ROCZNIK POLSKIEGO TOWARZYSTWA GEOLOGICZNEGO
ANNALES DE LA SOCIÉTÉ GÉOLOGIQUE DE POLOGNE

Tom (Volume) XLIII — 1973 Zeszyt (Fascicule) 1 Kraków 1973

KAZIMIERZ BOGACZ[1], STANISŁAW DŻUŁYŃSKI[2], CZESŁAW HARAŃCZYK[3]

# CAVES FILLED WITH CLASTIC DOLOMITE AND GALENA MINERALIZATION IN DISAGGREGATED DOLOMITES

(Pl. XI—XIV and 5 Figs.)

## *Jaskinie wypełnione osadem dolomitycznym i mineralizacja galenowa w rozsypliwym dolomicie kruszconośnym*

(*Tabl. XI—XIV i 5 fig.*)

Abstract: A laminated, fine-grained detrital dolomite occurs as a secondary component of the ore-bearing dolomite in the Muschelkalk of the Cracow-Silesian region. It fills crevices and caves, and consists of recycled grains derived exclusively from the ore-bearing dolomite, and notably, from solutionally disaggregated; i.e. "sanded" parts of this rock. The formation of the dolomite-filled caves was essentially penecontemporaneous with the disaggregation of the dolomite, and was linked in time with a late, presumably Tertiary, phase of galena mineralization. The galena resident in sanded dolomites occurs as irregular veinlets and patches. It also lines the relics of unsanded dolomite, so that the free crystal faces project into the disaggregated host-rock.

## INTRODUCTION

The ore-bearing dolomite in the Muschelkalk sequence of the Cracow-Silesian region contains cavities and fissures that are tightly filled with indurated or weakly cemented dolomitic silts. Such dolomitic siltstones consist of grains derived exclusively from the ore-bearing dolomite, and represent a specific type of cave-deposit, i. e. speleothem. One of the most striking features of this speleothem is the presence of fine lamination. Because of a characteristically laminated appearance, the deposits under consideration were given a descriptive and non-comittal name "laminates" (not to be confused with "laminites" in the meaning of Lombard 1963).

The laminates are sedimentary rocks and may be classed as clastic or detrital dolomites. They are also "primary" in the sense that the dolomite

---

[1] Zakład Geologii Regionalnej i Złóż Węgli, Akademia Górniczo-Hutnicza w Krakowie.

[2] Zakład Nauk Geologicznych PAN (mailing adress: Geological Institute, Jagellonian University, Oleandry 2a, Cracow

[3] Przedsiębiorstwo Geologiczne, Kraków Al. Inwalidów 6.

was deposited as such from aqueous solutions. Because however, the laminates consist of recycled dolomitic grains they must be regarded as "secondary" and "epigenetic" with regard to their parent rock (compare Friedman and Sanders, 1967).

The dolomitic siltstones here discussed are somewhat analogous to dolomitic sands deposited by rivers draining dolomitic terrains (see e. g. Amsbury, 1962). Their closest equivalents, however, are the "vug-filling" dolomitic sands from the Lower Ordovician of East Tennessee (Kendall, 1960). These "sands", or more properly dolomitic siltstones, are infilling of solutional cavities produced by warm mineralizing solutions (Hoagland and al. 1965, Fulweiler and McDougal, 1971) and resulted by "grain-by-grain release of particles of dolomite" (Kendall, 1960, p. 994). Clastic dolomites like those here discussed have also been mentioned by Lagny (1969) from the Alpine Triassic of Italy, and interpreted, in general terms, as paleokarst features (see Cros and Lagny, 1969, fig. 9). Similar "internal deposits" (in the meaning of Sander, 1936) have also been reported from the mineralized Wettersteinkalk of Triassic age in Austria (Siegl, 1956, Kostelka and Schulz, 1961). It should be noted, however, that the origin of the internal deposits from Austria (Bleiberg) is still disputable, and different opinions on this subject are being held (see e. g. Rainer, 1957, Schneider, 1957).

## SCOPE OF THE REPORT

The present account, the third in a sequel devoted to zinc and lead deposits in the Cracow-Silesian region (see Bogacz et al., 1971, 1972) is limited to the dolomite-filled cavities that are genetically related to extensive zones of solutional disaggregation and late galena mineralization. The observations here presented, and the examples cited are from the Matylda mine in the region of Kąty, west of Cracow.

Acknowledgements

The present authors are greately indepted to Mr. Stanisław Panek from Jaworzno for excellent cooperation given to them during their field work. Mr. Panek provided also considerable information on the occurrences of dolomite-filled caves.

### Ore-bearing dolomite

The ore-bearing dolomite, the host-rock of dolomite-filled caves was formed toward the end of Triassic time by metasomatic replacement of the Muschelkalk carbonates. The epigenetic and replacement origin of the dolomite is accepted by the majority of geologists, and seems to be well documented by recent investigations (Bogacz et al., 1972).

### Disaggregated ore-bearing dolomite

Relevant to the following discussion is the fact that certain parts of the ore-bearing dolomite are disaggregated and transformed into weakly cemented and porous mass of crystals and grains (see Assman, 1944, Śliwiński, 1969). Such altered dolomites, commonly referred to as "sanded", have been reported from several regions (e. g. Emmons et al., 1927, Lovering et al., 1949, Behre, 1953, Heyl et al., 1959, Zgogović, 1966, Zalaffi, 1969). The process of disaggregation is attributed to dissolution of crystal edges. It may result from the action of hydrothermal solutions or ordinary ground-waters. This process tends to efface or obscure the primary structures. The end-product of such alteration, if water-saturated, may yield by plastic flow or may be a site of plastic and quasi-plastic deformations.

The "sanded" parts of the ore-bearing dolomite may assume various shapes. They tend to occur, however, as roughly tabular bodies, concordant with the bedding. Such bodies may contain numerous relics of the unaltered dolomite. The contact between the disaggregated and unaltered parts of the ore-bearing dolomite is usually gradational, but commonly through a very short distance. Parenthetically it may be noted that very similar disaggregation occurs in recrystallized and barren limestones of Triassic age in the Cracow-Silesian region (Dżułyński and Kubicz, 1972).

### Dolomite-filled cavities

The ore-bearing dolomite is riddled by countless karst cavities. Some of them are filled with sulfide ores and ore-lined collapse breccias, some other with rock debris and residual products of external origin. These cavities belong to different generations of karst processes, frequently overlapping in time and superimposed one upon another. The ore-lined cavities are considered as having resulted from the action of hydrothermal solutions ("hydrothermal karst" — Bogacz et al., 1971). The karst features, which are devoid of mineralization are due to the action of ordinary meteoric waters.

The dolomite-filled caves represent a separate group of karst features, and differ from other cavities in that they are tightly filled with recycled dolomitic grains (Fig. 1, 2, 3). In addition, they are devoid of any external contaminations and products of surfacial weathering. They also lack evidence of having been formed under oxidizing conditions, although they occur in the dolomite which has undergone long-continued weathering.

While a considerable number of dolomite-filled caves were formed by erosional processes (dissolution combined with mechanical removal of grains), there are also openings which resulted from fracturing and spalling of the ore-bearing dolomite. Such openings, too, are filled with clastic dolomite and represent a special type of "clastic dikes" (Pl. XI, fig. 2, text-fig. 1). They should not be confused either with the dolomitic veins produced by open-space crystallization of dolomite or with dolomitic veins of metasomatic origin.

The dolomite-filled cavities in the ore-bearing dolomite range from small openings on a milimeter scale to large caverns measuring several meters in breadth. Their height, however, rarely exceeds 1 m. The cavities presumably form an irregular network of considerable length which, however, is difficult to assess.

