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STUDY ON PHYSICO-CHEMICAL PROPERTIES OF SOIL IN THE RADES MINE AREA

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Abstract

Past mining activities in the Almasu Mare area have led, along the time, to environmental pollution, especially of the soil. Rades gold mine is a source of negative impact today. The improperly mine closure gives the possibility of the leaks from the inside of mine to arrive at surface, creating large imbalances in soil and not only. Also, the sterile dump which is very near of Rades mine is a concern for the environment from Almasu Mare because it is not subject to ecological coating process, and the wind and rain can lead the particulates on the surface of the dump at long distances. In order to analyse the current situation of soil in Rades mine area some physico-chemical analysis were performed. The physico-chemical analysis consisted in determination of the humidity content, the structure, texture and pH of the soil. The results of experiments related to the humidity showed that the soil humidity in the forest (18.34%-34.77%) was higher than the humidity determined from the surface tailings of Rades dump (14.15% - 22.39%). The soil in forest area is partially structured and the dump material is poorly or very poorly structured. The dump material and soil texture is largely rough and the pH of tailings material taken from the Rades dump surface was in the range of 3.4-4.8 pH units and in the forest was in the range of 5.3-5.6 pH units.

***Key words**: environment, mining activities, physico-chemical parameters, Rades mine, soil pollution*

INTRODUCTION

The soil is defined as the surface layer of the earth's crust. Is made of mineral particles, organic matter, water, air and living organisms. It is very dynamic performs many functions and is vital to human activities and survival of ecosystems (Oh et al., 2013).
Therefore, soil is the fundamental foundation of our agricultural resources, food security, global economy and environmental quality (Oh et al., 2014).
Soil pollution is a problem worldwide, often resulting from the legacy of industrial activities, waste management practices, and mining activity (Gay and Korre, 2006) with a potential threat to human health (Vidali, 2001).
Mining activities in recent decades, was lead to generation of huge quantities of mining waste. Their poor management in the past has resulted the accumulation of heavy metals in the environment which contributing to contamination of soil substrates, destroying its texture, green landscapes, groundwater pollution and decreased biodiversity (Liu et al., 2008). Non-ferrous mining activity (including the mining, transport and preparation) is a source of soil pollution. When the ore is crushed, some heavy metals reach the earth's surface and these settle in soil and water due to air diffusion. Cadmium, chromium, copper, mercury, lead, nickel and zinc are metals that represent an effect of concern (Babut et al., 2012).
Following activities performed in the past, in the underground mines, have been produced huge amounts of sterile that are brought to the soil surface. This often becomes toxic waste when in contact with air and water.
Surface tailings particles arrive in the air by wind action and can be transported long distances then deposited on soil, contributing to its pollution.
Romania has a long-standing tradition of mining, particularly within the Apuseni mountains area. Unfortunately, in this area there are various negative consequences which occur as a direct and indirect result of mining process, such as: acid mine drainage, heavy metal pollution and degradation of environmental and life quality (Dabu, 2015).
Heavy metal pollution has a cumulative character. Once contaminated, soil can no longer be regenerated (only very difficult) and

this is why their reduced fertility (Sur and Micle, 2012).

In order to establish the degree of soil pollution in mining areas it is important to know the physical and chemical properties. Two important functions of soil are retention and transmission of water, which directly impact plant productivity and the environment. Water stored in the soil profile is essential for plants and other organisms to survive. Biological, physical, and chemical processes continually interact with time resulting in a diversely arranged mixture of soil minerals, organic matter, and pore spaces, which together define soil structure (Arshada et al., 1999; Juma, 1993). Also, in order to choose remediation measures of polluted soils it is very important to know the pH soil.

Soil structure is a key factor in the functioning of soil, its ability to support plant and animal life, environmental quality and water quality (Bronick and Lal, 2005).

