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THE MOBILLITY OF COPPER IN THE STREAM SEDIMENTS OF BISTRIŢEI MOUNTAINS (EASTERN CARPATHIANS - ROMANIA)

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Abstract

This paper presents the quantitative distribution of Cu (total and mobile) in the stream sediments of Leşu and Ursu Brooks in the Bistriţei Mountains-Eastern Carpathians.

The geological background reveals the presence of low-grade metamorphic rocks belonging to the Tulgheş Group to which the singenetic polymetallic sulphide mineralization (the Leşu Ursului ore deposit) is associated; this mineralization is considered of volcano-sedimentary origin, metamorphosed during an early Caledonian event.

The concentration of Cu was determined using the atomic absorption spectrometry.

The contents of Cu total from the investigated stream sediments display contents placed in a large range: 17.8 - 87µg/g .

In the stream sediments are presented positive correlations between the contents of Cu total and Cu mobile.

The coefficient of concentration (k) shows that the sediments from the investigated area accumulate higher amounts of Cu than the soils and the vegetation of some other regions.

Keywords: stream sediments, Cu mobile, Cu total, positive correlations, concentration coefficient (k)

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Introduction

Stream sediments justify the widespread interest they show by their specific morphogenetic characteristics and by their economic importance.

The aim of this paper is to provide information on the quantitative distribution of Cu in the stream sediments of Leşu and Ursu brooks, in Bistriţei Mts (Bucovinic Unit) - Eastern Carpathians. The analytical data of this paper are compared to the heavy metal concentration found by previous papers in the mountain soil (Gleyi-Dystric Cambisol, FAO/UNESCO) and in the forest vegetation (*Abies alba, Populus tremulus, Fagus silvatica*) of the investigated area (Murariu and Mihăilescu, 1990; Murariu et al., 1991).

Materials and Methods

In the stream sediments, Cu has been determined in a solution obtained by digestion of samples in a mixture of HNO_3 + $HClO_4$ (for total form) and EDTA + CH_3COONH_4 solution at a pH = 7.0 (for mobile form).

The concentration of Cu was determined using the atomic absorption spectrometry. Methods used for the analysis of other parameters were: pH measured in H_2O, the content of organic matter by the Walkley-Black method and soil texture by pipette method.

Geological setting

The geological background reveals the presence of low-grade metamorphic rocks of Tulgheş Group (Tg.3 Formation = Leşu Ursului Lithozone; fig.1) to which is associated the singenetic polymetallic sulphide mineralization (the Leşu Ursului ore deposit) considered of volcano-sedimentary origin and metamorphosed during an early Caledonian event (the Sardic phase).

Results and Discussion

The stream sediments material is of allochtonous origin, represented mainly by products of weathering processes and of the chemical disintegration of the Tulgheş Group metamorphic rocks (Tg. 3 Formation = Leşu Ursului Lithozone); these rocks are associated with polymetallic sulphide mineralization (fig. 1). Some reworked elements from the soil and vegetation remnants may be considered also.

The Cu (total and mobile; mg/kg = μg/g) of the analysed sediments (tab. 1; 2; 3; 4) is a result of the rocks nature (more or less mineralized), of their granulometry, of the organic matter and of the presence of adsorbants (Fe-Mn oxides; clay accumulations) etc.

An important role in Cu release from the unconsolidated fragments and in its accumulation in sediments is held by the element mobility and by the pH and Eh values.

The Cu from the investigated stream sediments displays contents placed in a large range: 17.8 - 87µg/g Cu.

These concentrations are higher than the values specific to the continental crust (Taylor and McLennan, 1985) and than those of the average soil contents (Vinogradov, 1957; Kloke, 1980; Davidescu et al., 1988; Kabata-Pendias and Pendias, 1992), having an important impact on the environment (Adriano, 2001). The Cu has the tendency of downstream accumulation, maily in the fine grained fraction of the sediments.