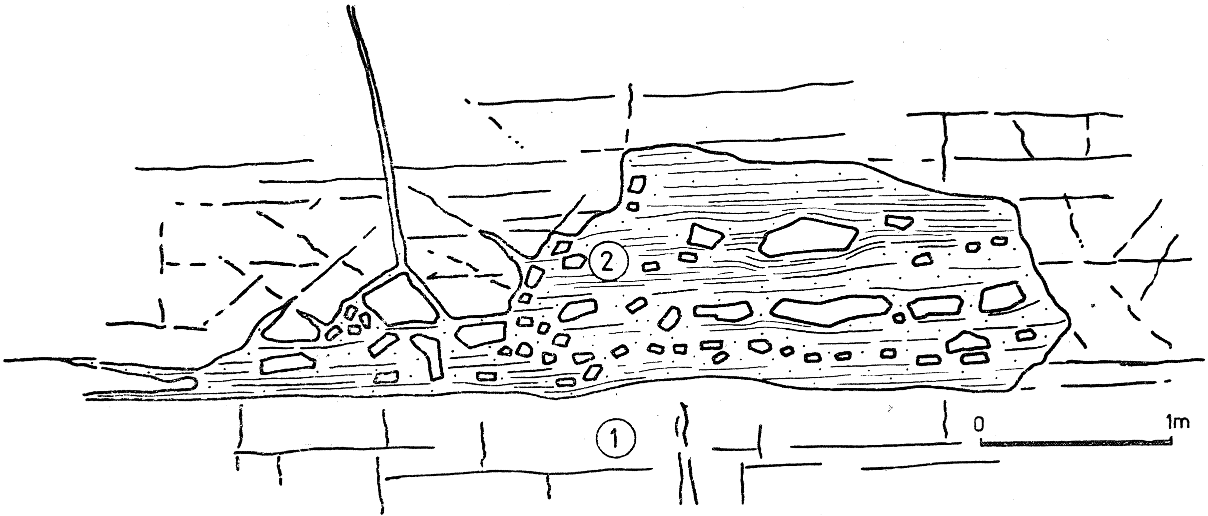


Fig. 1. Dolomite-filled cave developed in unsanded ore-bearing dolomite (1). Note angular rock-fragments enclosed in fine -grained cave deposit (2) and fractures filled with clastic dolomite

Fig. 1. Jama krasowa w twardym dolomicie kruszconośnym (1), wypełniona osadem dolomitowym (1) z fragmentami skalnymi

Some of the dolomite-filled caves are lined with galena crystals. The one shown in (Pl. XII, fig. 1, text-fig. 3), reveals incrustations indicative of open-space crystallization which occurred prior to the deposition of dolomitic mud. Other cavities, and such are more abundant, are devoid of ore-linings.

## Petrography of clastic dolomites

The clastic dolomites are generally light-gray to almost white. Locally they may show a dark tint due to the presence of sulfides and/or silica. Some of them are yellowish, although this color is due to a secondary oxidation.

The texture of the clastic dolomites may be described as generally very fine-grained, although many large and angular rock-fragments, de-

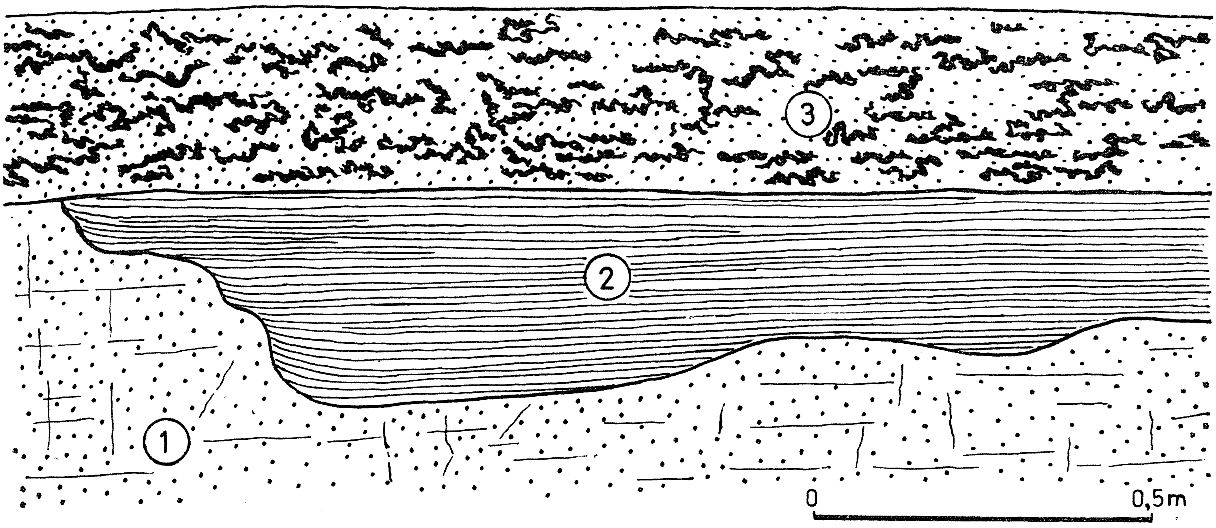


Fig. 2. Flat-roofed dolomite-filled cave filled with fine-grained dolomitic sediment (2). 1 — disaggregated dolomite with disseminated sphalerite; 3 — disaggregated dolomite with "vermicular" galena veinlets. Disaggregation of this dolomite occurred after the formation of the cave and its filling. Note upwarping of laminate at the wall of cavity

Fig. 2. Jama krasowa w rozsypliwym dolomicie kruszconośnym wypełniona drobnoziarnistym osadem dolomitowym (2). 1 — rozsypliwy dolomit z rozproszonym sfalerytem; 3 — rozsypliwy dolomit z „robaczkowymi" żyłkami galeny. Zwróć uwagę na kompakcyjne podgięcia lamin przy ścianach jamy

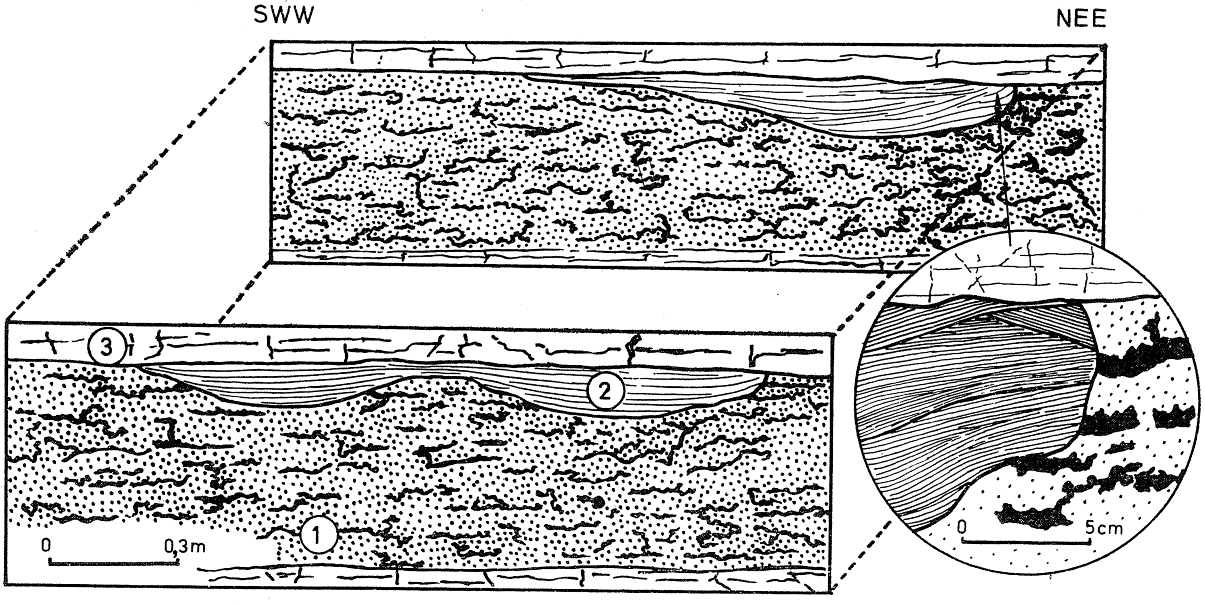


Fig. 3. Dolomite-filled cavity developed in sanded dolomite. Note plano-convex shape of the cave and distinct lamination of cave deposit (2). 1 — disaggregated dolomite with "wermicular" galena veinlets; 2 — laminated cave deposit; 3 — ore-bearing dolomite not affected by solutional disaggregation. Note croscutting relations between galena veinlets (black patches) and cavity walls (circle-lower right)

