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15. КОНГРЕСА ГЕОЛОГА СРБИЈЕ
СА МЕЂУНАРОДНИМ УЧЕШЋЕМ

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OF THE 15TH CONGRESS OF GEOLOGISTS OF
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Heavy Metals in Sediments of Artificial Hydro Accumulation Mavrovica and Orelska Reka, Eastern Macedonia

Тешки метали у седиментима вештачке акумулације Мавровица и Орелска река, источна Македонија

ORCE SPASOVSKI¹, JULIA RISTOVA² & TRAJCE MITEV¹

Abstract. The city Sv. Nikole as a basic resource for water-supplying is using the “Mavrovica” hydro accumulation. There is a very serious question asserted about the quality of water, actually the possibility for chemical or other kind of pollution. The researchers from geological-chemistry and ecological aspect are showing the potential possibilities for anthropogenic contamination of the bio-environments (water, soil and sediments) in the area. More examinations where-as the presence of the heavy metals in the water and the sediments from the Mavrovica hydro accumulation are not made jet. For determining the content of the heavy metals in the slime-sediments from the above mentioned accumulation, there are samples taken from the sediments and there are concentrations of the following group of elements traced: Mn, Fe, Al, Zn, Pb, Ni, Cd, Cu, Cr, Ag, As and Co.

The results gained are showing increased concentrations in the sediments of all of the analyzed elements.

Key words: Hydro Accumulation Mavrovica, Orelska Reka, Heavy Metals, Sediments, Maximum Allowed Concentrations, AES-ICP.

Анстракт. Основни извор снабдевања насеља Св. Никола је акумулација Мавровица. Постоји врло озбиљно питање квалитета воде, односно могућности за земљишне или друге врсте загађења. Истраживања са геолошко-земљишког и еколошког аспекта показују потенцијалне могућности антропогене контаминације био-окружења (воде, земљишта и седимента) у тој области. Детаљнија истраживања присуства тешких метала у води и седиментима из акумулације Мавровица још увек нису вршена. За одређивање садржаја тешких метала у муљу између акумулације узети су узорци и констатоване концентрације Mn, Fe, Al, Zn, Pb, Ni, Cd, Cu, Cr, Ag, As као и Co.

Добијени резултати показују повећану концентрацију свих анализираних елемената у седиментима.

Кључне речи: Акумулација Мавровица, Орелска река, тешки метали, седименти, највећа дозвољена концентрација, AES-ICP.

Introduction

Existing water resource Sv. Nikole municipality is the artificial hydro accumulation “Mavrovica”, which is placed on the river Mavrovica. In the above mentioned hydro accumulation the water from the following rivers are: Orelska reka, Makreska reka and Kiselica.

Because of more of the contamination of the sediments with heavy metals, there is research made of the slime-sediments in the foundation of the mentioned accumulation

and the river-sediments that we consider will give additional information's - of which components were transmitted with the water flows.

Exploring the sediments is discovering elements and substances with non-organic or organic, natural or artificial origin, showing the level of their concentrations in the water, the locations they can be found on, and the conditions under what those elements or substances are.

Some of the previous studies of the heavy metals in water and sediments in the area of interest were performed

¹ The “Goce Delchev” University, Faculty of Natural and Technical Sciences, Goce Delchev 89, Stip -2000, R. Macedonia. E-mail: orce.spasovski@ugd.edu.mk

² Geoprojekt-IMS Stip, Ul. Zeleznicka bb, Stip -2000, R. Macedonia.

Table 1. The concentration of the analyzed elements in the samples of sediments and standards in (% ,mg/kg)

	Ms-1	Ms-2	Ms-3	Ms-4	Ms-5	ORs-1	ORs-3	SR
%								
Al	3.81	4.14	6.63	7.06	3.02	8.17	6.54	6.63
Stand.	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Mn	0.11	0.13	0.08	0.14	0.06	0.17	0.13	0.12
Stand.	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Fe	2.79	3.72	3.56	4.37	2.03	4.38	5.58	3.78
Stand.	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
Mg/kg								
As	3.019	<1	4.228	1.381	<1	<1	4.447	
Stand.	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Ag	<0.1	0.604	0.744	0.299	<0.1	<0.1	0.135	
Stand.	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Ni	93.731	175.551	72.874	85.073	45.5	97.457	113.245	97.633
Stand.	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9
Cr	78.165	150.188	56.343	74.028	46.216	92.682	99.859	85.3544
Stand.	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Zn	60.485	71.166	71.381	76.477	36.753	99.211	91.857	72.3328
Stand.	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Cu	33.340	39.158	27.520	38.844	19.238	42.186	39.543	34.2612
Stand.	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
Pb	16.073	16.682	17.968	28.281	21.952	24.751	16.693	20.2
Stand.	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Cd	3.973	4.477	4.597	5.828	2.605	6.035	7.778	5.0418
Stand.	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Co	17.211	20.936	18.144	23.048	11.674	26.387	24.352	20.2502
Stand.	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

by numerous researchers such as SPASOVSKI & DONEVA (2007), MIRCovski & SPASOVSKI (2009), SPASOVSKI & MITREV (2009), SPASOVSKI & DAMBOV (2009)

Methodology

The collection of the samples of the sediments is made with help of little shovel from the 2–4 cm of the sediment. The in appropriate plastic bags and it is properly marked for further processing.

The preparation of the samples of the sediments is in 3 phases: drying, seeding and dissolving.

The analysis of the samples of the instrument ICP-AES was done in the laboratory of the Mining-geological faculty in Stip.

