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STUDY ABOUT THE AFFINITY FOR HEAVY METALS OF SPONTANEOUS VEGETATION THAT GROWS UP ON THE WALLS OF THE TAILING PONDS

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ABSTRACT. The paper present aspects concerning accumulation of heavy metals (Pb, Cu, Zn) in the walls of a tailing pond and in the spontaneously vegetation species who grow up on that. 10 soil samples and 8 vegetation species samples have been analyzed. Based on two parameters, namely concentration degree and selectively coefficient, the preferentially accumulation series has been established for studied heavy metals.

INTRODUCTION

Processing ores activity, an important branch of mining industry, presents a major impact on environment because of wastewaters and solid wastes resulted from different applied technologies. Considering that in every year thousands tones of ores are processed, it is obviously that the amount of wastewaters is very important. The wastewaters coming from non-ferrous and golden ores processing plants, that applied flotation technology, contain flotation reagents (xanthates, phenols, simple and complex cyanides), soluble salts of heavy metals (Pb, Cu, Zn, Fe) and solid suspensions. Solid suspensions are represented by the raw processing particles, contained in range 50 – 96% in the ores processed. For the most processing plants, the only solution to store and clean up the wastewaters is a tailing pond. Those take place a decanting of suspensions, the clear waters resulted cannot be spilled in running waters because they still contain dissolved pollutant agents. That is why, the mentioned waters should be advanced cleared. Because the cleaning process takes a long time, an important problem shows up, concerning the strong pollutant impact of tailings ponds on the environment. Theirs integration in environment is a major problem. The solid wastes, where the chemical analysis show high concentrations of heavy metals, are made by low granularity particles. They are easily transported by the wind and pollute the environment on a wide area. The stability of the tailing ponds is improved by the vegetation that grows up spontaneously on the walls.

COLLECTING AND PROCESSING THE SAMPLES

Our study has chosen the tailing pond exploited by REMIN SA Company – Baia Mare – Romania, spreads on 120 hectares. The profile of the company is obtaining of the heavy metals (Pb, Cu, Zn) concentrates by using flotation technology. The wastes resulted from the processes are spilled in the mentioned tailing pond.

Also, in the same tailing pond are spilled the wastewaters coming from golden ores cyanidation process and acid mine waters resulting from the non-ferrous mines that surrounded the area.

On the areas where the flotation waters are spilled, with a basic pH, the vegetation grows up better than the areas were acid mine waters are evacuated. Also, as we claim to the top of the tailing pond, the vegetation is less and on the last level, the newest one, none vegetation species have been present.

Development of the vegetation on the walls of tailing pond is stopped by the high concentration of heavy metals and acidity of the soil and by the bacterial leaching processes that occur inside of solid layers of the walls.

For the study, have been collected 10 soil samples from surface and 30 cm depth and 8 vegetation species samples that grower-up on that soil [1].

These samples were air-dried at room temperature prior to grinding in agate mortars, sieving (at –500 microns) and dissolution. In this purpose, 10 mL of 1:1 (v/v) HCl was added to 0.2 g sample in a 150 mL beaker and the sample heated to near dryness. After cooling, 10 mL of 3:1 (v/v) HNO_3 + HCl Lunge mixture, was added, and again the acid was evaporated to near dryness. The residue was dissolved in 25 mL HCl 1:4 (v/v) and heated for approximately 15 minutes in open air. The sample was then transferred into a 100 mL volumetric flask and diluted to the mark with distilled water. The sample was filtered to remove suspended particulate matter and the solution has been chemical measured using an AAS-IN spectrometer. The concentrations of heavy metals contained were analyzed by nebulization of the solution in the acetylene-air flame and measuring the light absorption of lead, zinc and copper atoms, at 283.3 nm, 213.9 nm and 324.7 nm wave lengths [2, 3, 4].

The heavy metal concentrations were calculated as follows:

$$C = \frac{C_0 \cdot V}{m} \tag{1}$$

where:

C_0 – the metal concentration read from calibration curve, mg/l

V – the total volume of solution, ml

m – the weight of dried sample taken for analysis, g

In Figure 1÷ 3 are presented the calibration curves used.