Fig. 3. Jama krasowa w rozsypliwym dolomicie kruszconośnym (1), wypełniona drobnoziarnistym laminowanym osadem dolomitowym (2). Zwrócić uwagę na płaski strop i wklęsłe dna jamy oraz na stosunek „robaczkowych" żyłek galenowych (czarne pola) do ścian jamy (w kole po prawej stronie); 3 — twardy nierozsypliwy dolomit

rived from the walls of cavities, are also present (Pl. XI, fig. 1, text-fig. 1). The small grains that make up the bulk the clastic dolomite are either dolomitic crystals or minute lithic fragments of the ore-bearing dolomite. Still finer grades are chiefly of residual origin and comprise argilaceous matter. Galena is present as clastic fragments and as newly formed idiomorphic crystals.

## Sedimentary structures

The sedimentary structures include; horizontal and cross-lamination, graded bedding and scour-and-fill structures (Pl. XIII, fig. 2). The lamination, in general, agrees with the bedding of the host dolomite, though exceptions to this are known to occur. The cross-lamination is chiefly due to infilling of erosion furrows (Pl. XIII, fig. 2). No ripples proper have been observed.

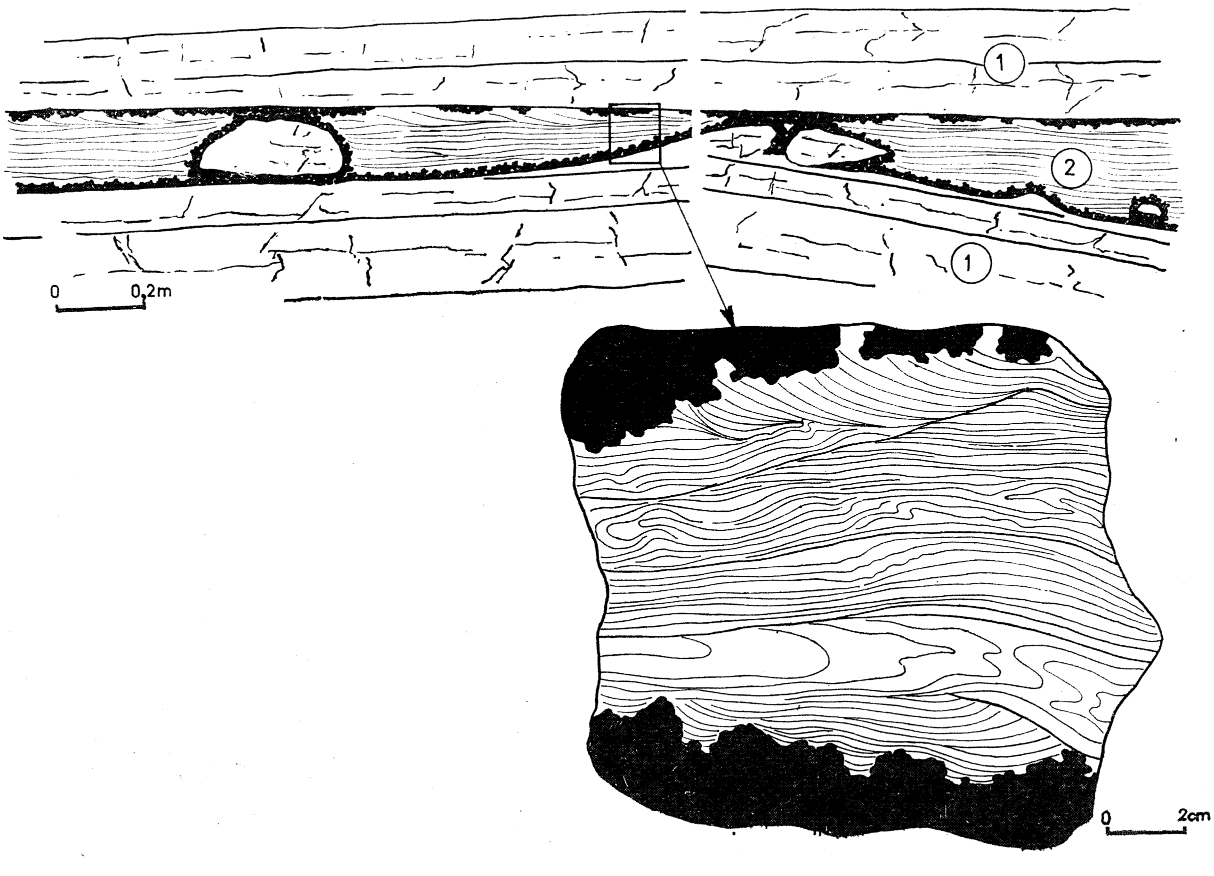


Fig. 4. Dolomite-filled fracture-cave lined with galena crystals (black). 2 — indurated, fine-grained "laminate"; 1 — unsanded dolomite. Note relations between galena lining and sedimentary and deformational structures in laminate (lower right-detail of the cave, compare also Pl. XII, fig. 1)

Fig. 4. Jama w postaci rozwartej szczeliny wypełniona drobnoziarnistym „laminatem" i inkrustowana kryształami galeny. 2 — laminowany osad dolomitowy; 1 twardy nierozsypliwy dolomit. Po prawej stronie u dołu szczegół jamy. Zwróć uwagę na struktury sedymentacyjne i deformacyjne w osadzie dolomitowym i ich stosunek do inkrustacji galenowej

### Deformational structures

The primary erosional and depositional structures were repeatedly disturbed by loading, compaction, local micro-slumps, liquefaction, and deformations induced by droping rock-fragments. The compactional deformations are manifested by upwarping of laminae at the walls of cavities (Fig. 2). Similar deformations occur around rock-fragments and pieces of galena which dropped from the roofs of cavities and became embedded into a fine dolomitic mud (Pl. XIII, fig. 1). The laminae beneath such fragments are bent down and compressed, while those which cover the fragments terminate against or bent over them. Of common occurrence are also micro-load structures and deformations resembling micro-slumps (Pl. XIII, fig. 1, text-fig. 4). Many of these latter are due to instability in density stratification or lateral push exerted by falling rock-fragments. Of particular interest here are liquefaction phenomena which tend to appear around some of such fragments (Pl. XII, fig. 2).

It should be noted that not all the fragments incorporated in the laminate are associated with the above deformations. Some of such fragments came to rest on the bottom that was strong enough to support their weight without any visible deformation.

## INTERPRETATION OF SEDIMENTARY AND DEFORMATIONAL STRUCTURES

Sedimentological interpretation of the structures previously described is relatively simple. Such structures are indicative of transportation of particles and their deposition by currents. Pulsatory variations in the velocity of such currents account for the appearance of rhytmic lamination. The direct cause of the pulsations is, however, not apparent. In this connection it may be mentioned that similar varved sediments are known to occur in many recent cave deposits (see e. g. Renault. 1968).

The filling of cavities took place successively, laminae by laminae. The accumulation of particles was, however, frequently interrupted by erosion consequent upon temporary and slight increases in current velocity. The currents, however, were weak and capable of scouring only a very fine bottom sediment. They were not strong enough to move larger particles.

### Source of clastics

The nature of the detrital particles of which the clastic dolomite is composed is such as to suggest very strongly the derivation from the disaggregated ore-bearing dolomite. Indeed, the similarity between the laminates and the sanded dolomites may be so close that they can easily be confused, particularly if the lamination in the clastic dolomite is not very apparent. Under such circumstances only a carefull examination reveals the outlines of cavities developed in disaggregated dolomites.

