POSSIBILITIES FOR GROUND AND SURFACE WATER POLLUTION FROM THE LEAD AND ZINC ORE PROCESSING IN THE ZLETOVO MINES

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ABSTRACT: The Zletovo tailing dump formed to collect the tailings and other waste derived from the lead and zinc ore processing is situated close to the town of Probistip (Fig. 1). Its location and the direction of the tailings flow allow us to assume that ground and surface waters are polluted. The paper presents the results obtained from studies carried out on surface waters that receive the contaminated waters from the tailing dump.
The results obtained yielded increased concentrations of heavy metals such as lead, zinc, manganese, cadmium etc. in almost all samples particularly those collected in close proximity to the tailing dump.
Key words: Heavy metals, pollution, tailing dump, ore processing, MAC, the River Kiselicka, Zletovo, lead, zinc, manganese , cadmium.

ЗАМЪРСЯВАНЕ НА ПОЧВАТА И ВОДИТЕ ПРИ ОБОГАТЯВАНЕ НА ОЛОВНО- ЦИНКОВИ РУДИ В НАХОДИЩЕТО „ЗЛЕТОВО”

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РЕЗЮМЕ: Хвостохранилището в Злетово, предназначено за оловно- цинкови отпадъци, се намира близо да гр. Пробищип (фиг.1). Разположението му и потокът от отпадъци замърсяват почвата и водите в региона. Докладът съдържа данни за това замърсяване, свързано със съдържанието на олово, цинк, манган, кадмий и др. в почти всички взети проби в близост до хвостохранилището.
Ключови думи: Тежки метали, замърсяване, хвостохранилище, обогатяване, МАК, р. Киселика, Злетово, олово, цинк, манган, кадмий

INTRODUCTION

The intensive development of industry and the increased exploitation of mineral raw materials are the reasons for large pollution of ground and surface waters as well as the whole human environment. A number of reagents of various chemical composition and origin are used in the processing of lead and zinc ores. Most of the reagents are toxic and hazardous for the environment.

Fig. 1. Map of the survey area, SE Macedonia

The major source for ground and surface water pollution is the flotation waste material deriving from the flotation process discharged into the tailing dump (fig. 2).

Almost 90 per cent of the materials used in the technological enrichment process are discharged as effluent containing an average of 18 to 31 per cent solid phase.

The liquid phase is composed of highly mineralised waste water with increased concentrations of sulphates, heavy metals, phenols and other toxic materials.

The contents of waste materials depend on the kind, the amount of flotation reagents, the characteristics of the ore being processed and the enrichment process applied.

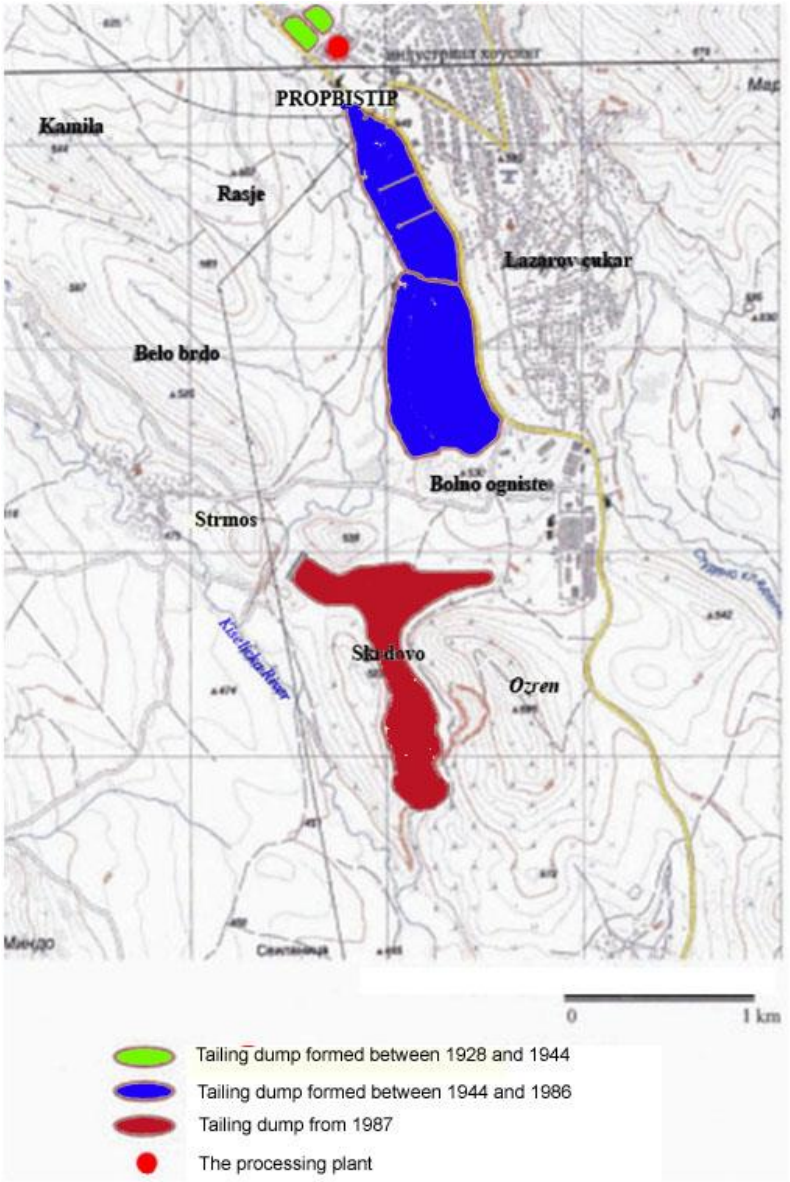

Fig. 2. Location of the old tailing dump and the new one called Skrdovo.

