Some Examples of Lead-Zinc-Barite Depositions in Karstic Environments

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Foreword

Many occurrences of lead-zinc-barite deposits in karstic environments have been described by several authors, all over the world, during the last years; e. g. Leleu, 1966b; Bernard and Leleu, 1967; Cross and Lagny, 1969; Lagny, 1969. Many other authors are listed in the above mentioned papers; they point out the advancements in this subject.

Before starting to describe these occurrences we should like to point out that, in our opinion, all the karst deposits are formed by similar genetic processes, although they display different characteristics in their texture, shape, mineral composition etc.

Italy (Sardinia)

The karstic ore deposits in South-Western Sardinia — described by several authors in these last years (Benz, 1964; Tamburrini and Violo, 1965; Tamburrini, 1966; Tamburrini and Zuffardi, 1967) — can be subdivided in three main types:

1. Thinly laminated beds, generally subhorizontal or slightly inclined along the crevice walls (Fig. 1), thus unconformably lying on the (Paleozoic) host rocks.

This occurrence shows many varieties in the association both of ore and of gangue minerals. The ore minerals, which may occur, are: pyrite (framboids), galena, sphalerite, barite; the gangue minerals are: carbonates (calcite, dolomite, siderite), quartz, iron hydrated oxides, clays.

The types of deposits made by different associations of these minerals are mainly two:

— The first one shows mainly thin alternances of barite and dark quartz beds, with minor galena and framboidal pyrite; sometimes carbonates and minor limonite and clay, cemented by quartz, are present.

Not uncommonly, these deposits are covered by conglomerates and sandstones, whose cement, generally clayey and/or siliceous, is sometimes

Fig. 1. S. Giovanni mine. "Ricchi Ag" stope. Sardinia (Italy). It is visible from right to left:

— crevice wall made up by Cambrian carbonatic rock (dark grey)
— a large band of spathic calcite (whitish)
— thin beds of sulphides-clay-carbonates rhythmic depositions.

A gentle inclination of the beds is visible in this part of the karstic crevice.

partially made by barite (Brusca, Pretti and Tamburrini, 1967).

— The second one is characterized by the presence of sphalerite: the karst filling beds are thin, rather dark to black, made by sphalerite, galena, framboidal and euhedral pyrite, cemented by dolomite (Fig. 2).

The most common type of karstic deposits is the first one, which is characterized by barite, carbonates, iron hydrated oxides, that is an association related to oxidizing environments (Leleu, 1966a); the occurrence of galena in these deposits may be due to different processes: either syngenetic galena related to horizons deposited in favourable Eh—pH conditions (Garrels, 1954), or (minor) galena formed when dispersed lead into the oxidized filling sediments was placed under reducing conditions and sulphurated during the normal evolution of the karsts.

Only seldom the occurrence of other sulphides (second type) testifies the achievement of strong reducing conditions, which are typical of a late senility stage (Bernard and Leleu, 1967).

Notwithstanding these characters, normally the described karsts are completely fossilized, thus they can be called holokarsts (Cvijić, 1925; Llopis-Llado, 1953).

Moreover the changing composition of the karst fillings testifies variable chemical-physical conditions, related to paleogeographical variation during the deposition of residual materials.

These types of karstic deposition are well developed mainly in the Cambrian carbonatic formation, especially where it is completely flattened by the post-Hercynian erosion.

2. Galena-barite-calcite cockades and stalactites. This kind of structures, particularly well developed in the San Giovanni mine (Cambrian limestones, Iglesiente — SW Sardinia), (Brusca and Dessau, 1968), is related to meteoric water percolating into karstic cavities and leaving there the carried ions, which form the above mentioned minerals. This type of karstic deposition is quite similar, almost regarding to the macroscopic appearance of the ore, to that of Sidi Bou Aouane, which will be described later.

The cockades may have a Cambrian limestone fragment, as nucleus, surrounded by white calcite, silver-rich galena and quartz bands (Fig. 3); in other cases they are without any nucleus and included in large masses of spathic calcite (Fig. 4).

