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SPHALERITE ORES REFLECTING THE PATTERN OF PRIMARY STRATIFICATION IN THE TRIASSIC OF THE CRACOW-SILESIAN REGION

(Pl. XXVII—XXXVI and 5 Figs.)

O strukturach kruszcowych odziedziczonych po pierwotnym uwarstwieniu

(Tabl. XXVII—XXXVI i 5 fig.)

Abstract: Much of the controversy over the genesis of the Cracow-Silesian Zn-Pb ores is brought about by unwarranted assumption that the ores reflecting the pattern of stratification are primary marine deposits or early-diagenetic concentrations. It is shown that such ores are epigenetic vein deposits produced by mineralizing solutions spreading along sedimentary interfaces in indurated carbonate rocks.

INTRODUCTION

The present study is a part of a continuing investigation of the Cracow-Silesian Zn-Pb deposits (see Bogacz et al. 1970, 1972, 1973). The following discussion aims to determine the origin of sulfide ores reflecting the pattern of primary stratification. Such ores have recently given rise to much discussion and have been held as proof of syngenetic origin of the Cracow-Silesian deposits (Gruszczyk 1967, Smolarska 1966, 1967, 1968; Smolarska, Gruszczyk, Phong and Nha 1972).

The preservation of sedimentary pattern is of common occurence in many replacement ores of accepted epigenetic origin (see e.g. Currier 1937, Bastin 1950, Ohle and Brown 1954, Brecke 1962, Fulweiler and McDougal 1971, and others). In this respect

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the problem here discussed is not new. It needs, however, further attention in view of the unsettled controversy still existing with regard to the Cracow-Silesian deposits (for discussion see e. g. Ridge and Smolarska 1972), and many similar deposits in other ore districts.

The ores reflecting the pattern of sedimentary structures are not very common in the Cracow-Silesian region. They occur chiefly in the Trzebionka mine west of Cracow, where most of the examples cited by "syngeneticists" came from. The ore structures discussed in this paper are from the same mine so that the reader may compare the evidence for and against the interpretation here presented.

INHERITED STRUCTURES IN THE ORE-BEARING DOLOMITE

The sulfide ores in the Triassic of the Cracow-Silesian region occur chiefly in the "ore-bearing dolomite". The contention of earlier investigators that this dolomite is of epigenetic origin has since been substantiated by so much evidence that no further argument as to this question is here necessary (see Bogacz et al. 1972), although, admittedly, opposite opinions are still being held (Smolarska 1972). The dolomite is a crystalline neosome and shows metasomatic, crosscutting contacts against the surrounding carbonates. These latter include limestones and early-diagenetic dolomites. The primary structures resident in them are seen to pass through the contact surfaces into the ore-bearing dolomite. Consequently, the ore-bearing dolomite contains numerous vestiges of primary sedimentary structures. An obvious exception to this are structures the size of which is smaller than that of the newly formed dolomite crystals of the ore-bearing dolomite.

The first phase of sulfide mineralization appears to have been following and overlapping the formation of the ore-bearing dolomite. This means that the vestiges of primary structures were already in place prior to the emplacement of ores. This conclusion alone is enough to render the syngenetic[1] origin of the Cracow-Silesian ores unacceptable. It will be shown that an investigation of the sphalerite ores reflecting the pattern of horizontal and cross-stratification leads to the same conclusion.

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[1] Strictly speaking, the term "syngenetic" refers to ores that are perfectly contemporaneous with their host rock. This term however, carries, an implication of size and order. An ore may be syngenetic on a scale of a stratigraphic unit, but epigenetic on a smaller scale (compare Amstutz 1959, p. 100). In this report the term "syngenetic" is used synonimously with "synsedimentary". It implies the contemporaneity and penecontemporaneity of ores with the enclosing rock on the scale of a layer or layers that are still within the reach of processes operating on the sea bottom. Thus, the early-diagenetic transformations are included into the group of syngenetic phenomena. A perusal of literature shows that this corresponds to the practice of the majority of authors.

Ores reflecting the pattern of primary stratification

The pattern of sphalerite ores resident in the ore-bearing dolomite may be consistent with the attitude of stratification planes. Thus, the ores that occur in horizontally laminated dolomites may exhibit horizontal banding and those which occur in crosstratified dolomites may show overlapping angular configurations (text-fig. 1, 2; Pls. XXVII—XXIX, XXXVI).

As seen in cross-section, the ores discussed consist of thin ore bands and narrow ore-lined vugs. These latter are commonly confluent to produce sheet-cavities of a considerable horizontal extent (text-fig. 3; Pl. XXXVII, Fig. 1; Pls. XXXVIII—XXX, XXXIII, Fig. 1). Such cavities represent the solutionally widened sedimentary interfaces and laminae. The cavities are lined with sulfide crystals and crustified zinc blende showing secretionary growth into open cavities and competitive crystallization (compare Smith 1970). The presence of such linings is indicative of open space crystallization and deposition of sulfides in open voids.

The ore-lined voids are bordered, on both sides, by zones of granular aggregates of sphalerite crystals which are devoid of preferred orientation (text-fig. 3; Pl. XXX). Such aggregates have formed by replacement and their contacts with the dolomite are often very irregular and patchy (text-fig. 3; Pl. XXX, Fig. 1). The more or less continuous aggregates give way to a dispersion halo of isolated sphalerite grains the abundance and size of which decreases with increasing distance from the cavites (Pl. XXX, Fig. 1; Pl. XXXIV). Such isolated sphalerite grains also have formed by replacement.

From the foregoing it appears that the ores under consideration are comprised of three basic constituents: 1. solutional voids, 2. crustified ores, and 3. sphalerite aggregates replacing the host dolomite. Thus the ores bear a joint record of three processes: 1. cavity making, 2. cavity--filling, and 3. metasomatic replacement.

An important aspect of such ores is that the above mentioned constituents occur in parallel sets so that the succession of bedding controlled voids, crustifications and replacements is repeated many times in vertical crossections. Such repetition and alternation give rise to discrete repetitive ore-sequences or "rhythms". No difference in age, however, is discernible between such rhythms.

Essential features of the ore rhythms are summarized in text-fig. 3 see also Pl. XXX, fig. 1; Pl. XXXIV, XXXV. It should be noted that the replacement bands growing from different voids may, or may not come into contact. Where the latter be the case the ore rhythms include also the relics of the host dolomite.

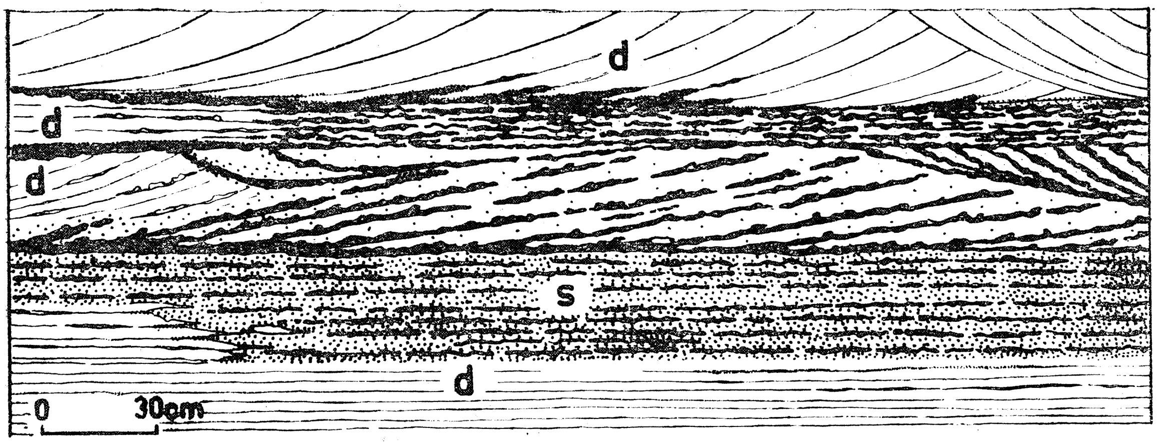

Fig. 1. Section showing contact of sphalerite ores (s) with barren dolomite (d). Ores reflect inherited pattern of cross-stratifiction and horizontal lamination. Thick lines are sphalerite incrustations lining voids. Dotted areas are dolomite with scattered sphalerite grains. Part of this section is shown in Pl. XXVIII, fig. 1

Fig. 1. Kontakt dolomitu okruszcowanego (s) z dolomitem nieokruszcowanym (d). Struktury kruszcowe są odziedziczone po warstwowaniu skośnym i poziomym (por. Pl. XXVIII, fig. 1). Grubymi liniami zaznaczono inkrustacje sfalerytowe wokół kawern rozmieszczonych wzdłuż pierwotnych powierzchni warstwowania.

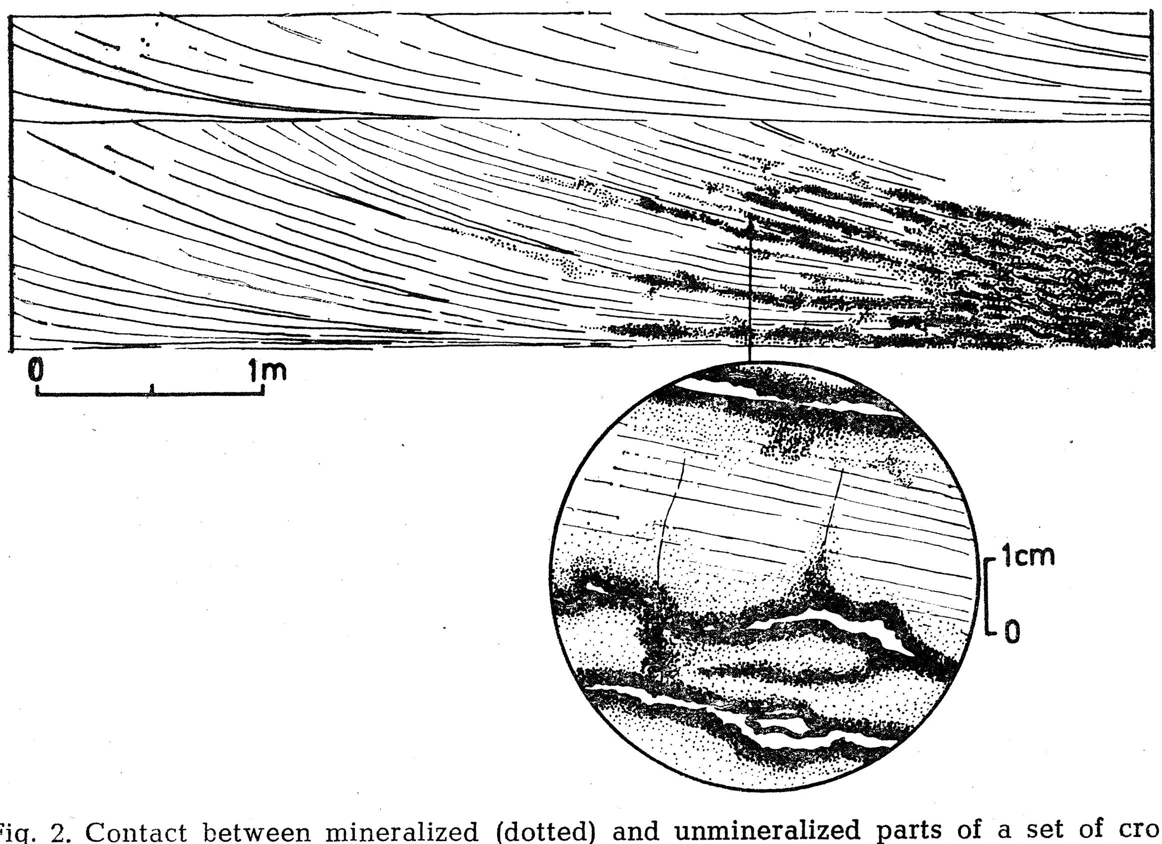

Fig. 2. Contact between mineralized (dotted) and unmineralized parts of a set of cross-strata. Note incongruency between bedding controlled, ore-lined voids (thick lines) and lamination (circle)

