muszlowego, a spągowe części badanych ciał rudnych znajdują się w obrębie serii zlepieńcowej warstw gogolińskich. Ciała rudne wykształcone są w postaci gniazd oraz w formach zbliżonych do pokładów. Skałami otaczającymi złoże są wapienie i dolomity kruszconośne wykazujące duże zróżnicowanie petrograficzne. Wyróżniono sześć odmian wapieni oraz siedem odmian dolomitów (tabela 2). Dolomity kruszconośne jako utwory epigenetyczne powstałe z przekształcenia wapieni wykazują w wielu przypadkach struktury odziedziczone po nich. Niekiedy są one zatarte wskutek działania procesów rekrystalizacji i rozpuszczania towarzyszących metasomatozie.

W złożu metasomatycznym jedynym minerałem użytecznym jest sfaleryt, rzadko występuje galena, niekiedy spotyka się duże nagromadzenia markasytu. Ciała rudne mają zwykle formę płaską zbliżoną do pokładu, o miąższości 0.5—2.5 m. Czasami jednakże dochodzi do gwałtownego wzrostu miąższości przekraczającej wielokrotnie przeciętną. W skali ociosu pokłady mają kształt nieregularny, a ich spąg pokrywa się ze spągiem ciał dolomitowych dziedzicząc po nim nieregularny metasomatyczny kontakt (fig. 1, 2, 3). Podobnie jak dolomit dziedziczył struktury po wapieniu, tak i rudy metasomatyczne dziedziczą struktury po dolomitach. Przykładem są struktury warstwowane i plamiste przedstawione na planszach II i III.

Przeprowadzone badania makro- i mikroskopowe rud metasomatycznych i skał otaczających pozwoliły na wydzielenie kilku form występowania sfalerytu, odpowiadających kilku generacjom (fig. 4). Jest to sfaleryt rozproszony I, impregnacyjny II, kolomorficzny IIIa i krystaliczny IIIb. Tworzenie się tych odmian związane jest z kolejnymi metasomatycznymi przekształceniami skał otaczających. Rozwój procesów metasomatycznych przedstawiono na fig. 5. Uogólniając, w rozwoju złoża metasomatycznego można stwierdzić działalność następujących procesów: 1 — dolomityzacji wapieni, 2 — rekrystalizacji dolomitu, 3 — zastępowania metasomatycznego siarczkami cynku, 4 — wypełniania wolnych przestrzeni powstałych przy metasomatozie siarczkami cynku i żelaza oraz 5 — zastępowania metasomatycznego dolomitów i minerałów kruszcowych przez siarczek żelaza.

Obserwowane fragmenty rud metasomatycznych w zmineralizowanych brekcjach zawałowych świadczą, że procesy krasowe w złożu rozwijały się po utworzeniu się złoża rud metasomatycznych.

Praca niniejsza została wykonana w ramach realizacji problemu resortowego „Rozpoznanie warunków geologiczno-złożowych dla potrzeb eksploatacji i racjonalnej gospodarki złożami Zn—Pb" koordynowanego przez ZBIP „Cuprum".

EXPLANATION OF PLATES — OBJAŚNIENIA PLANSZ

Plate — Plansza I

Fig. 1. Banded ores: s — colloform sphalerite (light grey and black); m — marcasite (dark grey); k — calcite (white). In the lower part of the sample, sphalerite bands contain relics of dolomite (d). Marcasite replaced colloform sphalerite or filled the empty voids formed during the metasomatism. The youngest calcite and galena (g) filled up all open spaces.

Fig. 1. Ruda o strukturze warstwowanej złożona z pasm kolomorficznego sfalerytu (s — jasnoszare i czarne pasma), markasytu (m — ciemnoszary) oraz kalcytu (k — biały). W dolnej części okazu pasma sfalerytu zawierają relikty dolomitu (d). Markasyt zastępuje sfaleryt kolomorficzny oraz wypełnia wolne przestrzenie powstałe wskutek metasomatozy sfalerytowej. Najmłodszy kalcyt i galena (g) wypełniają prawie całkowicie pozostałe pustki.

