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# STRATIFIED SULFIDE ORES IN KARST CAVITIES OF THE OLKUSZ MINE (CRACOW — SILESIAN REGION, POLAND)

(Pl. I—II, and 3 Figs.)

## *Warstwowane rudy siarczkowe w kawernach krasowych w kopalni Olkusz (rejon śląsko-krakowski)*

*(Tabl. I—II i 3 fig.)*

Abstract: Karst cavities beneath the brecciated ore-bearing dolomite and solution channels developed in limestones are filled with stratified sphalerite ores. These ores represent internal sediments deposited by underground solutions and provide an argument in favor of epigenetic and karstic origin of Zn-Pb ores in the Triassic of the Cracow-Silesian region.

This note aims to describe a specific type of sulfide ores that tend to occur in karst cavities of the Muschelkalk limestones exposed in the Olkusz Mine (Cracow-Silesian ore district). The cavities in question show an apparent genetic association with solution-collapse breccias in the ore-bearing dolomite. These breccias have already been comprehensively described in earlier paper (M. Sass-Gustkiewicz, 1974). Thus, only a brief reference to them will be made. The breccias under consideration consist of angular dolomite blocks and fragments set at all angles. The interfragmental space is filled with finer dolomite particles and, in places, with sulfide ores (the breccias are the chief receptacles of sulfides ores in the area). The breccias originated from solution-collapse consequent upon the formation of karst cavities and the removal of carbonates. The karst cavities and breccias, believed by some authors to have been formed by hydrothermal solutions ("hydrothermal karst" in the meaning of Bogacz et al. 1970), tend to develop along the metasomatic boundary between the ore-bearing dolomite and the underlying unaltered limestones (for details concerning the character of dolomite limestone contact see K. Bogacz et al., 1972). Accordingly, the base of the breccia structures is a sharply defined solution surface of limestones (the

limestones below the dolomite are not involved in brecciation). The surface in question represents the original floor of the karst cavities and shows all the diagnostic features indicative of underground karst processes. The features include: solution pockets, solutionally enlarged joint fractures and protruding relics of undissolved limestones. Some typical examples of such karstic forms are shown in Fig. 1 and Pl. I. Fig. 1.

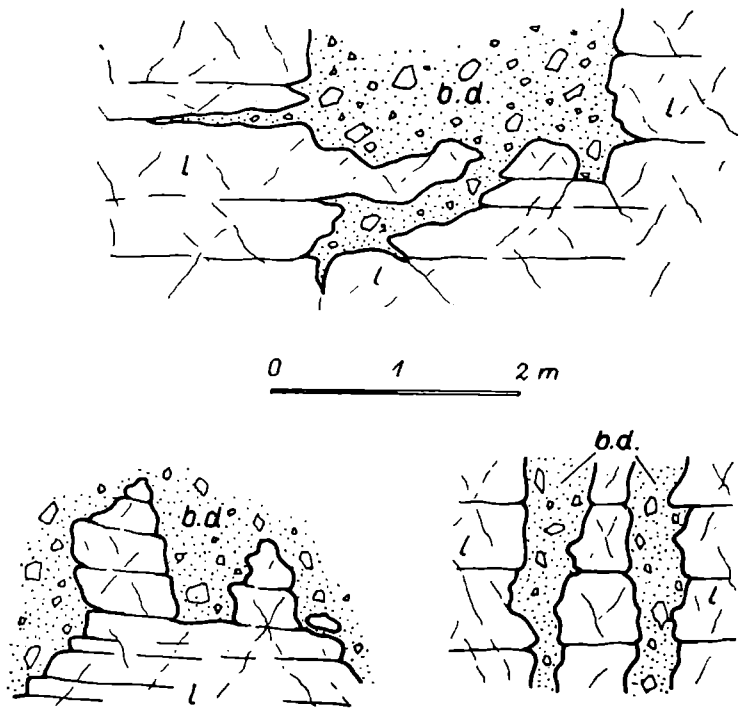


Fig. 1 — Examples of karst features in limestones (1) filled with brecciated dolomite and residual matter (b. d.)

Fig. 1 — Przykłady typowych form krasowych w wapieniach (1) wypełnionych brekcją dolomitową i materiałem rezydualnym (b. d.)