Similar to soil structure, the soil texture influences retention and transport of water substances. A rough texture enables an intensive leaching leading to poor water retention of nutrients in the soil/dump material. Fine texture precludes the accentuated leaching, stimulates the activity of humus, creates gleyzation conditions and pseudogleyzation in conditions of excess water, also allow to increase the water by capillary action, has a low cohesive, low absorption of substances nutritive and is easily crossed by the roots plants The sand is inactive or less active material in terms of physicochemical properties (Micle and Sur, 2012).

The objective of our research was to assess the impact of former mining activities performed in the Rades mine area from Almasu Mare by determining physico-chemical soil parameters (humidity, structure, texture and pH).

MATERIALS AND METHODS

The Rades mine is located in Almasu Mare village from Alba County. The total area of Almasu Mare is 9330 ha. Since 1900, in this village were performed mining activities. This mine is inactive and it is not subject to conservation or reforestation process (Stancu, 2013; Hulpoi, 2008). At a distance of about 50 m of the mine is the Rades dump, which has a height of about 30 m (Stancu, 2013) and the forest is located right above the Rades mine.

In order to assess soil quality in the Rades mine area, twelve soil samples were taken from the sterile dump and forest. On the surface of the dump nine soil samples were taken from three different places (on the left, middle dump and on the right). Also, these samples were from 3 different depths, such as: 0-10 cm, 10-30 cm and 30-100 cm (Figure1).

Figure 1.The soil sampling of the Rades dump

In order to determine the impact of the sterile dump on the forest (Figure 2) were taken also three samples of soil from same depths. The action of taking soil samples was accomplished using a shovel and a garden manual drill.

Figure 2.The soil sampling in forest

The soil sampling was performed on November 19, 2016 and the sample analysis was performed in the laboratory of Technical University from Cluj Napoca. The soil samples were brought to the laboratory in the next day, and they were analysed.

The humidity content of soil samples was determined by gravimetric method. Practically, in each sample was weighed, with analytical balance, about 100 g of soil. After this, the weighted soil samples were put in trays (Petri dish). The soil samples weighed and placed in Petri pots were taken then in an oven at 105° C until they reached constant mass.

The soil structure was determined with Sekera method, which consists of dissolution in water of the soil aggregates and assessment the results after a dash helpful (Micle and Sur, 2012).

The texture was determined with RETSCH (EP 0642844) AS 200 device of sieving. Practically 500 g of sterile material from each sample were then passed through the device for 10 minutes and then were measured remained quantities in each sieve The sieves had dimensions of 4 mm, 2 mm, 1 mm, 500 µm 250 µm and < 250 µm.

The pH was determined by WTW 2FD47F Multi 3430 Multiparameter Meter.

RESULTS AND DISCUSSIONS

As far as that goes the results of the soil moisture content determination, after the soil samples reached constant mass, the humidity content was determined by the formula:

$$U = \frac{A}{S} \times 100 = \frac{M1 - M2}{M2 - t} \times 100 \ [\%] \qquad (1)$$

The results obtained for determination of soil humidity content are shown in Figures 3 and 4.

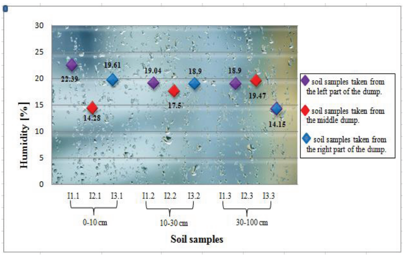

Figure 3. The soil humidity in samples taken from the surface of the Rades dump

The lowest content of humidity is in the soil sample taken from the left part of the dump is 18.9% at the depth of 30-100 cm and the highest is 22.39% at the depth of 30-100 cm.

In the middle dump, the maximum value of humidity reached 19.47% in sample taken from the depth of 30-100 cm and the minimum is 14.28% of the depth of 0-10 cm. On the right part, the minimum of humidity was 14.15%, at the depth of 30-100 cm and the maximum was 19.61% at the depth of 0-10 cm.

Figure 4 shows the soil humidity in samples taken from the nearest forest to the Rades mine.

