THE INFLUENCE OF HEAVY METALS ON SOIL CHEMICAL CHARACTERISTICS FROM COPSA MICA

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Abstract

The main pollution source in Sibiu is represented by the continued emissions of particulate matter and sediment containing heavy metals from S.C. Sometra S.A. located in Copsa Mica. High metal concentrations in the environment have widely ranging impacts on soils, plants and animals. Early 90s, polluted area stretched along the Târnava Mare valley, from Dumbrăveni town in the East, to Blaj in the West, and bordered to the north by Smig and Cetatea de Balta localities and in the southern part by Mihăileni, Şeica Mare and Cenade localities. Investigation area covered Târnava Mare Valley (upstream and downstream of Copsa Mica), between Tîrnava (upstream) and Micasasa (downstream) localities. Also, it have been done research in the valley slopes area. There were collected 30 soil samples on 0-20 cm depth (or Ap horizon), inside SOMETRA S.A. company and in the immediate vicinity, to obtain analytical data to characterize the dominant soils in the area and determine the pollutants content accumulated in the soil, especially on surface horizon and spread throughout the existing environmental conditions; laboratory tests on some chemical characteristics were achieved in ICPA Bucharest laboratories. In the investigated area formed a coating of diverse soil composed of terms belonging to four soils classes: Protisoils, Luvisoils, Hydrisoils, Antrisoils. Soils identified were classified according to Romanian System of Soil Taxonomy. The paper presents the chemical characteristics (soil reaction, organic matter content and total nitrogen and phosphorus and potassium supply mobile) of soil sampled from Copsa Mica. Soil samples collected from the enterprise influence area have a soil reaction neutral to weak alkaline. Regarding the contents of humus, total nitrogen, phosphorus and potassium are very low and low cell all the soil samples collected in the area.

Key words: soil, pollution, chemical characteristics, Copsa Mica

INTRODUCTION

Heavy metals get into the soil by geochemical alteration processes in rocks and minerals, transport and deposition of chemical elements (Rauta and Carstea, 1983).

Throughout evolution, these elements suffer a series of transformations through which their mobility is changed according to the type of geochemical evolution (Lacatusu, 2000). Influence of soil (pH, content of clay, cation exchange capacity, organic matter content) on the distribution coefficient (Kd) of the studied metals have been shown to be different from one element to another. Thus, it has been found that the adsorption of cadmium, chromium, lead or nickel is highly influenced by soil reaction and cation exchange capacity and, in copper adsorption, organic matter content and clay are the parameters that have a high influence (Gomes *et al*., 2001). Heavy metal cations are preferentially adsorbed on specific adsorption centers against of heavy metal cations from soil (Ca, Mg, Na). At the moment in which these specific adsorption centers are saturated, cation exchange reactions become dominant in the major metal ions compete with the heavy metal cations (Toti *et al*., 1993; Vrinceanu *et al*., 2005).

Copsa Mica industrial platform was founded during 1935-1939 when the first installations were made manufacturing carbon black (1935) and zinc production (1939). Over the course of 55-60 years of industrial activity, the two units have been developed separately, one with chemical profile and the other with metallurgical profile. Gaseous emissions (SO_2, NOx) and particles enriched in Zn, Cd, Cu and Pb cause severely environmental damages, with important consequences for human and environmental health. These effects are particularly serious because the factory is close to an urban environment (Vrinceanu *et al*., 2005).

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MATERIALS AND METHODS

The field research was undertaken aimed at:

- ✓ knowledge of the soil cover in the area of mentioned enterprise influence;
- ✓ soil sampling to obtain analytical data in order to characterize the soil prevailing the area and to determine the pollutants content accumulated in the soil, especially in the surface horizon and spreading in the existing environmental conditions;
- ✓ study area covered Târnava Mare valley (in upstream and downstream of the Copsa Mica) between the localities Tîrnava (upstream) and Micasasa (downstream). Also,it have been done research in the valley slopes.
- ✓ soil samples were collected from 30 sampling points in the depth of 0-20 cm;
- ✓ laboratory determinations regarding some chemical characteristics (organic matter content, soil reaction, the contents of main nutrients - total nitrogen, mobile phosphorus, mobile potassium) have been achieved in laboratoriesof ICPA Bucharest.

For chemical characterization of the soil samples were achievedthe following chemical analysis (according to the ICPA methodology):

- ✓ pH (aqueous suspension 1: 5, potentiometric method);
- ✓ organic matter content (wet oxidation and titrimetric methodafter Walkley – Black, Gogoaşă modification);
- ✓ total nitrogen content (Kiejdhalmethod);
- ✓ mobile phosphorous and mobile potassium content (soluble phosphorus and potassium in acetate - lactate, colorimetric method).