The solution pockets and channels in limestones are filled with a specific type of cave deposits containing considerable amounts of sulfide ores. Such deposits may differ depending on their position with regard to the main breccia bodies (Fig. 2).

Immediately beneath the breccias there is often an earthy mass with dolomite and limestone fragments. This material contains also fragments of sulfide ores obviously derived from the overlying mineralized parts of the breccias. Some of the ore-fragments show rounded contours indicative of short transport by underground waters. The above discussed earthy mass represents presumably a residuum of the solution process and reveals a close analogy to the so called "vitriol clays" from the Bytom region as described by J. H o r z e m s k i (1962).

The earthy mass with embedded rock- and ore-fragments may entirely fill the solution pockets. In many places, however, the pockets are partly or entirely filled with stratified ores. Such ores represent "internal sediments" in the meaning of B. S a n d e r (1936) and consist of

laminae of alternating lighter and darker shades (Pl. I. Fig. 2). The laminae are made up of black argillaceous and gray carbonate matter and of sphalerite grains. The amount of sphalerite is high enough to justify the term "ores" with respect to such deposits. The laminated ores contain also pyrite and, sporadically, colloform aggregates of marcasite.

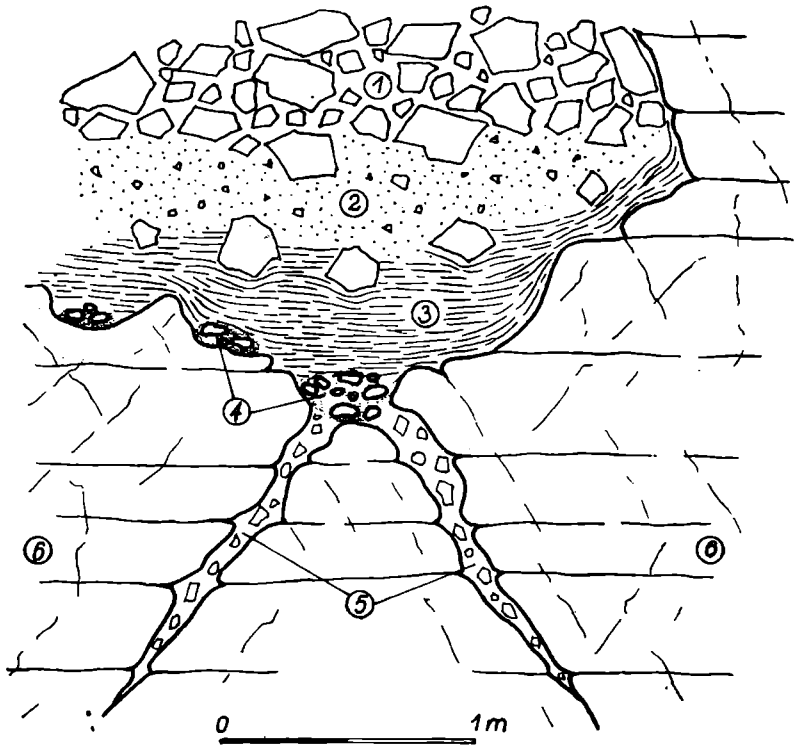


Fig. 2 — Schematic presentation of a karst cavity filled with cave deposits that filled solution pockets and solutionally enlarged fractures in limestones underlying the brecciated ore-bearing dolomite. 1 — brecciated dolomite; 2 — earthy mass with dolomite fragments and sulfide minerals; 3 — stratified sphalerite ores; 4 — rounded limestone fragments cemented by sphalerite; 5 — argillo-calcareous mass with limestone fragments that filled solutionally enlarged fractures; 6 — limestone

Fig. 2 — Schemat ułożenia utworów wypełniających kieszenie krasowe i poszerzone spękania w wapieniach podścielających zbrekcjowane dolomity kruszconośne. 1 — brekcja dolomitowa; 2 — ziemista masa z drobnymi okruchami dolomitów i minerałów siarczkowych; 3 — rudy laminowane; 4 — obłe fragmenty wapienia spojone sfalerytem; 5 — ilasto-węglanowa ziemista masa zawierająca okruchy i obłe fragmenty wapienia; 6 — wapień

As seen in thin sections, the carbonate laminae consist of detrital dolomite grains showing often graded bedding. In addition to distinct horizontal stratification, the ores discussed reveal cross-lamination and soft-rock deformation indicative of micro-slumping. There are also minute syn-depositional faults. The overall attitude and habit of these stratified ores suggest lateral movement of underground solutions.