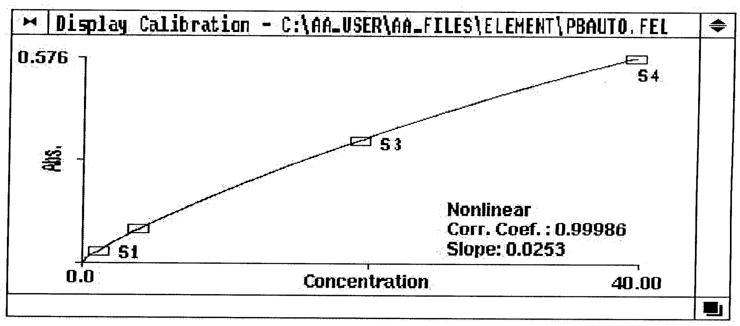

Figure 1. *Calibration curve for Pb*

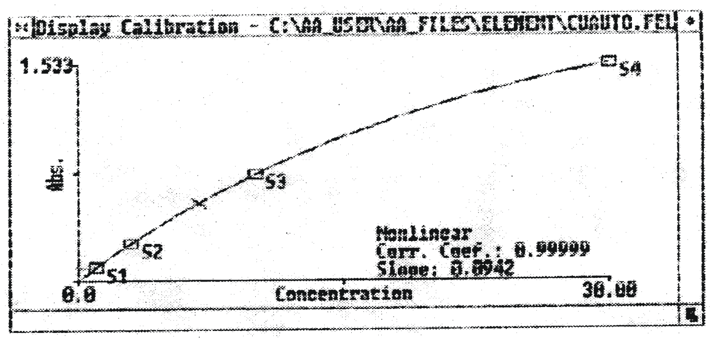

Figure 2. *Calibration curve for Cu*

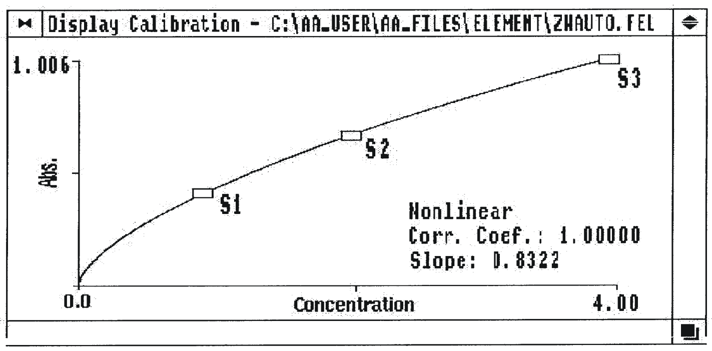

Figure 3. *Calibration curve for Zn*

EXPERIMENTAL RESULTS

In Tables 1 and 2 presents the amounts of heavy metals in soil and vegetation samples collected.

Table 1.

The amount of heavy metals in soils samples

General symbols of the sample	Soil samples				
	Collecting depth	Symbols of the soil sample	Concentration of heavy metals, C_1 (%)		
			Cu	Pb	Zn
1	Surface	1A	0.07	0.17	0.22
	At 30 cm depth	1B	0.03	0.14	0.11
2	Surface	2A	0.01	0.12	0.07
	At 30 cm depth	2B	0.01	0.10	0.08
3	Surface	3A	0.04	0.19	0.15
	At 30 cm depth	3B	0.03	0.14	0.11
4	Surface	4A	0.07	0.2	0.21
	At 30 cm depth	4B	0.05	0.19	0.18
5	Surface	5A	0.07	0.11	0.46
	At 30 cm depth	5B	0.07	0.12	0.24

Table 2

The amount of heavy metals in vegetation samples

Vegetation samples			Concentrations of heavy metals C_2, (%)		
Names of plants	Symbols of the soil samples from where the plants have been collected	Symbols of plants samples	Cu	Pb	Zn
1	2	3	4	5	6
Reinoutria japonica	1	1C	0.0020	0.0059	0.0185
Arctium lappa	1	1D	0.0043	0.0080	0.0194
Robinia pseudaccacia	2	2C	0.0024	0.0005	0.0187
Typha latifolia (rush)	3	3C	0.0022	0.0033	0.0059
Festuca pratensis (grass)	4	4C	0.0032	0.0065	0.0107
Vegetation samples			Concentrations of heavy metals C_2, (%)		
Robinia pseudaccacia (acacia – pods)	4	4D	0.0054	0.0191	0.0196
Chamomilla millefolium (chamomile)	4	4E	0.0312	0.0295	0.2053
Alchemilla millefolium	5	5C	0.0138	0.0175	0.1277

DISCUSSION OF THE RESULTS

For an objective appreciation of the results, we calculated two parameters: *concentration degree (CD, %)* and *selectively coefficient (SC, %)* for each heavy metal from plants.

