

POSSIBILITIES OF ECOLOGICAL REHABILITATION OF THE AREAS AFFECTED BY COPPER EXPLOITATION ACTIVITY FROM ROȘIA POIENI

POȘIBILITĂȚI DE REABILITARE ECOLOGICĂ A ZONELOR AFECTATE DE ACTIVITATEA DE EXPLOATARE A CUPRULUI ROȘIA POIENI

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Abstract: The scope of the study is the ecological rehabilitation of the areas affected by the cupriferous exploitation from Roșia Poieni, in present being in conservation. Although the exploitation and preparation activity of the cupriferous material is stopped, the waters pollution with heavy metals is continuous, because of waters resulted from the precipitations that lave the barren dumps and the decantation lakes. The second aspect is the importance of the reconstruction of vegetation from areas affected by the pollution and the reconstruction of fertile soil layer. There were used technical data from S.C. Cuprumin Abrud, as well as hydrological data and chemical analyses made by the National Administration of Romanian Waters – System of Water Management from Alba.

Rezumat: Scopul studiului este reabilitarea ecologică a zonelor afectate de exploatarea cuprifera Roșia Poieni, în prezent aflată în conservare. Deși activitatea de exploatare și preparare a minereului cuprifera este oprită, poluarea apelor cu metale grele continuă, datorită apelor provenite din precipitații care spală haldele de steril și iazurile de decantare. Al doilea aspect este importanța refacerii vegetației din zonele afectate de poluare și refacerea stratului de sol fertil. S-au folosit date tehnice provenite de la SC Cuprumin Abrud, precum și date hidrologice și analize chimice efectuate de către Administrația Națională Apele Române – Sistemul de Gospodărire a Apelor Alba.

Key words: valley lake, inverse sound, decantation lake, barren (sterile) cloudiness, sterile hydromass, acidophil microbiota, bacterial leaching.

Cuvinte cheie: iaz de vale, sonda inversă, iaz de decantare, turbureala sterilă, hidromasă sterilă, microbiota acidofilă, leșiere bacteriană

INTRODUCTION

Tacking into account the violation of maximal allowable limits regarding the evacuation of pollutants in the Arieș river, was imposed the closing of exploitation combine of lean cupriferous ores from Roșia Poieni, unit that was founded at 21.05.1977. With all these drastic measures, fatal for the economy of the zone, the principal problem of the zone, water pollution, was not solved. Thus, was imposed a study regarding the ecologization of the area affected by the mining activity.

The cupriferous ore from Roșia Poieni (fig. 1) is situated on the territory of Lușța commune, in the Zone of Vârfurile Poieni, Vârși, Curmătura, of the right versant of the Arieș Valley. Roșia Poieni represent the largest cupriferous ore from Romania, and the second from Europe, possessing over 1 milliard tones of ore, with 0.36% Cu, representing 64.5% from the national reserve of copper.



Figure 1. The cupriferous ore from Roşia Poieni

The ore exploitation is made by two types of works, on the surface of the quarry. At this moment, the surface of quarry is by 21 km², and the exploitations were closed at the horizon +910 m.

The barren resulted from coverless and the ore with low content of Cu, below 0, 2 %, was transported to the sterile dumps that are located out of the exploitation perimeter, upstream of the decantation lake of Valea Şesei, totalizing a quantity by about 120 millions tones. These dumps are the following:

Dump of Valea Cuibarului is the most important deposit of sterile from the exploitation perimeter. It has a total surface by 148 ha, the occupied surface being by 64 ha, and it store a volume by 44.568 thousands m³ of sterile. It is located on the eastern versants of the Curmătura and Ruginiş mountainous massifs. The dump includes a number of 9 steps in the massive of Curmătura (1180 m, 1165 m, 1150 m, 1135 m, 1120 m, 1105 m, 1075 m, 1060 m and 1045 m), and other 3 steps in the massive of Ruginiş (1090 m, 1075 m and 1060). The highness of steps vary between 100 and 250 m, and the formed angle is between 30-40°.

Dump of Geamăna (fig. 2) is placed on the eastern versant of the massive of Dealul Jgheabului and has its platform at the elevation 996 m. the total surface is by 67 ha, from which, in present, are occupied only 21 ha. In the dump are stored about 4.458 thousands m³ of sterile. The highness of this dump is 150 m, and the angle formed by the talus is 30°.

Dump of Obârşia Muntari is located in Valley of Steregoi, on the southern versants of the massifs Vârşii Mici and Curmătura, and has its platform at the elevation 1170 m and is a surface by de 46 ha. In this dump are stored 5.300 thousands m³ of sterile, which occupy an effective surface by 27 ha. The highness of the dump is 120 m, and the general angle of talus is 30°.