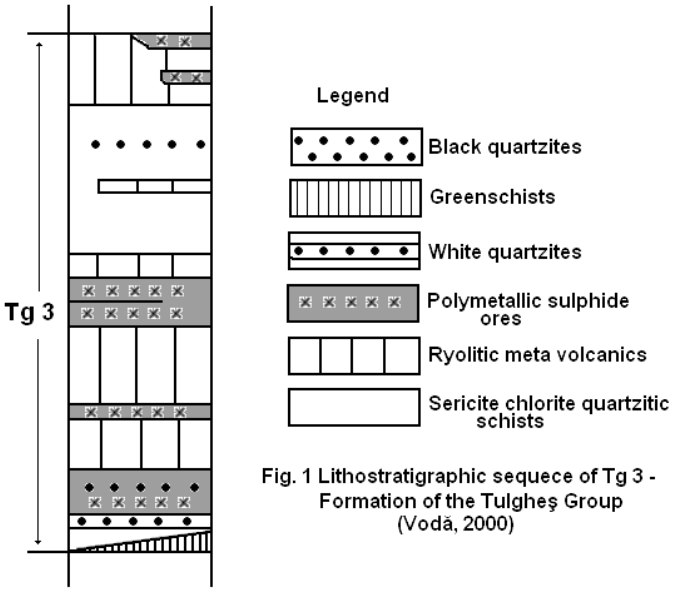

Fig. 1 Lithostratigraphic sequece of Tg 3 - Formation of the Tulgheş Group (Vodă, 2000)

Tab. 1 Cu contents (µg/g) in parental rocks, stream sediments, soils and in trees species from the Bistriţa Mountains

Sample		Cu (total) mg/kg = µg/g
Barren rocks (Tg 3)		30
Mineralized rocks (Tg 3)		157
Sream sediments		47.2
Soil profile (Crucea 4)		
Horizons	Texture (0.002mm)	
Oh	9.5	19
Aon 1	11.3	14
Aon 2	11.7	18
AB	9.6	19

Bs 1	7.,5	18
Bs 2	7.5	19
Bv	6.5	22
BR	3.5	15
R+B		51
Average		21.6
Pedoconcentration factor (PCF)		1.1
Average content in soils		20
Soil normal limits		1-20
Maximum allowable limits*		100
Forest vegetation:		
Populus tremulus		
Leafs		5.0
Branches		3.7
Bark		3.7
Average		4.1
Bioconcentration factor (BCF)		0.1
Maximum concentration in common plants**		30
Transfer coefficients***		
Leafs		0.22
Branches		0.16
Bark		0.16

Tab. 2 Cu total (µg/g) in the stream sediments of Leşu Brook (Bistrita Mts)

Sample	Organic matter (%)	Cu (total) mg/kg = µg/g
1-L	2.54	74
2-L	3.09	44
3-L	3.20	46
4-L	8.20	**38**
5-L	3.57	48
6-L	2.51	56
7-L	1.70	58
8-L	3.28	**78**
9-L	5.20	60
10-L	1.09	64
11-L	0.99	26
12-L	5.94	60
13-L	3.94	56
14-L	1.22	64
15-L	5.31	72
16-L	3.46	54
17-L	7.02	43
18-L	1.49	58

19-L	2.41	60
20-L	4.94	48
Averages		55.3
k		1.2

Tab. 3Cu total (µg/g) in the stream sediments of Ursu Brook (Bistriţa Mts)

Sample	Organic matter (%)	Cu (total) mg/kg = µg/g
21-U	6.59	34
22-U	5.61	39
23-U	5.89	57
24-U	9.36	17
25-U	5.09	46
26-U	6.31	40
27-U	5.25	34
28-U	4.32	36
29-U	7.50	37
30-U	4.11	39
31-U	4.94	45
32-U	3.28	47
33-U	4.39	54
34-U	0.96	35
35-U	4.07	87
36-U	8.43	67
Averages	-	46.5
k		1,0

Tab. 4 Cu total and Cu mobile in some samples of the stream sediments from Bistriţei Mts.

Sample	Location	Organic matter (%)	Cu total (mg/kg)	Cu mobile (mg/kg)	Cu mobile/Cu total (%)
1L	Leşu Brook	2.54	74	8.6	0.11
8L		3.28	78	15.3	0.19
10L		1.09	64	8.3	0.13
13L		3.94	56	14.3	0.25
18L		1.49	58	10.3	0.17
20L		4.94	48	17.1	0.33
3U	Ursu Brook	5.89	57	31.5	0.55
5U		5.09	46	14.0	0.30
13U		4.39	54	15.3	0.28

The factor of soil-to-plant accumulation (*AF*) is frequently used to describe the transport between the soil and the plant components. It may be defined as the ratio between the heavy metals amount (Me) in plant (dry wt.) and soil (dry wt.):

$$AF = \frac{M_e \text{ in plant}}{M_e \text{ from the soil available for the plants}} [Kabata-Pendias \text{ and } Pendias, 2001]$$

The positive correlations between some heavy metals in the stream sediments are presented in figures 2, 3 and 4. In table 4 and in figure 5 the positive correlations between the contents of Cu total and Cu mobile in the stream sediments are presented.