The stratified ores contain aboundant dolomite fragments that dropped from the roof of cavities and became embedded in the soft cave deposits. The softness of the deposit is demonstrated by the fact that the laminae beneath the dolomite fragments are commonly bent down (Fig. 3 and Pl. II. Fig. 1). This, as well as the fact that the laminated ores often

occur in form of irregular bodies within the breccias, indicates that the brecciation and the formation of laminated ores were essentially contemporaneous processes.

The laminated ores may also fill solution channels in limestones underlying the brecciated dolomite. In such instances these ores are notably devoid of dolomite fragments.

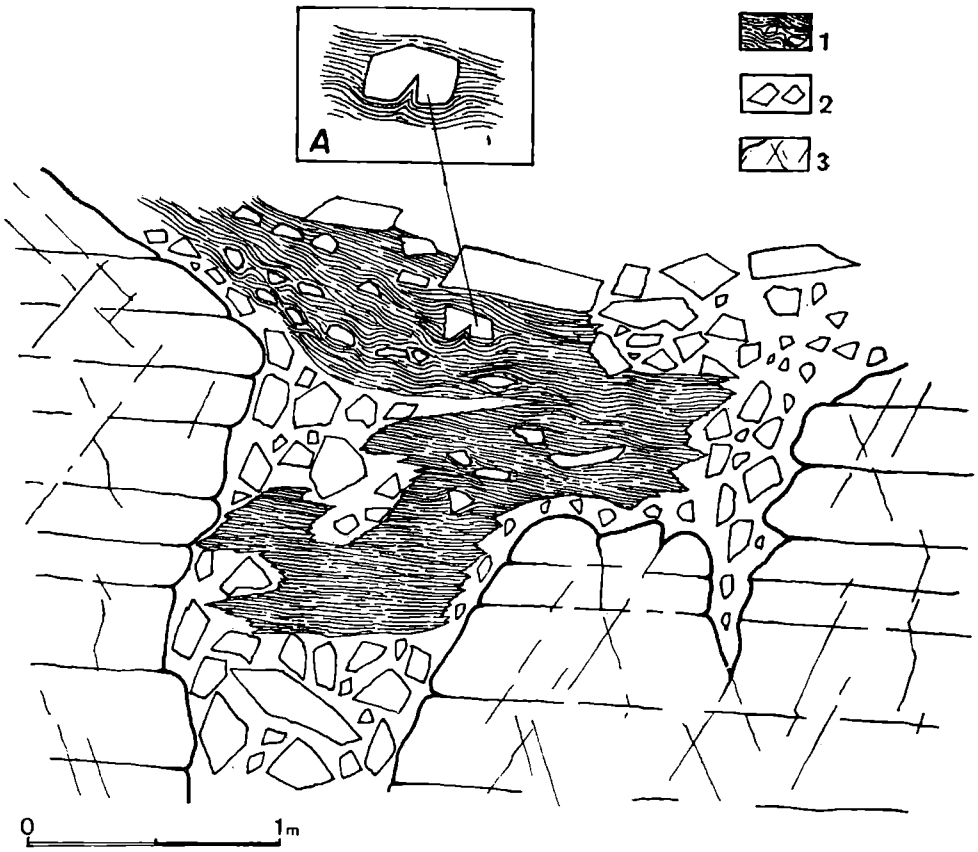


Fig. 3 — Detail of mineralized cave deposits at the base of brecciated ore-bearing dolomite. 1 — stratified sphalerite ores; 2 — brecciated ore-bearing dolomite; 3 — limestone. Note deformation of laminae beneath dolomite fragment in stratified ores (A)

Fig. 3 — Szczegół ilustrujący występowanie rud laminowanych w spągu brekcji dolomitów kruszconośnych, 1 — rudy laminowane; 2 — niescementowana brekcja dolomitowa; 3 — wapień. Widoczne uginanie się lamin pod okruchem dolomitu (A)

Often, near or at the bottom of solution pockets filled with stratified ores, there occur rounded limestone fragments. Such fragments bear a record of corrosion processes proceeding from the surface of fragments toward their interior. In places, such limestone fragments are cemented by crystalline sphalerite, a rather uncommon feature in the Cracow-Silesian deposits (Pl. II. Fig. 2).

