

## HEAVY METAL CONTENT OF THE VEGETATION ON KARSTIC SOILS

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**Összefoglalás** - A talaj-növényzet kapcsolatrendszer fontos szerepet játszik a karsztökológiai rendszer folyamataiban. A talaj tolerálni képes a környezeti behatásokat, amelyek megváltoztathatják a karsztrendszert. Bizonyos korlátok között a talaj képes megkötni a nem-karsztos anyagokat, amelyek természetes vagy mesterséges folyamatok eredményeként jutnak be a talajba. A talajok savanyodása következtében a nehézfémek mobilizálódhatnak a talajban, és így könnyen bejuthatnak a növényi szervezetekbe és a karsztvízrendszerbe. A tanulmány bemutatja az Aggteleki Karszt területén folyó vizsgálati eredmények alapján a területen az EDTA oldható nehézfém tartalom és a növényzet nehézfém tartalmának kapcsolatát.

**Summary** - The soil-vegetation system has a great importance to process in the karst-ecological system. Soils can buffer environmental impacts and they can change the karst system. Within certain limits, soils can bind the non-karstic materials (e.g. heavy metals) which enter the soil by deposition or any anthropogenic influent. The result of the soil acidification the heavy metals can get into the vegetation and the karst water system. The present paper describes investigations the heavy metal content of plants in relation to the exchangeable heavy metal content in the Aggtelek region, Hungary.

**Key words:** Aggtelek Mountains, karsts, heavy metal, vegetation

### INTRODUCTION

The soil-vegetation system of karst region is important from the viewpoint of the processes in the sensitive karst geo-ecological system. (Kevei-Bárány and Mezősi, 1999) Soils can buffer those environmental impacts which change the processes of the karst system. Within certain limits, soils can buffer the different damaging materials (e.g. heavy metals) which can get into the soil by different depositions. Through the acidification of the soil, heavy metals in water may be taken up by vegetation and can have toxic impacts for the plants. The present study investigates the heavy metal content of the plants in relation to the soil acid soluble- and exchangeable heavy metal content in the area of the catchment basin of the Béke cave in Aggtelek Mountain in Hungary.

### PROPERTY OF THE SAMPLED AREA

The area is 10 km<sup>2</sup>, the catchment basin of the Béke-cave. It is situated in the Northern part of Hungary (see on the *Fig. 1*), the Southwestern part of the National Park of Aggtelek. In the northern part of the area Trias limestone comes up to the surface, for this

reason it is called uncovered karstic area. Get on south, this Trias limestone goes to the deep, and on this rock sediment in the age of pannon settles. We can observe this duality on the developed soil at parent material. In the northern part of the area you can find mainly reddish tone remained soils which are rich in clay minerals, and brown forest soils. On the other hand in the covered karstic area we can find bright, yellowish-brown coloured soils, which contain loam and sand (remain like terra fusca)