RESULTS AND DISCUSSIONS

In these conditions, in the investigated area have been formed a diverse soil cover made up of terms belonging to the four classes of soils: Protisoils, Luvisoils, Hydrisoils, Antrisoils. For soil identification was used the Romanian soil map, scale 1: 200,000. Soils identified were classified according to Romanian System of Soil Taxonomy (SRTS 2003). In table 1 are presented the identification of soil type and subtype for all 30 sampling points.

Protisoils

This class includes such aluvisoil type with entic-calcic, gleyc and haplic fluvisol subtypes (Asenka, Asgc, Asco). All soils are formed on recent fluvial deposits, with varied texture and groundwater located at depths of 1-3 m. Coluvic subtype was identified on colluviums deposits at the base of the slope, in the waterside contact, with the groundwater to more than 5m.

These are soils with a type profile Ao(ka)-Cka(gc), with a predominant sandy loam-loamy sand texture. They have a low organic matter content (around 2%), a weak alkaline reaction (pH = 7.4 to 7.6), eutric.

Also this class includes Regosols type, calcic subtype (Rska), present on the weak - moderate inclined slopes (7-12....15%), developed on characteristic deposits of plateau area, with good overall drainage and groundwater at more than 10 m depth.

The soils have a profile Aoka-Cntype with weak development. These are eutric soils with a low-middleorganic matter content and an alkaline reaction.

Luvisoils

These soils encountered in the plateau, formed from different materials (clay,loam) under moderately good drainage, on low to moderate inclined slopes (7-15%) or flat surfaces (bridge interfluves). The surfaces are affected by the surface processes and deep erosion or excess surface moisture (stagnic).

The class includes such Preluvosoil, with typical, typical - calcic and mollic subtypes (ELti, ELti(xma), ELmo) and Luvosoil type with typical subtype (LVti).

Soil profile is Ao(m)-Bt-Cn or Ao-El-Bt-Cntype. The texture of the upper and below horizon varies from clay sandy loamto clay loamy sand.

Organic matter content is low-middle, soil reaction is weak moderate acid (pH from 5.2 to 6.1), being mesobasic soils.

Hydrisoils

These soils occupy a small area in the meadow, related with the very low depth of groundwater (0.5-1 m), giving rise to this Gr horizon in the first 50 cm (upper limit). In this class it ranged Gleysol type with subtypes mollic and calcic (GSmo, GSka).

Soils have a profile byAm(ka)Go-Gr-CkaGotype.

The soil are saturated (eutric) with a low middle organic mattercontent, a weak acid-weak alkaline soil reaction and with a poor drainage.

Table 1 Identification of soil type and subtype in samplin points from Copsa Mica area

Sampling points	Land form Slope (%)	Current use	Distance from pollution source	Soil-name Symbol
S1 Valea Lunga	Meadow	Arable (maize)	14.69 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S2 Lunca	Slightly uneven - Southern inclination	Arable (lucerne)	13.65 km West	Calcaric Regosols (ERka)
S3 Lunca	Meadow	Arable (lucerne)	14.86 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S4 Lunca	Meadow	Grassland	13.85 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S5 Țapu	Northslope inclination	Pasture	13.18 km West	Haplic Luvisols (ELtie)
S6 Micasasa	Meadow	Arable (lucerne)	11.06 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S7 Micasasa	Meadow	Arable (maize)	11.78 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S8 Seica Mica	North-West Slope inclination	Arable (maize)	7.95 km West	Calcaric Regosols (ERka)
S9 Seica Mica	Meadow	Arable (maize)	7.92 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S10 Seica Mica	North-Westslope inclination	Arable (maize)	6.33 km West	Haplic Luvisols (ELtie)
S11 Copsa Mica	Meadow	Arable (lucerne)	3.50 km West	Gleyic Fluvisols(ASgc)
S12 Copsa Mica	North slope inclination	Grassland	2.51 km West	Haplic Luvisols (Lvti,e)
S13 Copsa Mica	Meadow	Arable (maize)	2.72 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S14 Copsa Mica	NEslope inclination	Grassland	1.78 km West	Haplic Luvisols (Lvti,e)
S15 Copsa Mica	Meadow	Arable (maize)	1.61 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S16 Copsa Mica	Meadow	Grassland	0.72 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S17 Copsa Mica	Meadow	Grassland	1.26 km West	Gleyic-calcaric Fluvisols (ASgc-ka)
S18 Copsa Mica	Eastslope inclination	Grassland	1.70 km East	Calcaric Regosols (ERka)
S19 Copsa Mica	Meadow	Arablefallow ground	0.90 km East	Gleyic-eutric Fluvisols (ASge-eu)
S20 Copsa Mica	Meadow	Arable (maize)	2.37 km East	Calcaric Fluvisols (ASka)
S21 Copsa Mica	Meadow	Arable (maize)	3.55 km East	Calcaric Fluvisols (ASka)
S22 Târnava	NW slope inclination	Pasture	4.84 km East	Haplic Luvisols (Elti)
S23 Târnava	Meadow	Arable (maize)	4.14 km East	Calcaric Fluvisols (ASka)
S24 Medias	NEslope inclination	Grassland	7.91 km East	Haplic Luvisols (LVti)
S25 Medias	Meadow	Arable (maize)	9.09 km East	Eutric Gleysols (GSeu,dr)
S26 Târnava	Meadow	Arable (lucerne)	5.85 km East	Calcaric Fluvisols (ASka)
S27 Medias	Meadow	Arable (maize)	13.54 km East	Eutric Gleysols (GSeu,dr)
S28 Brateiu	Meadow	Arable (maize)	16.79 km East	Eutric Gleysols (GSeu,dr)
S29 Atel	Meadow	Arable (maize)	18.82 km East	Haplic Luvisols(ELti)
S30 Atel	Meadow	Arable (lucerne)	20.78 km East	Calcaric Fluvisols (ASka)

