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THE ALSHAR POLYMETALLIC DEPOSIT AND ITS IMPACT ON THE WATER IN LAKE TIKVES

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Abstract

The paper presents investigations carried out on the possible effects of the Alshar As-Sb-Tl-Au-Ba deposit on the water of Lake Tikves.

Lake Tikves is the largest artificial water reservoir in this part of the Republic of Macedonia and plays an important role in the development of agriculture in the region and the municipality of Kavadarci.

Lake Tikves is constructed on the Crna River, which is the largest water artery that receives most of the waters in the western region of the country. The River Blasnica empties into Lake Tikves below the village of Klinovo carrying the waters of the western parts of Mts. Kozuf and Kozjak. It receives the waters of the Majdanska, Portska, and Kozarnic. The River Mjadanska flows through the central part of the Alsar mineralized zone and through numerous earlier dumps of waste material abundant in As, Tl, Sb, Pb and Zn.

Investigations carried out regarding the present state at the Alshar mine indicate that it does not have a large impact on the waters in Lake Tikves and that it is important to protect the balance.

Introduction

The town of Kavadarci is located in the Tikves Region of the Republic of Macedonia, one of the most fertile and productivite areas of the country. The township has a surface area of 1,132 square kilometers and a population of some 42,000 residents. The relief is rolling hills and flatland in the vicinity of Vardar River valley in Central Macedonia, with an average altitude above the sea level of 280 meters. The warm summers and mild winters make Kavadarci one of the best areas for viticulture in the country and a major exporter of quality vines. The climate of the area is mild and semiarid. Temperature during the summer frequently reach 40 degrees Celsius, and during the winter rarely fall minus 10 degrees Celsius. Total annual precipitation is only about 500 mm on the average,a nd occurs mostly during the winter and early spring.

The climate and the vast area of semi arid land in the vicinity of Kavadarci necessitated the construction of the largest artificial lake in the country, with the capacity of about 500 million cubic meters. There is also a small hydropower plant the total power of 120 megawatt/h, located near the dam (fig. 1). The waters of the lake irrigate about 8 000 hectares arable land, vineyards and other agricultural crops.

For all these reasons the authority of the Kavadarci Township, the Ministry of Environment and Planning are concerned with the water quality in Lake Tikves.

Fig.1. The panoramic view of Tikves Lake

The catchment area of the Crna is large and carries untreated communal and industrial waste waters. This makes the issue of the contamination of Lake Tikves waters very serious.

Quality of water in Lake Tikves

The quality of the water in Lake Tikves depends on the quality of the waters of the Crna. Table 1 shows the quality of waters of the rivers Dragor, Elaska, Crna, Blasnica and those of Lake Tikves close to the dam.

Table 1 Category of waters of the Crna and Lake Tikves

Measure points	Water quality as measures (category)
River Dragor, at estuary to the Crna River	IV
River Elaska, at estuary to the Crna River	III and II
River Crna	
At Topolcani	II and III
At Novaci	II and III
At Skocivir	III and IV
River Blasnica	I
Lake Tikcesm at dam	II

The data in Table 1 indicate that Lake Tikves receives river waters of variable category. On the other hand, the length of the artificial lake (about 30 km) has a good effect on the self-purification of water.

Table 2: Water quality in Lake Tikves (mg/l)