Although the distance and direction of transportation is difficult to assess, the general character of detrital particles leaves no doubt that they were derived from sources in the immediate environment of their present accumulation.

## Cavity-making in sanded dolomites

Inasmuch as the sanded dolomite offers an easy access to percolating liquids, the rate of dissolution, which is directly proportional to the velocity of the flow, increases. In addition, the dissolution of grain edges is followed by a decrease in volume and consequently by settling of disaggregated grains ("solutional thinning" compare e. g. Heyl et al., 1959, Hagni and Dessai, 1966). Such a settling, in turn, may lead to the formation of larger openings which preferentially tend to develop along the upper boundaries of sanded bodies (Dżułyński and Kubicz, 1972, fig. 5). The openings initiated by settling invite a more rapid flow of underground waters, and consequently are enlarged, first by dissolution and then by mechanical removal of disaggregated particles. It is the significance and sometimes even the predominance of such a mechanical erosion that makes the cavity-making in disaggregated carbonate rocks different from similar processess operating in hard limestones and dolomites (Dżułyński and Kubicz, 1972).

As already noted, the sanded parts of the ore-bearing dolomite frequently occur as tabular bodies concordant with the bedding. The channels which start to develop along top surfaces of such bodies acquire a plano-convex crossection provided the downward incision is not impeded by the appearance of hard rock (Fig. 3). With further enlarging of channels, or with a diversion of the main flow into a new conduit, the rapid circulation of the underground waters is again replaced by a slow movement. Thereafter the cavities are being filled with fine dolomitic silt.

## Ore-mineralization in sanded dolomites

Galena is the most common sulfide in sanded dolomites. Sphalerite occurs in very subordinate amounts. Appart from some disseminated accumulations it is often enclosed in galena and occurs in the form of earthy, fine-grained blots. The galena concentrations are variously shaped, but most commonly they occur as highly irregular veinlets. These, as seen in crossections, give to the ores a vermicular appearance Pl. XIV, fig. 1. A notable feature of such "vermicular" galena is the fact that crystals are usually euhedral against the sanded dolomite. One can observe the galena crystals lining the relics of unsanded dolomite in such a way that the free crystal faces project into the sanded rock (Fig. 5). The shape of the galena bodies is thus dependent upon the outline of the boundaries between sanded and hard dolomite. The galena lining the relics is irregular, since the relics themselves are usually very irregular. If, however, the boundaries between the sanded and unsanded rock take a more straight form, the galena bodies are more regular (Fig. 5).

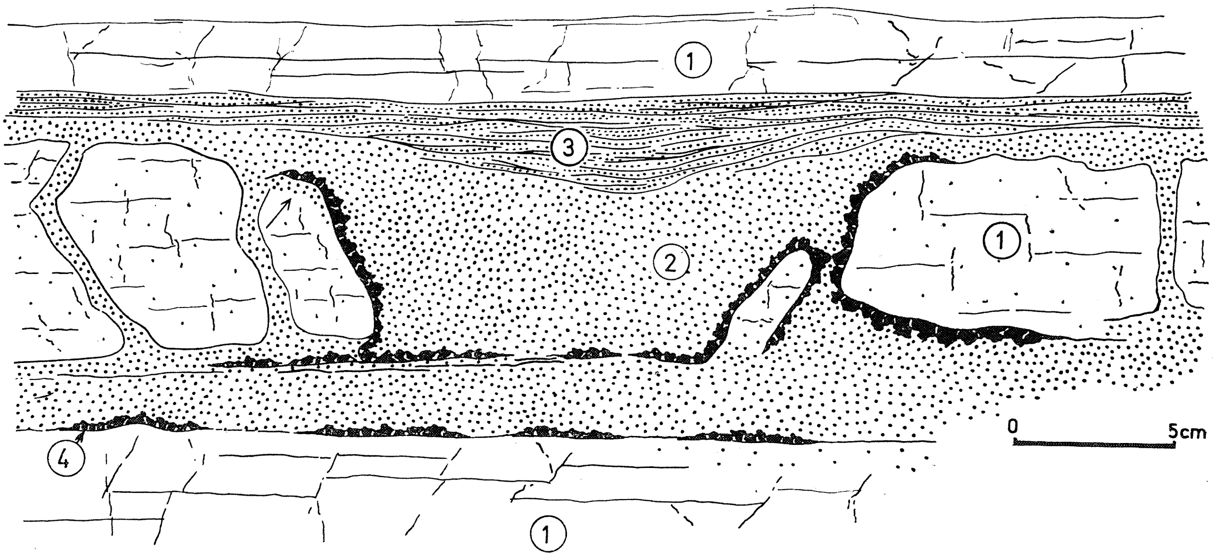


Fig. 5. Galena crystals (black) lining boundaries between undisaggregated (1) and disaggregated (2) dolomite; 3 — clay intercalations with nontronite. Note free crystal faces of galena oriented against sanded dolomite and incipient post-ore disaggregation of relic (arrow)

Fig. 5. Inkrustacje galenowe (czarne pasy) wzdłuż granic między twardym nierozsypliwym dolomitem (1) a dolomitem rozsypliwym (2). Zwrócić uwagę na euhedralne ściany kryształów zwrócone w stronę rozsypliwego dolomitu oraz na zaczątkowy pogalenowy rozpad ziarnisty dolomitu (strzałka)

The examples just cited point to the fact that the dolomite was already partly disaggregated before the introduction of the galena. The disaggregation, however, continued after the emplacement of this sulfide. One can see the galena-lined relics being further subjected to disaggregation, so that a newly formed sanded rock appears between the galena incrustations and the reduced relics (Fig. 5). With complete disaggregation, the relics disappear, and the end-product of such alterations consists of irregular veinlets of the vermicular galena suspended in a mass of sanded dolomite (Pl. XIV, fig. 1). It need hardly be said that the contours of such galena bodies mark the original boundaries of relics.

In view of the above considerations it may be stated that; 1) the boundaries between sanded and unsanded dolomites were among the factors controlling the emplacement of galena, 2) the disaggregation and the emplacement of galena were overlapping in time, and that both were essentially contemporaneous. In postulating the essential contemporaneity of these two processes, sight should not be lost of the fact that the disaggregation may proceed independently of ore-mineralization and that the foregoing conclusion cannot be extended for other occurrences of sanded dolomites.

In addition, it should be noted that the galena in sanded dolomites may also occur as filling of fractures formed prior to, or concurrently with the disaggregation. Such fractures may also extend beyond the limits of sanded bodies, and may give rise to gash-vein galena deposits in the unsanded ore-bearing dolomite. Worth noting are also numerous deformations revealed by the galena veinlets in sanded dolomites. Such veinlets are frequently broken and displaced by micro-faults. The disturbances of this kind might have resulted from various causes. It should be borne in mind, however, that the disaggregation is usually accompanied by stress-redistribution within the rock subjected to this alteration. Such stress-redistribution may easily lead to localized fracturing (Dżułyński and Kubicz, 1972).

Concluding the foregoing considerations it should be noted that the predominant orientation of free crystal faces toward the sanded dolomite merits particular attention also in view of the discussion on the origin of zinc and lead ores in the Triassic of the Cracow—Silesian region. The above indicated orientation is what one would expect from crystal growing into a soft medium, and is commonly met with in syn-sedimentary ore deposits. A case in point is that the sulfide ores in the Triassic of the Cracow—Silesian region are still regarded by some geologists (Gruszczyk, 1967, Smolarska, 1968) as synsedimentary, although the balance of evidence is on the side of hydrothermal and epigenetic interpretation (see e.g. Bogacz et al., 1971), It should be realized that the galena crystals euhedral against the sanded dolomite cannot be cited as evidence in favor of syngenetic interpretation, since the galena is penecontemporaneous with solutional disaggregation, the secondary origin of which is beyond any doubt. The crystals that are euhedral against the disaggregated dolomite merely point to a considerable secondary softening of the ore-bearing dolomite subjected to solutional disaggregation.