Results and discussion

Samples taken from the river sediments, as well as the slime-sediments are from the Mavrovica hydro accumulation.

The samples of sediments are taken right from the flow of the river, where the water is slow. The sediments from

the hydro accumulation are taken with shovel from the bottom of the hydro accumulation. The results of the chemical examinations are given in table 1.

For comparison of the heavy metals in the samples taken from the sediments (NOAA) standard for the sediments is used.

The results shown in table 1 are showing that the aluminum in all the samples is occurring in much bigger concentrations concerning used standards for concentrations of the same element in sediments.

The biggest concentration is shown in sample Ors-1 (8,177%), and the smallest content in sample Ms-5 (3,026%). The average content of the aluminum is 6.637%.

It can be seen that the content of the manganese is higher, compared to maximum allowed concentrations for sediments (Table 1).

The biggest concentration is detected in sample Ors-1, where it is 0.175%, and the lowest content in sample Ms-5 where it is 0.062 %.

Maximum allowed concentrations of the manganese in the sediments is 0.040 %.

Average content of the manganese in the samples is 0.1214 %.

Increased concentrations in iron are present in all the samples. Biggest contents seen in sample Ors-3 (3.56 %) and lowest concentration in sample Ms-5 (2.037 %). The average content of iron in the samples is 3.7802 %.

According to the results given in table 1 it can be concluded that, the nickel is showing in all the samples in a lot bigger concentrations compared to maximum allowed standard content.

The biggest content is shown in sample Ms-2 where is 155.551 mg/kg, and lowest concentration in sample Ms-5 (45.5 mg/kg). The medium content of nickel in the samples is 97.633 mg/kg.

Biggest concentration of the chrome is shown in sample Ms-2 where is 150.188 mg/kg, and the smallest concentration is shown in sample Ms-5 where is 46.216 mg/kg. The average content of the chrome in the samples is 85.354 mg/kg.

According to the results given in table 1 it can be seen that the content of zinc is much higher compared to the content of zinc given with the standards for sediments.

The biggest content of zinc is determinate in the sample Ors-1 (99.211 mg/kg), and the lowest content of zinc we have in the samples 72.33 mg/kg.

The biggest concentration of the cuprum is present in the sample Ors-1 (43.186 mg/kg), and the smallest content we have in the sample Ms-5 (19.23 mg/kg).

The maximum allowed concentrations of cuprum in the sediments is 17.5 mg/kg.

The average content of cuprum in the samples is 34.26 mg/kg.

From mentioned in table 1 it can be concluded that the contents of this metal also are higher compared to maximum allowed concentrations.

The maximum content of lead (plumbum) is seen in the sample Ms-4 and it is 38.84 mg/kg, and the minimum concentration is in the sample Ms-1 and it is 16.073 mg/kg.

The average content of the lead (plumbum) in the samples is 20.2 mg/kg. The results given in table 1 according to the contents of cadmium, it can be seen that the content of cadmium are higher compared to maximum allowed concentrations for sediments.

The biggest contents are in the sample Ors-3 (7.778 mg/kg), and the smallest contents are in the sample Ms-5 (2.605 mg/kg). The average content of cadmium in the samples is 5.041 mg/kg.

The cobalt, like the other elements is showing higher contents in the sediments compared to its contents in the standards of NOAA.

The biggest content is found in sample Ors-1 and it is 26.387 mg/kg, and the smallest content is in the sample Ms-5 and it is 11.674 mg/kg.

The average value of the cobalt in the samples is 20.25 mg/kg.

The shown data for the contents of the heavy metals in the sediments from Oreška reka and Mavrovica accumulation indisputably indicate of their bigger contents compared to the standards of NOAA. These increased contents of heavy metals in the sediments are due to their geochemical characteristics. Namely the measured pH values of the water from Oreška reka are in the limits of 5.98 to 6.88, and in the Mavrovica accumulation they are in the limits of 6.91 to 6.93 and in the conditions for pH values lower than the measured it is disposed reducing of the heavy metals and their concentration in the sediments. This kind of thinking is confirming also with the fact that the examined heavy metals in the water from the researched area are in a lot smaller contents compared with their maximum allowed concentrations in the drinking water.

Conclusion

According all the data collected before, concerning the attitude of the heavy metals in the sediments in the river Mavrovica and the Mavrovica artificial accumulation, that were the subject of study, the following conclusions can be carried out:

Existing water resource in Sv. Nikole municipality is the artificial accumulation "Mavrovica", which is placed on river Mavrovica, from which the water is used for water supplying for Sv. Nikola. In the above mentioned accumulation the water from Oreška reka, Makreska reka and Kiselica are running in.

The researchers from geological-geochemical and ecological aspect are showing the potential possibilities for natural (naturally increased concentrations of certain elements) and anthropogenic (increased contents of certain elements provoked from the people's activities), contamination of the bio-environments (water and soil) in the area.

According the results that are gained from the analyzes of the samples taken from the sediments from Oreška reka and Mavrovica hydro accumulation it can be concluded that heavy metals are recording certain enlargement compared to maximum allowed concentrations for heavy metals in the sediments. The silver is the only one metal that shows lower contents from maximum allowed concentrations in the samples Ms-1, Ms-5, ORs-1, ORs-3.

The reasons for increased concentrations of the metal in samples taken from sediments are different, their attitude, the conditions and geology of the researched area, pH and redoks potentials of the environments that are leading to deposition, sedimentation etc.

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