Substance	Location	1	2	3	4	5	6
Dsolved oxygen	Skocivir	6.50	5.81	3.40	5.45	4.50	3.95
	Lake Tikves	11.21	10.50	13.45	9.87	11.24	10.07
	Blasnica	15.24	14.68	16.47	15.64	17.32	15.42
BOD	Skocivir	5.50	4.45	5.08	4.82	6.87	6.81
	Lake Tikves	5.32	2.98	5.34	5.87	5.23	3.55
	Blasnica	2.41	2.13	2.11	2.23	2.45	2.14
COD	Skocivir	4.25	6.78	13.90	6.78	10.87	8.97
	Lake Tikves	2.87	3.54	4.50	5.24	5.21	5.36
	Blasnica	2.14	2.35	3.51	2.65	2.35	2.50
Amonia	Skocivir	0.957	1.147	5.653	0.653	2.195	4.02
	Lake Tikves	0.247	0.342	0.519	0.179	0.123	0.141
	Blasnica	0.023	0.021	0.012	0.021	0.011	0.013
Nitrite	Skocivir	0.203	0.191	0.189	0.511	0.393	0.511
	Lake Tikves	0.011	0.115	0.152	0.091	0.941	0.095
	Blasnica	0.001	0.001	0.002	0.001	0.003	0.001
Nitrate	Skocivir	1.037	1.348	1.394	1.221	1.801	1.581
	Lake Tikves	0.603	0.854	0.414	0.886	0.851	0.811
	Blasnica	0.035	0.054	0.021	0.014	0.021	0.031
Fe	Skocivir	0.139	0.584	0.742	0.529	0.275	0.691
	Lake Tikves	0.284	0.063	0.051	0.089	0.273	0.032
	Blasnica	0.091	0.051	0.023	0.035	0.065	0.021
Mn	Skocivir	0.117	0.011	0.096	0.035	0.069	0.053
	Lake Tikves	0.023	0.003	0.004	0.017	0.008	0.007
	Blasnica	0.003	0.001	0.002	0.001	0.002	0.003
Pb	Skocivir	0.007	0.007	0.011	0.007	0.007	0.011
	Lake Tikves	0.007	0.004	0.008	0.004	0.007	0.009
	Blasnica	0.002	0.001	0.002	0.001	0.002	0.001
Zn	Skocivir	0.036	0.037	0.038	0.022	0.038	0.052
	Lake Tikves	0.029	0.048	0.032	0.018	0.018	0.017
	Blasnica	0.008	0.009	0.012	0.003	0.008	0.009
Cd	Skocivir	0.0009	0.0005	0.0008	0.0009	0.0007	0.0006
	Lake Tikves	0.0006	0.0004	0.0006	0.0005	0.0005	0.0004
	Blasnica	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
Cr	Skocivir	0.003	0.004	0.002	0.014	0.002	0.002
	Lake Tikves	0.001	0.002	0.001	0.005	0.002	0.002
	Blasnica	0.001	0.001	0.001	0.002	0.001	0.001
As	Skocivir	0.001	0.001	0.002	0.001	0.002	0.002
	Lake Tikves	0.001	0.001	0.002	0.002	0.002	0.002
	Blasnica	0.001	0.002	0.003	0.001	0.001	0.002

A look at the data about the water quality of Lake Tikves (table 2) makes it possible to conclude that the water of Lake Tikves is not contaminated by any of the elements mentioned and that the elements studied are within the allowable concentrations.

The data in the table also show that no increased arsenic concentrations have been found which implies that the Alsar ore zone does not have an enormous impact on the water in the lake.

However, the paper will discuss some features of the ore zone and the concentration of some elements in the waters and soils in the vicinity of Alsar.

The deposit is located at the foot of Mt Kozuf and the valley of the River Majdanska (fig. 2). It is a low temperature hydrothermal As, Sb, Tl, Au, Ba deposit. More information can be found in the papers of Boev et al., (1993, 1996, 2002), Ivanov (1986), Jankovic (1993), Pavicevic et al., (2004).