Fig. 2. Kontakt między zmineralizowanym (zakropkowane) a płonnym dolomitem o uwarstwieniu przekątnym. Zwrócić uwagę na niezgodność między przebiegiem kawern a laminacją w dolomicie (w kole)

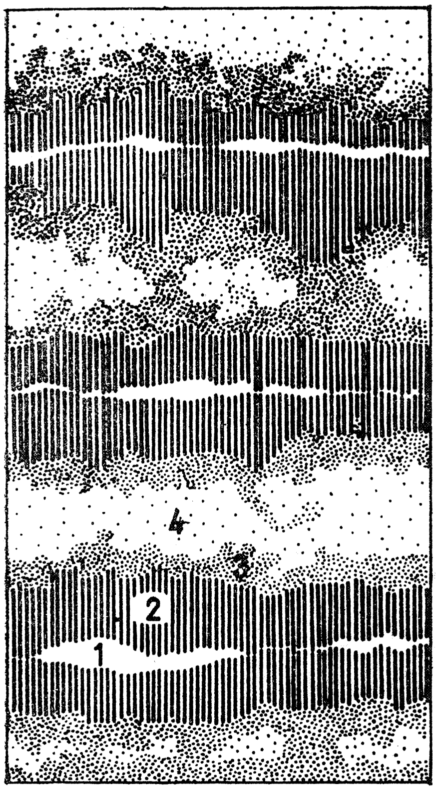

Fig. 3. Diagram showing essentials of ore rhythmus. 1 — solution cavities, 2 — sphalerite incrustations, 3 — sphalerite replacement rims and 4 — relics of unmineralized dolomite

Fig. 3. Schemat „rytmów" kruszcowych; 1 — kawerny; 2 — inkrustacje sfalerytowe; 3 — dolomit częściowo lub całkowicie zastąpiony przez sfaleryt; 4 — ostańce dolomitu nieokruszcowanego lub z pojedynczymi ziarnami sfalerytu

Several variations and modifications to the above discussed simple ore-rhythms may occur. Some of the rhythms may be incomplete, e. g., the replacement rim may be missing. There may also be additional deposition in voids of younger sulfides or secondary minerals. Certain cavities are filled with residual clays or fine dolomitic silts (Pl. XXX, Fig. 2). These latter are not represented as marine deposits in the Triassic rocks, but are the products of solutional disaggregation of the ore-bearing dolomite. Such products were deposited in open cavities by circulating underground solutions (see B o g a c z et al. 1972).

The repetitive ore sequences may also be subject to partial or total replacement by galena (Pl. XXXIII, Fig. 1). Such replacement is commonly observed in proximity of large galena bodies representing a different and later phase of sulfide mineralization.

Although it is not of immediate consequence for the subject discussed it may be noted that, in places, the bedding controlled solution voids are chiefly or exclusively filled with light colored dolomite rhombohedra. An alternation of such "gangue dolomites" with the dark host dolomite gives rise to a crude banding (Pl. XXVII, Fig. 2) similar to that described as "zebra dolomite" from other ore districts (e. g. P a r k and C a n n o n 1934, C l a v e a u et al. 1952, B e h r e 1959).

In conclusion, it may be stated that dissolution of the ore-bearing dolomite, deposition of sulfides in open cavities and metasomatic replacement of the cavity walls have contributed to the formation of ores reflecting the pattern of primary stratification. The bedding controlled cavities were made in an already lithified carbonate rock as indicated by their considerable lateral extension (the host rock must have been sufficiently lithified to form a roof over the empty crevices). There is also no evidence that the ore-lined solution voids have ever formed in the presence of an unconsolidated primary marine sediment (such sediment is of common occurrence in early-diagenetic cracks). It thus appears that the ores discussed show all the properties of epigenetic ore-veins rather than syngenetic marine deposits.

CONTACT RELATIONSHIPS

The ores following the pattern of primary stratification occur as roughly tabular bodies within the ore-bearing dolomite. The contacts of such bodies with the enclosing host rock are rather abrupt. They are grading through a distance of centimeters or milimeters and are frequently crosscutting with regard to stratification planes. Typical examples of such contacts are shown in text-figures 1 and 4 and Pls. XXXI; XXXII, Fig. 1; XXXIV; XXXV, Fig. 1. These figures are largely self-explanatory, but need the following general comments:

1. The narrow transitional zones between the ore-bodies proper and the host dolomite are characterized by the presence of isolated sphalerite grains that impart to the host rock a slightly lighter tinge (Pl. XXXII, Fig. 1). These grains, of an unquestionable replacement origin, are distributed in such a way that their abundance and size increase towards the ore bodies proper (Pl. XXXIV).

2. The crosscutting contacts of ores with the enclosing dolomite may show a somewhat jagged appearance (Pl. XXXII, Fig. 1), because the sulfides tend to concentrate along bedding controlled voids. Some of such voids may project deep into the host dolomite. They taper gradually toward the distal ends and merge imperceptibly into the undissolved and unmineralized laminae. Significantly, the bedding controlled voids are virtually absent in unmineralized parts of the ore-bearing dolomite. It thus appears that the sulfides are closely associated with solution voids. Indeed, the ore-linings and replacement rims are best developed where the voids are large and abundant (Pl. XXXIII, Fig. 2).

3. An important fact that emerges from the study of contact relationship is that the ore-sequences are far from being congruent with sedimentary rhythms preserved in the enclosing host dolomite (the congruency of this type is one of the diagnostic features of syngenetic ores; compare A m s t u t z 1959).

There are several reasons for the apparent incongruency between the ore rhythms and sedimentary rhythms. One is the fact that the bedding controlled voids in laminated dolomites encompass more than one lamina and their walls are irregular and crosscutting (text-fig. 2). More-

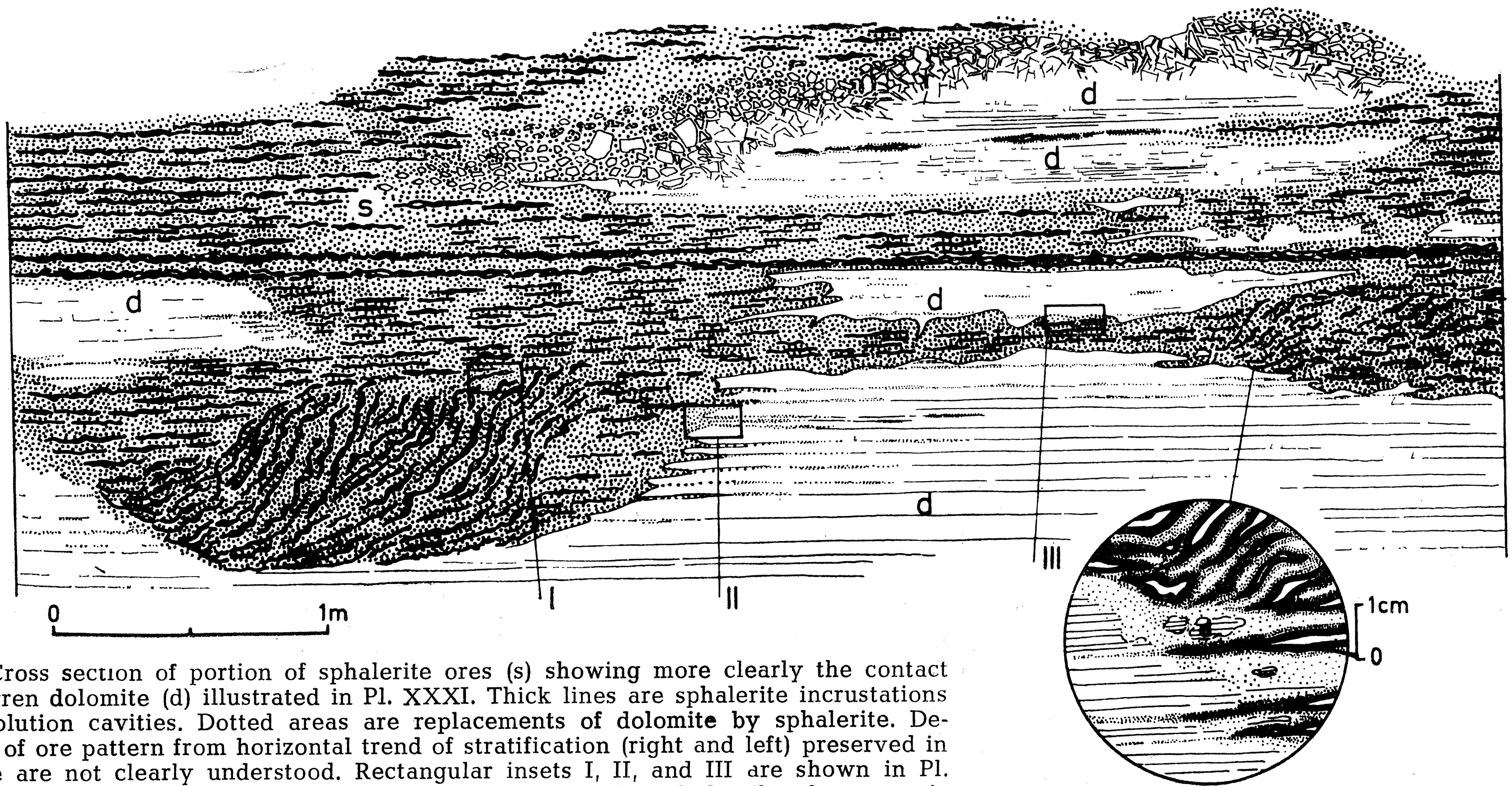

Fig. 4. Cross section of portion of sphalerite ores (s) showing more clearly the contact with barren dolomite (d) illustrated in Pl. XXXI. Thick lines are sphalerite incrustations lining solution cavities. Dotted areas are replacements of dolomite by sphalerite. Deviations of ore pattern from horizontal trend of stratification (right and left) preserved in dolomite are not clearly understood. Rectangular insets I, II, and III are shown in Pl. XXXIII, fig. 2, Pl. XXXII, fig. 1 and Pl. XXXV fig. 1. Enlarged details of contact is shown circle. Breccia in the upper part of this sections is not fully understood (presumably of metasomatic origin) it predates emplacement of sphalerite that partly or totally, replaces some of breccia fragments

Fig. 4. Fragment ciała rudnego (s) w kontakcie z dolomitem nieokruszcowanym (d) (por. Pl. XXXI). Grubymi liniami zaznaczono inkrustacje sfalerytowe wokół kawern. Pola zakropkowane to dolomit zastąpiony częściowo lub całkowicie przez sfaleryt. Widoczne po lewej i prawej stronie rysunku odchylenia w strukturach kruszcowych od ogólnie poziomego warstwowania zachowanego w dolomicie, nie są w pełni wyjaśnione. Prostokątami I, II, III zaznaczono lokalizację zdjęć zamieszczonych na Pl. XXXIII fig. 2, Pl. XXXII fig. 1, Pl. XXXV fig. 1. Rysunek w kole to powiększony fragment kontaktu

over only some of the laminae are sultionally enlarged while others are not, although no difference between them is discernible. The intervening undissolved laminae are blurred or obliterated by irregularly encroaching replacement front. Consequently the ore bands are not geometrically superposable upon the sedimentary laminae and the ore-rhythms as a whole appear to be more widely spaced than the equivalent sedimentary rhythms. It is only the general pattern of ores that is partly congruent with the general trend of sedimentary interfaces.