Fig. 2. Ore fragment from the top of a metasomatic body: ds — sphalerite impregnations in dolomite. The sphalerite grains follow the lamination of dolomite. The amount of sphalerite grains increases towards the sheet-like vugs (ev) passing into the light- and dark-brown incrustations of sphalerite (s). g — galena, m — irregular metasomatic concentrations of marcasite.

Fig. 2. Fragment rudy ze stropu pokładu rud warstwowanych. Znaczną część okazu (szare części — ds) stanowi dolomit impregnowany sfalerytem. Impregnacje sfalerytowe układają się w pasma równoległe do laminacji. Ilość sfalerytu wzrasta stopniowo w kierunku podłużnych pustek (ev) przechodząc w inkrustacje jasnego i ciemnobrązowego sfalerytu (s). g — galena, m — nieregularne metasomatyczne skupienia markasytu.

Plate — Plansza II

Examples of inherited structures. Spongy-like ore-bearing dolomite with rhythmically repeated layers of clay minerals — dark laminae (Fig. 1). In Fig. 2 — sample of spongy-like sphalerite ore. The vugs incrusted by colloform sphalerite (s) correspond exactly to laminae of clay minerals observed in Fig. 1.

Przykład dziedziczenia struktur w procesie metasomatozy. Figura 1 przedstawia gąbczasty dolomit, w którym powtarzają się rytmicznie laminy substancji ilastej (ciemne smugi). Na Figurze 2 przedstawiony jest okaz rudy sfalerytowej. Jej struktura jest również gąbczasta. Rytm pustek inkrustowanych sfalerytem (s) odpowiada ściśle rytmowi lamin substancji ilastej na Figurze 1.

Plate — Plansza III

Set of spotted structures observed in limestone (Fig. 1), ore-bearing dolomite (Fig. 2), sphalerite ore (Fig. 3), and marcasite ore (Fig. 4). They illustrate the inheritance of structures during the dolomization and ore metasomatism.

Zestaw struktur plamistych obserwowanych w wapieniu (Fig. 1), w dolomicie kruszconośnym (Fig. 2), w rudzie sfalerytowej (Fig. 3) oraz w rudzie markasytowej (Fig. 4). Stanowią one ilustrację dziedziczenia struktur w procesie dolomityzacji oraz metasomatozy kruszcowej.

Plate — Plansza IV

Fig. 1. Metasomatic sphalerite ore. The sphalerite (s) forms impregnations in ore--bearing dolomite. Transmitted light, one nicol.

Fig. 1. Ruda metasomatyczna. Sfaleryt (s) tworzy impregnacje w dolomicie. Bez analizatora, światło przechodzące.

Fig. 2. Ore-bearing dolomite. Coarse crystalline, idiotopic dolomite. Iron hydroxides (black) aceentuate outlines of dolomite rhombohedra. Transmitted light, one nicol.

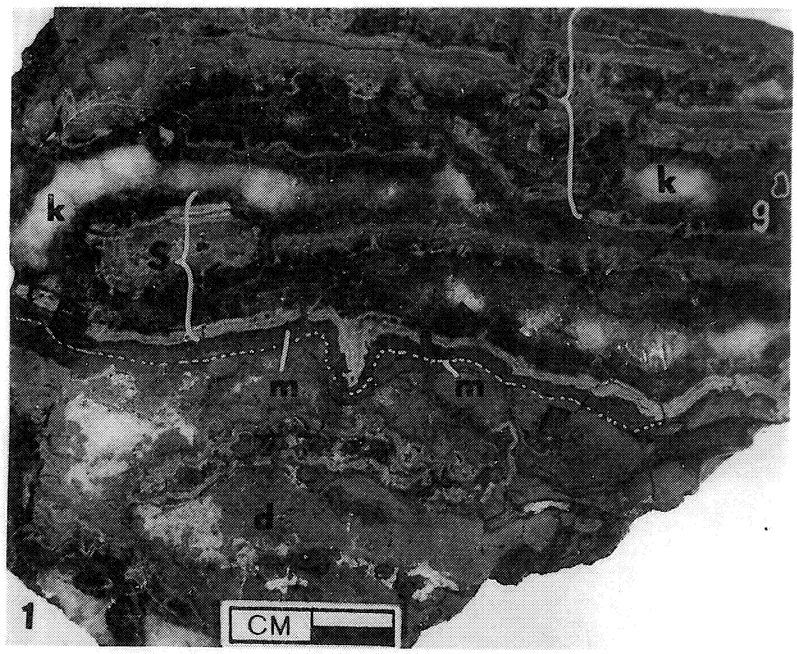
Fig. 2. Dolomit kruszconośny. Dolomit grubokrystaliczny, idiotopiczny. Skupienia wodorotlenków żelaza (czarne) podkreślają zarysy rombów dolomitu. Bez analizatora, światło przechodzące.