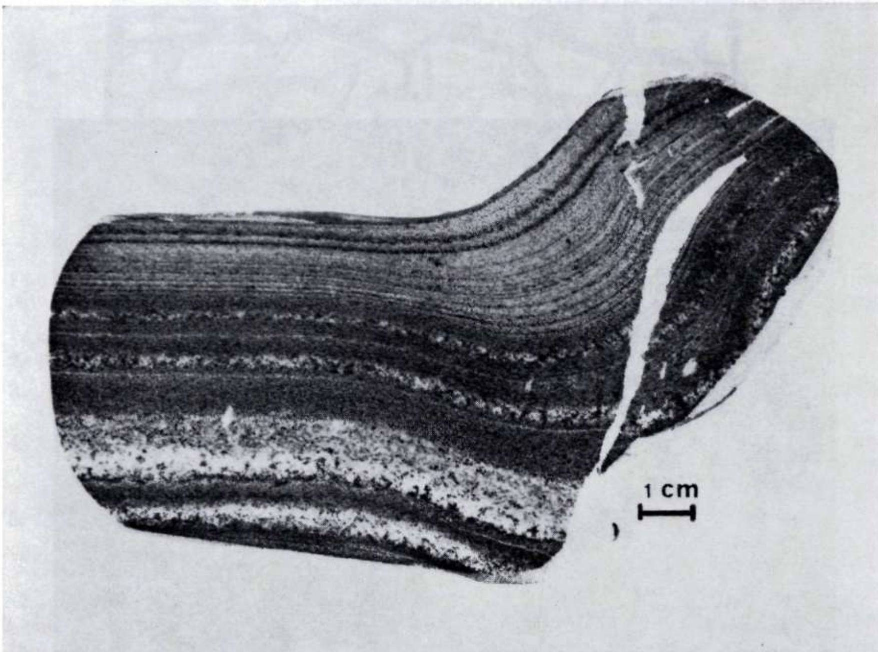

Fig. 2. Gutturu Pala mine. Sardinia (Italy). Thin beds of galena, sphalerite and pyrite (very often with framboidal structure) cemented by dolomite and calcite. The clearer beds are richer of carbonates than the others. Small quartz veins (white) cut the bedding. Polished hand-specimen. Natural light.

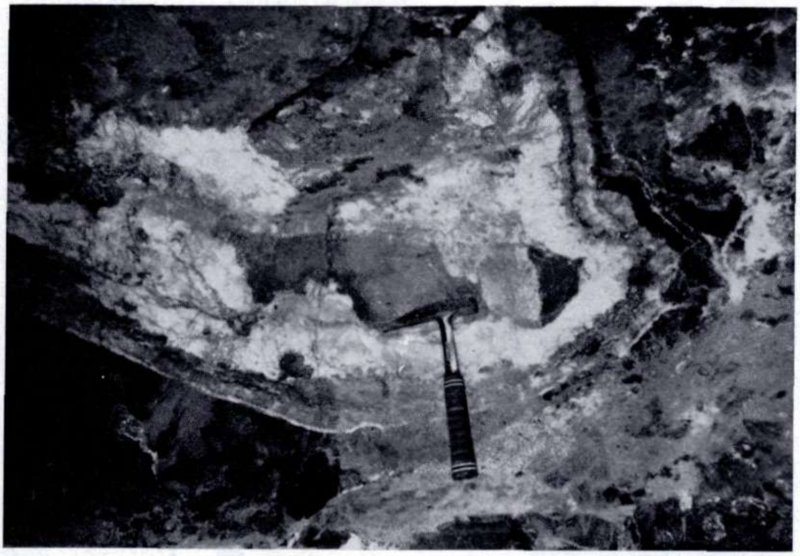

Fig. 3. S. Giovanni Mine. "Ricchi Ag" stope. Sardinia (Italy). Fragment of Cambrian carbonatic rock surrounded by prevalent calcite (white) and quartz--galena (grey to black).

