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IRON SULPHIDE MINERALIZATION IN CARBONATE ROCKS
AND SANDSTONES FROM THE TERTIARY-MESOZOIC CONTACT ZONE
OF THE BĘŁCHATÓW DEPOSITS (SZCZERCÓW FIELD)

Abstract: Mineralization with iron sulphides (pyrite and marcasite) occur in the tectonic, Tertiary–Mesozoic contact zone between carbonate rocks and sandstones in the Bełchatów deposit. In the carbonate rocks the iron sulphides occur as fine incrustations, while in the sandstones as cryptocrystalline aggregates as well as hipidiomorphic and idiomorphic grains. Applying SEM-EDS, distribution and concentration of Cu, Zn, Cd, Hg and Pb have been analysed in the iron sulphides and the enclosing rocks. These elements concentration in of sulphides is higher in comparison to the rocks.

Keywords: iron sulphide, contact zone, Bełchatów

INTRODUCTION

The „Bełchatów” lignite deposit is situated in the area of Polish Lowlands, within the Kleszczów trough. It represents a tectonic-type deposit, developed in a depression within Jurassic and Cretaceous strata. It is subdivided into three parts: the eastern Kamieński field, the central Bełchatów field and the western Szczerców field, currently being prepared of mining.

The investigations were focused on a contact zone of the Tertiary lignite-bearing strata with their Mesozoic basement. Previous research established this zone to be composed of rocks considerably diversified with regard to their lithology, petrography and mineralogy (Ratajczak et al. 2002).

The paper presents preliminary results of studies on iron disulphides mineralization of Mesozoic carbonate rocks and Tertiary sandstones. Samples were collected from boreholes drilled within the area of the „Bełchatów” deposit. The type and the amount of sulphur-bearing compounds have been determined in these rocks, while the content of selected toxic elements in rocks and iron disulphides.

The methods of investigations included X-ray diffractometry, optical microscopy in transmitted and reflected light, as well as scanning microscopy with chemical microanalysis (EDS).

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RESULTS

Microscope observations of limestones have revealed numerous signs of their mineralization with iron disulphide. The limestones, in which two colour varieties occur, show lithological variations. The lighter zones consist of beige-creamy, fine-detrital limestone, while the dark zones of creamy-green, biodetrital limestone. The latter variety contains fragments of oysters, crinoids, serpulids, and shows the presence of geopetal textures. It seems that the dark colour depends on the content of iron disulphide that occur mainly as fine incrustations. Oval forms, filled with crystalline calcite in centre, can also be covered by an iron disulphide rim.

In the carbonate organic fragments, the iron disulphide replace partly calcite or fill empty spaces. In some of the fragments traces of selective mineralization can be seen: iron disulphide fill voids or irregularly crystallize on the surfaces of organic skeletons. Other fossils show no traces of mineralization whatsoever, but also there exist such bioclasts in which calcium carbonates has completely been substituted by iron sulphide. Summarizing, mineralization with iron disulphides in the limestones is epigenetic, and pyrite or marcasite partly replace dissolved calcite or mimic exactly the bioclasts (Fig. 1).

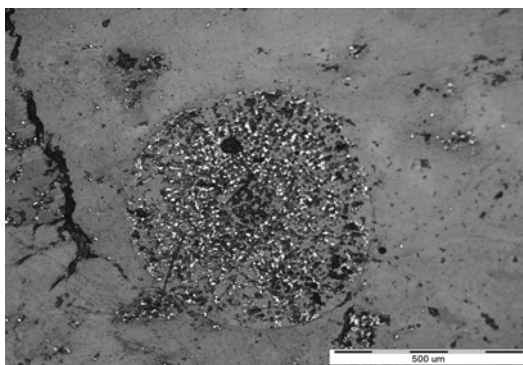


Fig. 1. Iron sulphides replace organic fragments.
Reflected light, crossed polarizers.

Sulphide mineralization in sandstones is concentrated in their basal cement. Iron disulphide reveal diversified habits, from cryptocrystalline, or hipidiomorphic to well-developed idiomorphic crystals. The latter are relatively rare. The most common are granular aggregates, without visible crystal forms.

X-ray investigations have corroborated the presence of both pyrite and marcasite. Gypsum is another sulphur-bearing mineral (Fig. 2).

