

# INFLUENCE OF SURFACTANTS ON ARSENIC BIOLEACHING FROM MINING WASTES

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## INTRODUCTION

Heavy metal contamination of the environment is particularly problematic in former mining areas. In Poland, one of the old arsenic-gold mining and processing centres is Złoty Stok in the southwest of the country. Ore mining and processing generated large amounts of waste materials rich in As, such as mine waste rock.

The immobilisation of bacterial cells on the mineral surface promotes bio-oxidation, which under favourable conditions can cause acid mine drainage and arsenic release. Therefore, it is important to control these phenomena. One method is to change the surface properties of the solid by adsorption of surfactants. Similar modifications are used in mineral processing, such as flotation or flocculation. Therefore, bioleaching experiments were performed using pure and modified arsenic-bearing waste (after contact with cationic and anionic surfactant), to define conditions under which arsenic release can be inhibited.

## MATERIALS AND METHODS

**Mineral material:** Arsenic-bearing waste was taken from a large stockpile of mining waste deposited in the area of the backfilled Jan shaft in Złoty Stok, Poland (particle size 1-1.25 mm).

**Surface modification:** The mineral was conditioned with 0,1 M cetyltrimethylammonium bromide CTAB, and sodium dodecyl sulfate, SDS (Sigma-Aldrich), for 24h.

**Bioleaching** was carried out in columns (68 x 4.5 cm) with 50 g of pure or modified arsenic waste. A consortium of autochthonic, acidophilic microorganisms, grown on 9K medium was used (inoculum 10% v/v, pH 2.0). The metal concentration was determined through the inductively coupled plasma-optical emission spectrometry technique (Agilent 5110 ICP-OES Agilent Technologies, Australia).

**Zeta potential:** The surface potential of leaching residues (1-1.25 mm) was measured using Surpass3 analyzer (Anton Paar, Austria), and solid by-products (fine particles) was measured with the Zetasizer 2000 (Zetasizer, Malvern, United Kingdom) at a constant ionic strength of  $10^{-3}$  M NaCl, pH 2.0.

## AIM

- Surface modification of arsenic-bearing waste to inhibit the metal release into the environment.
- Investigation of the surface properties of bacteria, arsenic waste, and secondary products by monitoring zeta potential in order to explain bacteria-mineral-surfactant interactions in bioleaching.

## CONCLUSIONS

- **The presence of cationic surfactant (CTAB) on the mineral waste surface increased the arsenic removal,** and the adsorption of anionic surfactant (SDS) inhibited metal release.
- **The presence of surface-active compounds promoted lead bioextraction,** but after one day of the process, a systematic decrease in concentration was observed. Probably due to the precipitation of lead sulfate. In the case of zinc, its concentration for modified arsenic waste was higher within the first seven days and then decreased slightly until the end of the process.

- **The adsorption of surfactants caused changes in the surface properties of mineral waste.** The arsenic-bearing surface charge became more negative after contact with SDS due to the presence of negatively charged sulfate polar heads of surfactant. When mineral waste was conditioned with CTAB, The  $\text{SiO}^-$  anion present on the waste surface interacted with the CTAB-charged cation head group ( $\text{N}^+(\text{CH}_3)_3$ ) resulting in a positive zeta potential.
- **As a result of the bio-oxidation, precipitation of the secondary product occurred** leading to positive zeta potential of bioleaching residues.

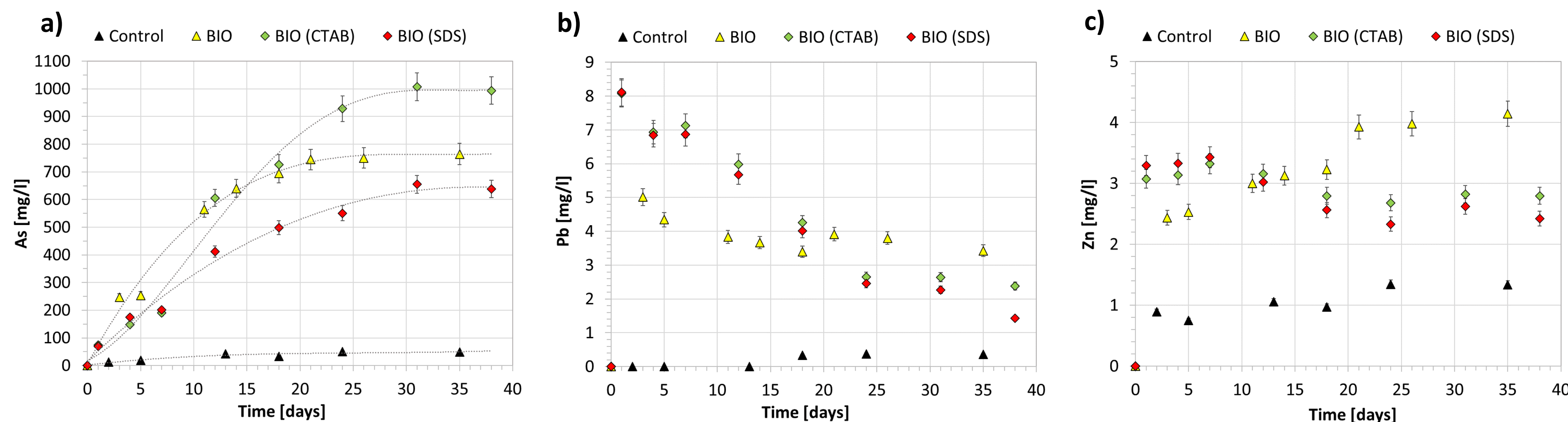
## RESULTS

**Table 1.** Elemental analysis of arsenic waste

Element	Amount [g/kg]
Al	45.16
As	16.38
Fe	58.06
Pb	0.196
Si	239.6
Zn	0.054

**Table 2.** Zeta potential values of samples

Sample name	Zeta potential [mV]
Bacteria	4.70
As waste	- 0.45
As waste + CTAB	5.71
As waste + SDS	- 8.24
Control	4.09
BIO	13.8
BIO (CTAB)	11.8
BIO (SDS)	14.1
BIO	
(secondary product)	26.6
BIO (CTAB)	
(secondary product)	24.3
BIO (SDS)	
(secondary product)	24.8



**Figure 1.** Changes of **a)** As, **b)** Pb, and **c)** Zn concentration within time; **Control** – proces without bacteria; **BIO** – bioleaching of arsenic waste; **BIO (CTAB)** – bioleaching of arsenic waste after contact with CTAB; **BIO (SDS)** – bioleaching of arsenic waste after contact with SDS



**Figure 2.** Mineral particles of arsenic waste and secondary products after bioleaching

**Table 3.** Elemental analysis of secondary products

Element [g/kg]	Secondary product		
	BIO	BIO (CTAB)	BIO (SDS)
As	8.984	4.201	5.194
Fe	240.2	326.7	335.6
Pb	0.356	0.381	0.331
S	108.8	126.9	122.8

## ACKNOWLEDGEMENTS

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