The concentration coefficient (k) shows that the sediments from the investigated area accumulate higher amounts of Cu than the soils and the vegetation of some other regions. The Cu – Pb – Zn diagram and the positive geochemical correlations between the investigated heavy metals along with the continental crust normalized values, show that they share a common source.

The content of Cu in studied soils (tab. 1; fig. 3; Murariu et al. 1991) is higher than the average contents in soils (Vinogradov, 1957; Bowen, 1979; Davidescu et al., 1988) and than the normal limits (Kloke, 1980). Pedogeochemical abundance of Cu in the soil horizons was studied in terms of parental rocks nature (barren; mineralized), organic matter, texture and pH (fig. 1; tab. 1).

In the study area the forest vegetation manly consist of *Abies alba*, *Populus tremulus* and *Fagus silvatica*. Chemical analyses of the vegetative organs of the *Populus tremulus* indicated a higher accumulation of Cu in *Populus tremulus* leafs, in respect of Cu accumulation in other species.

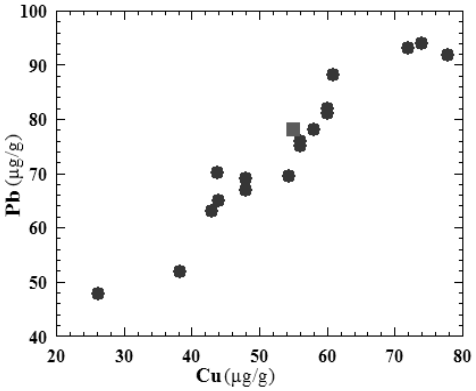

Fig. 2 Correlation between Cu and Pb

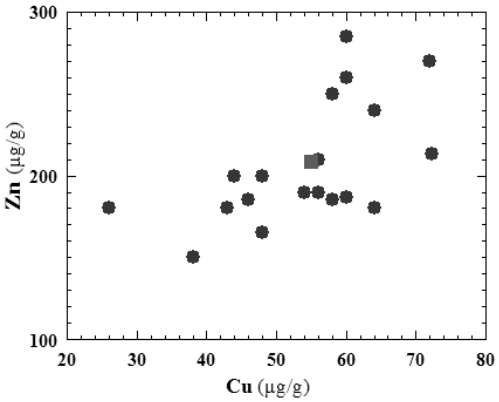

Fig. 3 Correlation between Cu and Zn

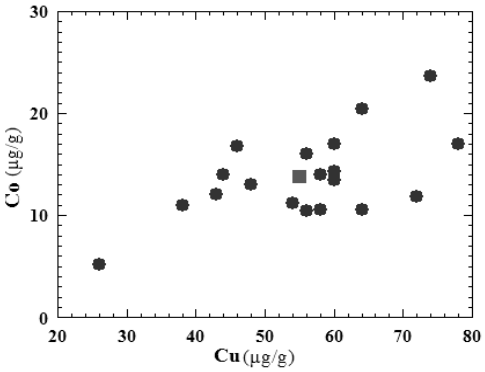

Fig. 4 Correlation between Cu and Co

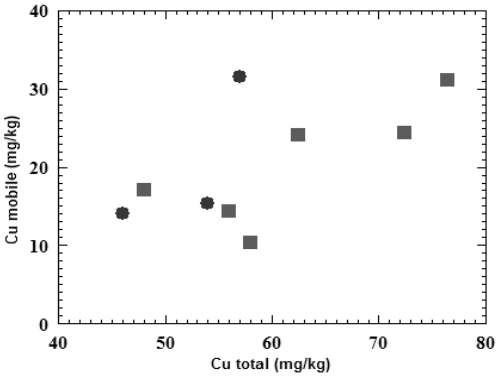

Fig. 5 Correlation between Cu total and Cu mobile

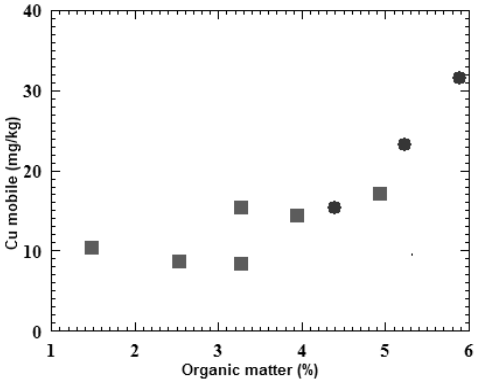

Fig. 6 Correlation between Organic matter and Cu mobile

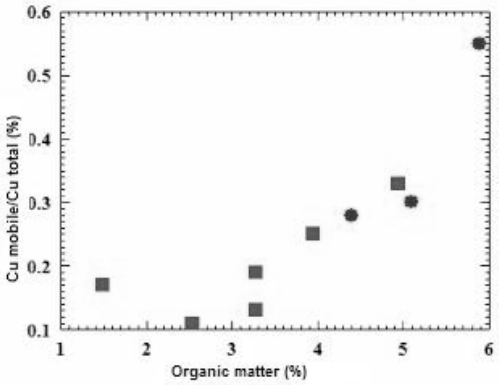

Fig. 7 Correlation between Organic mater and Cu mobile/Cu total

Conclusions

- This paper presents the quantitative distribution of Cu (total and mobile) in the stream sediments of Leşu and Ursu Brooks in the Bistriţei Mountains - Eastern Carpathians.

- The geological background reveals the presence of low-grade metamorphic rocks belonging to the Tg 3 Formation = Leşu Ursului Lithozone, of the Tulgheş Group, to which the polymetallic sulphide mineralization is associated.

- The stream sediment material is of allochtonous origin, represented mainly by products of weathering processes and of chemical disintegration of the Tulgheş Group metamorphic rocks, asociated with polymetalic sulphide mineralization (the Leşu Ursului ore deposit).