So far about 11.608.864 tons of flotation waste have been disposed of into the Zletovo tailing dump after the technological process. Now, the flotation tailing is discharged into the new Skrdovo tailing dump located in the River Kiselicka valley.

Preliminary investigation results of this type can be found in the publication from (Mircovski, Spasovski, at al. 2002[1];. Mircovski, Spasovski at al. 2004, [2]; Spasovski at al. 2007, [3]; Spasovski, Doneva, 2007, [4][5]).

Possibilities for ground water pollution

The most important environmental issue regarding storage of flotation waste in tailing dumps is the discharge of contaminated waters into ground and surface water courses. This issue is of particular importance with the Skrdovo tailing dump compared to the old tailing dumps that have been mostly restored nowadays. Impermeable surface layer has formed in some of the dumps that protects them from atmospheric water infiltration.

A small amount of water from the Skrdovo is sent back to the flotation plant by a pump facility, whereas the excess water is discharged into the nearest water course of the River Kiselicka.

In spite of all measures taken for control and improvement of water quality (decantation with several day settling), the water being discharged from the collector is contaminated. Part of drainage waters penetrate ground water courses causing aquifer pollution close to the tailing dump.

Ground water pollution is also caused by the Kiselicka surface waters since it is in direct hydraulic connection with the aquifers formed in the Topolka, Kiselica and Zletovska Rivers. Ground waters can also be contaminated from polluted surrounding land and waste dumps with dispersion of aggressive dust by wind currents. Rainfall seepage into such polluted land may become contaminated and cause ground water pollution.

Results obtained and discussion

In order to unravel the effects of tailing dumps on surface and ground water pollution with heavy and toxic metallic materials water samples were collected from the Skrdovo tailing dump, from the Kiselicka and from ground water wells beneath the tailing dump down stream the river bearing the same name. Studies were carried out in the Faculty of Mining, Geology and Polytechnic using the AES-ICP method. The results are given in Table 1.

Table 1. *Results obtained from water sample analyses with (mg/l).*

Sample	Pb	Zn	Cd	Mn	As	Ag	Cu
1	0.0011	0.062	0.002	0.011	0.006	0.005	0.006
2	0.0021	0.296	0.001	0.576	0.006	0.004	0.019
3	0.0146	3.167	0.027	30.89	0.042	0.008	0.078
4	0.191	0.835	0.015	3.78	0.048	0.02	0.061
5	0.0081	0.353	0.014	2.60	0.006	0.003	0.009
6	0.0088	0.215	0.002	0.569	0.034	0.006	0.004
Standard	0.03	0.2	0.01	1000	0.05	0.02	0.05

1. water from the Skrdovo tailing dump, 2. outflowing water from the tailing dump, 3 and 4. water from the Kiselicka, 5 and 6. water from wells.

Of particular interest are the high manganese concentrations in sample no. 3 (30.89 mg/l) collected from the River Kiselicka course close to the village of Neokazi. The reason for the high manganese concentrations in the river water is the tailing dump located close the river in which effluents are discharged after the operation process in the Zletovo Mine.

Increased zinc amounts were found in almost all samples, the highest being those collected from the River Kiselicka (3.176 mg/l). The increased concentrations are the result of waste water discharge from the operation process in the Zletovo lead and zinc processing in the mine and the proximity of the the tailing dump to the river.

Increased lead concentrations were found in samples 3 (0.146 mg/l) and 4 (0.191 mg/l).

It is obvious that increased lead concentrations appear in the same samples in which increased amounts of manganese and zinc were found. This justifies the concern for the increased effects of the tailing dump and the environmental pollution with metals derived from the operation of the Zletovo Mine.

Increased concentrations of copper were found only in the samples collected from the River Kiselicka. Copper concentrations in the samples collected from the river course are due to the presence of copper minerals (chalcopyrite) which is a common accompanying mineral to the lead-zinc mineralisation.

Special attention should be paid to cadmium, arsenic and silver concentrations.

In three samples cadmium was found in markedly increased concentrations relative to MAC. Increased cadmium concentrations were found in the river and in one sample collected from a well water close to the river. Increased cadmium concentrations were found in areas that have been polluted from zinc and lead .....

Only in two samples arsenic concentrations are close to MAC, but they are lower. Arsenic occurs due to the arsenopyrite which occurs as an accompanying mineral to lead - zinc mineralization in the Zletovo Mine.

Silver was found in all samples. Its concentrations are either close or lower than MAC.

CONCLUSION

From the results obtained it can be inferred that surface and ground waters contain increased concentrations of a number of elements regarding III and IV class water standards (Table 1). Samples collected from surface waters, where the tailing dump has large and ground water pollution systematic analyses will be needed.

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