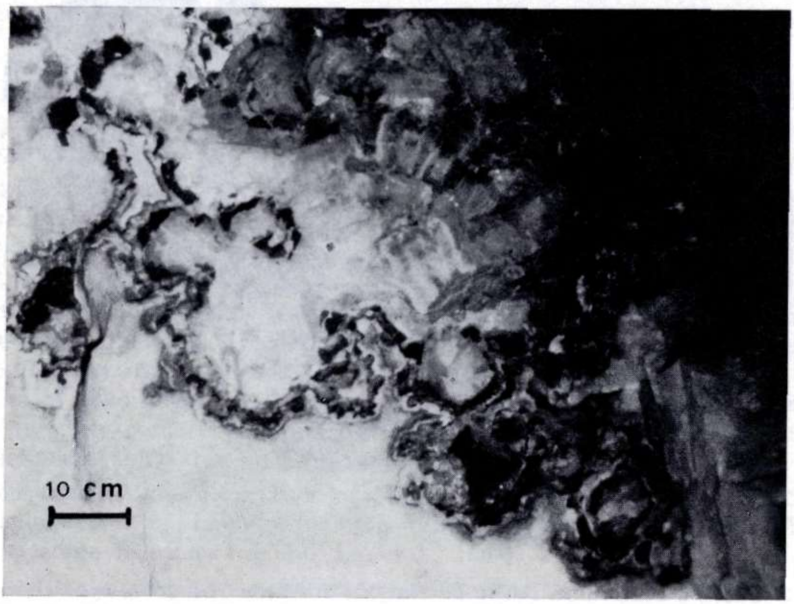

Fig. 4. S. Giovanni mine. "Ricchi Ag" stope. Sardinia (Italy). Cockades of galena (black), quartz and calcite included in spathic calcite (white).

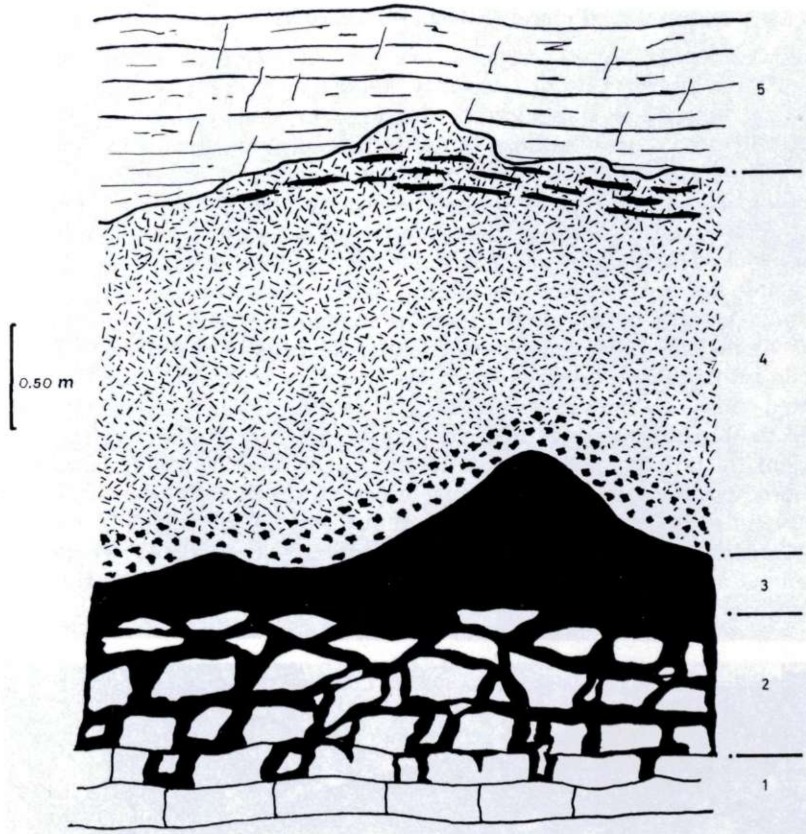

Fig. 5. Orcel Biały mine. Bytom district. Poland, Sketch showing a typical mineralization in this mine. It is possible to observe from bottom to top:

1. Barren "Gogolin" limestone.
2. Fragments of "Gogolin" limestone included in "vitriol clay" passing to
3. A large band of "vitriol clay" which is a residual deposit due to karstic solution.
4. Bedded mineralization, where marcasite is prevalent in lower part and sphalerite content is gradually increasing upwards; small lenses of galena appear in the top part.
5. Ore-bearing dolomite.

