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LANDSCAPE DEGRADATION AS A RESULT OF MINING OPERATIONS- LAND RESTORATION AND REMEDIATION OF MINING WATER. CASE STUDY OF BOITA LOCALITY, ROMANIA

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Abstract

"Boita", the mining site, shows a very diverse potential study. The mining complex included horizontal galleries, vertical wells and related galleries. Also, near by was built the preparation station of ore and at few hundred meters is situated the mining settling pit which served as preparation station. Very interesting is the study which refers to the type's evolution of extracted ore: was begun with iron ore, continue with sulphur ore, sulphur complex and reached to uranium ore (and then the exploitation was stopped). In that area I studied: the quality of groundwater from galleries, stabilization of dirt-heaps, stabilization and composition of the mining settling and the influence of all mining operations on the land and population. Also I considerate that is necessary to continue the study five years from now; about the remediation of water from mine- in present the mining water treatment is done with questionable efficiency. In the paper are identified several potential disasters determined by these mining works. This work is a case study about the anthropic changes of Boita locality from Romania.

Key words: *mining activities, slope galleries, waste dump, revegetation, acid drainage, treatment station, radiometric measurements, potential disasters*

1. INTRODUCTION

In the Poiana Rusca Massive, the Getic domain- in the "Sebes" series, there are some siderite appearance with dimensions relative smalls, over the mezzo- metamorphic unit. There are disposed in the dolomites limestone. At Boita can see very easy the way of the mineralization forming through the metal-genetic complex, which started in the Superior Anteproteruzoic and finalized in Quaternary. In the area, the crystalline rocks series of "Sebes" Mountains is present through the sericite– quartiles phyllite with chlorite and is closed with the complex of the actinolite schist, which are formed by muscovite with garnet and graphitic pigment. In the inferior part were identified lens intercalations with amphibolites shale and crystalline calc, dolomite.

At "Boita" village, the siderite and ankerit are impregnate in that lens. Those forms come from the area metamorphosing of the facies of the green shale which are formed by:

- chlorite $[(MgFe)_6(AlFe)_2(OH)_8Si_4Al_2O_{10}]$– albite $[NaAlSi_3O_8]$– quartz SiO_2;
- quartz SiO_2 – albite $[NaAlSi_3O_8]$– almandine $[Fe_3Al_2(SiO)_4]$
- quartz SiO_2 – albite $[NaAlSi_3O_8]$– muscovite $[Kal_2(AlSi_3)O_{16}(OH)_2]$
- chlorite $[(MgFe)_6(AlFe)_2(OH)_8Si_4Al_2O_{10}]$

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The mining exploitation from "Boita" is located up from "Boita". The "Boita"– "Hateg" fault is the tectonic board of the Paleogene deposit from the Piedmont's Hateg. In the north area of the tectonic contact can be found the "Boita" complex ore deposit. The goal of the mining activities, in 1949 was to extract the iron ore gossan. The exploitation was well developed until 1966 when all mining activities were stopped and the mines were conserved until 1969. The medium production was around 6000 – 8000 t/month. First all ore was transported with auto means to the "Subcetate" railway and from there to "Gura Barza"– "Brad" by train. The beginning of the mining activities for the complex ore (S, Zn, Pb, Mo, Ca), made necessary the construction of a Flotation Station for the first processing of the exploited ore.

The processed ore was transported: the sulfur to "Valea Calugareasca" area, zinc and lead to "Copsa Mica" locality. The Flotation Station worked until September 1997 when all mining activities were stopped. The mining exploitation was organized with more work points:

A. Levels on the well:
    a. The "120" level was the principal level and was named also the "Meches" level. After 1.5 km on horizontal plain the level continue in down to the inferior levels;
    b. The "160" level;
    c. The "200" level;
    d. The "240" level;



Fig.1. Level 120



Fig.2. The +10 Gallery

B. Slope Galleries:
    a. The "+10" gallery– go 3 km to "Livezile". In present the galleries are situated in back of the flotation pulp. The "+10" West gallery have 7– 800 m to the well and in the horizontal level have some longwall advancing and was projected to get at "Rachitova" locality. The ore from this gallery were transported to "120" main gallery. The well get to "+40", "+80" and "120" levels and the ore was transported underground to the main gallery;
    b. The "+10" West gallery is located in the "Parani" Valley, in the superior part of the valley. From this gallery began the works for the galleries "8" and "9". The "8" gallery had a opening to exterior. The "9" gallery had no exterior opening;
    c. The "+40" gallery and "+80" gone from the "+10" West gallery;
    d. The "+8" gallery was the exploration drift and wasn't utilized for production;

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e. The "11" gallery which is open is located up from the decantation lake from the "Luponi" Valley.