Table 2 Chemical characteristics of Protisoils sampled from Copsa Mica area (n = 2)

Sampling points	Distance from pollution source	Soil reaction *(pH)*		Organic matter *(%)*		Total nitrogen *(%)*		Mobile phosphorous *(mg/kg)*		Mobile potassium *(mg/kg)*	
		value	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*
S1Valea Lunga	14.69 km West	8.28	weak alkaline	1.51	low	0.152	middle	39	high	178	middle
S3Lunca	14.86 km West	8.06	weak alkaline	1.44	low	0.124	low	27	middle	182	middle
S4Lunca	13.85 km West	8.00	weak alkaline	2.27	low	0.223	middle	18	low	175	middle
S6 Micasasa	11.06 km West	8.07	weak alkaline	1.93	low	0.184	middle	21	middle	1012	veryhigh
S7 Micasasa	11.78 km West	8.05	weak alkaline	2.55	low	0.196	middle	41	high	553	veryhigh
S9 Seica Mica	7.92 km West	8.01	weak alkaline	1.37	low	0.146	middle	17	low	251	high
S11 Copsa Mica	3.50 km West	7.56	weak alkaline	1.53	low	0.130	low	29	middle	235	high
S13 Copsa Mica	2.72 km West	7.85	weak alkaline	2.62	low	0.208	middle	18	low	291	high
S15 Copsa Mica	1.61 km West	7.97	weak alkaline	1.44	low	0.121	low	16	low	78	low
S16 Copsa Mica	0.72 km West	8.00	weak alkaline	1.22	low	0.137	low	15	low	185	middle
S17 Copsa Mica	1.26 km West	7.98	weak alkaline	2.24	low	0.211	middle	19	middle	131	middle
S19 Copsa Mica	0.90 km East	5.45	moderate acid	1.53	low	0.126	low	25	middle	267	high
S20 Copsa Mica	2.37 km East	7.59	weak alkaline	2.84	low	0.196	middle	31	middle	340	veryhigh
S21 Copsa Mica	3.55 km East	8.17	weak alkaline	0.99	verylow	0.124	low	13	low	148	middle
S23Târnava	4.14 km East	8.01	weak alkaline	2.05	low	0.205	middle	34	middle	276	high
S26Târnava	5.85 km East	7.83	weak alkaline	1.72	low	0.174	middle	23	middle	279	high
S30Atel	20.78 km East	7.70	weak alkaline	1.77	low	0.200	middle	23	middle	232	high

Table 3 Chemical characteristics of Luvisoils sampled from Copsa Mica area (n = 2)

Sampling points	Distance from pollution source	Soil reaction *(pH)*		Organic matter *(%)*		Total nitrogen *(%)*		Mobile phosphorous *(mg/kg)*		Mobile potassium *(mg/kg)*	
		value	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*
S5Țapu	13.18 km West	7.18	neutral	2.27	low	0.199	middle	23	middle	282	high
S10 Seica Mica	6.33 km West	5.59	moderate acid	2.22	low	0.180	middle	54	high	396	veryhigh
S12 Copsa Mica	2.51 km West	7.60	weak alkaline	2.60	low	0.204	middle	17	low	271	high
S14 Copsa Mica	1.78 km West	7.45	weak alkaline	1.77	low	0.179	middle	8,8	low	147	middle
S22Târnava	4.84 km East	8.12	weak alkaline	0.99	verylow	0.118	low	20	middle	178	middle
S24Medias	7.91 km East	6.12	weak alkaline	2.63	low	0.212	middle	12	low	198	middle
S29Atel	18.82 km East	6.67	weak alkaline	2.29	low	0.240	middle	56	high	276	high