To complete the picture it may be added that the solutionally enlarged joint fractures extending downwards from the bottom of solution pockets are commonly filled with an earthy argillo-calcareous mass containing angular limestone fragments.

The stratified ores discussed in this paper are analogous to the so called "laminates", i.e., laminated clastic dolomites which occur in caves developed in the ore-bearing dolomite (see Bogacz et al. 1973). Similar deposits have also been reported from other ore-districts. The so called "Sonderfazies des Erzes" described and variously interpreted by Austrian authors (Siegl, Schneider 1957) belong presumably to the same class of deposits. Stratified ores like those here discussed have also been described from Salafossa by P. Lagny (1974). The striking similarity between the karst ores from Salafossa and the ores from the Olkusz Mine is accentuated by their analogous position with respect to the breccia bodies.

Concluding our discussion it may be stated that the stratified sphalerite ores in question represent a typical cave sediment and provide yet another argument in favor of epigenetic and karstic origin of the Cracow-Silesian deposits.

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## STRESZCZENIE

W złożu cynku i ołowiu w Olkuszu, w spągu struktur brekcjowych opisanych w pracy M. Sass-Gustkiewicz (1974), występują charakterystyczne rodzaje rud siarczkowych, które wykazują oczywisty związek genetyczny z brekcją. Brekcje dolomitów kruszconośnych spoczywają na powierzchni, którą cechuje obecność typowych form krasowych, i powstały w wyniku zawału w puste przestrzenie, utworzone w drodze rozpuszczania krasowego. Kieszenie krasowe zawierają rudy siarczkowe, których wykształcenie wiąże się z ich położeniem względem spągu kieszeni i głównej masy brekcji. Spośród nich najbardziej interesujące są rudy warstwowane. Charakteryzują je laminacje, przekątne warstwowanie oraz wykazują one deformacje plastyczne. Pozycja rud względem brekcji oraz układ lamin wokół występujących w nich okruchów dolomitu wskazują na to, że rudy laminowane tworzyły się równocześnie z brekcją dolomitową i są przykładem tzw. „wewnętrznej sedymentacji", która zachodziła w kawernach krasowych w trakcie procesu mineralizacji. Pozycja i wykształcenie rud warstwowych wykazuje duże analogie do tzw. „sonderfazies des Erzes" w Bleibergu oraz do rud laminowanych w złożu Salafossa, może więc stanowić argument w toczącej się dyskusji nad ich pochodzeniem.



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## EXPLANATIONS OF PLATES

## OBJAŚNIENIA TABLIC

### Plate — Tablica I

Fig. 1. Detail of contact between brecciated ore-bearing dolomite (d) and limestone (l)

Fig. 1. Żebro krasowe wypreparowane w poziomo zalegających wapieniach (l) otoczone brekcją dolomitową (d)

Fig. 2. Stratified sphalerite ores filling karst cavities. od — fragment of ore-bearing dolomite; mr — marcasite aggregates. Note cross-stratification and soft-rock deformation of laminae

Fig. 2. Sfalerytowe rudy laminowane wypełniające kawerny krasowe. od — okruch dolomitu kruszconośnego; mr — sferyczne skupienia markasytu. Widoczne przekątne ułożenie zespołów lamin oraz ich plastyczne deformacje