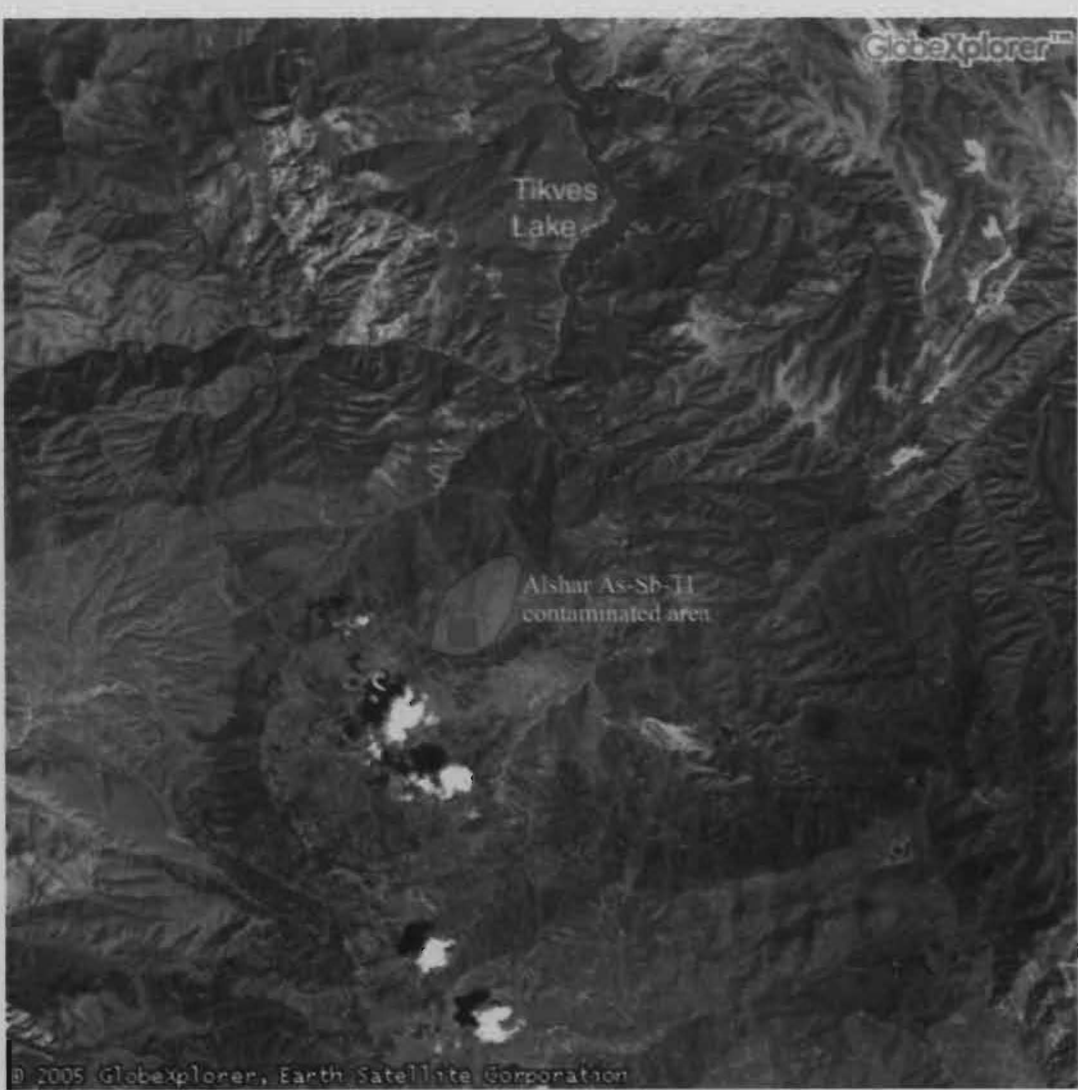

Fig. 2. Geographic position of Lake Tikves and Alsar As-Sb-Tl contaminated area.

The Alsar area is characterized by increased concentrations of arsenic, antimony and thallium. Increased arsenic and thallium concentrations have also been found in some plants such as Thimus and Viola (Boev at al.,2002). It can generally be said that the Alsar deposit contains about 500 000 tones of antimony ore (with 2.50 Sb) and about 1.50% As. Increased concentrations of thallium of 0.2% Tl (or some 40 tones of thallium ore) have also been determined.

The increased arsenic, antimony and thallium concentrations are a risk for the human environment along the River Majdanska, which empties into Blasnica and later the water flows into Lake Tikves.

It is of note that earlier mining waste dumps with large amounts of waste material that resulted from mining activities have been found in the riverbed of Majdanska. Increased concentrations of trace elements have been determined in the material and in the river sediments (Table 3).