3. Collapse breccias, characterized by limestone and dolomite boulders (coming from the Middle Cambrian "Metallifero" member) cemented with barite, calcite and "terra rossa" with a strongly anomalous geochemical lead-zinc content (M a r c e l l o, 1969). This type of karst, which is probably younger than the others, is rarely related to economic ore deposits, excepted some clastic barite deposits.

Poland (Silesia — Cracow)

The well known Silesia-Cracow ore deposits have been the topic of many genetic interpretations. Recently B o g a c z , D ż u ł y ń s k i , H a r a ń c z y k described some karstic features in the ore-bearing Triassic rock of this area; these authors imputed the sulphide deposition and the karst itself to hydrothermal-type ascendant streams.

One of us had the possibility of studying the Bytom and Chanow mining districts, for some months, and the *per descensum* karstic deposition looked to play a main role in the sulphide genesis; in fact the ore-bearing horizon, which lies on the generally unmineralized Gogolin limestone, is made by an almost general sequence, which is, from bottom to top: vitriol clay, sphalerite-pyrite-marcasite beds (Fig. 5), which evolve upwards into collapse breccias made by boulders of ore-bearing dolomite cemented with collophorm sphalerite or brunkite and galena veinlets (Fig. 6). In this case, again, the karst evolved till reaching strong reducing conditions in its lower parts, while in the upper ones, where the reducing conditions were not so strong, large masses of "terra rossa" with veinlets of rejuvenated galena are present, actually, in the ore-bearing horizon. This "terra rossa" and perhaps the galena are the recent weathering phenomena and they are mainly developed where the mineralizations are shallower (e. g., Matylda mine), nearer the surface.

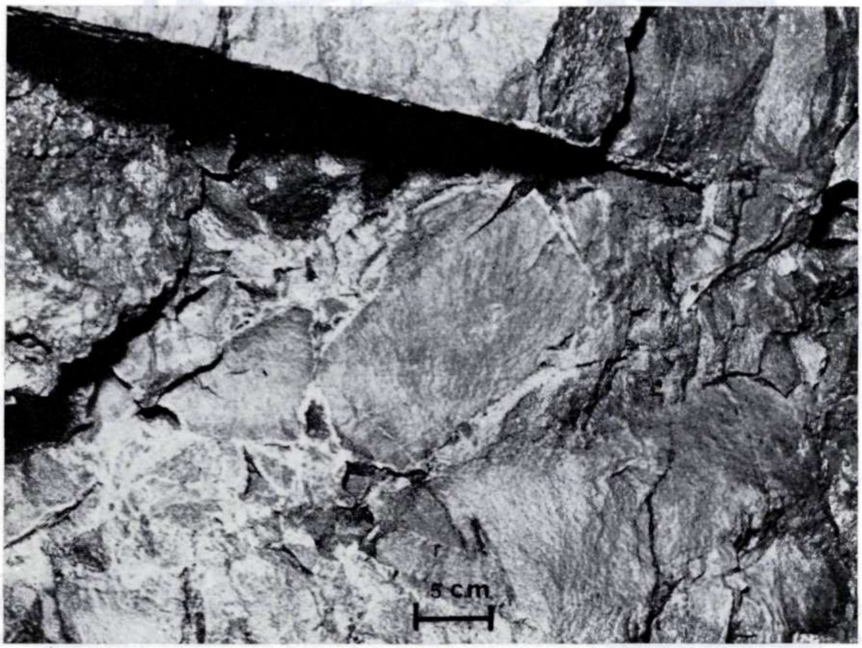

Fig. 6. Trzebionka mine. Chanow district. Poland. Collapse breccia made up by ore-bearing dolomite fragments, cemented with calcite (white) and galena. Sphalerite is rather uncommon in this type of deposit.