Fig. 3. Ore-bearing dolomite. Coarse crystalline idiotopic dolomite. Iron hydroxides accentuate outlines of dolomite rhomboedra. Moreover, the pseudomorphosis of sphalerite (s) after dolorhombs are visible. Transmitted light, one nicol.

Fig. 3. Dolomit kruszconośny. Dolomit grubokrystaliczny, idiotopiczny. Zarysy rombów podkreślone są skupieniami wodorotlenków żelaza (czarne). Widoczne są ponadto pseudomorfozy sfalerytu (s) po rombach dolomitu. Bez analizatora, światło przechodzące.

Fig. 14. Metasomatic sphalerite ore: s — sphalerite, d — dolomite rhomboedra. Transmitted light, one nicol.

Fig. 4. Ruda metasomatyczna: s — sfaleryt impregnacyjny, d — romby dolomitu Bez analizatora, światło przechodzące.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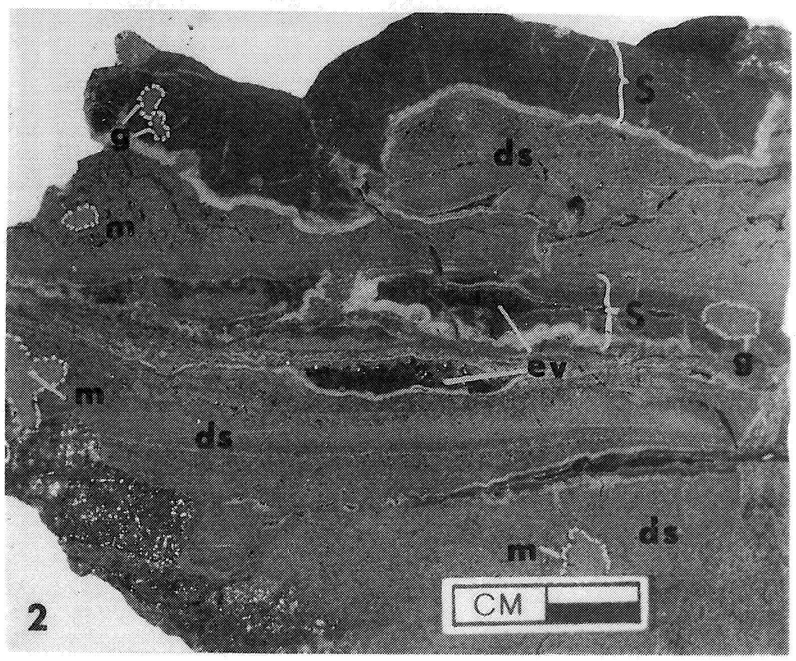
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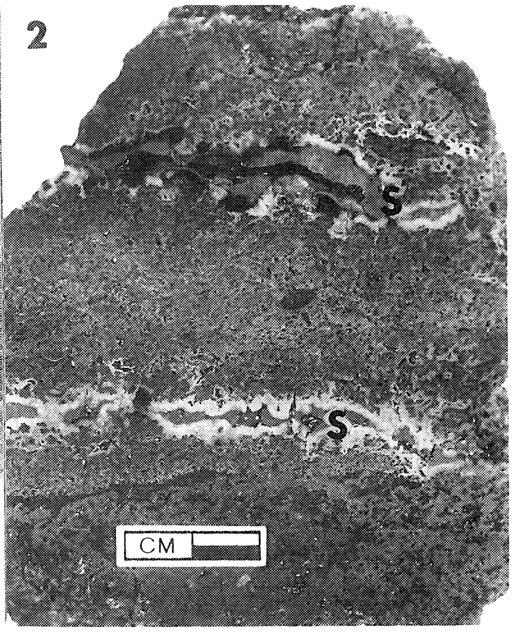