Fig. 3. Area of 120 and 10 galleries



Fig. 4. Flotation from "Boita" locality

The sterile mining wastes dumps have small dimensions:

- at "+10" West gallery, the length of mining waste dump is 50 m, the width is 30 m and the height is 25 m; the dump is artificial re-vegetates with acacia and conifers but can be seen a natural re-vegetation also;
- The mining waste dump from the gallery of the "120" principal level is situated at 50 m down. The surface of the mining waste dumps in the "120" gallery and Flotation Station area have around 3.5– 4 ha and was artificial re-vegetated with acacia but there can be seen also the natural re-vegetation.
- The "+8" and "11" galleries have no mining waste dumps.
-



Fig. 5. Water treatment system



Fig. 6. Decanted slime

The drainage from the mining works is more types:

1. The drainage from the "120" gallery is made through the Treatment Station nearby the former Flotation: the water from the gallery comes with a 6 to 7 pH, never constant. The rain and snow change the pH. The debit is around 2.700 m^2/12 h. Inside the Treatment Station the water is treated with white lime and leave the station with a 8.5- 10 pH in to the "Galbena" Stream trough an 4 km underground pipe. The drainage mouth is located in the "Densus" village area. The

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slimes resulted from mine waters treatment is decanted in two phases in two open concrete basins.

a. The resulted dry slime is transported with mechanic means into a deposit up in front of the "10" gallery.
b. "10" gallery is closed with a concrete wall with drainage system on the base and a ventilation mouth in the superior side. The water have a 7.5– 8 pH.
c. The "+10" West gallery and "11" gallery have no drainage system only the rain water wash the sterile waste dump.
d. The natural drainage in the Flotation perimeter are very well marked but are not controlled. All drainage flow over in the nearby stream which crosses "Boita" village.



Fig. 7. Drainage from 120 gallery



Fig. 8. Uncontrolled drainage from Flotation

Another mining work is the decantation lake on the "Luponi" Valley. This is a lake between two slopes at a few hundred meters distance from flotation. The decantation have 2 ha surface with 100 m dry distance, 100 m floated distance, 80– 90 m width and 30– 35 m height. This work is not stabile because the dump wasn't stabilized. Consolidates activities was made but those are not enough. Artificial revegetation with acacia was also made. The natural revegetation is slowly. On the decantation lake horizontal surface there are ditches from the rain or the drainage water. Were build collecting canals for the rain waters. The water from the direct drainage which comes from the decantation lake has a 7.5 pH.

In the "Boita" area, mining activities can be also identified in the "Meches" Valley and "Plesu" Valley, but those are not very important. Here, there are four stabile mining waste dumps and all are natural re-vegetated.

2. MATERIAL AND METHODS

2.1. Information about the site

Topography, History, Geology and Soils, Climatology, Hydrology, Vegetation, anthropic and entropic modifications, radionuclide and heavy metals circuit in the nature (the studied exposure ways), Stages in the process of the metal extraction, the site for the sterile material, abandoned sites, problems and solutions.