## DISCUSSION OF RESULTS

The general sequence of processes associated with the disaggregation of the ore-bearing dolomite, in one place, is as follows: 1) solutional disaggregation, 2) emplacement of galena, 3) formation of open cavities and, 4) infilling of cavities with recycled dolomitic grains.

Evidence has already been presented that the first two processes were essentially contemporaneous. The formation of dolomite-filled caves followed shortly after. In any way, the mutual relations between these cavities and the sanded dolomites are not such as to indicate any considerable age difference between them. Also the absence of foreign material from without leads to the conclusion that the laminates were introduced into the position they now occupy, shortly after the formation of cavities. For this reason, the present authors suggest that, although the conspicuous galena deposition preceded the cavity-making in sanded dolomites, both processes were essentially penecontemporaneous and overlaped in time and space. The dolomite-filled cavities were most likely formed by late ore-bearing solutions or by post-ore waters which directly followed the galena mineralization and the disaggregation. They were not formed by downward-percolating meteoric waters, because no indication of surfacial infiltration or deposition of weathered debris has been found. In this respect the dolomite-filled caves contrast strongly with recent and pre-Miocene caves and sink-holes.

The solutions responsible for extensive disaggregation of the ore-bearing dolomite, the emplacement of the vermicular galena, and for the dolomite-filled caves were reducing in character and, presumably, of low pH. Nothing definite, however, is known of the origin and temperature of these solutions. Another question, which on the basis of existing evidence cannot be positively solved is whether the galena was introduced from deep-seated sources by rising hydrothermal solutions, or was derived from older ores resident in the ore-bearing dolomite. This dolomite has already been subjected to ore-mineralization at the close of the Triassic, and much of the dispersed and mixed zinc and lead ores dates back to that time. However, the galena in sanded dolomites as well as the sanded dolomites themselves are of younger age. Evidence for this is as follows: The disaggregation, i.e. the formation of sanded dolomites was preceded by oxidation of the ore-bearing dolomite and this, most likely, occurred during early Tertiary time. On the other hand, the pre-Miocene sink-holes that are superimposed upon the sanded dolomites and occur in proximity of the dolomite-filled cavities, are barren. They contain, however, detrital fragments of the galena incrustations (Bogacz et al., 1971). It is not known whether these detrital fragments were derived from the vermicular galena resident in sanded dolomites or from older ores. In view of the information furnished by the present study, the former suggestion appears very probable. If this be the case, the disaggregation, the emplacement of galena and finally the formation of the dolomite-filled caves occurred prior to the formation of the pre-Miocene sink-holes, and most likely during early Tertiary time.

## WYKAZ LITERATURY
## REFERENCES

Amsbury D. L. (1962), Detrital dolomite in central Texas. *Journ. Sed. Petr.* 32, pp. 1—14, Menasha Wisc.

Assmann P. (1944), Die Stratigraphie der Oberschlesischen Trias *Abh. Reichs Bodenforsch.* N. F., 208, pp. 1—125, Berlin.

Berhe 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, Washington.

Bogacz K., Dżułyński S., Harańczyk Cz. (1970), Ore-filled hydrothermal karst features in the Triassic rocks of the Cracow-Silesian region. *Acta Geol. Pol.* 20, 2, pp. 247—267, Warszawa.

Bogacz K., Dżułyński S., Harańczyk Cz., Sobczyński P. (1972), Contact relations of the Ore-bearing Dolomite in the Triassic of the Cracow-Silesian region. *Ann. Soc. geol. pol.*, 42, 4, pp. 347—372, Kraków.

Cros P. et Lagny Ph. (1969), Paléokarst dans le Trias moyen et supérieur des Dolomites et des Alpes Carniques occidentales. Importance stratigraphique et paléogéographique. Sciences de la Terre, 15, pp. 139—195, Nancy.

Dżułyński S. and Kubicz A. (1971), Recrystallized and disaggregated limestones in the Triassic of Silesia. *Annales Soc. geol. pol.*, 41, 3, pp. 519—530, Kraków.

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

Friedman G. M. and Sanders J. E. (1967), Origin and occurrence of dolostones. In "Carbonate Rocks", *Developments in Sedimentology 9A, Elsevier,* Amsterdam. (Edited by Chilingar G. V. Bissel H. J. and Fairbridge Rh. W.).

Fulweiler R. E. and McDougal S. E. (1971), Bedded-ore structures, Jefferson City Mine, Jefferson City, Tennessee. *Econ. Geol.* 66, pp. 763—769, Lancaster Pa.

Gruszczyk H. (1967), The genesis of the Silesian-Cracow deposits of lead and zinc ores. *Econ. Geol. Monograph.* 3, New York.

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

Heyl A. V., Jr. Agnew A. F., Lyons E. J. and Behre Ch. H. (1959), The Geology of the Upper Mississipi Valley Zinc-lead District. U.S. Geol. Survey *Prof. Paper.* 309, p. 310, Washington.

Hoagland A. H., Hill W. T. and Fulweiler R. E. (1965), Genesis of the Ordovician zinc deposits in East Tennessee, *Econ. Geol.*, 60, pp. 697—714, Lancaster Pa.

Kendall D. L. (1960), Ore deposits and sedimentary features Jefferson City Mine — Tennessee. *Econ Geol.*, 55, 5, pp. 985—1003.

Kostelka L. and Schulz O. (1961), Beobachtungen an jungen Hohlraumsedimenten. *Berg-u. Hüttenm. Mh.*, 106, pp. 372—377. Leoben

Lagny M. P. (1969), Minéralisation plombo-zincifère triasique dans un paléokarst (Gisement de Salafossa, Province de Belluno, Italie). Comptes rendus *Acad. Sc. Paris,* t. 268, pp. 1178—1181.

Lombard A. (1963), Laminites: A structure of flysch-type sediments. *J. Sediment. Petrol.*, 33, pp. 14—22.

Lovering T. S. and others (1949), Rock alteration as a guide to ore — East Tintic District, Utah. *Econ. Geol. Mon.* 1, p. 27.

Rainer H. (1957), in Diskussionsbeiträge, Thema: Zonare Anordnung, Sonderfazies und Anlagerungsgefüre. *Berg-u. Hüttenman. Mh.*, 102, pp. 235—236. Leoben.

Renault Ph. (1968), Contribution à l'étude des actions mécaniques et sedimentologisques dans la spéléogenèse III partie *Ann. de Spéléologie* 23, 3, pp. 529—596.

Sander B. (1936), Beitrage zur Kentniss der Anlagerungsgefüge (Rhytmische Kalke und Dolomite aus der Trias). *Min. und Petr. Mitt.*, Bd. 48, pp. 27—137, Leipzig..

Schneider H. L. (1957), in Diskusionsbeiträge, Thema: Zonare Anordnung. Sonderfazies and Anlagerungsgefüge. *Berg-u. Hüttenman. Mh.* 102, 237.

Siegl W. (1956), Zur Vererzung der Pb-Zn Lagerstätten von Bleiberg, *Berg-u. Hüttenman. Mh.*, 101, pp. 108—110.

Śliwiński S. (1969), Rozwój dolomitów kruszconośnych w obszarze krakowsko-śląskim. *Pr. geol. Kom. Nauk. Geol. PAN w Krakowie.* 57, p. 124. (The development of ore-bearing dolomites in the Cracow-Silesian area — Engl. summary), Warszawa.

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

Zalaffi M. (1969), Osservazioni su alcuni affioramenti di farina di dolomia al bordo meridionale del Matese. *Boll. Soc. Geol. Ital.* 88, pp. 161—170, Roma.

Zgogović D. (1966), Hidrogeoloska uloga dolomita u dinarskom karstu. *Vesnik. Inženjerska geologija i hidrogeologija.* VI pp. 5—166, Beograd.