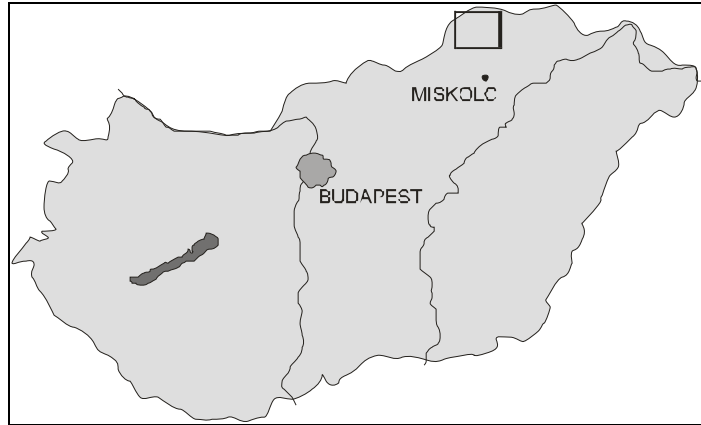


Fig. 1 The situation of the study area in Hungary

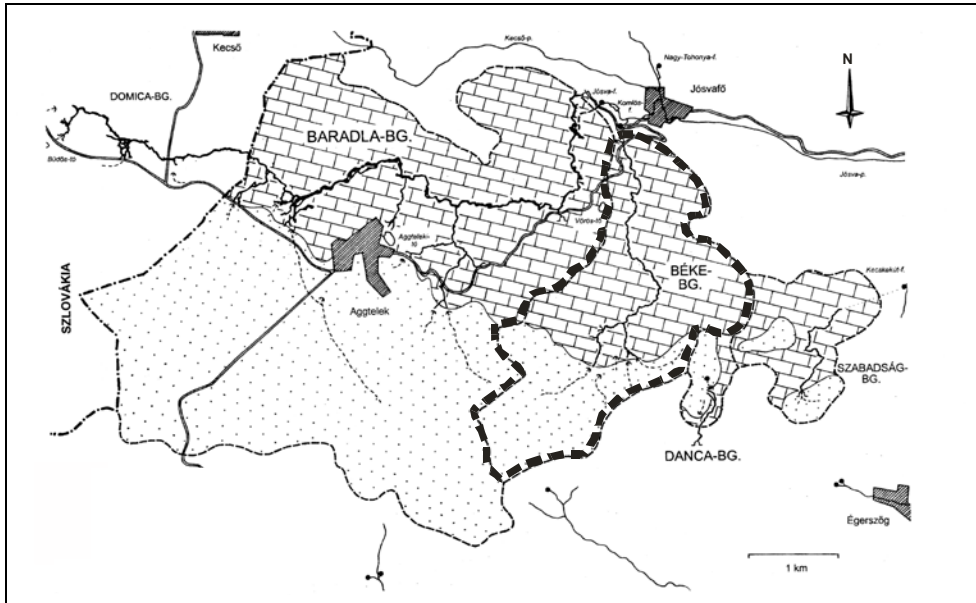


Fig. 2 The geological map of Aggtelek Mountain. Spotted part shows the area which has Pannon settlements and squared area has Trias limestones host rock. The pecked line enclosed area is the catchment basin of Béke cave, the investigated area.

The vegetation on the open karstic area is hornbeam-oak forest mixed with beech (*Carpinus Quercetum Fagetosum*) with scattered undergrowth. In some places we can find

warm preferable cornel-oak forest (Corno Quercetum Pubescenti Petrea). On the treeless places juniper (*Juniperus Communis*) and blackthorn build up impenetrable scrub. Most of the southern terrain is covered with slope steppe-grassland (*Salvio festucetum rupicole*).

## METHODS

The soil and the plants samples were collected during the summer of 2002. The soils samples came from two depth : one from the surface (0-10 cm) and the other came from 20-30 cm depth.

The acid soluble heavy metal-content was measured by ICP-OES techniques after digestion with acid mixture ( $\text{HNO}_3\text{-H}_2\text{O}_2\text{-HClO}_4$ ) (Rowell, 1994). The heavy metal-content of the air dried greenery was also determined ICP-OES techniques after digestion with  $\text{HNO}_3$  (Merian, 1984).

The measurements took place in the University of Veszprém.

## DISCUSSION AND RESULTS

### *The heavy metal content of the vegetation*

According to Füleky (1999) the examined plants contain metals in the following concentrations: Cu: 2-20 ppm, Co: 0.02-0.5 ppm, Cr: 0.5-4 ppm, Zn: 25-150 ppm, Kádár I. (1995) measured the following concentrations in the leaves of oak tree: Cu: 9 ppm, Co: 0.22 ppm, Ni: 1.8 ppm, Cr: 1.7 ppm, Zn: 44 ppm, Pb: 16 ppm

The heavy metal uptake of the plants is variable, depending on species. For this reason those species were chosen which could be found almost in the whole examined area. On the basis of this information we collected the following species of the plants: leaves of the hornbeam (*Carpinus betulus*), oak (*Quercus petrea*), and cornel (*Cornus mas*).

Table 1 Heavy metal content of *Carpinus betulus*

Sample number	Cu (ppm)	Ni (ppm)	Zn (ppm)	Co (ppm)	Cr (ppm)	Pb (ppm)
19	5.72	4.60	12.55	2.13	0.00	3.99
22	5.89	5.45	30.89	2.10	0.19	2.30
23	6.64	7.74	75.87	2.07	0.27	3.71
24	6.19	5.65	18.56	2.20	0.15	1.44
26	5.42	21.27	44.23	13.71	7.10	2.98
28	5.56	0.31	7.99	0.00	0.42	4.97
35	7.68	4.37	8.97	0.00	1.35	6.16
36	5.38	2.74	32.41	0.00	1.24	2.40

Table 2 Heavy metal content of Cornus mas

Sample number	Cu (ppm)	Ni (ppm)	Zn (ppm)	Co (ppm)	Cr (ppm)	Pb (ppm)
1	6.87	1.74	20.41	0.00	0.30	0.72
2	9.38	0.70	20.50	0.40	0.60	1.10
9	5.82	1.80	28.03	0.00	0.50	0.84
10	4.35	0.72	13.18	0.00	0.00	0.83
11	3.73	2.16	10.42	0.00	0.15	2.46
12	3.68	0.30	17.02	0.00	0.23	0.99
13	3.98	0.00	14.82	0.15	0.42	1.64
14	7.40	4.59	11.58	0.00	0.00	3.63
16	4.53	0.54	17.29	0.00	0.00	1.01
17	3.41	0.90	19.15	0.00	0.00	0.83
18	4.16	0.42	24.91	0.00	0.00	0.99
19	3.48	0.64	9.07	0.00	0.00	1.12
20	3.60	0.68	17.71	0.00	0.00	0.91
21	3.41	1.85	40.23	0.31	0.31	2.83
22	3.48	1.05	19.02	0.43	0.35	1.42
24	3.79	1.06	12.52	0.46	0.34	0.98
25	3.41	0.34	20.54	0.00	0.23	0.89
37	4.46	5.67	41.50	0.00	0.30	1.04