Table 3: Geochemical analyses of the mine waste, soils and stream sediments (ppm)

Sample Reference	Sb	As	Cd	Cr	Pb	Ni	Tl
Stream sediment							
1	6	150	<1	97	9	156	<1
2	280	356	1	20	9	31	<1
3	18	186	<1	26	8	31	<1
4	57	296	1	18	7	26	<1
6	260	256	<1	22	3	22	<1
7	155	602	4	16	6	18	<1
8	70	277	1	15	2	19	<1
9	123	677	3	18	4	22	<1
10	85	813	4	24	4	25	<1
11	129	829	5	22	6	26	<1
12	58	315	<1	98	7	92	<1
13	33	70	<1	569	6	675	<1
14	24	25	<1	353	2	360	<1
Mine waste							
1	514	>32000	261	4	17	6	478
2	1288	8514	45	10	9	26	100
3	4481	7613	39	16	20	6	716
4	12	153	<1	5	3	11	<1
5	146	8477	922	9	19	4	775
Soil							
1	1731	3602	22	32	6	46	107
2	8098	1182	5	92	6	123	92
3	2116	672	3	130	7	154	<1

It is also of note that the rocks hosting the arsenic, antimony and thallium mineralizations contain increased concentrations of those elements (Table 4).

Some analyses (Table 4) indicate that the antimony and arsenic contents range within percentages. This results in the occurrence of antimony minerals (crystalline stibnite) and arsenic (crystalline realgar). Arsenic minerals (auripigmentum As_2S_3, realgar As_4S_4) as well as antimony minerals (stibnite Sb_2S_3) in surface conditions are rather unstable minerals and are affected by oxidation and weathering processes.

These processes of supergene transformation result in the release of arsenic, but due to its low mobility in secondary geochemical media it easily concentrates into sediments.

This is also the case with antimony, which is of low mobility in secondary geochemical media, and since these media are abundant in iron it adsorbs on ferri-hydroxides.

It should be mentioned that mercury concentrations are rather low. On the other hand, mercury in secondary geochemical media concentrates in primary geochemical halos that form during ore mineralizations. Its mobility in water is not high and it occurs as bi-chlorine and sulphate compounds.

Table 4: Trace Elements Concentrations in Fresh Altered and Minealised Rocks form the Alsar area (ppm)

Samples	Sb	As	Cr	Pb	Hg	Ni	Tl
1	<5	<5	2	2	0.01	1	0.3
2	<5	24	2	2	0.01	1	0.4
3	<85	<5	135	7	0.01	109	1.8
4	<5	8	37	40	0.01	8	2.6
5	31	<5	71	13	4.33	14	1.4
6	225	5300	8	4	3.25	71	390
7	897	2.2&	83	24	3.93	196	77
8	978	1920	18	8	5.86	8	690
9	3.5%	2.29%	17	12	7.54	23	750
10	19.6%	2300	144	12	21.02	34	53
11	2900	7800	78	2	24.52	1	950
12	4330	2600	182	3	160	184	210
13	345	1672	240	7	10.09	42	420
14	4400	946	261	8	30.80	15	41
15	12.2%	1.33%	176	8	60	30	6900
16	231	501	35	2	3.51	1	140
17	1279	8.1%	41	18	10.98	101	95
18	421	2800	187	9	5.66	5	170
19	850	2.76%	62	48	3.51	17	420

Table 5: Water Sample Analysis Results from the Alsar region (ppm)

Metal	1	2	3	4	5
As	<0.001	<0.001	0.037	<0.001	0.072
Cd	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cr	<0.001	<0.001	<0.001	<0.001	0.002
Ni	<0.003	0.046	<0.003	<0.003	<0.003
Pb	<0.002	<0.002	<0.002	<0.002	<0.002
Sb	<0.003	<0.003	<0.006	<0.003	0.010
Tl	<0.001	<0.001	<0.001	<0.001	0.002

Examination on As, Cd, Cr, Sb, Pb, Ni and Tl concentrations in the waters of the River Majdanska and those of the springs close to the Alsar ore zone (Table 5) were carried in order to study the mobility of certain trace elements (of the primary geochemical halos – rocks, mineralizations).

The results lead to the conclusion that the concentration of arsenic in the water of Majdanska in some cases is higher than the allowable, whereas in the spring in the village of Majdan the concentrations of all elements studied are within the allowable values (analysis 2, Table 5).

Conclusion

The results obtained during the geochemical examinations of the presence of trace elements in some geochemical environments in the Alsar zone, the contents of trace elements in the waters of Majdanska, Belasnica and in Lake Tikves lead to the conclusion that the Alsar ore mineralization, with the present state, is not a potential danger for the waters in Lake Tikves. It is important to preserve the geochemical balance and protect it from certain activities such as ore exploitation that would produce large amounts of waste waters or materials.

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