## STRESZCZENIE

W dolomicie kruszconośnym występują szczeliny i jaskinie krasowe, które wypełnia szczelnie drobnoziarnisty osad dolomitowy. Osad ten składa się wyłącznie z ziarn dolomitu kruszconośnego oraz z większych odłamków skalnych odpadłych od ścian jaskiń. W niewielkiej ilości pojawia się również galena zarówno pod postacią okruchów, jak autigenicznych kryształów. Drobnoziarnisty osad dolomitowy wypełniający jamy odznacza się szeregiem struktur sedymentacyjnych (rozmycia, warstwowanie skośne i frakcjonalne) oraz deformacyjnych, które wskazują na działanie prądów. Ściany niektórych jam wypełnionych dolomitem obleczone są galeną. Źródłem materiału klastycznego, który wypełnił omawiane jaskinie, był dolomit kruszconośny podlegający procesom rozpadu ziarnistego. Rozpad ten dokonał się pod wpływem roztworów rozpuszczających krawędzi kryształów dolomitu kruszconośnego. Powstałe w tej drodze „rozsypliwe" dolomity kruszconośne ulegały, niemal równocześnie z procesem rozpadu, zjawiskom krasowym, w których wyniku wytworzyły się jaskinie. Rozpadowi ziarnistemu dolomitu kruszcowego towarzyszyła mineralizacja galenowa. Galena tego rodzaju krystalizowała często na granicy między rozsypliwym dolomitem a ostańcami dolomitu nie tkniętego jeszcze procesem rozpadu. Znamienną właściwością omawianych skupień galenowych jest to, iż euhedralne ściany kryształów często skierowane są w stronę rozsypliwego dolomitu. Proces rozpadu i mineralizacja galenowa były sobie prawie współczesne, podobnie jak powstawanie jam wypełnianych następnie ziarnami dolomitowymi. Zjawiska te miały miejsce stosunkowo późno, przypuszczalnie w dolnym trzeciorzędzie, i nastąpiły w wyniku krążenia redukcyjnych wód podziemnych, których pochodzenie nie jest jest jeszcze znane.

## EXPLANATION OF PLATES
## OBJAŚNIENIE TABLIC

### Plate — Tablica XI

Fig. 1. Fine-grained dolomitic cave deposit with large rock-fragments. Detail of dolomite-filled cave from text-figure 1

Fig. 1. Duże fragmenty dolomitu kruszconośnego w drobnoziarnistym osadzie jaskiniowym. Szczegół jaskini wypełnionej osadem dolomitowym z fig. 1 w tekście

Fig. 2. Detail of dolomite-filled cave from text-figure 1 with fracture filled with clastic dolomite

Fig. 2. Szczegół jaskini z fig. 1 w tekście z szczeliną wypełnioną dolomitem

### Plate — Tablica XII

Fig. 1. Detail of dolomite-filled cavity with galena-lined wals Compare fig. 4, lower right

Fig. 1. Szczegół poziomej szczeliny wypełnionej dolomitem klastycznym o ścianach inkrustowanych galeną. Porównaj fig. 4 w tekście

Fig. 2. Fine-grained dolomitic cave deposit with angular fragments of enclosing ore-bearing dolomite. Note liquefaction-halo around fallen rock-fragments (arrow). Detail of dolomite-filled cave from text-figure 1

Fig. 2. Drobnoziarnisty osad dolomitowy z ostrokrawędzistymi fragmentami dolomitu kruszconośnego. Zwrócić uwagę na upłynnienia wokoło spadłych okruchów skalnych (strzałka). Szczegół jaskini wypełnionej dolomitem z fig. 1 w tekście

### Plate — Tablica XIII

Fig. 1. Negative print of thin section. Detail of laminated cave deposit from text--fig. 3. Note bedding disturbances induced by impact of dolomite fragment with galena (upper center) and deformations due to instability (right)

Fig. 1. Zdjęcie negatywne płytki cienkiej „laminatu" wypełniającego jamę krasową. Szczegół jamy wypełnionej dolomitem z fig. 3 w tekście. Zwrócić uwagę na zaburzenia wywołane spadkiem kawałka dolomitu z galeną (górna część zdjęcia) oraz deformacje spowodowane niestatecznością w warstwowaniu

Fig. 2. Negative print of thin-section. Detail of laminated cave deposit from text--fig. 2. Note scour structure and crosstratification

Fig. 2. Zdjęcie negatywne płytki cienkiej. Szczegół wypełnienia dolomitowego jamy z fig. 2 w tekście. Zwrócić uwagę na powierzchnie erozyjne oraz uwarstwienie skośne

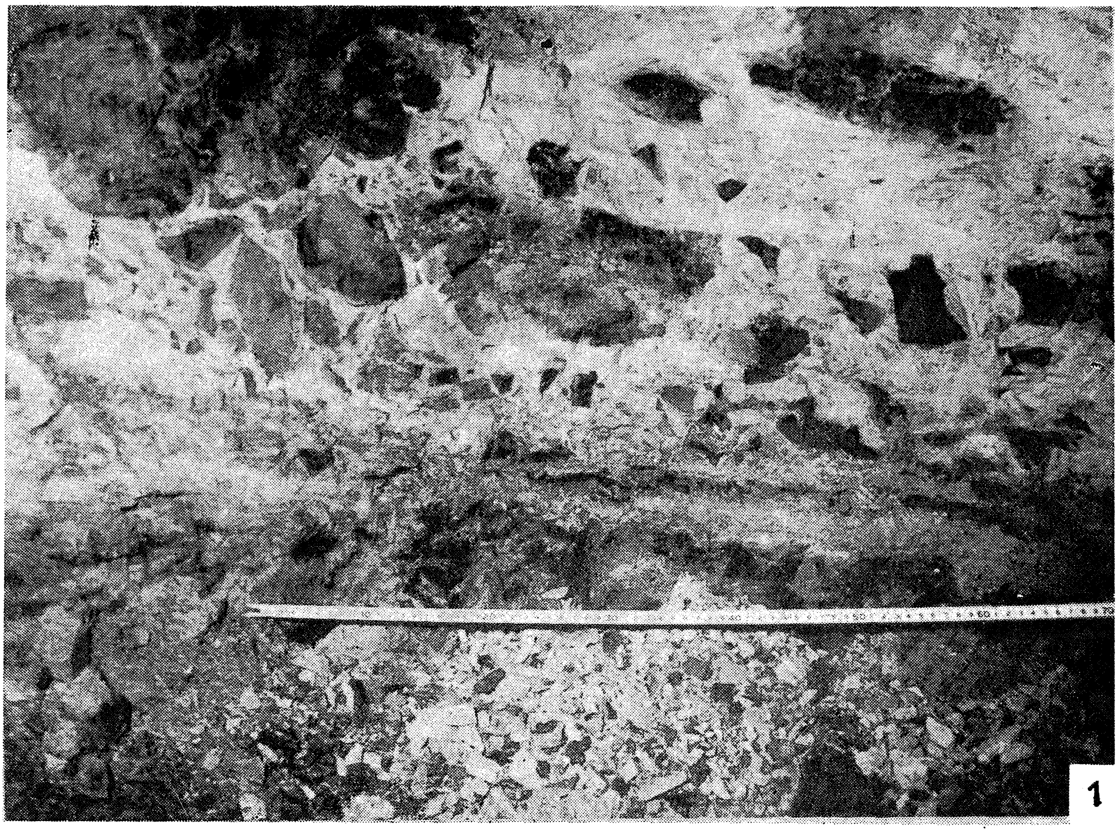
### Plate — Tablica XIV

Fig. 1. Dolomite-filled cavity (1) and disaggregated dolomite with vermicular galena. Detail of dolomite-filled cavity from text-fig. 3. Disaggregated dolomite with vermicular galena (1), dolomite-filled cavity (2) and not-sanded dolomite (3)