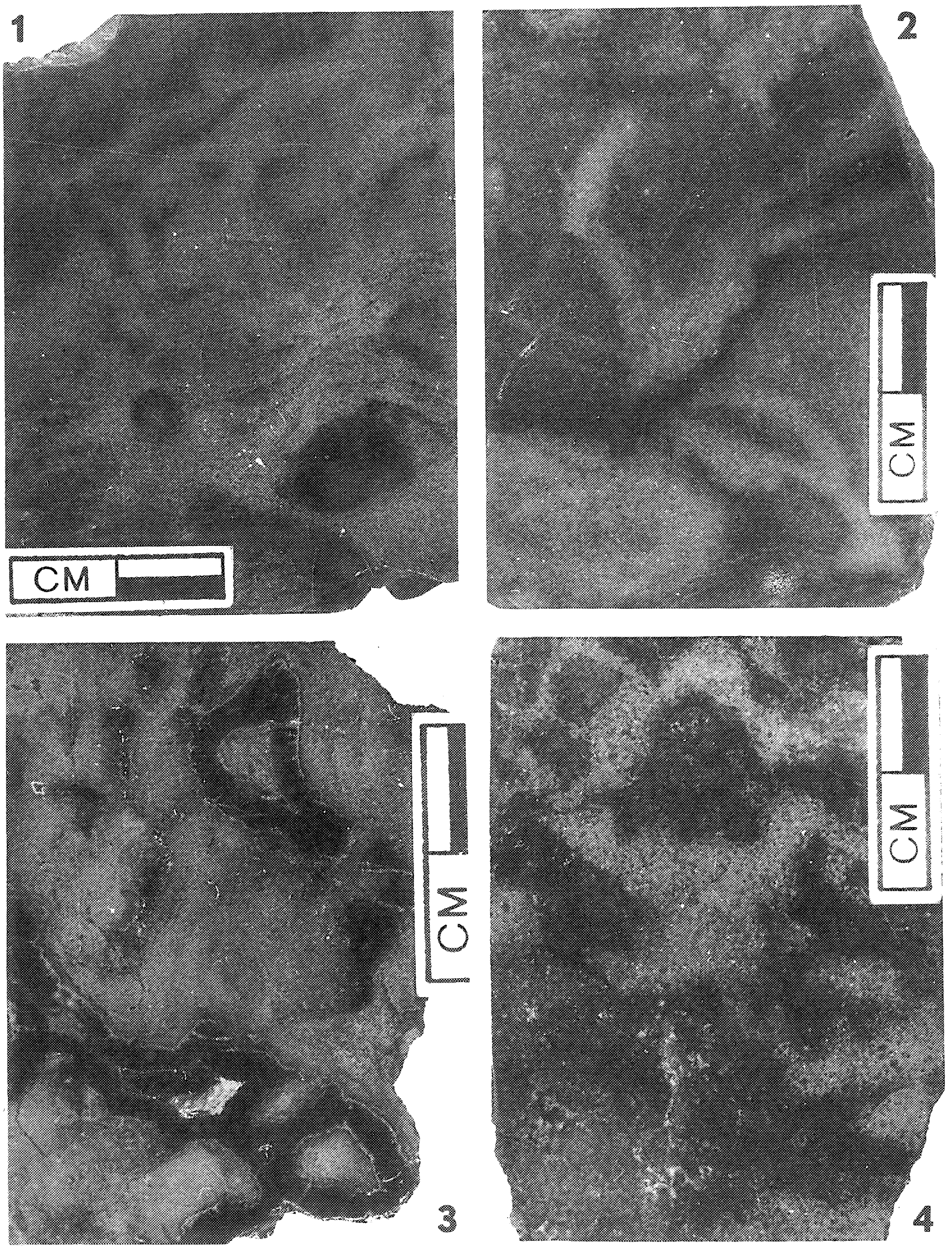
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