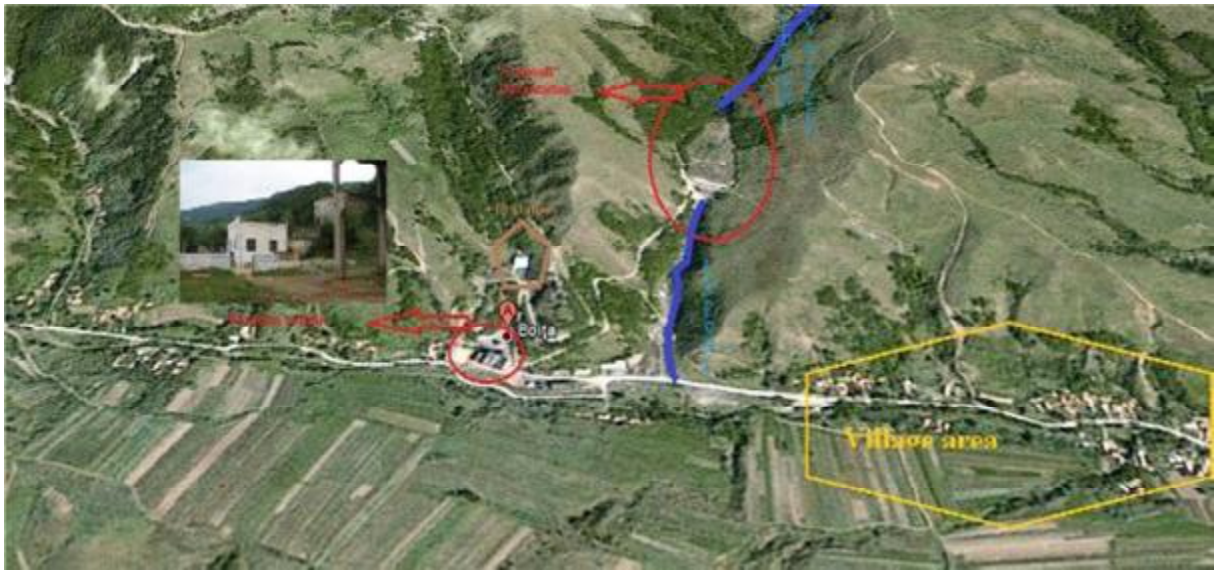

Fig. 9. Location on the map of mining area

2.2. Methodology

Collecting samples, analyses, mechanic and biologic stabilization of the site: goal, methods, species selection, planting techniques, management of wastes; This study was made on base of own research. It's useful to identify and the history of mining work to understand all the phenomena which take place and are into independence bond. The working methods have been interdisciplinary and had following stages:

- the identification zone on maps and using the technique airpartial;
- discussions with locals and authorities who worked in the area;
- measurements on the field and laboratories in the country and abroad;
- questionnaires applied inhabitants.

Materials- NBC (nuclear- bacteriological- chimical) autolaboratory provided with radiopolymeter and fast analysis putty.

3. RESULTS AND DISCUSSIONS

In August 2010 were made radiometric measurements in those areas. Speaking with the local inhabitants we found that those know that to "–200" and "–240" levels was identified uranium ore. The geological knowledge shown that at "–120" level was found an gossan (an iron– magnetite and hematite lens). At the "–160" and "–200" levels were found sulfur, wolfram and zinc and at the "–240" level was found lead. The uranium ore is under "–240" level. Were founded lungs cancer forms at miners who worked in galleries; but then the wrong ventilation was accused or the fact that the work was dry. After 1970 the double ventilation was installed but this was no permanent. Many miners who worked in the "+10" gallery got cancer in throat.



Fig. 10. The "Luponi" Decantation



Fig. 11. Revegetated area

In the measurement made in 2010 are found following values:

- ✓ 20– 35 cps in the Flotation perimeter;
- ✓ 15– 30 cps in the slam in the decantation basins;
- ✓ 20–35 cps in the sterile mining waste dump up from Flotation;
- ✓ 20-35 cps inside "8" gallery;
- ✓ 50– 60 cps at the entrance of "+10" gallery;
- ✓ 75–80 cps in the mining waste dump of „10" gallery;
- ✓ 65–85 cps on the access road to „10" gallery
- ✓ 65–95 cps in the natural ventilation in „10" West gallery;
- ✓ 25–48 cps in the mining waste dump at „10" West gallery– superior area;
- ✓ 25–40 cps in the mining waste dump at „10 West" gallery– inferior area;
- ✓ 50–55 cps in the „Luponii" Decantation Lake– in the soil (clay) on the slopes;
- ✓ 25–35 cps the „Luponii" Decantation Lake– horisontal surface.

The studies made allow the identification of some potential natural disasters, as result of the mining in "Boita" area. Those can be:

- The contamination of the wells or streams in the area with mine waters. Today the well's water has a 7 pH and is often tested. Is very interesting the fact that the drainage from "–120" level drain now ore and some toxic substances even in the clean up area were build three concrete walls and the going up were closed;

- The uncontrolled drainages will contaminate a surface bigger and bigger in the down area;

- The decantation lake in the "Luponii" Valley is very instable. The stabilization actions have to continue especially in the inferior base of the seeding dump. Also the revegetation of this lake through artificial bio stabilization has to be encouraged.

4. CONCLUSIONS

- Concerning the health of the population, have to follow the health situation of the miners group which were retired at 40 years old. An interesting phenomenon is common at lambs born with congenital malformations. The shepherds told that this happens quite often at the sheep which grassing in "Boita" area.

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- Is required to be done a detailed study after cleaning-up and to remediate what is possible.



Fig. 12. Slime thickener channels



Fig. 13. Acacia surface

The mining waste dump in the "Parani" Valley, from "+10" West gallery, is now a day broken down and stopped the "Parani" stream. Down on the stream was building a transversal concrete dump but in the situation of a deflation of the mining waste, this is not enough to stop the disaster.



Fig. 14. Mesurements on "Luponi" decantation

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