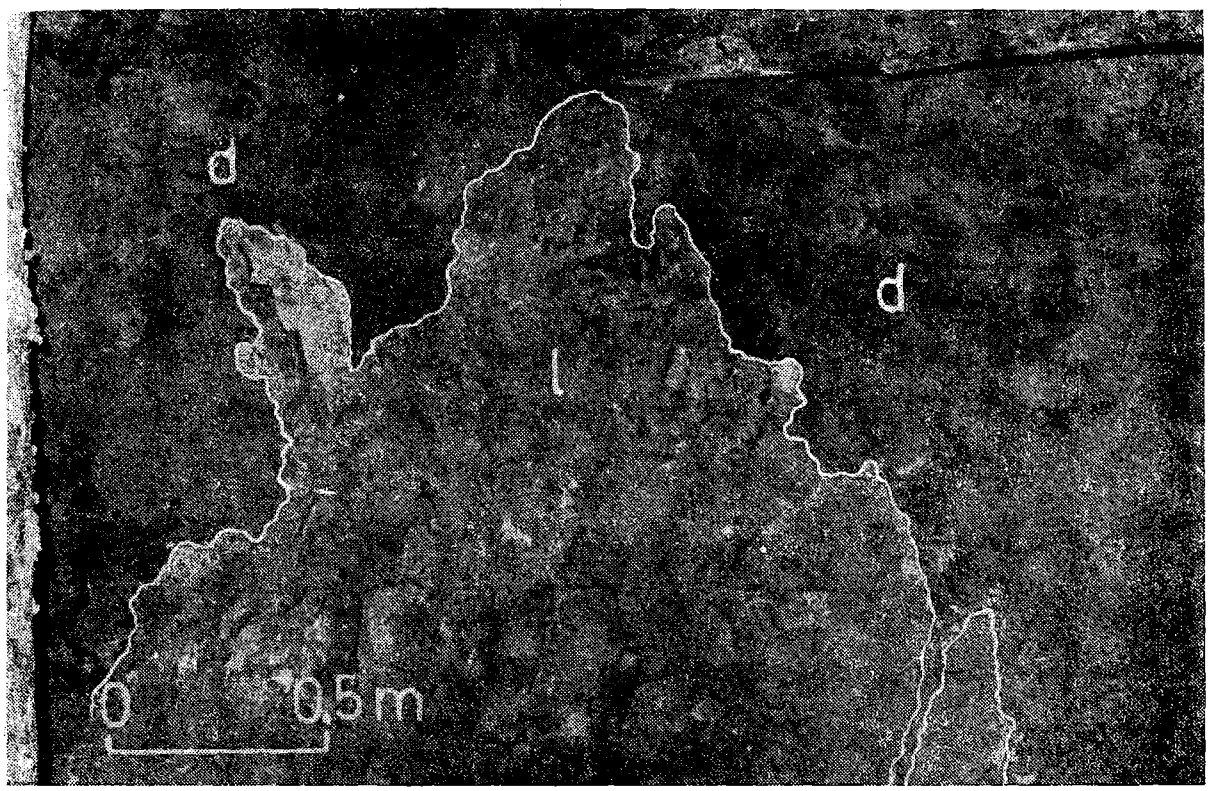
### Plate — Tablica II

Fig. 1. Laminated sphalerite ores with dolomite fragment (od). Note down bending of laminae beneath the fragment (lower right).

Fig. 1. Fragment struktur laminowanych zawierających okruch dolomitu (od). Z prawej strony widoczne są pod nim ugięcia lamin

Fig. 2. Limestone fragments (l) cemented by crystalline sphalerite (s)