Concentration degree (CD, %) is defined as follow:

$$CD(\%) = \frac{C_2}{C_1}100 \quad (2)$$

where C_1 and C_2 are the parameters from the Tables 1 and 2.

The resulted values are presented in Table 3.

Selectively coefficient (SC, %) indicate the affinity of each vegetation specie for a heavy metal and he has been calculated as follow:

$$SC(\%) = \frac{CD}{\sum_{i=1}^{n} CD} = 100 \quad (3)$$

where:

Σ CD – the sum of concentration degrees of all heavy metals analyzed, [%];
n – the number of vegetative species analyzed, [adimensional].

Table 3

The values of concentration degree (CD, %) for analyzed metals

Symbols of plants samples	Vegetation species	Concentration degree, CD (%)		
		Cu	Pb	Zn
1	2	3	4	5
1C	*Reinouttria japonica*	2.86	3.47	8.41
2C	*Robinia pseudaccacia*	24.00	0.5	23.38
3C	*Typha latifolia* (rush)	5.50	1.74	3.93
4C	*Festuca pratensis* (grass)	4.57	3.25	5.09
5C	*Achilea millefolium*	19.71	14.58	53.21
1D	*Arctium lappa*	6.14	4.70	8.82
4D	Robinia pseudaccacia (acacia – pods)	10.80	10.05	10.89
4E	Matricaria chamomile (chamomile)	44.57	24.58	85.54

In Table 4 are presented the calculated values of SC (%) for studied species. Base on these, we express the preference of each studied species for each analyzed heavy metals.

Table 4

The calculated values of selectively coefficient, SC (%), for each studied species and heavy metals

Name	Selectively coefficient SC (%)			Preference for heavy metals		
	Cu	Pb	Zn	Maximum	Middle	Low
Reinoutria japonica	19.29	23.57	57.14	Zn	Pb	Cu
Arctium lappa	31.23	23.90	44.87	Zn	Cu	Pb
Robinia pseudaccacia (acacia – leafs)	50.12	1.04	48.84	Cu	Zn	Pb
Festuca pratensis (grass)	35.39	25.17	39.44	Zn	Cu	Pb
Robinia pseudaccacia (acacia – pods)	34.02	31.66	34.32	Zn	Cu	Pb
Matricaria chamomilla (chamomille)	28.81	15.88	55.31	Zn	Cu	Pb
Achilea millefolium	22.52	16.67	60.81	Zn	Cu	Pb
Typha latifolia (rush)	49.24	15.58	35.18	Cu	Zn	Pb

CONCLUSIONS

Based on the experimental data, we can draw the following conclusions:

1. All analyzed species accumulate heavy metals from the soils that they develop;

2. With the exceptions of *Typha latifolia* (rush) and *Robinia pseudaccacia* (acacia-leafs), Zn is the heavy metal present the higher concentration degrees. These are in range 85.54%, for *Matricaria chamomille* (chamomile) and 3.93 for *Typha latifolia* (Table 3). The explanation is connected to the high level of Zn in the solid wastes where the mentioned species grows. The species *Typha latifolia* (rush) and *Robinia pseudaccacia* (acacia – leafs) have a particular behavior. Thus they were collected from a soil containing 0.15 % Zn and 0.04% Cu (*Typha latifolia)* and 0.07% Zn and 0.01% Cu (*Robinia pseudaccacia)* (Table 1), the analyses of plants show a higher concentration degree for Cu than Zn (Table 2).

3. Most of vegetative species accumulate a low led amount (Table 3). The maximum concentration degree was realized by *Matricaria chamomilla* (chamomile), 24.58%, and the lower, by *Robinia pseudaccacia* (acacia -leafs), 0.5%.

4. Between the studied heavy metals, copper presents the lower concentration in solid wastes, in range 0.01 ÷ 0.07% (Table 1), but vegetative species assimilate copper rather than led, although the concentrations of led in soil samples are almost ten times higher (Table 1).

5. We can observe that, as the others authors indicate [5-10], the plants adapted on these conditions, act according to a buffer system. They accumulate in a high quantity the metals with lowest concentrations in soil and in a low quantity the metals with the highest concentrations in soil.

Starting from the presented data, we can conclude that, for the analyzed vegetation species, the preferentially accumulation series of studied heavy metals is:

$$Zn > Cu > Pb.$$

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