Summarizing the pertinent conclusions arrived at from the study of contact relationship the following statement can be made. The cross-cutting contacts and the lack of real congruency between the ore rhythms and the sedimentary rhythms testifies strongly against the syngenetic origin of the ores following the pattern of sedimentary structures. Failure to recognize fully the implications of the contact relationships between the ore bodies and the enclosing host dolomite has led, and must continue to lead to misinterpretations. The close genetic association of such ores with solution voids indicates that the sulfides were deposited by the same solutions that dissolved the epigenetic host dolomite. The solutions were spreading outwards from solution voids and resulted in the formation of a halo of replacement around the cavities.

Irregularities and deviations from primary patterns

The partial congruency between the ores and the general trend of stratification appears to be limited to marginal parts of the ore bodies. Progressing towards the interior of such bodies, the ore bands become disrupted and show a contorted appearance (text-fig. 2; Pl. XXVIII, Fig. 2; Pl. XXXIII, Fig. 2). Such change is often seen to occur within a single set of laminae, wherein the irregularities are strikingly absent in unmineralized parts of the laminae (text-fig. 2).

There seems to be a close relationship between the degree of irregularity on one side and the intensity of dissolution and mineralization on the other. Where mineralization is strongest the pattern of ores becomes highly complicated. The ores consist of irregular replaced masses bounded by equally irregular, ore-lined cavities (Pl. XXX, Fig. 1; Pl. XXXIII, Fig. 2). The pictures here presented give only a glimpse into the complicated character of such ores because it is impossible to represent the irregularities graphically or in photographs. It may be added, however, that ores of similar type have been repeatedly described in literature (e. g. Emmons et al. 1927).

Some of the irregular patterns appear to have been inherited from

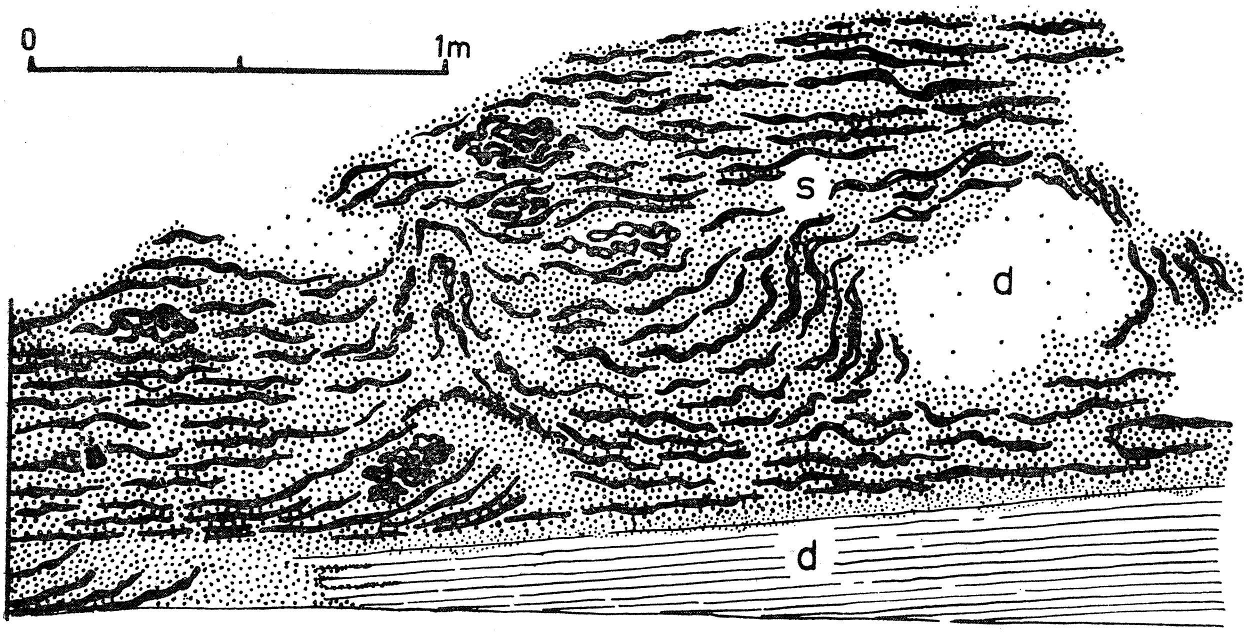

Fig. 5. Cross section of portion of ore body showing contortions resembling or preserving pattern of primary soft-rock deformations. Black lines are sphalerite incrustations lining vugs and sheet cavities. Dotted areas are all dolomite partly or totally replaced by sphalerite

Fig. 5. Struktura rudna imitująca lub odzwierciedlająca (?) deformację sedymentacyjną. Grubymi liniami zaznaczono inkrustacje sfalerytowe wokół kawern. Pola zakropkowane to dolomit częściowo lub całkowicie zastąpiony przez sfaleryt

syn-sedimentary slumps or convolutions (text-figure 5). This may hold true for many instances. In many other instances, however, the irregularities are evidently superimposed as secondary alterations upon a straight pattern of horizontal- or cross-stratification.

Some of such irregularities result from irregular dissolution of laminae (text-fig. 2) and from simple interference of solution voids and replacement rims growing from different bedding interfaces and cross-cutting fractures. In addition, the bedding controlled voids are seen to send irregular branches that disrupt the planar pattern of ores into a network of ore-lined cavities bounded by replacement rims (Pl. XXX, Fig. 1). There are, however, irregularities that appear to result from real deformations inflicted to the host rock and to the ores during the emplacement of sulfides. This is evidenced by numerous small displacements well observable on polished surfaces (Pl. XXXIII, Fig. 1). Such deformations may result from stress redistribution consequent upon the removal of carbonates and solutional thining (compare Heyl et al., 1955, Hagni and Dessai, 1966), or from a secondary softening and disaggregation of the dolomite by dissolution of crystal edges. The deviations from sedimentary patterns and the above mentioned deformations may and frequently do obscure the vestiges of inherited primary stratification.

RELATIONSHIP TO CROSSCUTTING ORE VEINS

It has already been shown that the ores reflecting the pattern of primary stratification may well be regarded as bedding controlled ore veins. Of significance is the fact that such bedding controlled veins may join and pass into oblique and vertical veins (Pl. XXXII, Fig. 2). Both types of veins have the same mineralogical composition and the mineral filling passes from one to another without break (B o g a c z et al. 1970). This means that the ores reflecting the pattern of stratification and those following vertical or crosscutting fractures were deposited at the same time and by the same ore-forming solutions. The crosscutting ore-veins, however, have a considerable vertical extent and are definitely of epigenetic origin. Thus the above relationship provides yet another argument in favor of epigenetic origin of the ores that follow the pattern of stratification.

CONCLUDING REMARKS

From the foregoing considerations it appears that the sulfide ores reflecting the pattern of primary stratification are ore veins that were made by mineralizing solutions spreading along bedding interfaces. Such solutions dissolved the interfaces, produced the bedding controlled cavities and filled them with crustified ores (compare K r a j e w s k i 1957). The cavity-making and the deposition of crustified ores was accompanied by infiltration of sulfides into the host rock and by metasomatic replacement of the cavity walls. Thus, the ores bear a record of dissolution, cavity-making and replacement, whereby all these processes were essentially contemporaneous, the replacement following by a short margin the formation of cavities.

The sedimentary interfaces preserved in the ore-bearing dolomite and inherited from the paleosome were among the structures guiding the flow of solutions and localizing the emplacement of ores. The pattern of such ores is thus inherited from an already ancestral pattern of structures predating the formation of the ore bearing dolomite (see H a - r a ń c z y k and S z o s t e k 1968).

There is a good reason to believe that the carbonate host rock was already lithified when the ore emplacement occurred. Otherwise the formation of empty and flat solution cavities would be impossible. In addition, there is no evidence that such cavities have ever formed in the presence of unconsolidated primary sediments. Also the relationship of the ores to the enclosing rock and their direct passage to large-scale crosscutting ore-structures of unquestionably epigenetic origin are inexplicable in terms of early-diagenetic alternations. This may serve as another argument in favor of epigenetic interpretation.

As noted, there is a dispersion halo of sphalerite grains around the ore-lined solution cavities and the present ore bodies. Such halo is best explained in terms of progressive depletion of solutions that were spreading outward from the present ore bodies. The latter, with their countless solution channels represent the former passageways of the ore-forming fluids. The lateral secretion, i. e. the sweating out of sulfides from the host rock is unlikely in view of the absence of sulfides in the paleosome and their scarsity or absence in unmineralized parts of the ore-bearing dolomite. In addition, there is no evidence of leaching and no trace of the loss of volume in the host rock that such leaching would entail.

In conclusion, it may be confidently stated that the stratabound ores here discussed are not primary marine sediments or early-diagenetic concentrations, as claimed by proponents of the syngenetic interpretation. Such ores are of epigenetic origin and are yet another manifestation of a widespread underground circulation of hot ore-forming solutions within the lithified carbonate sediments.

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REFERENCES
WYKAZ LITERATURY

Amstutz G. C. (1959), Syngenetic zoning in ore deposits. *Proc. Geol. Ass. Canada,* 11. pp. 95—114.

Bastin E. S. (1950), Interpretation of ore textures. *Geol. Soc. Amer. Mem.,* 45. p. 101.

Behre Ch. H. Jr. (1953), Geology and ore deposits of the West Slope of the Mosquito Range. *U. S. Geol. Surv. Prof. Paper,* 235. p. 176.

Bogacz K., Dżułyński S., Harańczyk C., (1970), Ore-filled hydrothermal karst features in the Triassic rocks of the Cracow-Silesian region. *Acta geol. pol.,* 20, no. 2. Warszawa, pp. 247—267.

Bogacz K. Dżułyński S., Harańczyk C., Sobczyński P. (1972), Contact relations of the ore bearing dolomite in the Triassic of the Cracow-Silesian region. *Rocz. Pol. Tow. Geol. (Ann. Soc. Geol. Pol.),* 42, no. 4. Kraków, pp. 347—372.

Bogacz K., Dżułyński S., Harańczyk C., (1973), Caves filled, with clastic dolomite and galena mineralization in disaggregated dolomites. *Rocz. Pol. Tow. Geol. (Ann. Soc. Geol. Pol.),* 43, no. 1. Kraków, pp. 59—72.

Brecke F. A. (1962), Ore genesis of the Cave-in-Rocks Fluorspar district, Hardin County, Illinois. *Encon. Geol.,* 57, no. 4. pp. 499—535.

Currier L. W. (1937), Origin of bedding replacement deposits of Fluorspar in the Illinoian field. *Econ. Geol.,* 32. pp. 378—386.

Claveau J., Paulhac J., and Pellerin J. (1952), The lead and zinc deposits of the Bou Beker-Toussit area, Eastern French Marocco. *Econ. Geol.,* 47.

Emmons S. F., Irving J. D., Loughlin G. F. (1927), Geology and ore deposits of the Leadville Minning district, Colorado. *U. S. Geol. Surv. Prof. Paper*, 148. p. 368.

Fulweiler R. E., McDougal S. E. (1971), Bedded-ore structures, Jefferson City Mine, Jefferson City, Tennessee. Encon. Geology, 66, pp. 763—769.

Gruszczyk H. (1967), The genesis of the Silesian-Cracow deposits of lead-zinc ores. *Econ. Geol. Mem.*, 3. pp. 169—177.