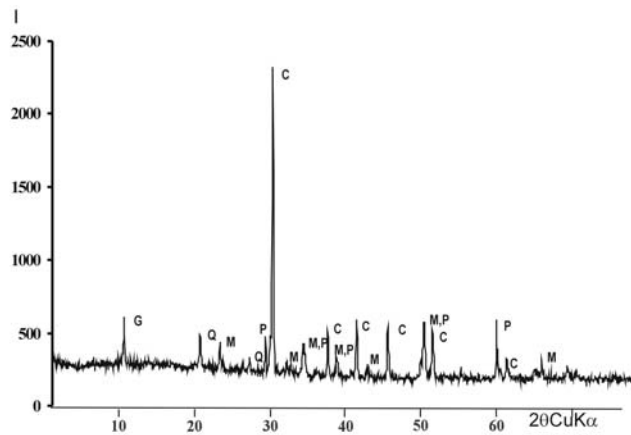


Fig. 2. X-ray pattern of a carbonate rock: C – calcite, G – gypsum, Q – quartz, M – marcasite, P – pyrite

Chemical microanalyses (EDS) was focused on determination of some toxic elements: Cu, Zn, Cd, Hg, and Pb, both in iron disulphide and in enclosing rocks (Fig. 3).

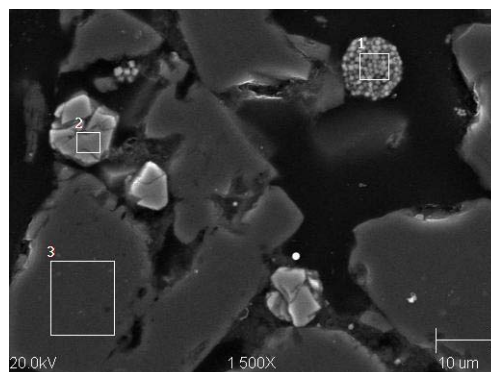


Fig. 3. Fields analysed in a sandstone. SEM image:
 area 1 – framboidal grain of iron sulphide, area 2 – crystalline grain of iron sulphide,
 area 3 – enclosing sandstone rock

Of the elements selected, the highest are the contents of Pb and Hg, both in the sandstones and the limestones. It must be, however, stressed that the Hg contents in the range 1-2.39 wt.% seem to be much higher than the usually reported in the literature and should be checked with another method. Comparing the contents of all the elements analysed, the iron sulphides concentrate more toxic elements than their enclosing rocks, while of the two rock types studied, these elements are more abundant in the carbonate rocks than in the sandstones (Tab. 1).

Table 1. Selected toxic elements in the rocks studied and their iron disulphides

| Element | Content [wt.%] | | | | |
|---------|----------------|---|--|-----------|------------------------------|
| | Sandstone | Iron disulphide (framboidal) in sandstone | Iron disulphide (crystalline) in sandstone | Limestone | Iron disulphide in limestone |
| Cu | 0,21 | 0,25 | 0,28 | 0,14 | 0,37 |
| Zn | 0,05 | 0,11 | 0,41 | 0,19 | 0,38 |
| Cd | 0,07 | 0,30 | 0,11 | 0,13 | 0,15 |
| Hg | 1,09 | 2,22 | 2,17 | 1,78 | 2,39 |
| Pb | 1,05 | 2,27 | 3,78 | 1,57 | 2,53 |

CONCLUSIONS

In the carbonate rocks and sandstones from the tectonic, Tertiary-Mesozoic contact zone in the lignite „Bełchatów” deposit, the author has found mineralization with iron disulphides, i.e. pyrite and marcasite. The forms of FeS₂ are different in these two rock types. In the limestones the sulphides occur mainly as fine, surface incrustations. Different habits of the iron disulphides in the limestones result from differences in the type organic remnants and porosity skeletons. The author agrees with the opinion of Sawłowicz (2000) that these stages were closely associated with the changes of physico-chemical regime of the microenvironment, and may be depend on the type of sulphate-reducing bacteria. In the sandstones they are developed as cryptocrystalline aggregates, hipidiomorphic grains and well-developed, idiomorphic crystals.

Chemical analyses in microareas have revealed higher amounts of selected, toxic elements: Cu, Zn, Cd, Hg and Pb, in the Mesozoic limestones than in the Tertiary sandstones. This observation suggests that the Tertiary sulphide mineralization within the trough containing the lignite deposit also affected the complex of Mesozoic rocks bordering the trough. The iron sulphides have been found to concentrate the toxic elements studied in comparison to the enclosing rocks. It can be explained by specific development of their grains that during their growth accumulated metals.

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