Fig. 2. Obłe fragmenty wapieni (l) spojone sfalerytem (s)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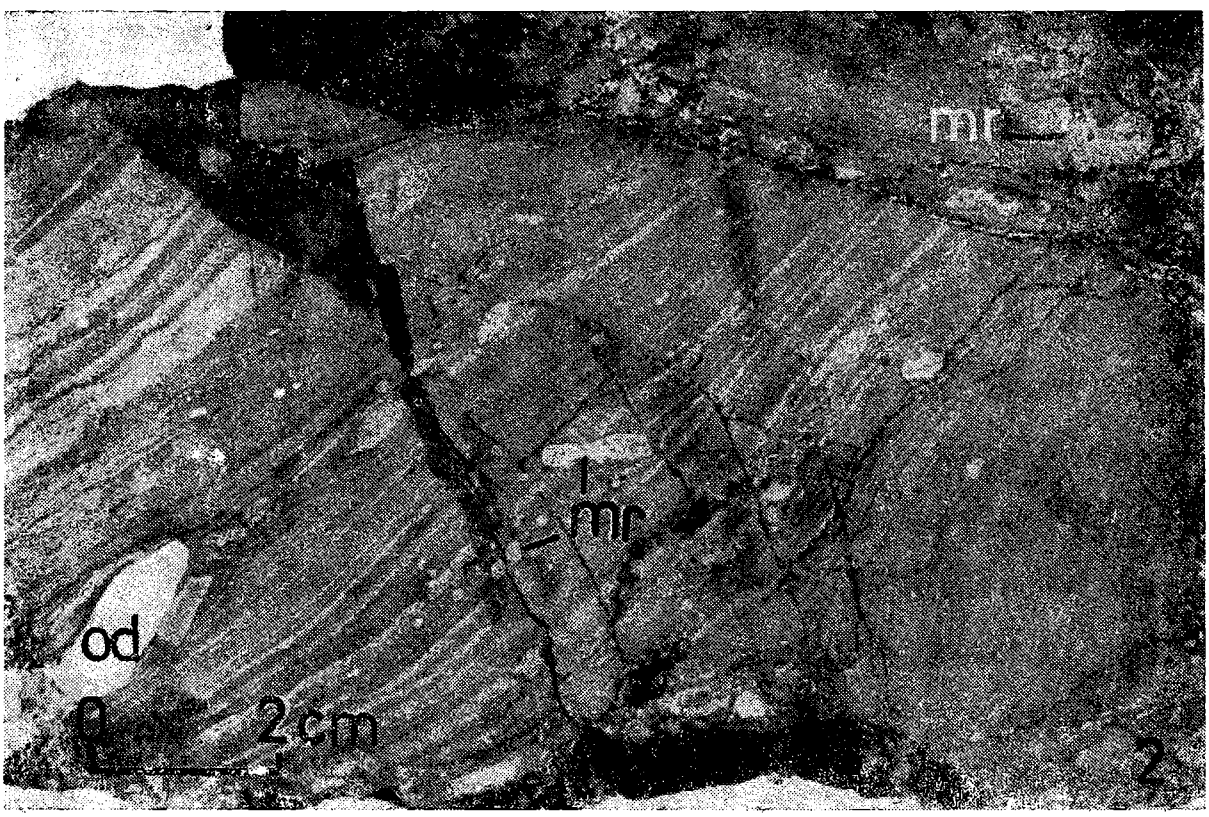
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