

## THE DISTRIBUTION OF THE HEAVY METALS IN THE SOIL ALONG THE RIVER ZLETOVSKA AND ITS TRIBUTARIES

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**Abstract:** This paper gives the results of the investigations carried out on the presence and distribution of heavy metals (lead, zinc, iron, manganese) in the Kratovo–Zletovo area. The geochemical determination of these elements and their presence in the soil materials in the area display relatively large variations, in the sense of allowed concentrations of contaminations whose amounts exceed the allowed values.

**Key words:** geochemistry; distribution; lead; zinc; manganese; iron; ecology

### INTRODUCTION

The development of industrialization, urbanization and all kinds of transport make a better standard of living possible for the anthropologic population, but at the same time results in a constant increase in the contamination of the biosphere by various kinds of industrial and nonindustrial harmful material.

During the 1990s the world, especially the developed world, reached a high standard of living and

started its struggle for survival which made our future become a mystery.

Among many diseases which appeared and were revealed, a new one with many peculiar signs is occurring, which unfortunately we often neglect. A lot of names are used for it in the western world which come down to one term: "ecological disease", and its message is unique – our environment is seriously ill.

### MATERIALS AND METHODS OF WORK

The soil is one of the basic factors in the ecological equilibrium and important natural source which conditions the social and economic development of society. Because of its features, position and role it is a biospheric component and a product of joint action between the biogene and abiogene environment. The soil – organism ecosystem is an important mechanism in the formation and productivity of the biosphere. The development of mining, agriculture, transport, urbanization and other economic and noneconomic activities during the past years has disturbed the normal function of the soil – water – plants – animal – man system. Because of this, the investigation of the amount and the degree of soil pollution by one of the greatest pollutants such as heavy metals is of special interest. This urged us to examine the soil along the River Zletovo flow

and its tributaries from the aspect of heavy metal pollution (our paper deals with pollution by lead, zinc, iron and manganese).

Samples were taken from the surface of the soil up to 5 cm in depth above the Village of Zletovo where the River Zletovo flows into the Bregalnica. The samples were taken along the river bed, then ten and twenty meters far from the river. The material was worked mechanically and the small stones and herb roots were taken out. The samples were packed and dried in a drier at a temperature of 105°C for 48 hours. Then wet combustion by nitric, perchloric and sulphuric acid in the ratio 400 : 20 : 10 (ml) was carried out. The reading of the heavy metal concentrations (iron, lead, zinc and manganese) was made by an atomic absorber.

## EXAMINATION RESULTS

The soil samples were taken from eight sites: Zletovo, Koritnica, Globica, Kiselica, Strmoš, Bučište, Žiganci and Ularci. Zletovo measurement site was the control station. Samples were taken once a month during the whole of 1992.

The results of the analyses are given in mean values, tables and graphs.

The average lead content in the Zletovo control station is given in Table 1 and amounts to 46.61 mg/kg Pb by the riverside, 102 mg/kg Pb ten meters from the river and 153 mg/kg Pb twenty meters from the river. The Table also shows that at the Koritnica, Kiselica and Bučište sites the average lead content is ten times higher as a direct consequence of pollution by the waste waters from the Zletovo mine flotation plants.

The average zinc content in the soil close to the river in the Zletovo control station is 150 mg/kg Zn. Ten meters from the river it amounts to 260 mg/kg Zn and at twenty meters it amounts to 1520 mg/kg Zn. The average zinc contents in the other sites are one to fifteen times higher. They are shown in Table 2.

Table 1

*Lead content in the soil given in mg/kg*

Site	by the river	at 10 m	at 20 m
Zletovo	46.61	102	153
Koritnica	513.33	402	199
Globica	114.66	188	201
Kiselica	491.66	442	359
Strmoš	482.42	368	440
Bučište	200.25	246	219
Žiganci	266.42	231	224
Ularci	170.25	158	188

Table 2

*Zinc content shown in mg/kg*

Measure site	by the river	at 10 m	at 20 m
Zletovo	150	260	152
Koritnica	2540	1720	320
Globica	270	470	280
Kiselica	2280	2400	1510
Strmoš	2410	3020	3390
Bučište	480	500	620
Žiganci	1120	1160	1430
Ularci	730	720	870

Manganese concentrations in the soil at the Zletovo control station range from 780 mg/kg Mn near the river, to 2090 mg/kg Mn ten meters from the river and 8930 mg/kg Mn twenty meters from the river. The average concentration in the other sites is 2 to 43 times higher.

The average manganese concentration at the Kiselica site is quite high, especially near the river where the waste waters from the flotation plant flow in.

The highest average manganese concentration 20 meters from the river was determined at the Strmoš site. The old waste dump which was built close to the site made pollution with one of the heaviest metals possible (Table 3).

The average iron content is given in g/kg and, unlike the other elements, its content does not show extreme differences. Only at the Koritnica, Kiselica and Strmoš sites it is two to three times higher, whereas at the other sites it has similar average content (Table 4).

Table 3

*Iron content in the soil shown in g/kg*

Measure site	by the river	at 10 m	at 20 m
Zletovo	25.80	31.86	30.32
Koritnica	48.30	32.87	34.00
Globica	25.59	36.98	31.85
Kiselica	59.57	58.43	39.19
Strmoš	70.00	63.32	53.57
Bučište	32.79	40.20	32.14
Žiganci	32.72	32.27	34.30
Ularci	32.25	31.36	31.36

Table 4.

*Manganese content shown in mg/kg*

Masure site	by the river	at 10 m	at 20 m
Zletovo	780	2090	8930
Koritnica	8640	5780	1760
Globica	2060	2060	2240
Kiselica	33900	6440	8720
Strmoš	4850	23560	17260
Bučište	3270	5720	2800
Žiganci	2700	2650	2840
Ularci	6840	7940	6110

## DISCUSSION AND CONCLUSION

The concentrations of heavy metal (lead, zinc, manganese and iron) in the soil along the River Zletovska is several times higher in those places where

waste waters from the sulphide concentration process from the Zletovo mine are dumped. The technological processes during the flotation of lead and zinc ore

throw out heavy metals which pollute the River Zletovo. Thus, the ecosystem water pollutes the ecosystem soil.

The control region above the Village of Zletovo displays very low pollution by heavy metals, whereas in the other places the lead content is ten times higher, the pollution by zinc is fifteen and that of manganese it is even forty times higher than that at the control station near the Village of Zletovo.

Only with iron the differences in the average contents are not so explicit.

As lead, zinc and manganese are potentially the most dangerous heavy metals, the studies of the environmental pollution must become a permanent task. The degree of the increase in heavy metal pollution of the soil, water, plants and animal life should also become the subject of our further investigations.

### SUMMARY

The Zletovo lead and zinc mines in Probištip, with their waste waters which flow out after lead, zinc and cadmium sulphide concentration processing, are the greatest potential polluters.

The town of Probištip, and some villages in its vicinity are situated very close to the polluted area. The old waste dump which is built close to these settlements is an open source for pollution.

Heavy metals tend to accumulate in the human body and have negative effects on many processes in human and animal organs.

The ecologic investigations were carried out in order to find out the degree of the pollution by heavy

metals (lead, zinc, manganese and iron). Similar investigations were carried out in the unpolluted control region of Zletovo as well.

The investigations indicated that the average contents of some of the heavy metals are the highest in the examined sites which are close to the waste dump and where the waste waters from the flotation plant of the Zletovo mine flow out.

The results lead to the conclusion that the soil along the course of the River Zletovska and its tributaries is extremely contaminated by heavy metals. This also reminds us to take serious steps against the pollution of settlements, soil and water ecosystems.

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