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## THE INFLUENCE OF METALLIFEROUS MINERALS ON BIOTIC COMPONENTS OF TOPSOIL IN Zn-Pb FLOTATION TAILINGS PONDS

### WPLYW MINERALÓW METALONOŚNYCH NA BIOTYCZNE SKŁADNIKI WIERZCHNICH WARSTW SKŁADOWISK ODPADÓW Z FLOTACJI RUD Zn-Pb

**Summary:** This paper analyses the mineral components of topsoil in the zinc and lead flotation tailings ponds. To examine such mineral components the authors used methods such as scanning electron microscopy (SEM), energy dispersive spectrometry (EDS) and atomic absorption spectroscopy (AAS). The goal of this study was to pay particular attention to the secondary metalliferous mineral phases formed in rhizosphere zones mainly on plant roots and the influence of autochthonous sulphur bacteria and ferric bacteria on the chemical mechanism of waste components. This study aims both to recognize the (bio)chemical change of flotation tailings which is of great significance for the vegetation of plants, fungi and microorganisms and to properly plan the treatment connected with reclamation and phytoremediation of the area affected by waste disposal.

**Key words:** Zn-Pb flotation tailings, secondary mineral transformations, autochthonous bacteria.

Mining activity and exploitation of sulphidic metal ores can produce large amounts of waste particularly during the Zn–Pb processing. One of the areas where the exploitation of Zn-Pb ores occurs on a large scale is the Olkusz region. Over 1.3 million tons of flotation tailings are deposited in the pond per year. Nowadays this settling pond covers more than 130 hectares and it is 37 m above surface level. The waste produced includes considerable quantities of fine-grained metalliferous minerals (Zn, Pb, Fe, Cd, Cu, As, Sb, Tl) with a fraction of up to 0,04 mm (55-81% of wastes) and a contribution of grains over 0.2 mm amounting to 3.9% [1]. Because of easy transport by the wind the fine-grained structure allows the waste to become a source of heavy metal pollution for the soil, water and atmosphere within several kilometers of the tailings ponds [2].

The vegetation in waste disposal sites becomes sparse and it is particularly difficult to cultivate with respect to a deficiency of water as well as the loss of nutrients (K, N, P).

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However, the negative impact of sulphidic mine waste and tailings on the environment can be significantly reduced in the cases where appropriate reclamation and phytoremediation is applied. Solutions infiltrating through the topsoils of tailings are enriched with chemically active ions such as  $\text{SO}_4^{2-}$ ,  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Tl}^+$ ,  $\text{Cu}^{2+}$  which affect plant roots, symbiotic fungi and microorganisms. In conditions of high stress on metals the plants [3] and symbiotic mycorrhizal colonization [4] initiate their biological immune defences which can reduce the transfer of toxic heavy metals into the root system of plants. The reaction between biotic exudates of roots and fungi and a solution rich with metal ions results in the crystallization of the secondary metalliferous phases [5, 6]. Up to now these phases have been slightly recognized because of difficulties in their identification. As it turns out the best possibilities for their study appear in flotation tailings sites settled by plants and other living organisms. Scanning methods such as BSE and EDS can be used for an examination of the secondary phases formed on a root's rhizoderm [7] to identify the metalliferous phases.

The authors' achievements to date show that bacterial strains of species such as *Acidithiobacillus ferrooxidans* and *Acidithiobacillus thiooxidans* isolated from tailings sites can have an influence on the ionic concentration level of heavy metals (Fe, Zn, Pb, Cd) in eluate solutions [8, 9]. Simultaneously these bacteria show a considerably low resistance both to metal ions considered to be toxic,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Ag}^{2+}$ , [10] and to residues of flotation reagents in tailings sites (data not published). That is why their metabolic activity is reduced.

The chemical change, mainly Acid Waste Drainage (AWD) [5, 6], limits the plant vegetation and the development of biotic components. Sub-microscopic mineral phases can be formed as a result of the interaction of metalliferous solutions with exudates of roots and fungi or bacteria metabolism products. Products of the chemical change of unstable metalliferous mineral components taken from tailings can be recognized in the BSE images [7]. Their identification can prove that the organic ligands participate actively in the migration of metal ions. The primary aim of this study was to analyse the impact of metalliferous minerals occurring in Zn-Pb ore waste sites on the biotic components of rhizosphere zones and on microorganisms settled on the surface of flotation tailings ponds.

## MATERIAL AND METHODS

Samples used for study were taken from the scarp and top soils of flotation tailings ponds of ZGH Boleslaw S.A located 2 km to the west of Olkusz in May, 2006. The mineralogical composition of tailings was determined using the X-ray diffraction method (XRD) with a 3710 PW Philips X-ray-diffractometer with gas monochromator. Scanning research (SEM) was done using a 30 XL Philips microscope with EDAX analyser and also an S-3400N Hitachi microscope. Accelerating voltage of 15 or 25 kV and the low vacuuous mode were applied. XRD and SEM analyses were done in the laboratory at the Faculty of Earth Sciences (University of Silesia) and in the laboratory at Faculty of Materials Engineering and Metallurgy (Silesian University of Technology). Chemical analyses of heavy metal contents were determined using the atomic absorption method (AAS) with an M6 SOLAAR spectrometer in the BOL-THERM S.A. laboratory in Bukowno.

Results – only in full printed text

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## WPLYW MINERALÓW METALONOŚNYCH NA BIOTYCZNE SKŁADNIKI WIERZCHNICH WARSTW SKŁADOWISK ODPADÓW Z FLOTACJI RUD Zn-Pb

**Streszczenie:** Autorzy za pomocą metod elektronowej mikroskopii skaningowej (SEM), mikroanaliz (EDS) oraz analiz chemicznych (AAS) badali składniki mineralne wierzchnich warstw odpadów zdeponowanych na składowiskach poflotacyjnych rud Zn-Pb. Szczególną uwagę zwrócono na wtórne, metalonośne fazy mineralne powstałe w strefach ryzosferowych, na powierzchni korzeni roślin oraz na wpływ autochtonicznych bakterii siarkowych i żelazowych na chemizm odpadów. Przeprowadzone badania są przydatne dla poznania (bio)chemicznych przemian odpadów poflotacyjnych, które mają duże znaczenie dla wegetacji roślin, grzybów i mikroorganizmów. Są one ważne dla prawidłowego projektowania zabiegów rekultywacyjnych i fitostabilizacji składowisk.

**Słowa kluczowe:** Odpady z flotacji rud Zn-Pb, składowiska odpadów, wtórne przemiany składu mineralnego, autochtoniczne bakterie.