The decantation lakes are the following:

Decantation lake of Valea Şesei

The sterile resulted from the preparation process is stored in the decantation lake of Valea Şesei (fig. 3), which is placed on the territory Lupşa commune, Geamăna village, on the direction of Şesei Valley. The dam made from calcareous rocks is placed at approx. 3.2 km from the confluence between Valea Şesei and Arieş River. The sterile quantity deposited until now is about 36.9 millions tones of sterile. The surface of lake is by 127 ha and is situated at elevation 689 m. It is a valley lake, with a reception basin by 23 km². The decantation dam is built at the elevation 610-686 m. Evacuation of cleared waters is made by two inverse sounds systems (which are connected to the weir canal) and by the evacuation gallery of the big waters. If the rapid evacuation of the big waters is necessary (in the case of snow melting or

torrential rainfalls), the evacuation of the waters could be made directly by the weir placed in the slope.



Fig. 2. - Dump of Geamăna



Fig. 3. – The decantation lake of Valea Şesei

Decantation lake of Valea Ştefancei I

In present, this lake is in conservation. It was put in function in 1983. Contains approx. 1.1 million tones of sterile and occupies a surface by 9 ha.

Damage lake of Valea Ştefancei II

This lake is located downstream of the lake Valea Ştefancei 1 and is a valley lake with a storing capacity by approx. 12 millions tones of sterile, and a occupied surface by 11.5 ha. The initial dam is made from rocks. It was put in function in 1993, after the irreparably breakdown of the evacuation system of cleared waters from the decantation lake Valea Ştefancei 1. The sterile cloudiness is sloped by a distribution conduct. The cleared water is evacuated by a weir canal placed on the right versant of the valley, made by two compartments, which successively cover one another with reinforced flagstones during the elevation of the lake.

MATERIAL AND METHOD

Study of the natural bacterial leaching of the sterile dumps

Because of the phenomenon of bacterial leaching, a natural phenomenon from the sterile dumps, the material stored in the dump is disintegrated, initially in the form of lumps, resulting closed-grained mining mass. In this situation, the stability of mining mass is not assured anymore, being favoured the phenomenon of erosion, because of action of pluvial waters and of wind. Thus, were formed in certain areas deep ditches with depth by approx. 10 m, and in other areas were formed trickling planes, and the mining mass is gravitationally transported by very long distances, arriving at the end of the lake. A substantial contribution to this transportation is given by the water of two affluent: Valea Steregoi and Valea Cuibarului.

Since 1990, the dumps Cuibarului and Obârşia Muntari placed in Steregoi Valley were affected by a process of natural bacterial leaching of metallic sulphurs, which are found in the stored material (phenomenon that is more intense in the last years). This process lead to the charging of waters that laves the dumps (meteoric waters, underground waters which come to the surface as springs) with concentration of ions of heavy metals (Fe^{2+} , Cu^{2+} , Zn^{2+} , Mn^{2+}) by hundred mg/l. Thus, the two brooks - Valea Şesei and Valea Steregoi, that catch the acid waters trickled from the dumps, arrive in the end of decantation lake with a pH between 1.5 and 2.5, with a mineralization between 10-20 g/l and a medium multiannual debit by 10000 mc/day. These water brown-reddish (because of the increased content in Fe^{3+} - 2-10 g/l) go in the lake, where meet the basic waters with a pH by 10-12, waters resulted from the sterile

hydromass from the Preparation Work. Therefore, the residual waters that go to the lake of Valea Şesei are strongly charged with ore particles in suspension and they have an alkaline pH at the evacuation. Because the two types of waters – acid and basic- are mixed only partially, the acid waters were accumulated at the end of the lake in very large quantities. Thus, from the decantation lake of Valea Şesei were evacuated permanently acid waters, with a pH between 3,0 and 3,5 and with a content in Fe^{2+} , Cu^{2+} , Zn^{2+} , Mn^{2+} by milligrams and Fe^{3+} by thousands of milligrams/l. The factors presented in the upper part of paper affect the quality water from downstream, with big impact on the entire ecosystem of the Arieş River. Starting from the presented situation, it was found that in this biotope with special conditions generated by the high acidity and by the presence of metallic ions in large concentrations, could be put in evidence a rich and interesting microbiota, adapted to these conditions. In the same time, it was found that the diversity of acidophil microbiota resistant to heavy metals could represent a potential source of microorganisms, which stay at the basis of some biotechnological applications for bio-solubilization, bio-absorption, and bio-precipitation of the heavy metals from the mining effluents.

Samples collected from the mining effluents

There were collected 2 samples of residual water from two points situated upstream of decantation lake of Valea Şesei, 3 samples from several marginal points of the decantation lake and 2 samples of mining effluent from two points situated downstream of the lake. Concomitantly, were collected and analyzed 3 samples of sediment from different marginal points of the decantation lake of Valea Şesei.

