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**ANTHROPOGENIC EFFECTS ON
THE HUMAN ENVIRONMENT IN
TERTIARY BASINS IN THE
MEDITERRANEAN**

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Trace Elements in the Soils of Some Regions in the Republic of Macedonia

BLAŽO BOEV¹ AND SONJA LEPITKOVA¹

¹Faculty of Mining and Geology Stip, University Sts Cyril and Methodius Skopje Goce Delcev 89, 2000 Stip, Republic of Macedonia e-mail: bboev@rgf.ukim.edu.mk

Abstract: The paper presents investigations carried out on the presence of rare elements in the soils in the vicinity of Kocani, Probistip (Neokazi, Zletovica), Lakavica (along the River Lakavica course) and in the vicinity of Sveti Nikole. The regions are known for their intense agricultural and other anthropological activities. Understanding the level of soil contamination is of enormous importance for the population in the region. The region is also known for the mining activities that also have an impact on the distribution of some microelements in the soils. Studies carried out by ICP-AES included elements such as Al, Mg, Ca, Fe, Mn, Na, K, Ti, Sr, Ba, Ni, Zn, Cu, Pb, Cr, Cd, Co, V, Li, Mo, Se and Ag. Based on the results obtained it can be inferred that there are increased anthropogenic impacts in the regions of Kocani, Zletovica and Lakavica.

Key words: Rare elements, anthropogenic impacts, soils.

Introduction

The Republic of Macedonia abounds in deposits and occurrences of mineral raw materials that have been exploited for a long period of time. Mining activities can be divided into exploitation of metals, exploitation of energy raw materials (coals) and exploitation of non-metallic raw materials.

Investigations carried out in connection with this paper are related to the anthropogenic impacts of mining activities in the lead, zinc and copper mines in the eastern part of the country. Investigations shown in (Fig.1) illustrate the presence of trace elements in the soils of the regions mentioned above. So far, the issue of the concentration of rare elements in the soils of the Republic of Macedonia has been studied and several papers have been published (BOEV&LEPITKOVA, 1996, 1997, 1998, 2002, 2004).

Results and discussion

The results obtained and methods of studies are given in Table 1.

Sr content in soils under investigation ranges from 34.56 to 138.21 mg/kg, which implies that the soils are poor in strontium. A comparison between the values obtained with those that are characteristic for other regions in the world shows that the soils in Denmark contain the lowest concentrations (GOVINDARAJU, 1994).

The highest Sr concentrations of 138.21 mg/kg in the Republic of Macedonia have been found close to the River Zletovica. The region is built up of volcanic tuffs of Tertiary age so that pedogenesis of the soils consists mainly of tuffs.

Table 1: Presence of trace elements in soils from some regions in the R. of Macedonia (mean value, ICP-AES method)

Sample No	Kocani	Neokazi	Zletovica	Lakavica	Sveti Nikole
Number of samples	19	21	82	24	24
(%)					
Al ₂ O ₃	4.660	8.15	8.17	5.528	8.434
FeO	3.165	4.978	4.832	3.616	6.795
CaO	1.479	2.370	3.231	1.416	6.894
MgO	0.937	1.473	1.574	1.397	6.723
Na ₂ O	0.052	0.120	0.187	0.039	1.177
K ₂ O	0.409	0.682	0.789	0.006	0.0974
TiO ₂	0.082	0.162	0.263	0.047	0.051
P ₂ O ₅	0.026	0.053	0.087	0.156	0.226
MnO	0.090	0.149	0.4753	0.1058	0.175
(mg/kg)					
Sr	108.3	124.05	138.21	34.56	112.40
Ba	128.14	281.60	275.24	120.99	162.58
Ni	23.61	27.58	14.89	58.98	122.69
Zn	48.24	76.84	833.2	62.52	79.34
Cu	21.31	27.732	168.90	69.21	39.54
Pb	24.215	38.69	1394	33.09	28.876
Cr	29.554	30.966	20.818	65.65	96.32
Cd	3.017	5.532	2.40	4.39	5.12
Co	8.202	14.694	38.09	14.77	18.86
V	4.223	7.98	15.25	134.21	124.06
Li	5.353	2.193	2.654	1.760	2.354
Mo	<4.74	<4.74	<4.74	<4.74	<4.74
As	<0.05	<0.05	95.68	<0.05	<0.05
Se	0.9652	1.90	4.40	0.23	0.24
Ag	<3.46	<3.46	<3.46	<3.46	<3.46

The content of Ba is from 120.99 to 275.24 mg/kg and if compared with the values in other areas reported in literature (GOVEDARAJU, 1994), it can be said that the amount of Ba in the area of investigation is low which is consistent with the values of histosols. It is of note that the highest Ba concentrations have been found in the surrounding of Zletovica and Neokazi where volcanic products with higher amounts of Ba in the pedogenesis of the soils are present.

Ni contents in the soils under investigation have been found in a wide span of 23.61 to 122.69 mg/kg which is characteristic of other regions in the world.

The increased concentration of Ni in the area of Sveti Nikole (122.69 mg/kg) (the allowed concentrations being 100 mg/kg) are due to the ophiolite series present in the Vardar Zone.

Zn contents have been determined in an exceptionally wide span from 48.24 to 833.2 mg/kg. The values obtained show that the high Zn concentration (833.2 mg/kg) near Zletovica is due to the intense anthropogenic influence, notably the disasters that occurred in the lead and zinc flotation dams (Fig.1). Except for these values, all other concentrations are consistent with values reported for the contents of Zn in the soils in many countries in the world (GOVINDARAJU, 1994).