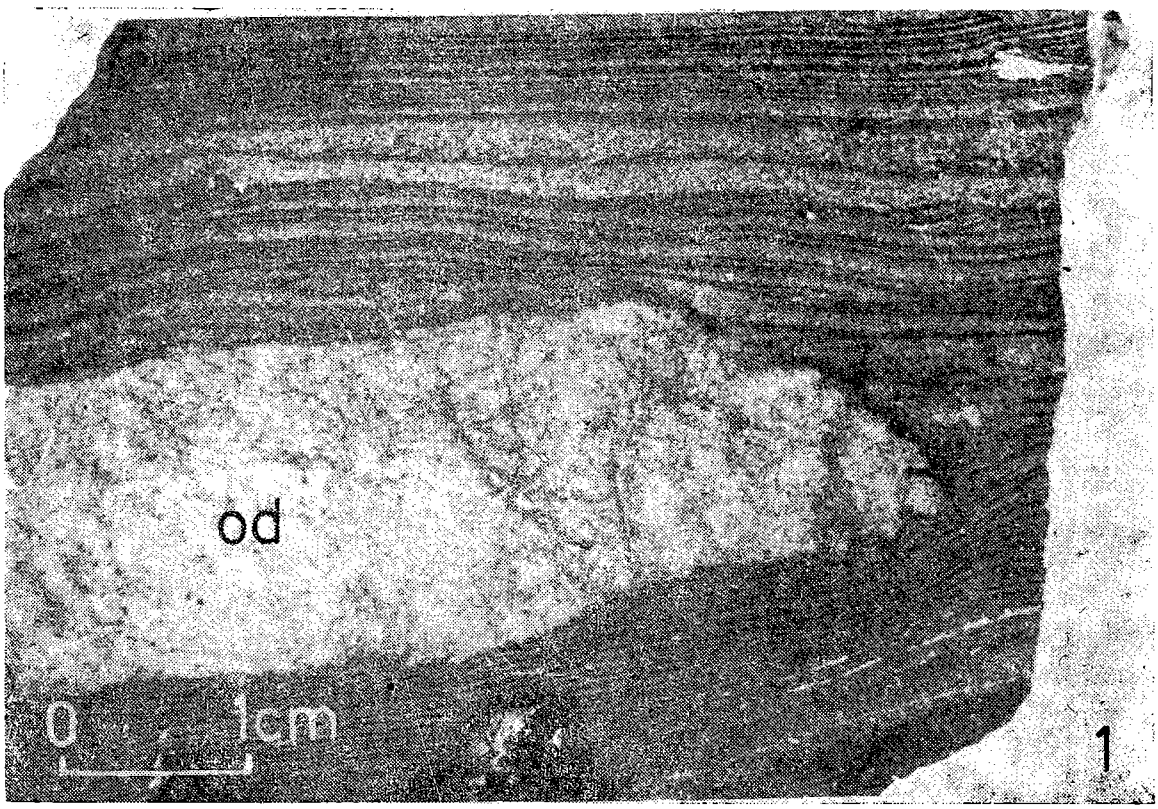
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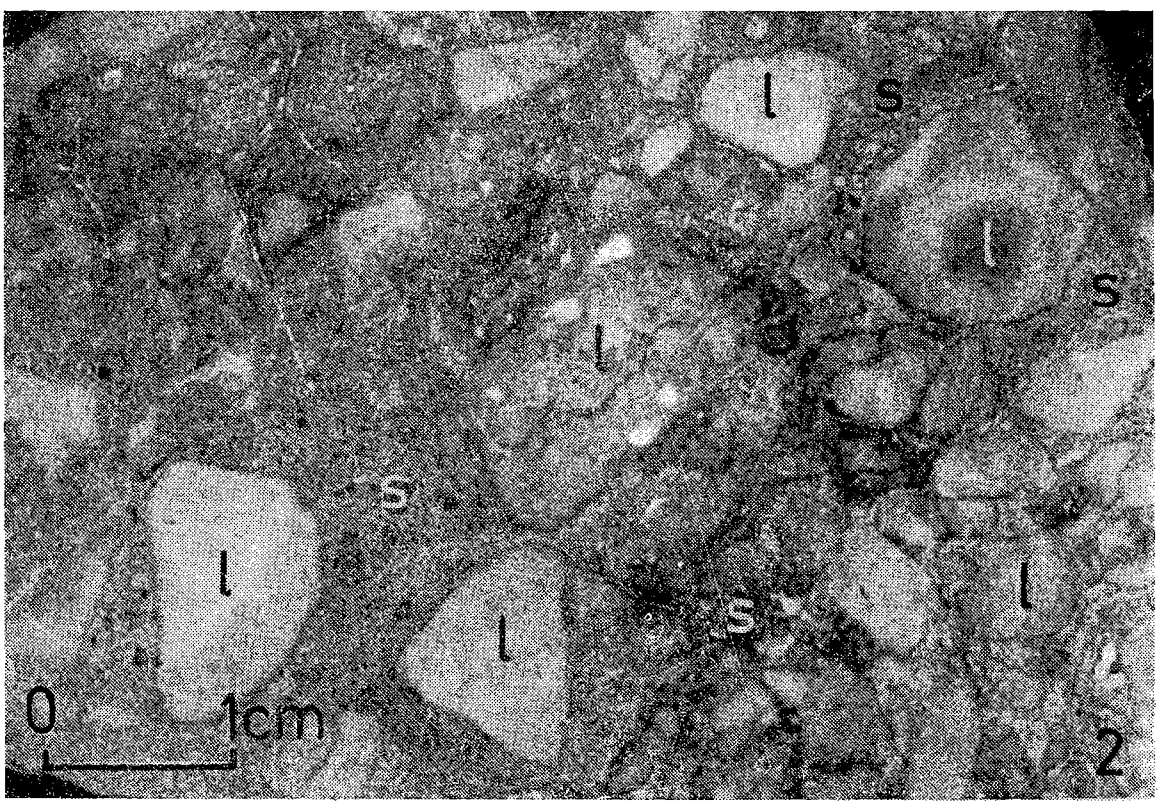
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