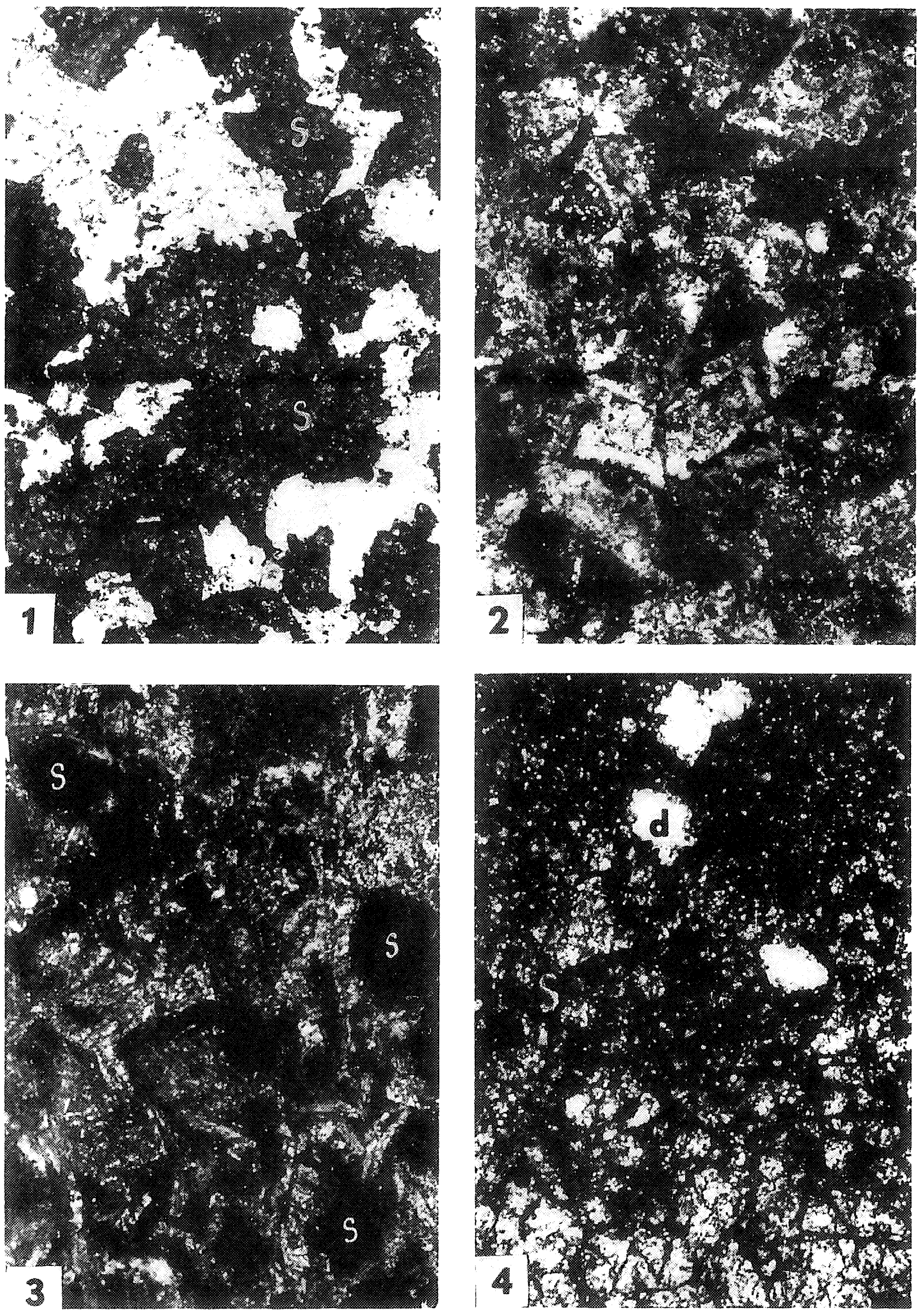

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