Hagni R. D., Dessai A. A. (1966), Solution thinning of the Bed Host-Rock limestone in the Tri-State district, Missouri, Kansas, Oklahoma. *Econ. Geol.*, 61. pp. 1436—1442.

Harańczyk C., Szostek L. (1969), O niektórych poglądach na budowę złoża rud cynku i ołowiu kopalni „Trzebionka" i genezę dolomitów kruszconośnych. *Rudy i Metale*, 14, nr 4. Katowice, pp. 215—225.

Heyl A. V., Lyons E. J., Agnev A. F., Behre Ch. H. (1955), Zinc-lead-copper resources and general geology of the Upper Mississipi Valley district. *Geol. Surv. Bull.* 1015—G, pp. 227—245.

Krajewski R. (1957), Uwagi na temat genezy górnośląskich złóż cynkowo-ołowiowych. *Prz. geol.*, 5, no. 7. Warszawa, pp. 311—314.

Ohle E. L., Brown J. S. (Editors) (1954), Geologic problems in the southeast Missouri lead district. *Bull. Geol. Soc. Amer.*, 65, pp. 201—222.

Park C. F., Cannon R. S. (1943), Geology and ore deposits of the Metalline Quadrangle. *U. S. Geol. Surv. Prof. Paper*, 202. p. 81.

Ridge J. D., Smolarska I. (1972), Factors bearing on the genesis of the Silesian--Cracovian lead-zinc deposits in southern Poland. *24 Int. Geol. Congr.*, Section 6. Montreal. pp. 216—229.

Shrock R. R. (1948), Sequence in layered rocks. McGraw-Hill Book Comp., INC., New York, Toronto, London.

Smith F. G. (1970), Physical Geochemistry. Addison-Wesley Publ. Comp., Massachusets, Palo Alto, London. p. 468.

Smolarska I. (1966), Der geologische Bau der Blei- und Zink-Erzlagerstatten von Trzebionka. *Bull. Acad. Pol. Sc., Ser. sc. geol. geogr.*, 14, no. Warszawa, pp. 187—191.

Smolarska I. (1967), Die Texturtypen der Blei-und Zinkerze im ostlichen Teil des Schlesisch-Krakauer Erzbeckens. *Bull. Acad. Pol. Sc., Ser. sc. geol. geogr.*, 15, no. 1. Warszawa.

Smolarska I. (1968), Charakterystyka złóż cynku i ołowiu kopalni Trzebionka (Characteristic of the zinc and lead ores of Trzebionka mine). *Kom. Nauk Geol. PAN w Krakowie. Prz. geol.*, 47. Warszawa.

Smolarska I. (1972), New data on the ore-bearing dolomites from the Silesian--Cracow ore basin. *Bull. Acad. Pol. Sc., Ser. sci de la Terre*, 20, no. 4. Warszawa, pp. 233—239.

Smolarska I., Gruszczyk H., Phong D. X., Nha Ch. T. (1972), Brekcje w stratyfikowanych złożach rud cynku i ołowiu obszaru śląsko-krakowskiego (Breccias in stratified zinc and lead ore deposits in the Silesian-Cracow area). *Kwart. geol.*, 16, no. 2. Warszawa, pp. 361—372.

STRESZCZENIE

W dolomicie kruszconośnym Trzebionki występują skupienia kruszców sfalerytowych, których budowa w ogólnych zarysach przypomina struktury sedymentacyjne. Kruszce takie są uważane przez zwolenników syngenetycznego pochodzenia złóż śląsko-krakowskich, za utwory

osadowe lub wczesno-diagenetyczne, chociaż epigenetyczny charakter skały goszczącej, to znaczy dolomitu kruszconośnego, nie powinien budzić wątpliwości.

Badania przeprowadzone przez autorów tej pracy wskazują niedwuznacznie, iż podobieństwo struktur kruszcowych do sedymentacyjnych jest jedynie następstwem wnikania roztworów mineralizujących wzdłuż powierzchni sedymentacyjnych zachowanych w dolomicie. Roztwory te rozpuszczały dolomit tworząc w nim wąskie kawerny, rozprzestrzeniające się wzdłuż powierzchni warstwowania. Przylegający do kawern dolomit został metasomatycznie zastąpiony sfalerytem, a ściany kawern pokryte inkrustacjami blendy cynkowej. Proces rozpuszczania, zastępowania i inkrustowania, zachodzący w dolomicie o uwarstwieniu przekątnym lub poziomym, doprowadził do utworzenia się struktur kruszcowych odzwierciedlających wzór struktur poziomego lub skośnego warstwowania. Struktury kruszcowe nie powtarzają jednak ściśle struktur sedymentacyjnych, gdyż nie wszystkie i nie na całym obszarze ich rozprzestrzenienia podlegały w jednakowy sposób rozpuszczaniu i mineralizacji. Wyraźnie zarysowane powierzchnie graniczne ciał rudnych o wspomnianej wyżej budowie w wielu miejscach przecinają skośnie powierzchnie warstwowania, zachowane w dolomicie kruszconośnym. Tego rodzaju powierzchnie graniczne (fronty mineralizacji) wskazują na wtórne pochodzenie okruszcowania, podobnie jak obecność wąskich kawern o dużej rozciągłości, które musiały utworzyć się w utwardzonej już skale węglanowej. Zanikająca stopniowo aureola złożona z metasomatycznych ziarn sfalerytowych rozsianych wokół inkrustowanych blendą kawern wskazuje na rozprzestrzenianie się roztworów mineralizujących od kawern w głąb dolomitu, a nie odwrotnie, jakby to miało miejsce w przypadku sekrecji lateralnej. Przeciwko sekrecji lateralnej przemawia ponadto brak śladów ługowania siarczków w płonnym dolomicie otaczającym ciała rudne. Kruszce sfalerytowe odzwierciedlające wzór warstwowania są zatem epigenetyczne a ich struktura odziedziczona po pierwotnym warstwowaniu.

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EXPLANATION OF PLATES
OBJAŚNIENIA TABLIC

Plate — Tablica XXVII

Fig. 1. Polished specimen of banded sphalerite ore showing repetitive sequence of ore-lined solution voids (dark), crustifications (light-colored bands), and replacement zones (gray). Ore-lined solution voids trend parallel to horizontal stratification

Fig. 1. Struktury kruszcowe odzwierciedlające poziomą laminację z powtarzającym się następstwem kawern (ciemne), inkrustacji sfalerytowych (jasne) i stref metasomatycznego zastąpienia dolomitu przez sfaleryt (szare)

Fig. 2. Light-colored dolomitic veins developed along solutionally enlarged primary interfaces and laminae in ore-bearing dolomite. Note the presence of empty solution voids in central parts of veins (black). Disruption and bending of veins reflect trace of animal burrow. Olkusz mine

Fig. 2. Jasno zabarwiony dolomit otulający kawerny rozwinięte wzdłuż lamin w obrębie dolomitu kruszconośnego. Rozerwania i ugięcia takich „żył dolomitowych" odzwierciedlają ślad żerowania w pierwotnym osadzie

Plate — Tablica XXVIII

Fig. 1. Sphalerite ores reflecting pattern of cross-stratification. Detail of structure shown in text-figure 1

Fig. 1. Struktury kruszcowe (sfaleryt) odzwierciedlające warstwowanie przekątne pierwotnego osadu. Szczegół ciała rudnego przedstawionego w tekście na fig. 1

Fig. 2. Polished section showing repetitive sequence of solution voids, incrustations (dark bands) and replacement zones (gray) superposed upon inherited cross-stratification. Ore bands show incipient contortions

Fig. 2. Wygładzona powierzchnia ilustrująca powtarzające się następstwo kawern, inkrustacji sfalerytowych (ciemne smugi) i stref zastąpienia dolomitu przez sfaleryt (szare smugi). Szczegół struktury kruszcowej odzwierciedlającej warstwowanie przekątne

Plate — Tablica XXIX

Fig. 1. Negative print of thin section of ore-bearing dolomite showing incipient solution voids trending parallel to stratification. Walls of voids are partly replaced by sphalerite and lined with sphalerite crystals showing parallel and competitive crystallization

Fig. 1. Zdjęcie negatywowe płytki cienkiej dolomitu kruszconośnego z zaczątkowymi kawernami rozwijającymi się wzdłuż laminacji. Ściany kawern są częściowo otulone lub zastąpione sfalerytem

Fig. 2. Sphalerite ores reflecting pattern of horizontal-, and cross-stratification. Vestiges of stratification are accentuated by well developed solution voids. The host rock is almost totally replaced by sphalerite

Fig. 2. Struktury kruszcowe odzwierciedlające warstwowanie skośne i poziome. Zarysy odziedziczonych struktur sedymentacyjnych podkreślone są przez obecność kawern. Dolomit został niemal całkowicie zastąpiony przez sfaleryt

Plate — Tablica XXX

Fig. 1. Polished slab of ore-bearing dolomite showing advanced stage of sphalerite mineralization, an example of irregularities in ore pattern resulting from interference of incrustations and replacement growing from different bedding controlled and crosscutting fissures. Dark bands are sphalerite incrustations and light colored areas are dolomite partly or totally replaced by sphalerite

Fig. 1. Wygładzona powierzchnia dolomitu kruszconośnego z daleko posuniętą mineralizacją sfalerytową. Inkrustacje sfalerytowe (smugi czarne) rozwijają się wzdłuż kawern równoległych i skośnych do laminacji. Pola szare to dolomit prawie całkowicie zastąpiony przez sfaleryt

Fig. 2. Polished section showing solutionally widened ore-lined fractures cutting obliquelly horizontal lamination preserved in dolomite (d). Solution voids are filled with clastic dolomite (cd)

Fig. 2. Wygładzona powierzchnia dolomitu kruszconośnego (d) z kawernami inkrustowanymi sfalerytem, a następnie wypełnionymi wtórnym dolomitem klastycznym (cd). Kawerny przecinają skośnie laminację

Plate — Tablica XXXI

Fig. 1. Contact between sphalerite ores (s) and dolomite (d) shown in text-figure 4

Fig. 1. Ciało rudne przedstawione na fig. 4 — w tekście, z widocznym kontaktem dolomitu okruszcowanego (s) z dolomitem płonnym (d)

Plate — Tablica XXXII

Fig. 1. Detail of contact between sphalerite ores (gray area) and barren dolomite (dark area, lower right) illustrated in rectangular inset II in text-figure 4. Note planar solutions voids (white) extending into barren dolomite

Fig. 1. Kontakt między dolomitem okruszcowanym (szary) i płonnym (ciemny). Szczegół struktury kruszcowej oznaczony III na fig. 4 w tekście

Fig. 2. Horizontally banded sphalerite ores branching into oblique crosscutting ore veins

Fig. 2. Struktury kruszcowe rozwinięte wzdłuż powierzchni pierwotnej laminacji z odgałęzieniami żył przebiegających skośnie do warstwowania

Plate — Tablica XXXIII

Fig. 1. Polished specimen showing disrupted and deformed bands of sphalerite ores reflecting general pattern of cross-stratification. Solution voids in the upper right part of this specimen are filled with late galena (white)

Fig. 1. Wygładzona powierzchnia struktury kruszcowej odzwierciedlającej ogólny zarys warstwowania przekątnego z deformacjami, które nie towarzyszą pierwotnym strukturom sedymentacyjnym. Kawerny w prawym, górnym rogu zdjęcia wypełnione są galeną (biała)

Fig. 2. Polished section of irregular sphalerite incrustations (dark bands) that follow horizontal bedding controlled solution fissures (top) and oblique crosscutting fissures (center and lower part). Detail of ore shown in inset I from text-figure 4