Table 3 Heavy metal content of Quercus petraea

Sample number	Cu (ppm)	Ni (ppm)	Zn (ppm)	Co (ppm)	Cr (ppm)	Pb (ppm)
2	6.81	0.00	16.75	0.00	0.65	3.68
9	5.56	0.00	18.45	0.00	0.83	28.87
10	7.10	17.08	23.12	13.57	0.00	4.59
11	3.23	0.00	93.73	0.00	0.61	0.95
13	6.83	0.00	19.78	0.00	0.42	1.10
20	4.96	2.05	7.65	0.04	0.60	1.14
21	4.64	0.00	22.86	0.00	1.01	2.85
35	5.69	1.85	33.75	0.00	1.30	2.09
39	5.52	0.46	24.26	0.00	1.04	1.93

It can be seen in the examined samples that the highest concentrations of the metals are in hornbeam, and the lowest concentrations are in cornel.

Based on the measurements the oak and the hornbeam, we can say that the chromium content of the soils that are setting on the pannon settle is higher than the others. In case of the hornbeam it can be seen that the cobalt concentration is lower in the terra fusca remained soils.

*The EDTA-soluble heavy metal content of the soils*

According to the literature (Adriano, 1986) the exchangeable heavy metal content of the examined soils is very low. However we can see that the heavy metal content of the plants exceeds in many cases the exchangeable metal content of the soils in the depth of 20-30 cm. We can explain it as a result of a normal physiological progression, in the course of this process the vegetation takes up metals of the amount that is vital for their life. Based on this fact the greenery is an act as an accumulator. For the comparison we use the date of the vegetation and the EDTA soluble heavy metal concentration of the soils from the depth of 20-30 cm. (The root of the vegetation can take up the nutrition elements from this depth.)

Table 4 The exchangeable heavy metal content of the soils in the depth of 20-30 cm.

Sample number	Cu (ppm)	Ni (ppm)	Zn (ppm)	Co (ppm)	Cr (ppm)	Pb (ppm)
1	3.64	1.66	1.14	3.94	1.22	9.70
2	5.23	1.68	9.83	3.79	2.36	9.72
9	1.97	0.36	0.15	3.22	0.19	6.93
10	3.38	3.13	0.93	4.33	0.00	8.81
11	2.69	1.79	1.34	5.94	0.03	8.67
12	2.44	0.67	1.86	2.44	0.14	11.54
13	4.03	3.03	7.88	4.31	0.00	15.45
14	2.23	0.05	0.43	2.40	0.03	12.39
16	4.23	1.81	0.46	4.82	0.14	13.23
17	5.04	2.43	0.00	6.65	0.09	14.20
18	5.57	1.33	1.97	5.45	0.00	20.81
19	3.87	0.00	0.39	4.75	0.00	31.98
20	5.31	3.15	7.03	5.91	0.00	24.75
21	5.00	0.57	0.00	9.71	0.00	13.80
22	4.21	2.22	1.15	6.51	0.00	14.83
23	3.99	1.00	1.46	4.58	11.94	11.66
24	3.56	0.74	1.20	4.24	11.88	14.69
25	6.66	1.76	5.49	4.62	12.09	21.28
26	4.19	2.72	0.69	5.01	0.84	12.15
28	3.48	2.07	1.07	3.41	0.88	13.87
35	2.60	0.80	0.69	1.94	0.00	6.26
36	3.37	0.88	0.77	1.04	0.00	3.51
37	2.65	3.42	0.65	2.89	0.62	8.25
39	2.51	0.70	0.92	2.57	0.64	5.09

CONCLUSION

The heavy metal content of the soils and the vegetation are relevant problems in conservation and agriculture.

As our investigations can show that the examined plants accumulate the heavy metals. They are deciduous plants and for that the metals get back to the natural circle and it means further loading for the soil.

As we are in karstic area, because of the unfavourable soil conditions the accumulated heavy metals from the greenery can get into the karst-water system. According to our researches the heavy metal content of the vegetation in the examined area convenient to the average value. In the future further occurrent contamination can be examined with a continuous controlling investigations series

#### REFERENCES

- Adriano, D.C., 1986: *Trace Elements in the Terrestrial Environment*. Springer-Verlag.
- Fülek, Gy., 1999: *Tápanyag-gazdálkodás (Alimentary substances husbandry)*. Mezőgazda Kiadó, 70-80.
- Káddár, I., 1995: *Környezet- és Természetvédelmi Kutatások (Research of Conservation and Environmental Protection)*. MTA Agrokémiai és Talajtani Kutató Intézet, Budapest, 131-132.
- Kevei-Bárány, I. and Mezősi, G., 1999: *The relationships between soil chemistry and the heavy metal content of vegetation on Karsts*. Essay in the ecology and conservation of Karst, Hungary, 47-53.
- Merian, E., 1984: *Metalle in der Umwelt*. Verl.Chemie GmbH. Weinheim, Florida, Basel, 722 pp.
- Rowell, D.L., 1994: *Soil Science: Methods and Applications*. Longman Group UK Limited, 350 pp.