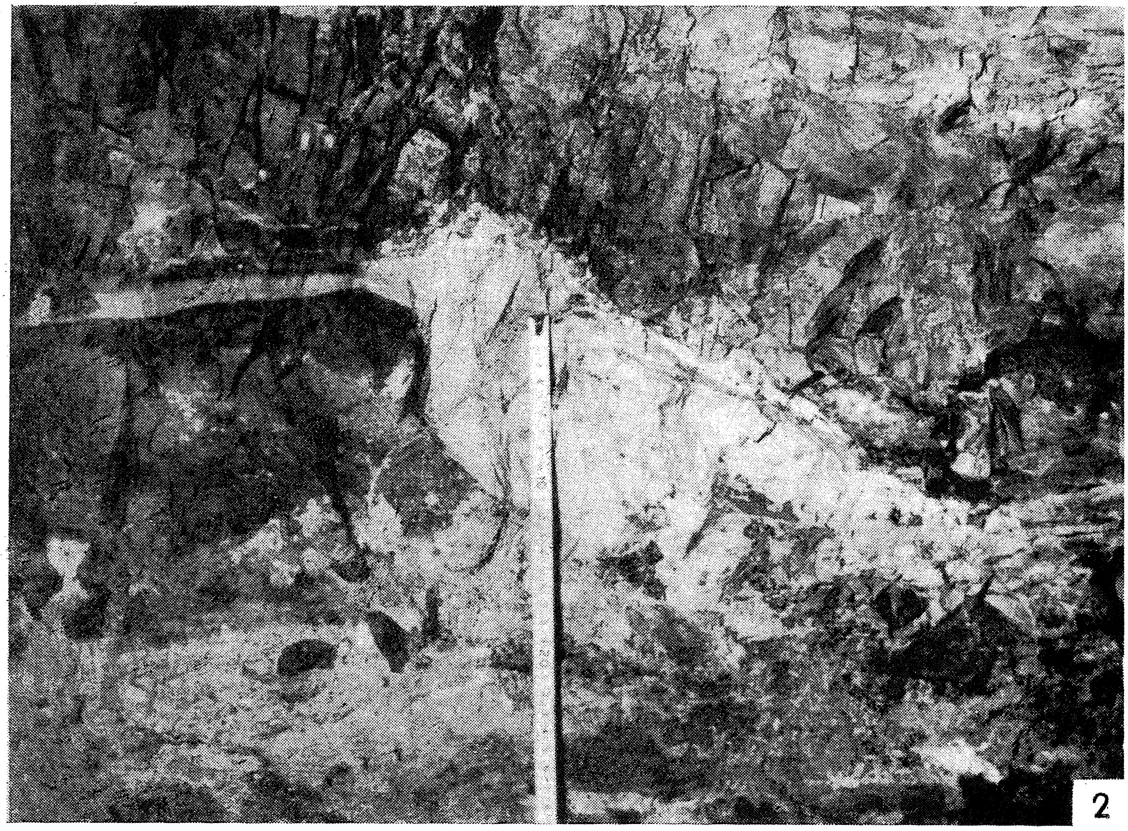
Fig. 1. Szczegół jamy wypełnionej dolomitem z fig. 3 w tekście. 1 — rozsypliwy dolomit z „robaczkową" galeną; 2 — dolomit klastyczny wypełniający jamę krasową; 3 — dolomit twardy

Fig. 2. Contact between dolomite-filled cave (right) and ore-bearing dolomite (left). Note dark sulfide-rich laminate in upper left corner of the cave

Fig. 2. Powierzchnia graniczna między „laminatem" wypełniającym jamę krasową a otaczającym dolomitem kruszconośnym. Zwrócić uwagę na ciemny wzbogacony w siarczki laminat w lewym górnym rogu jamy