Fig. 2. Inkrustacje sfalerytowe wokół kawern (ciemne) rozmieszczonych wzdłuż i w poprzek warstwowania. Szczegół struktury kruszcowej oznaczony I na fig. 4 w tekście

Plate — Tablica XXXIV

Fig. 1. Photomicrograph of thin section showing abrupt gradational contact between barren dolomite (d) and sphalerite ore (s). Black spots are sphalerite aggregates and incrustations. Detail of contact shown in circle from text-figure 4

Fig. 1. Płytka cienka z kontaktem między dolomitem nieokruszcowanym (d) i okruszcowanym (s). Barwa czarna odpowiada skupieniom sfalerytu. Szczegół kontaktu przedstawionego na fig. 4 w tekście

Plate — Tablica XXXV

Fig. 1. Polished section showing contact between weakly mineralized dolomite (d) and horizontally banded sphalerite ore (s). Detail of contact configuration shown in inset III in text-figure 4

Fig. 1. Wygładzona powierzchnia kontaktu między słabo zmineralizowanym dolomitem (d) a sfalerytowym ciałem rudnym (s). Szczegół zaznaczony III na fig. 4 w tekście

Fig. 2. Polished section of banded sphalerite ore roughly preserving pattern of horizontal lamination. Ore consists chiefly of alternating bands of sphalerite incrustations showing parallel growth of crystals (dark bands) and replacement bands

Fig. 2. Wygładzona powierzchnia struktury kruszcowej z powtarzającym się następstwem inkrustacji sfalerytowych (smugi ciemne) i stref zastąpienia dolomitu przez sfaleryt

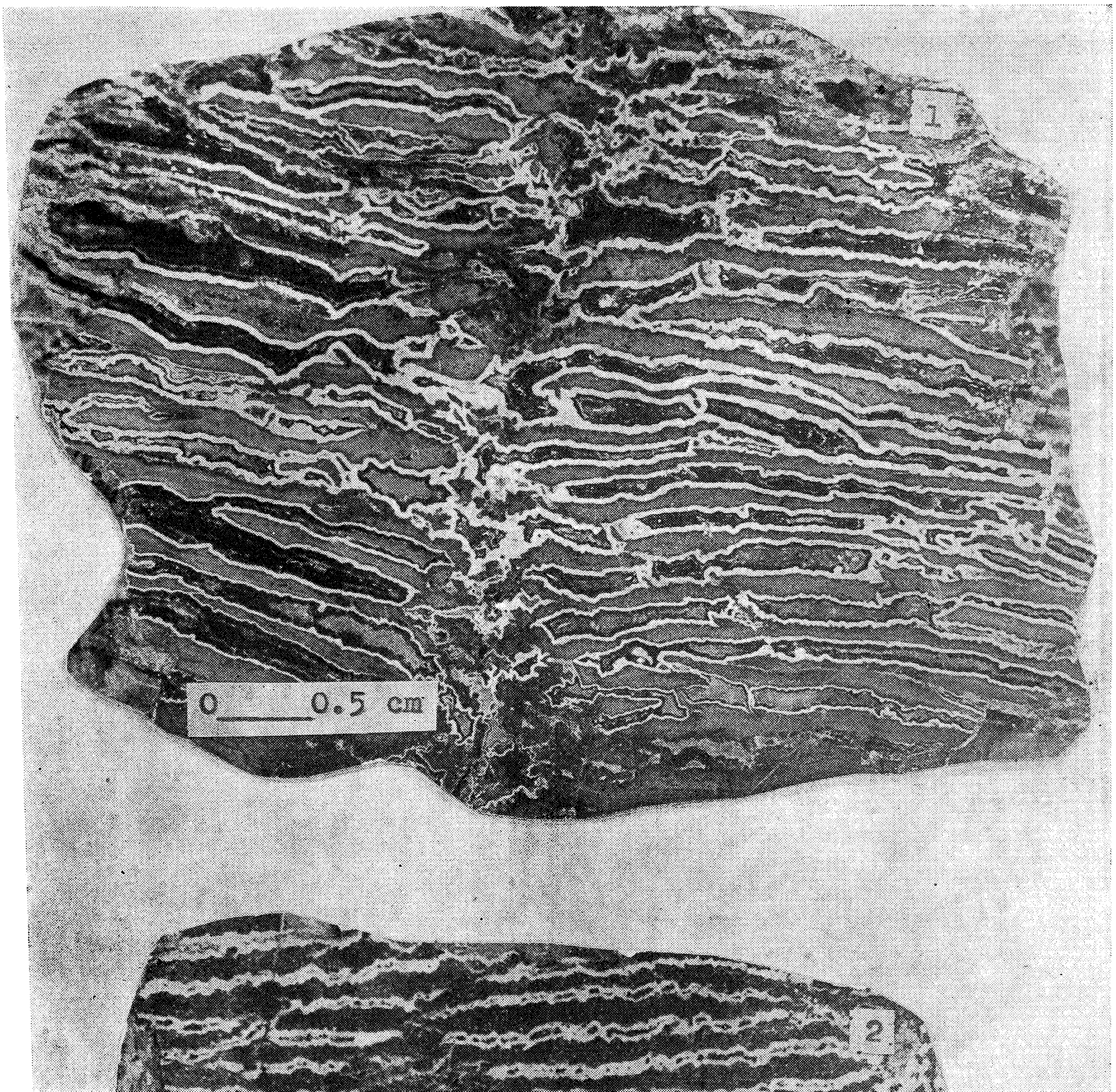
Plate — Tablica XXXVI

Fig. 1. Ore-lined solution cavities developed along horizontal and cross-stratification. Dolomite partly or totally replaced by sphalerite (light colored area). Note irregular contact with barren dolomite (dark)

Fig. 1. Kawerny rozwinięte wzdłuż warstwowania poziomego i skośnego. Dolomit częściowo lub całkowicie zastąpiony przez sfaleryt. Zwróć uwagę na nierówny kontakt między dolomitem zmineralizowanym (jaśniejsze zabarwienie), a płonnym (ciemniejsza barwa)

Fig. 2. Polished slab showing details from fig. 1 of the same Plate

Fig. 2. Wygładzona powierzchnia ze szczegółem struktury pokazanej na fig. 1 tej samej tablicy



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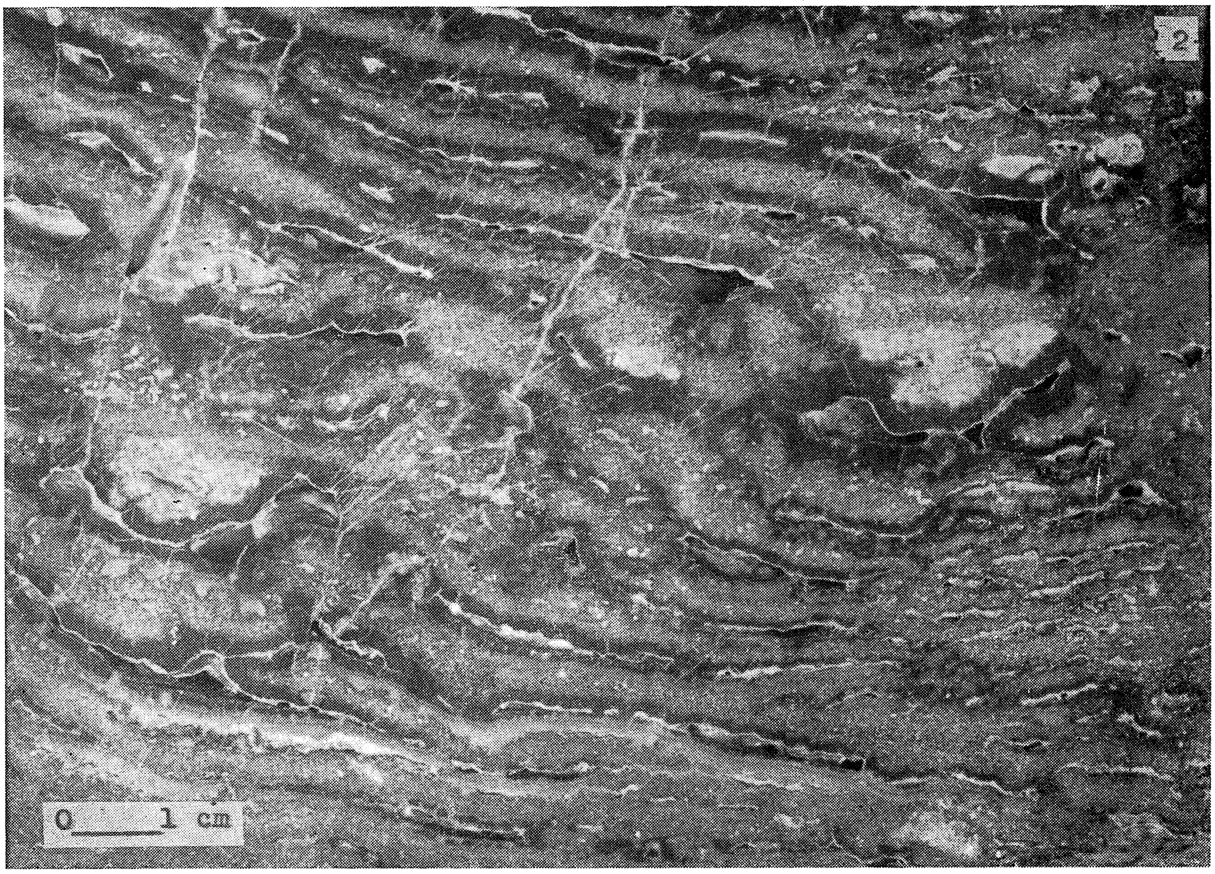

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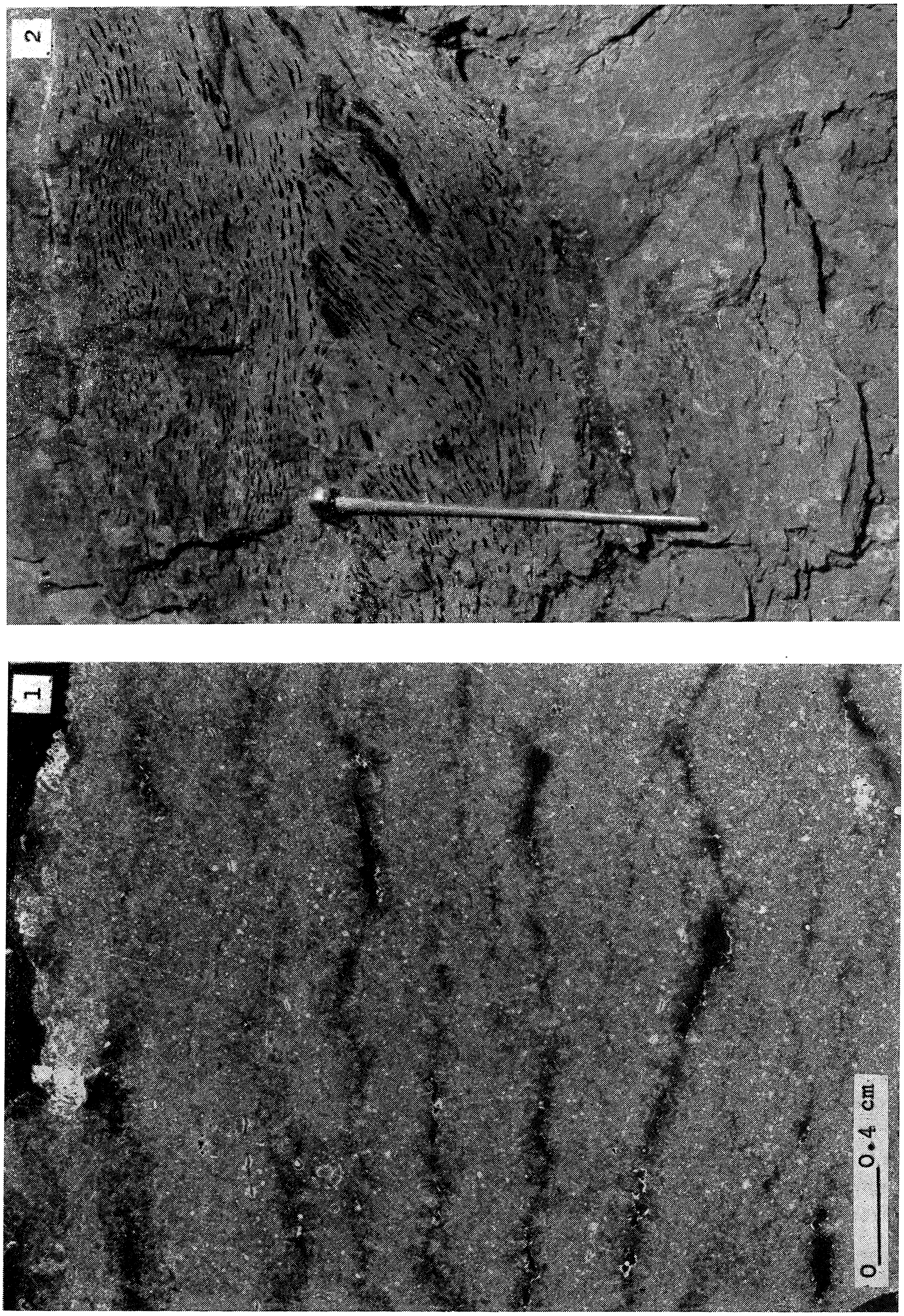