Fig. 7. Sidi Bou Aouane mine. Tunisia. Cockades of galena, sphalerite and calcite. Galena may be present both in the core of the cockades and in the small veinlets and starlets in the cement. Sphalerite is present mainly in concentric bands with collophorm structure.

Tunisia

The important lead district of Djebel Hallouf-Sidi Bou Aouane, which is about 130 km NW of Tunis, holds, at least in some places, ore bodies of karstic origin.

The ore bearing horizons, which occur mostly in massive Upper Cretaceous limestones at Djebel Hallouf and in Eocene marls at Sidi Bou Aouane, exhibit clear karstic features in some places.

These karstic features may be grouped in two main types:

1. Cockades (Fig. 7) and stalactites (Fig. 8) made up by galena-sphalerite--jordanite and calcite.

These structure are rather similar to those observed in S. Giovanni mine (Fig. 4).

2. Thin marly-sandy beds, impregnated by galena (Fig. 9): these beds, sub-horizontal or slightly inclined along the crevice walls, look like the described features in S. Giovanni mine from Sardinia (Fig. 1).

Phenomena of this type, that is crevices filled by red clays, calcareous boulders and galena veinlets, have been observed also in other Tunisian mining districts (Djebel Hamra — Violo, 1965; Niccolini, 1970).

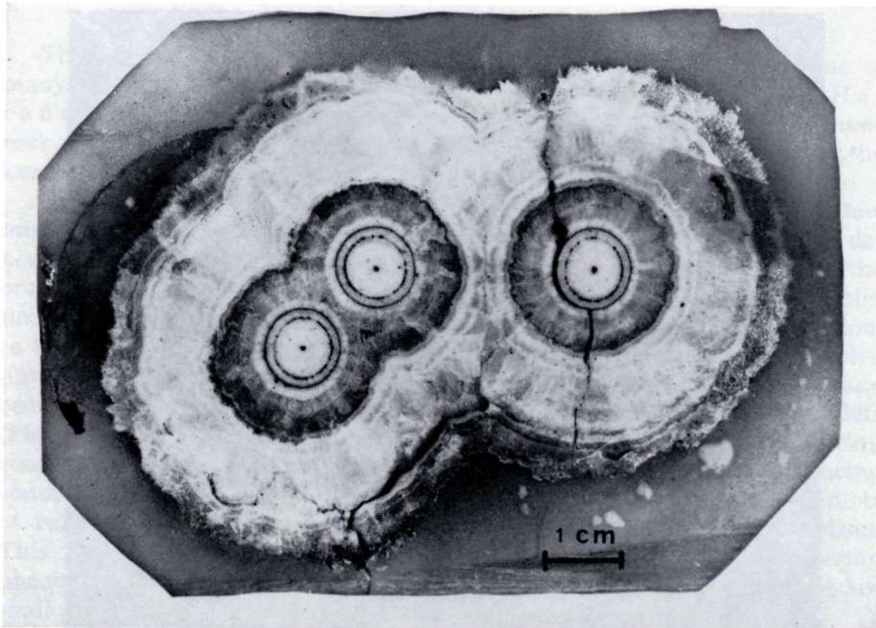

Fig. 8. Sidi Bou Aouane mine. Tunisia. Stalactites of galena (black) and calcite (white) collected in the same mine of the preceeding photograph.

Fig. 9. Sidi Bou Aouane mine. Tunisia. Thin marly beds impregnated by prevalent galena. They show characters similar to those observed in S. Giovanni mine (see Fig. 1).

England (Derbyshire)

An example of karstic deposition of lead-barite beds in Carboniferous limestone has been described recently by Ford and King (1965) in the Golconda mine, Derbyshire.

This occurrence, whose outcrops were visited by one of us, is very alike the first type of Sardinian ore bearing karsts, being made of thin galena-barite-dolomite beds which lie subhorizontally or slightly inclined near the walls of the karst cavity. The occurrence of collapse breccias confirms, once more, the supergenic, karstic nature of the cavities and their filling.