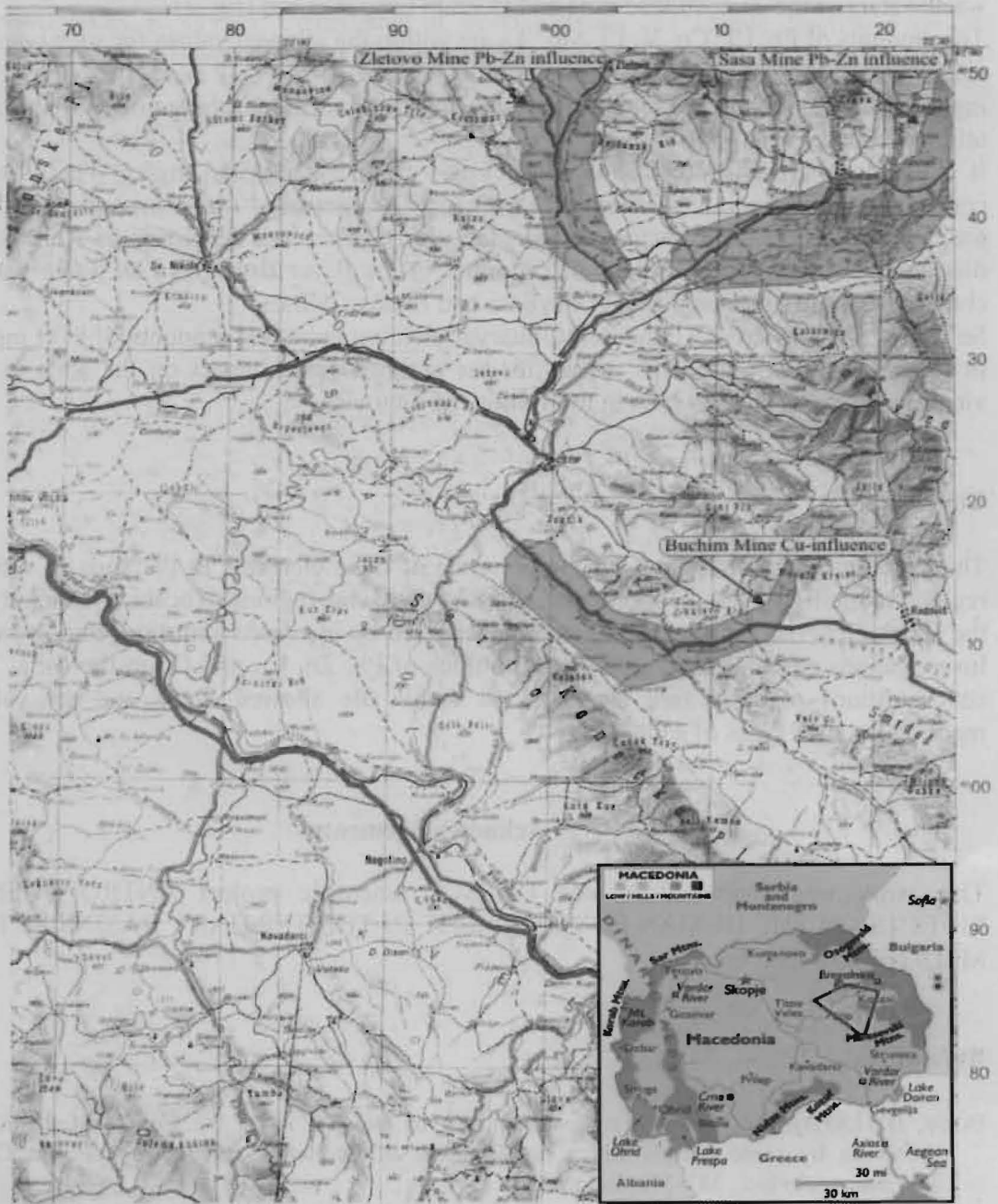


Fig. 1. Anthropogenic implications caused by the Zletovo and Sasa Pb-Zn mines and the Buchim Cu mine.

Cu contents in the soils studied are within the 21.31 – 168.90 mg/kg interval. Compared to allowed Cu concentrations in soils it is a value that is characteristic for many regions in the world, except for the regions of Zletovica (168.90 mg/kg) and Lakavica (69.21mg/kg). Notably, the regions of Zletovica and Lakavica are known for their anthropogenic activities and the discharge of increased amounts of copper in the wastewaters of the Zletovo lead-zinc and Buchim copper mines (fig. 2).

The amounts of Pb, Cr, Co, V, Li, Mo, As are within the allowed values for such types of soils, except for the increased concentration of lead in the soil near Zletovica (1394 mg/kg) which is due to the anthropogenic influences and the discharge of lead and zinc tailings from the mine.

It is of note that Cd content is relatively low – from 2.40 to 5.53 mg/kg. The allowed concentrations of cadmium are within 5 mg/kg. The increased cadmium concentrations are due to anthropogenic factors such as the use of phosphate fertilizers as well as the discharge of large concentrations of cadmium in the River Bregalnica as waste waters coming from the flotation plants of the Sasa and Zletovo Mines.

Se contents are in the 0.23 and 4.440 interval yielding increased amounts of 9.39 mg/kg in several samples only. This speaks for the anthropogenic impact on the soils in the vicinity of Kocani and the soils in the vicinity of Zletovica.

Conclusion

The investigations carried out on the presence of trace elements in the soils in certain regions of the Republic of Macedonia indicated that some regions (Kocani, the vicinity of the River Zletovica and Lakavica) are characterized by increased anthropogenic impacts. Investigations revealed increased concentrations of Pb, Zn, Cu and Cd in the soils. The concentrations of other rare elements are within the allowed limits and the values reported for such types of soils.

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