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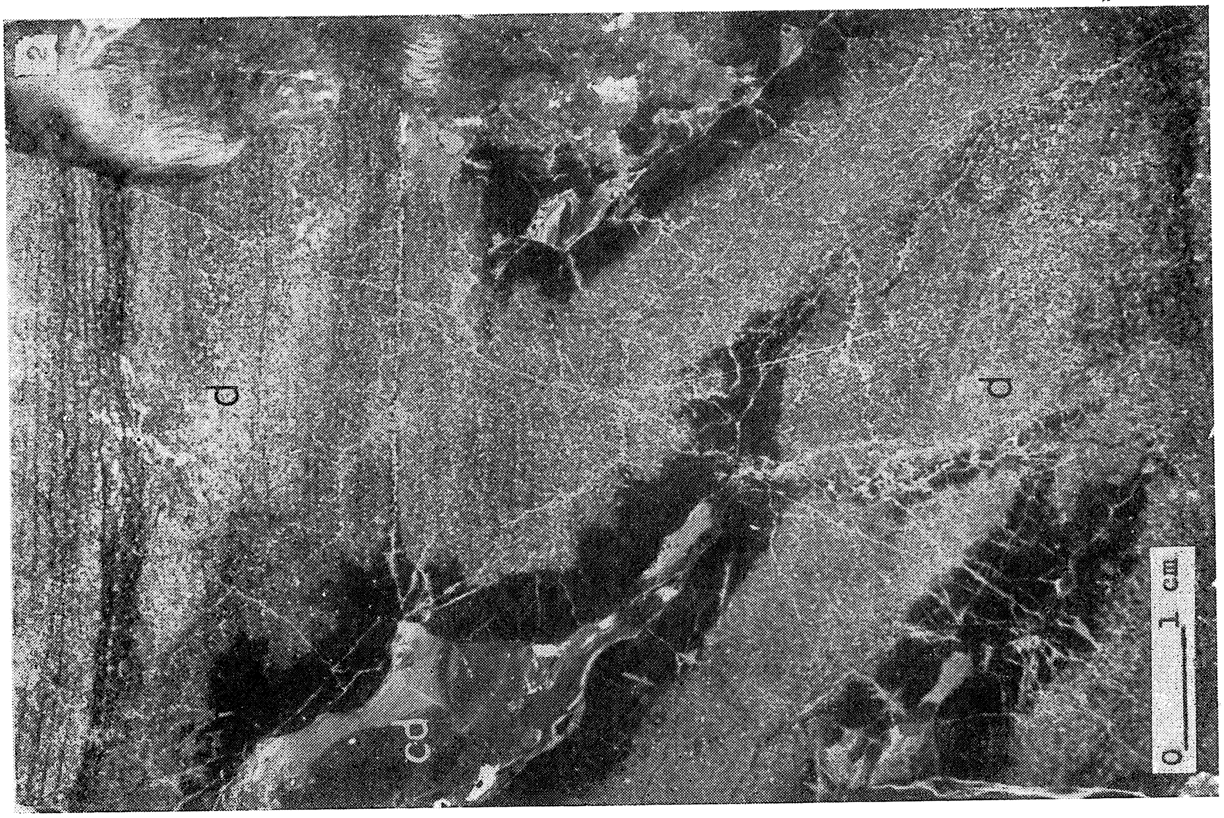

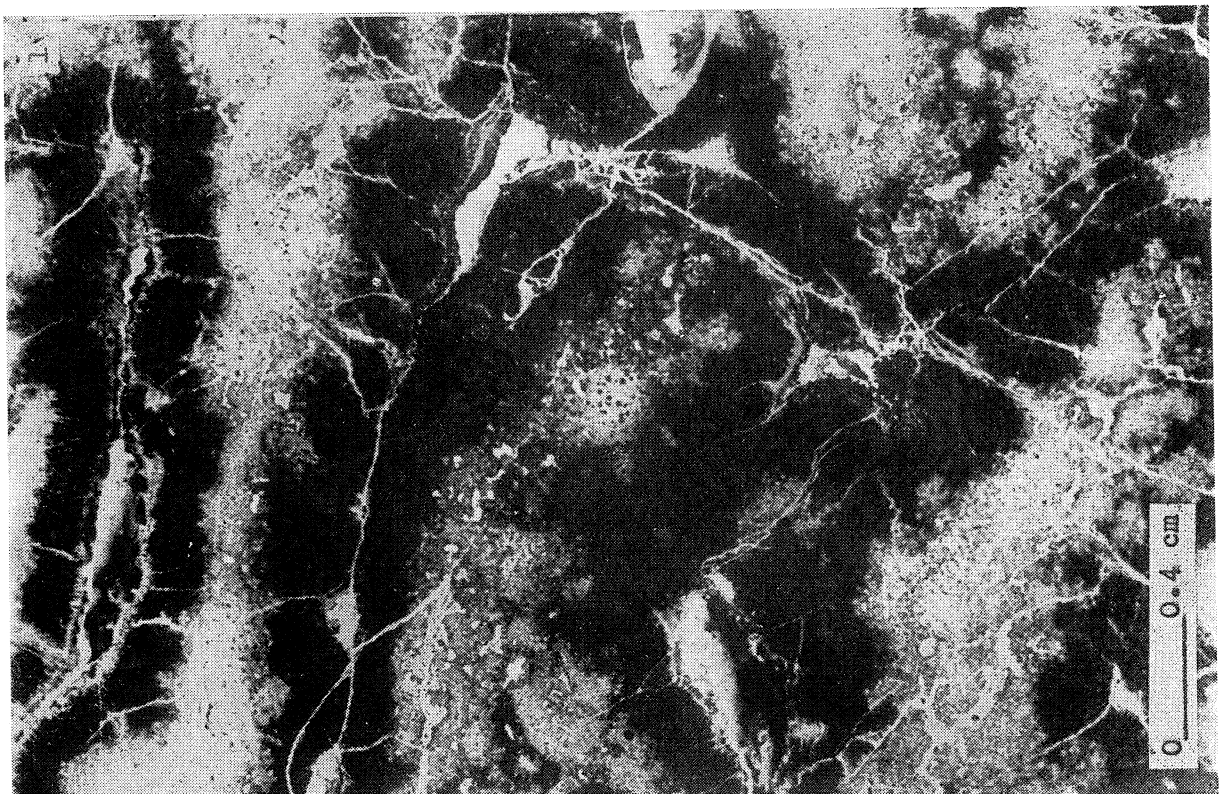

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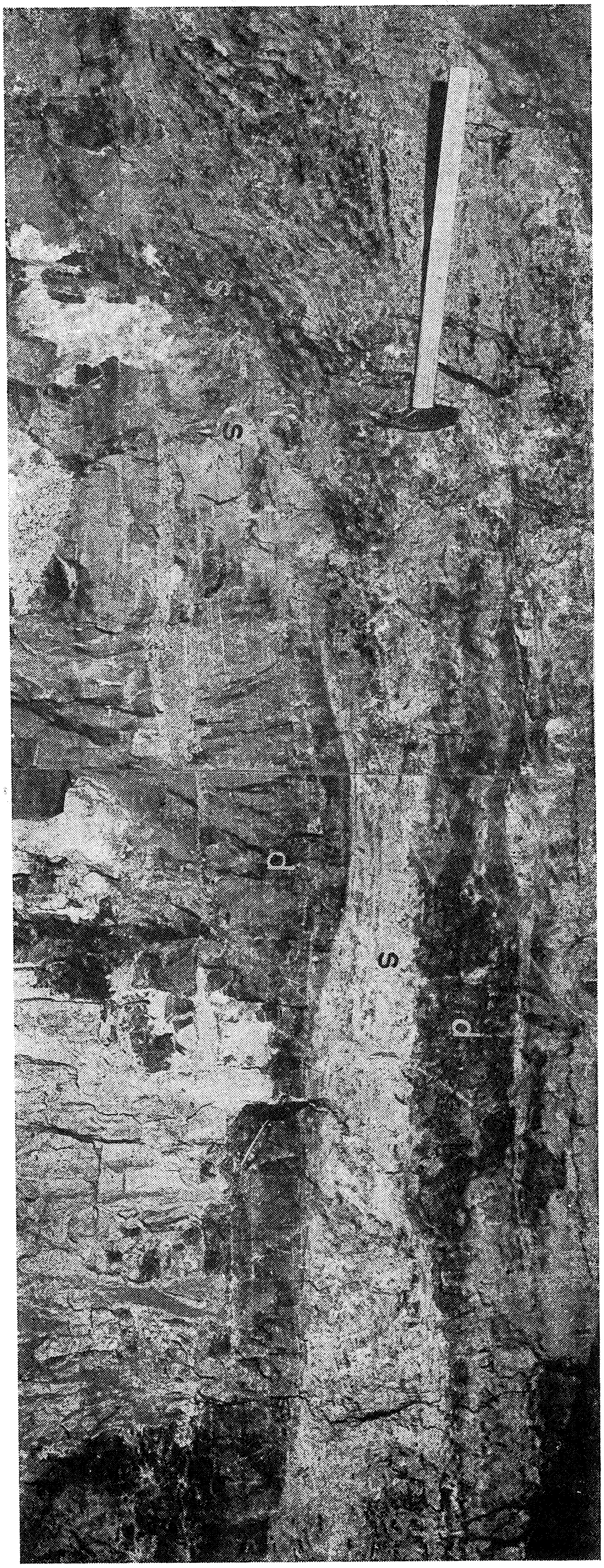