Conclusions

The few given examples show, even if roughly, the variety and spread of karstic mineral depositions; sometimes, e. g. in Sardinia and Silesia--Cracow, these karstic depositions may give rise, as regards both grades and tonnages, to exploitable ore accumulations.

The different structures, visible in the different ore districts, are controlled by several factors and namely: mineralogical compositions of the rocks subjected to karstic phenomena, mineralogical composition of the karst filling sediments, morphological evolution and chemical-physical environment during karst processes. These parameters should be carefully investigated when studying and researching ore depositions in karstic environments.

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SUMMARY

In this paper, which is a preliminary report, we shall attempt to illustrate some examples of sulphide and barite depositions in karstic environments, whose description was made either by us or by other authors, from different ore districts.

We describe briefly the shapes, the structures and the mineralogical associations of karstic ore deposits, trying to point out similarities and differences among some mining districts.

DISCUSSION

Emberger: D'une façon générale, avez-vous des informations sur les teneurs en oligoéléments des galènes encaissées dans des karsts? D'une façon plus particulière, quelles sont les teneurs en argent?

Violo: C'est une question à laquelle je ne peux pas répondre. En effet il y a une très riche bibliographie sur les minéralisations de la zone de Cracovie. En ce qui concerne les minéralisations en Sardaigne, nous avons des analyses de la galène de la mine de San Giovanni. Elle contient 2 ou 3 kg à 6 kg d'argent par tonne de Pb, avec une moyene de 2,5 kg/t d'argent. Certaines galènes des cavités karstiques dans le calcaire cambrien peuvent contenir jusqu'à 10 kg d'argent par tonne de plomb.

Lagny: Etes-vous certain que la terra rossa à veinules de galène que vous avez observé dans la brèche d'effondrement soit contemporaine du remplissage sulfuré de la base du gisement? Il ne me semble pas que B o g a c z , D ż u ł y ń s k i et H a r a ń c z y k en fassent état dans leur note. Si mes souvenirs sont bons, le remplissage de la brèche d'effondrement est essentiellement constitué de sulfures à texture colloforme.

Violo: Je crois que le remplissage de terra rossa avec des veinules de galène est plus récent que la formation massive des sulfures. En effet, la terra rossa est plus répandue dans la partie du Bytom où les affleurements du Trias métallisés sont plus voisins à la surface, par exemple, dans la mine de Matylda. On pourrait dire que peut être une élaboration des eaux superficielles plus récente que la formation des sulfures massifs. Mais à l'échèlle du gîte il me semble qu'il existe une variation dans la composition minéralogique des couches minéralisées (par exemple dans le gîte de Trzebionka où Smolarska* a décrit deux couches minéralisées), c'est à dire (a part la blende qui est répandue dans tous les gîtes), pyrite-marcasite dans la partie inférieure et galène dans la partie supérieure de l'horizon minéralisé.

Amstutz: Regarding the breccia picture you showed I should like to point to the fact that breccias are also abundant in normal sedimentary rocks and do not have to be connected with karst surfaces. In the Mississippi Valley-Bleiberg-Silesia deposits many breccia zones exist, either as seismic breccias or differential compression breccias. Since galena is always diagenetically late, it migrates, before consolidation, into spaces available to this "rest fluid" of sedimentary crystallization.

Violo: I am according to Prof. Amstutz that many types of breccia cannot be connected with karstic phenomena; in fact just in the Silesia ore deposits other types of breccia (as they have been described by Gruszczyk** and his coworkers) have been caused by different phenomena. But the supergene origin by weathering activity of the showed breccias is testified, I suppose, by several factors; these are visible in many mining districts as in Sardinia and Tunisia.

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* Smolarska I. — "Characteristic of the zinc and lead ore deposit of the Trzebionka mine". Polska Akademia Nauk — Warszawa 1968.

** Gruszczyk N.: The genesis of the silesian — Cracow deposits of Lead-zinc ores. Econ. Geol. Monograph 3. 1967.