Table 4 Chemical characteristics of Hidrisoilssampled from Copsa Mica area (n = 2)

Sampling points	Distance from pollution source	Soil reaction *(pH)*		Organic matter *(%)*		Total nitrogen *(%)*		Mobile phosphorous *(mg/kg)*		Mobile potassium *(mg/kg)*	
		value	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*
S25Medias	9.09 km East	7.66	weak alkaline	1.01	verylow	0.206	middle	40	high	334	veryhigh
S27Medias	13.54 km East	7.89	weak alkaline	2.86	low	0.240	middle	37	high	321	veryhigh
S28Brateiu	16.79 km East	6.59	weak acid	1.53	low	0.156	middle	21	middle	132	middle

Table 5 Chemical characteristics of Antrisoils sampled from Copsa Mica area (n = 2)

Sampling points	Distance from pollution source	Soil reaction *(pH)*		Organic matter *(%)*		Total nitrogen *(%)*		Mobile phosphorous *(mg/kg)*		Mobile potassium *(mg/kg)*	
		value	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*	*value*	*interpretation*
S2Lunca	13.65 km West	8.24	weak alkaline	1.39	low	0.162	middle	38	high	273	high
S8 Seica Mica	7.95 km West	8.06	weak alkaline	1.41	low	0.126	low	21	middle	149	middle
S18 Copsa Mica	1.70 km East	7.85	weak alkaline	3.44	middle	0.274	middle	6,4	verylow	218	high

Antrisoils

These soilsare represented by Erodosoils. Characteristic for Erodosoils are soil beheading by strong erosion; so that the remaining horizons do not permit inclusion in a particular type of soil. Sometimes the erosion is so strong that parental material is updated.

In table 2-5 are presented the chemical characteristics (soil reaction, organic matter content and total nitrogen, as phosphorus and potassium supply) of soil samples collected from Copsa Mica.

Thus, the soil reaction (pH) is weak alkaline (pH from 7.3 to 8.4) and weak-moderate at aluvisoils to preluvisols and luvosoil. A weak acidic soil reaction (pH from 6.63 to 6.96) have some Technosols and neutral reaction (pH from 7.0 to 7.2) in some gleyic aluvisoils is eutric.

Organic matter content is very low - low, with values between 0.87 and 2.86% in most soils except Technosols that have a middle content with values between 3.51 and 5.53%.

Total nitrogen content have low-middle values ranged between 0.110 and 0.274 in most soils except Entiantrosoils that have higher levels with values from 0.295 to 0.469%.

The mobile phosphorus content is very low - low with values between 8.8 and 18 mg / kg in 10 cases, middle with values between 19 and 35 mg/kg in 16 cases, high with values between 37-56 mg/kg in 8 cases and very high with values between 88 and 239 mg/kg in 2 cases.

The mobile potassium content is low with values by 78 mg/kg in a single case, middle with values of 131-198 mg/kg in 11 cases, high values between 232 and 282 mg/kg in 17 cases and very high with values between 321 and 1012 in 7 cases.

CONCLUSIONS

One of the forms in which heavy metals are found in the soil is in exchangable position on the soil inorganic constituents. This requires an interrelation between macroelements and metals from the soil. Knowing the evolution of chemical indicators such as soil reaction, organic matter content and some macroelements in soils can make a connection between them and heavy metals content in the soil.

The soil, the position occupied, the chemical characteristics, contribute to pollutants fixing or mobilization reached the surface shapes of them, registering on a scale thus vulnerable to pollution with different elements. Soil samples collected from the enterprise influence area have a soil reaction neutral to weak alkaline. Regarding the contents of humus, total nitrogen, phosphorus and potassium are very low and low cell all the soil samples collected in the area.

The next step is to study the heavy metals presence and their concentration level in the soils studied in the present paper.

ACKNOWLEGMENTS

The financial support provided by Ministry of Education and Research – project no. PN 16 07 03 06Studies on the use of phytoextraction as a remediation method of heavy metal pollution.

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****Sistemul Român de Taxonomie a Solurilor* (SRTS, București 2003)