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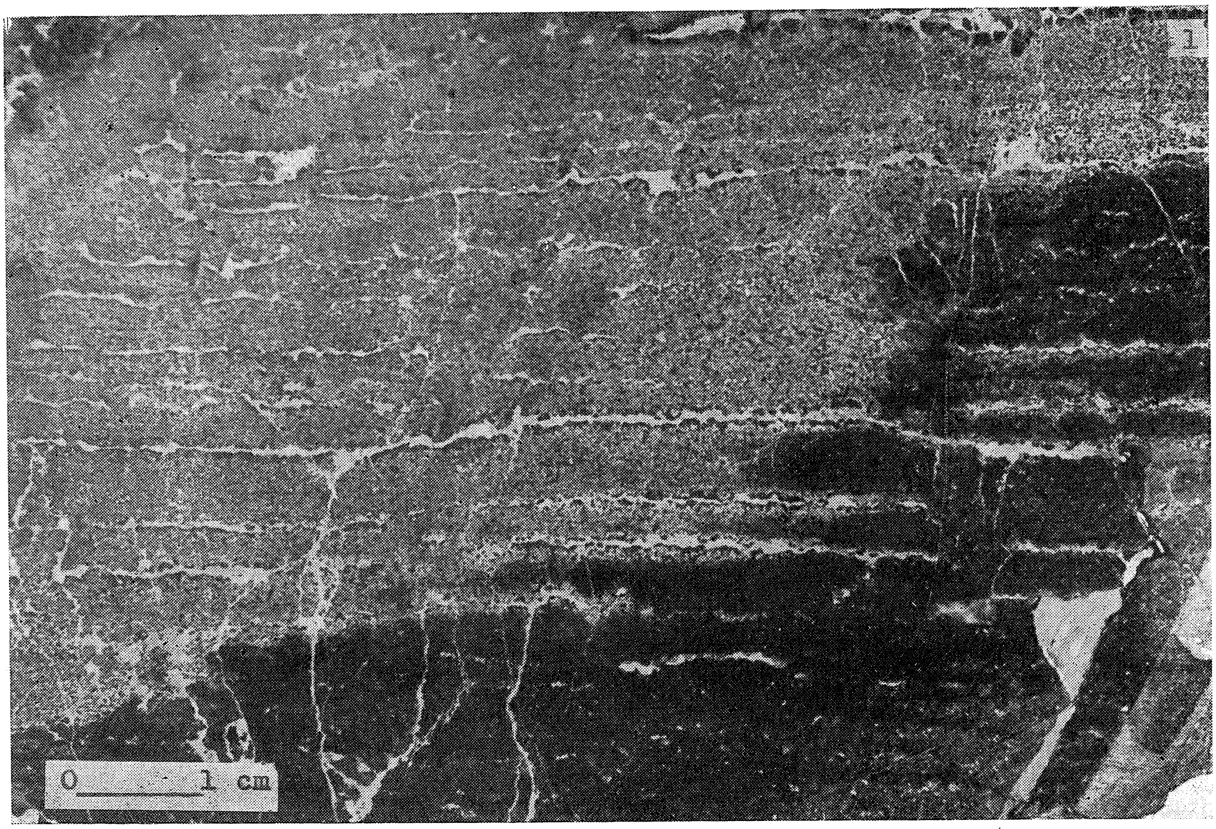

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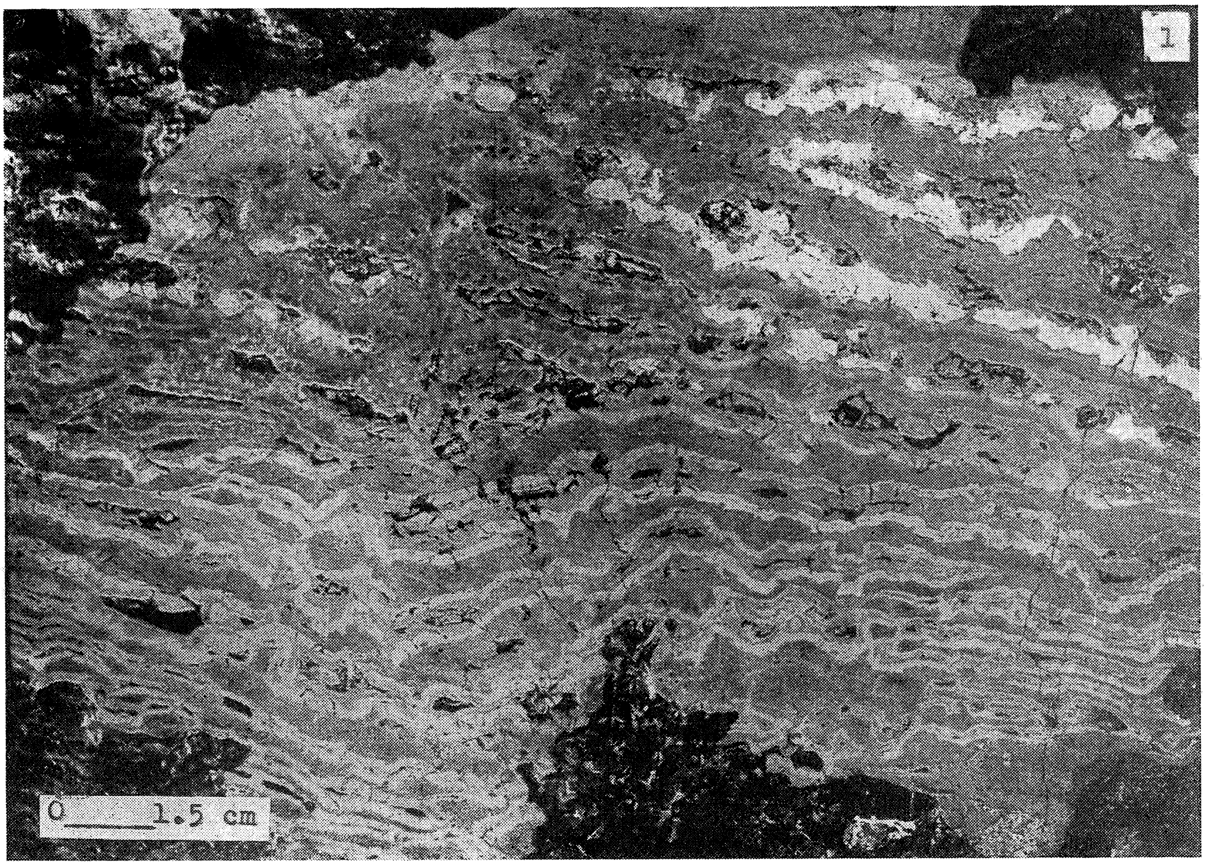