- The Cu from the investigated stream sediments displays contents placed in a large range: 17.8 - 87µg/g Cu. These concentrations are higher than the values found out for the continental crust and than the average soil contents.

- The positive geochemical correlations between the investigated heavy metals along with the continental crust normalized values, show that they share a common source.

- Cu is considered to be an important inorganic pollutant because of its toxic effects on biota, having a high enrichment factor and a slow removal rate.

- The contents of heavy metals in the stream sediments, in the soils and in the forest vegetation from the study area is a significant criteria for the estimation of their contamination.

Acknowledgements

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References

Adriano C.D., 2000. Trace elements in terrestrial environments. Second edition. Springer-Verlag, New York,Berlin, Heidelberg, 867

Bowen J.H.M., 1979. Trace elements in biochemistry. Acad. Press, London.

Davidescu D., Davidescu V., Lăcătuşu R.,1988. Microelementele în agricultură. Ed. Acad. România, Bucureşti.

Kabata-Pendias A. and Pendias H., 1992. Trace elements in soils and plants. Second edition. CRC Press Inc., Boca Raton, Florida, 299 .

Kloke A.. 1980. Richwerte ’80, Oreientierungsdaten für tolerierbare Gesamtgehalte einger Elemente in Kulturböden. Mitt. VDLUFA, Heft 1-3. FAO. 1974: FAO/UNESCO Soil map of the World.

Murariu T., Mihăilescu A.,1990. Recherches biogéochimiques dans la zone Broşteni (Monts Bistriţei). Anal. Şt. Univ. „ Al.I.Cuza „ XXXVI, s II b.

Murariu T., Mihăilescu A., Apostoae L., 1991. Cercetări pedogeochimice în zona Crucea-Broşteni (Mţii. Bistriţei). Anal. Şt. Univ. „ Al.I.Cuza „ XXXVII, s II b.

Smith S.R., 1996. Agricultural Recycling of Sewage Sludge and the Environment. CAB International, Wallingford, UK, 382

Taylor S.R. and McLENNAN S.M., 1985. The continental crust: its composition and evolution. Blackwell Scientific Publications, 379

Vinogradov A.P.,1957. Geohimia redkih I rasseannîh himiceskih elementov v pocivah. Izd. A.N. SSSR, Moskva.

Vodă Al., 1997. Sinteza zonei cristalino-mezozoice a Carpaţilor Orientali: date regionale. Geologie şi Metalogeneză regională. Tema V/15, S.C. Prospecţiuni S.A., Bucureşti.