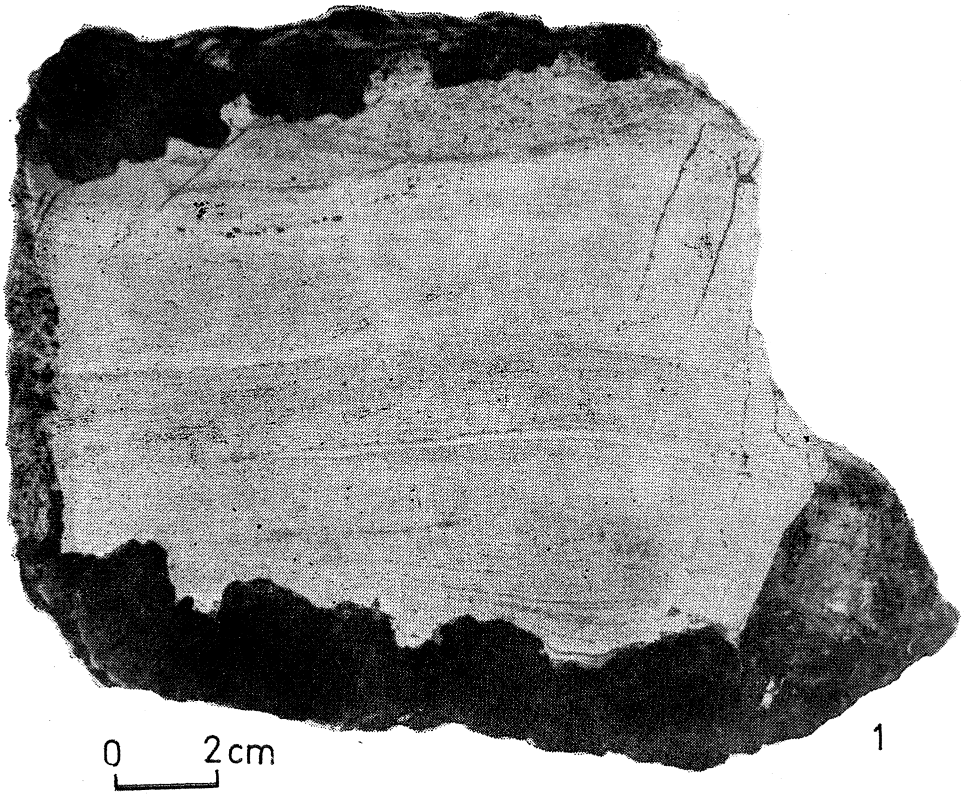


1

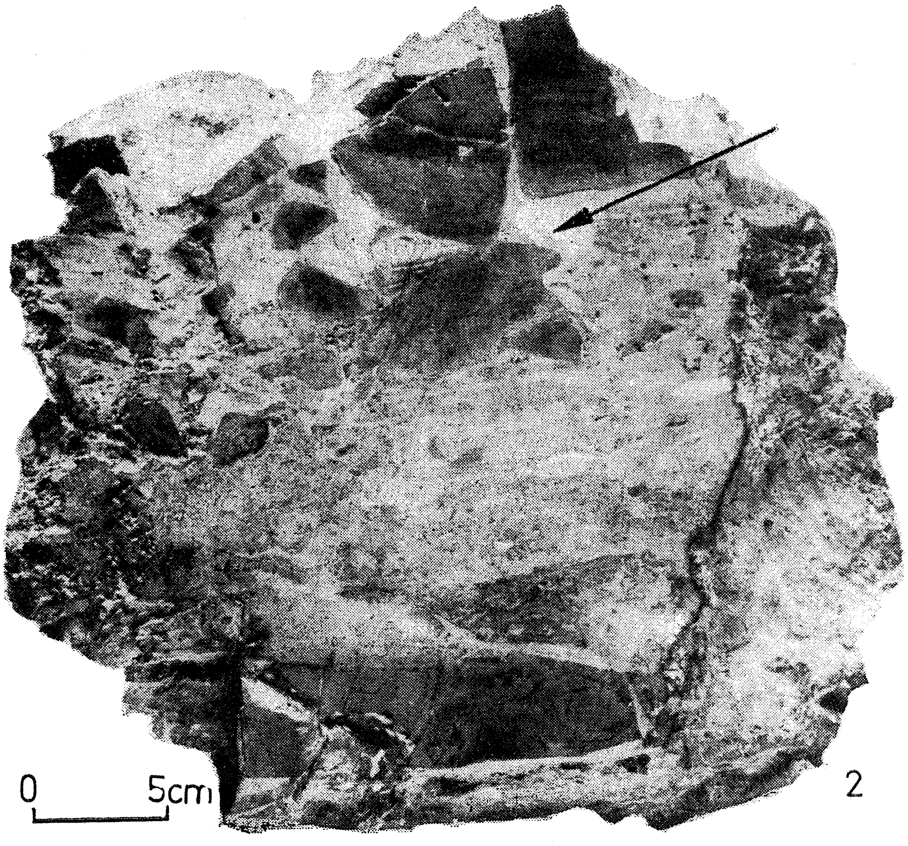


2

*K. Bogacz, S. Dżułyński, C. Harańczyk*



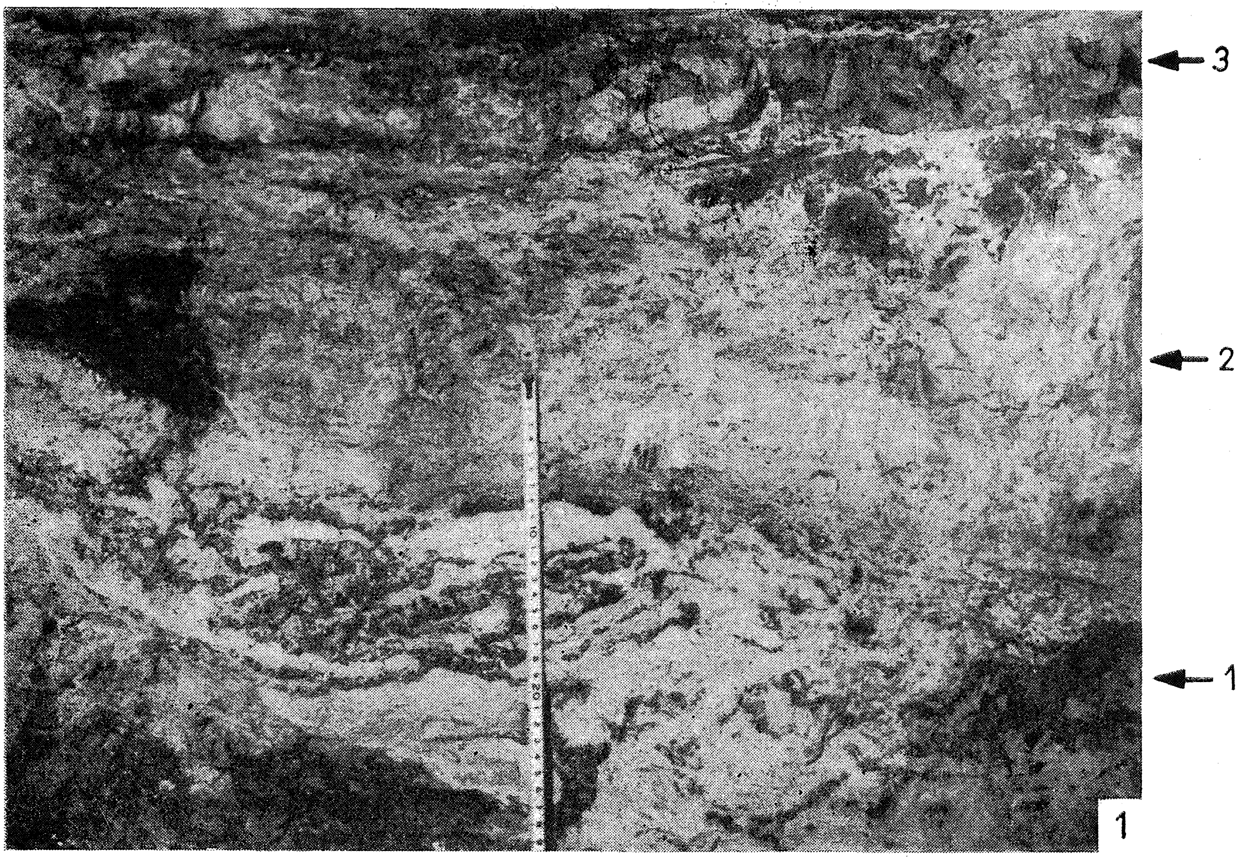
1

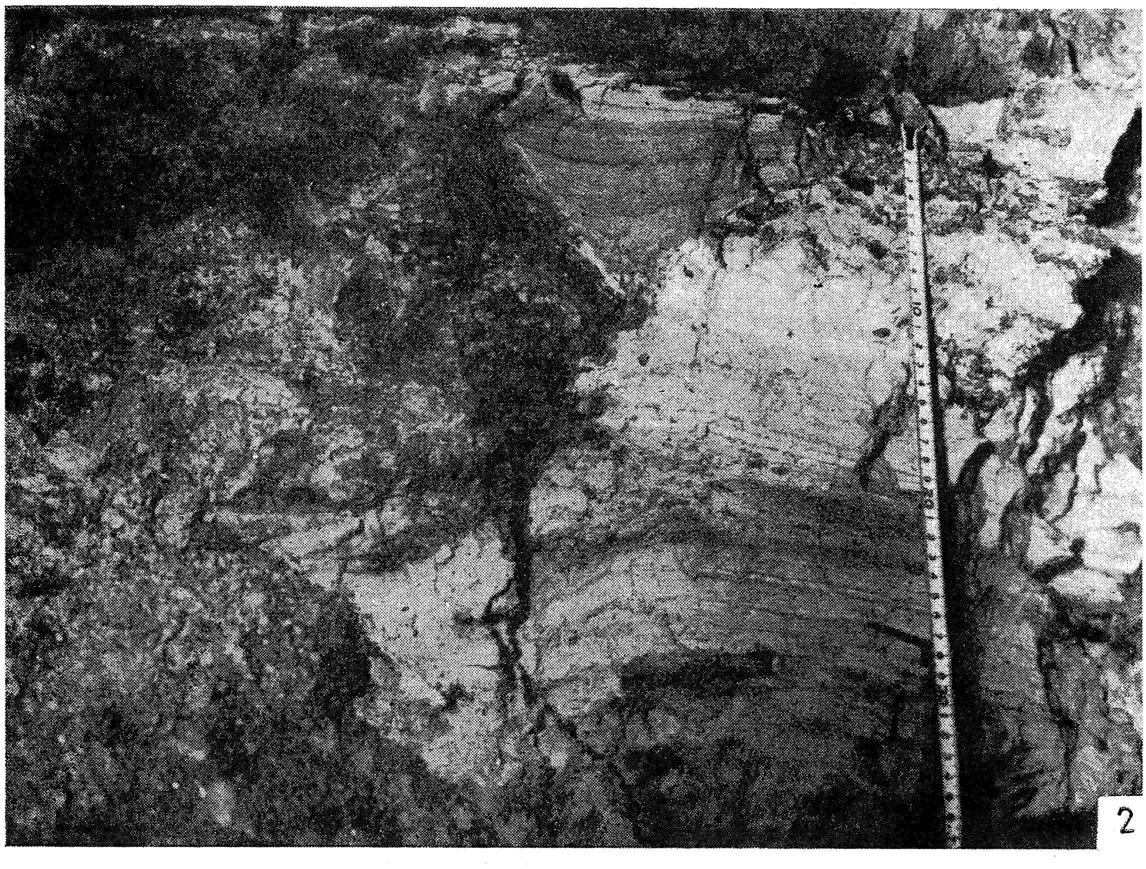


2

*K. Bogacz, S. Dżułyński, C. Harańczyk*

K. Bogacz, S. Dżułyński, C. Harańczyk





*K. Bogacz, S. Dżułyński, C. Harańczyk*