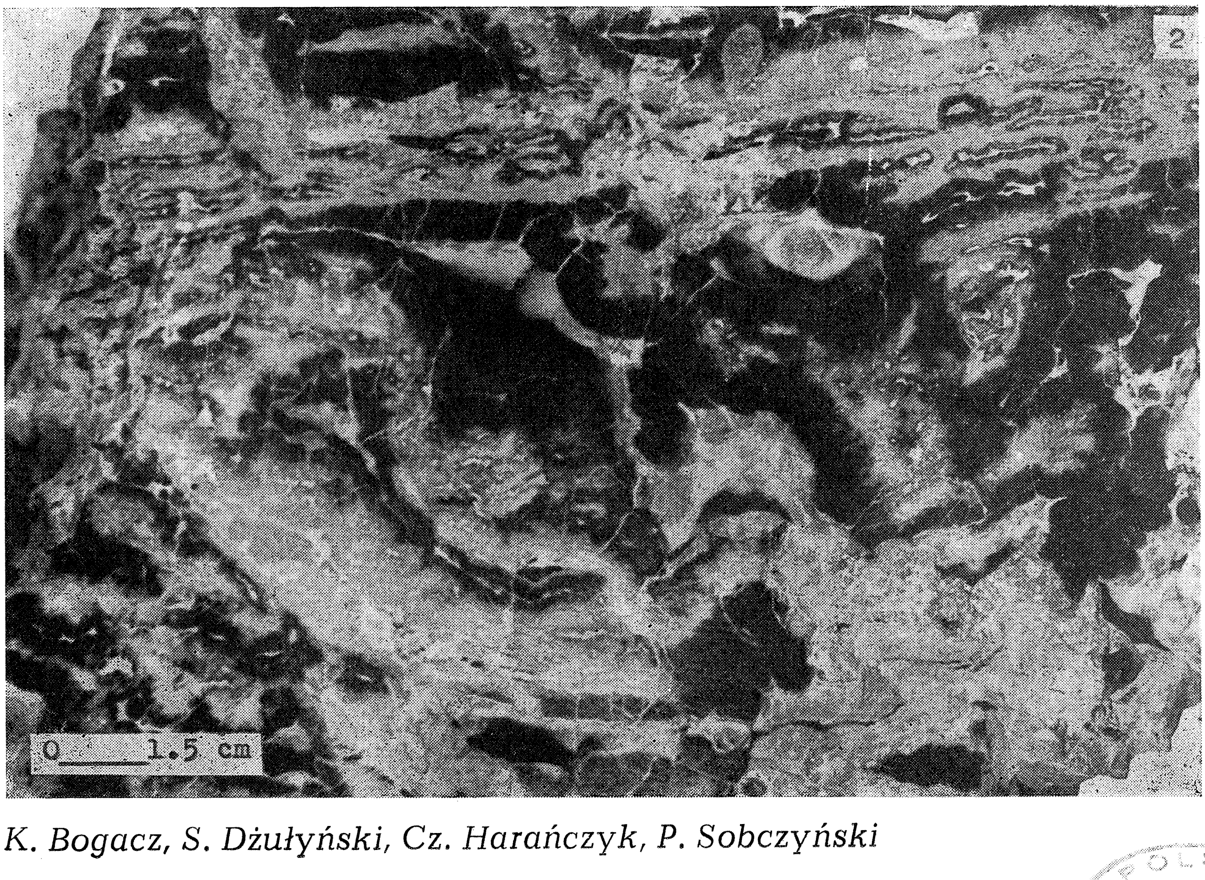

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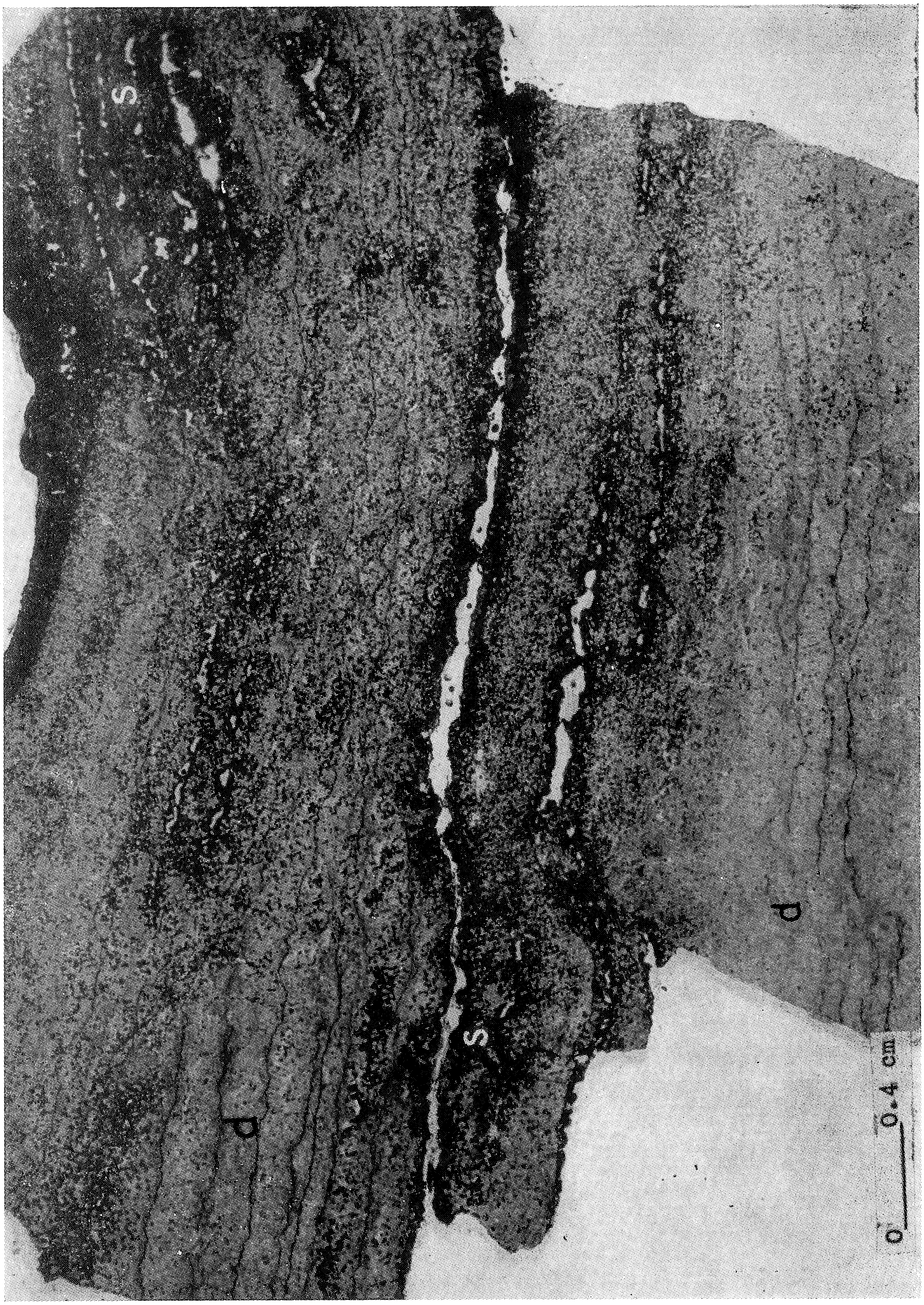

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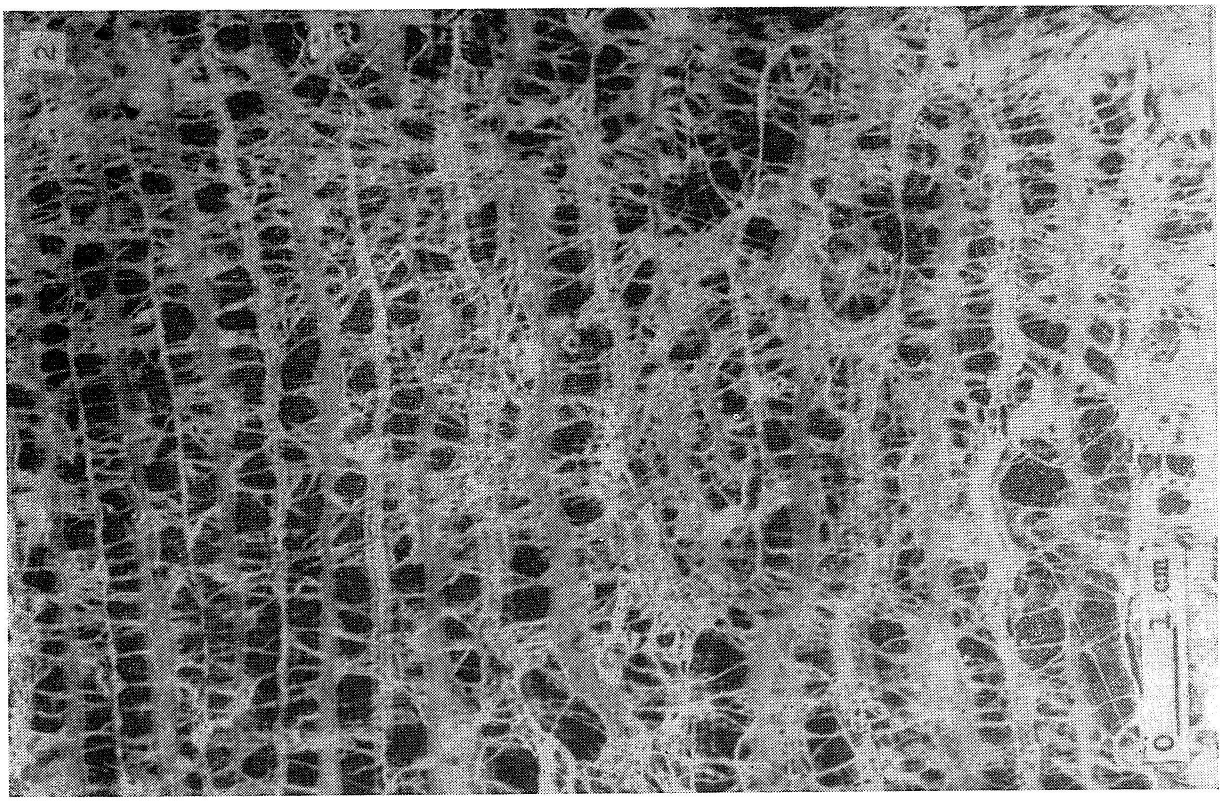

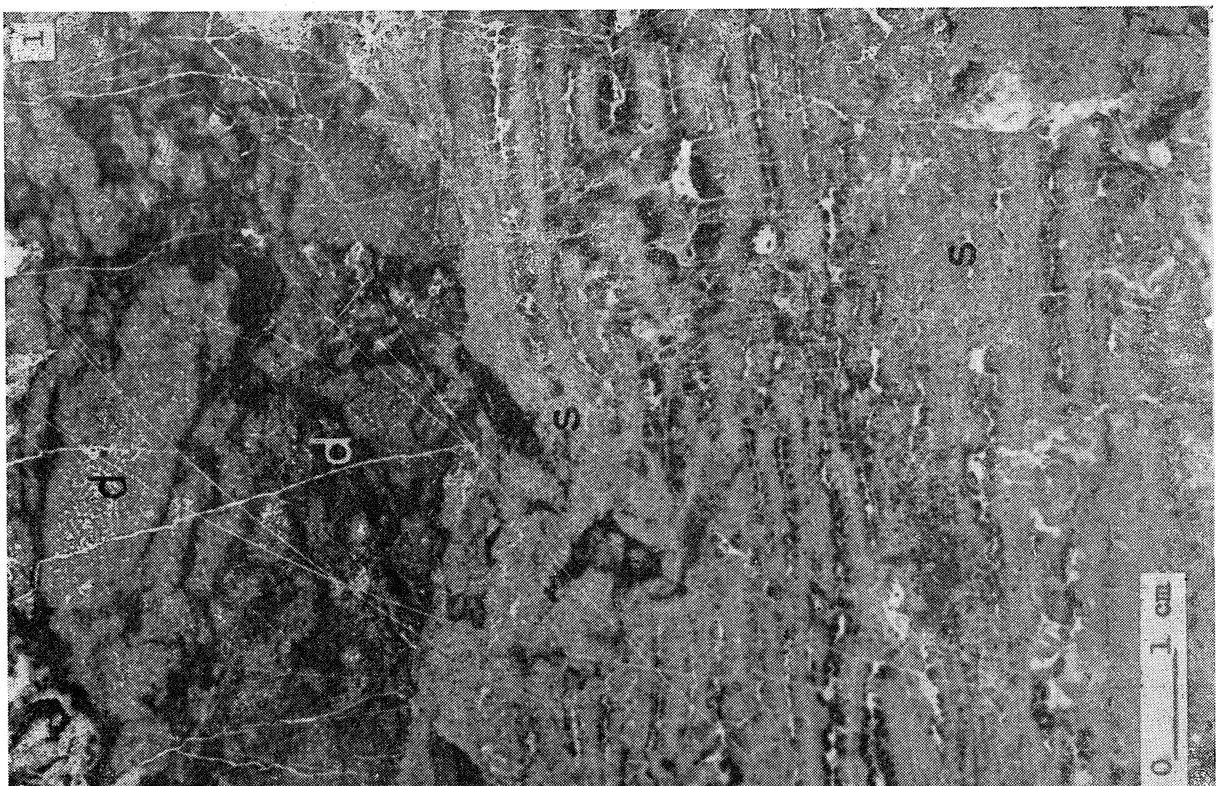

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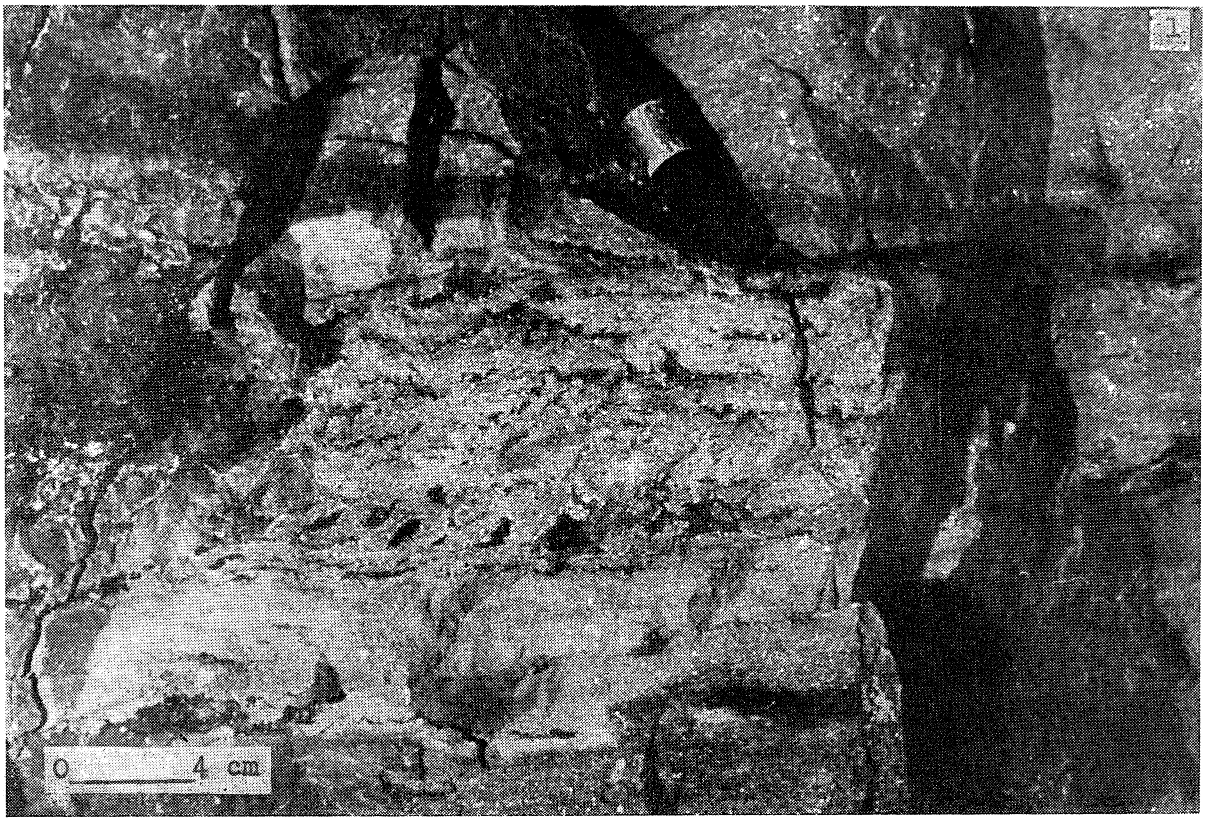

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