Characteristics of samples from mining effluents microbiologically analyzed

In the table 1 there are presented a few characteristics of metallic ions, sulphates and the values of pH of the samples from upstream, downstream and from the interior of the decantation lake Valea Şesei.

The table 2 content data referring to the chemical characterization of a sediment sample collected from the bottom of decantation lake Valea Şesei. The pH value of the three samples of sediment, microbiologically analyzed, varied between 7.14 and 8.63, while the pH of water samples were strongly acid (1.86 – 3.72).

Table 1

Chemical characterization of sediment samples collected from the decantation lake Valea Şesei (atomic absorption analyze)

Analyzed elements	Concentration (ppm)
Fe total	44706 - 44782
Cu	1583 - 1622
Zn	210 - 291
Pb	200 - 251
Cd	15 - 16
As	<400
Al	96381
Mn	568
Ca	9159
Mg	9470
Co	<80
Ni	81

Table 2

Concentration of metallic ions and sulphates of the mining effluent, in different points (upstream, downstream, interior)

<i>Metallic ions and sulphates</i>	<i>Concentration of metallic ions and sulphates (ppm)</i>		
	Upstream (pH=1.86-2.4)	Marginal points of the lake (pH=3.30-3.72)	Downstream (pH= 3.20-3.50)
Total Fe	2.230.0 - 6.705.0	3.300.0 - 4.000.0	49.0
Cu	416.00 - 941.18	148.0 - 200.0	27.08
Zn	139.2 - 288.5	127.0 - 270.0	7.84
Pb	0.91 - 1.00	0.12 - 0.70	0.05
Cd	0.93 - 1.87	0.243 - 0.940	0.027
As	1.66 - 8.63	< 1	-
Al	938.060 - 2.619.85	1.700.0 - 1.920.0	90.0
Mn	53.0 - 85.0	27.0 - 53.0	35.0
Ni	2.7 - 6.7	0.340	0.021
Ca	30.34 - 54.40	170.0	-
Mg	156.1 - 487.0	250.0	-
Co	2.09 - 5.56	-	-
K	-	0.42	-
Na	-	39.0	-
SO ₄ ²⁻	13240.0	40.000.0	1.200.0

CONCLUSIONS

Bellow are exposed a few measures for elimination of pollution of water of Arieş River and for ecological rehabilitation of the areas affected by mining activities.

1. Measures for elimination of risk of water pollution because of bacterial leaching of sterile dumps from S.C. Cupru Min Abrud

As a first measure for diminution of effects of water pollution, because of facts enumerated before, were disposed the construction of a station for neutralization of water resulted from the two brooks (Valea Steregoi and Valea Cuibarului). As well, it is taken into account the applying of the project regarding the valuation of copper by bacterial leaching, but the costs of this valuation is too expansive, and until now were not identified potential sources of funding.

2. Measures proposed for the ecological reconstruction of the areas affected by mining activities

The mining activities for exploitation of cupriferous ore from Roşia Poieni, developed in the course of 30 years, produced enormous prejudices to the environment of the zone. One of the biggest problem is the destruction of the fertile soil layer on a surface by approx. 23,6 ha km², from which 21 km² were removed in the process of quarry exploitation, the remaining surfaces being occupied by the sterile dumps and by decantation lakes.

For integrate this quarry in the natural circuit, must be accomplished the following works:

- Dislocation of massive rocks with explosives in order to homogenize the surface;

- Realization of a soil layer for vegetation, by 10 cm thickness, layer that will be sowing with seeds from the spontaneous flora of the zone;
- Plantation of birch trees and pines on the surface of the quarry. It was observed that these species have a big potential of natural reconstruction.

3. Measures proposed for the sterile dumps

- Slope reduction, from 30 and 40 degrees to a value below 30 degrees, for a optimal ecologization;
- Levelling for avoid the formation of deep ditches and creation of a collecting system of waters from the platforms of dumps, and leading them to the downstream;
- Realization of a layer of vegetal soil, by minimum 10 cm thickness, on the entire surface of the dumps;
- Plantation of birch trees on entire surface of dumps, in order to stabilize the area;
- Installation of organic mattress, biodegradable, pre-sowed, for the control of erosion and for development in good conditions of vegetations.

4. Measures proposed for the decantation lakes:

- Construction of canals at the contact between versant and decantation lake, with a slope by 1%, for the trickling of water;
- Applications of a soil layer by 20 cm thickness that will be sowed with seeds from the spontaneous flora of the zone;
- Between the lakes surfaces and soil layer will be applied a geotextile separation layer in order to avoid the mixing of soil layer with the sterile;
- On entire surface, over the vegetal layer, will be applied a biodegradable mattress, with natural fertilizer, with thickness by 10-15 mm, made from hay/straw and/or coconut fibers, plus protection materials and seeds, in order to control the erosion phenomenon of the surfaces which were recently arranged.

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