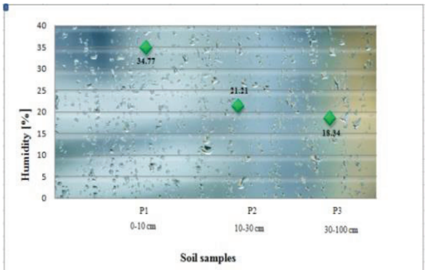

Figure 4. The soil humidity in forest.

In the forest soil humidity exceeds 30%, exactly this reaches the value of 34.77% at a depth of 0-10 cm.

The lowest value of humidity (18.34%) was found at the depth of 30-100 cm and the depth of 10-30 cm this was 21.21%.

Regarding the structure of dump, in the left part of it, this is poorly structured at the depth of 0-10 cm and on the depth 10-30 cm and 30-100 cm this is partially structured because the aggregates are opened in big parts and small parts. In the middle dump, the material structure is partially structured in all sampling depths, and in the right part, this is poorly and very poorly structured because most of the aggregate are opened in small parts and fewer in large parties.

In the forest (which is even over the Rades mine) the soil is partially structured.

In Figure 5 the dump material and soil structure is presented.

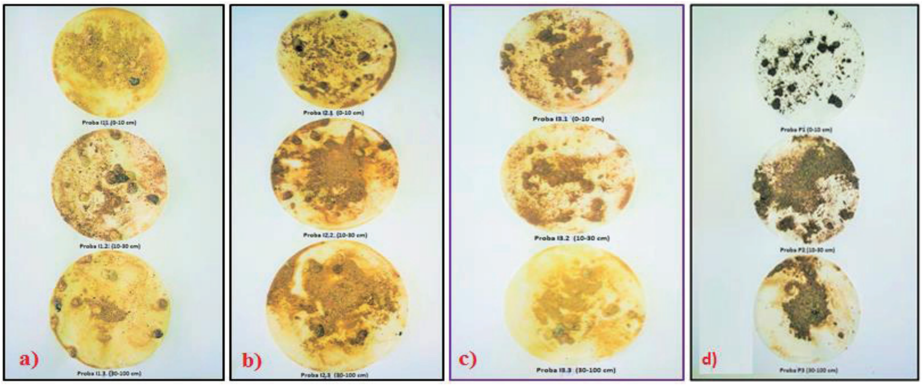

Figure 5. The soil structure: a) the dump material structure in the left part of the dump, b) the dump material structure in the middle dump, c) the dump material structure in the right part of the dump, d) the soil structure in the forest area

In Table 1 the sterile material and soil texture is presented. The results obtained show that the sterile material and soil texture is characterized by a high content of coarse sand (51%-71.86%) and low of fine sand (30.62%-48.5%).

Table 1. The sterile material and soil texture

Sample		Depth [cm]	Sample weight [g]	Coarse sand mass [g]	Coarse sand [%]	Fine sand mass [g]	Fine sand [%]
I1.1	From the left part of the dump	0-10	500	257.2	51.44	242.5	48.5
I1.2		10-30	500	320	64	175.8	35.16
I1.3		30-100	500	317.3	63.4	190.7	38.14
I2.1	From the middle part of the dump	0-10	500	318.05	63.61	176.95	35.39
I2.2		10-30	500	269.5	53.9	226.2	45.24
I2.3		30-100	500	343.4	68.68	154.6	30.92
I3.1	The left part of the dump	0-10	500	302.5	60.5	191.4	38.28
I3.2		10-30	500	315.9	63.18	182.9	36.58
I3.3		30-100	500	364.3	71.86	194.2	38.84
P1	From forest	0-10	500	335.3	67.06	161.6	32.32
P2		10-30	500	308.9	61.7	184.7	36.94
P3		30-100	500	341.4	68.28	153.1	30.62

Figure 6 shows the pH values obtained from the analysis performed on samples taken from the dump surface on those three sampling depths.

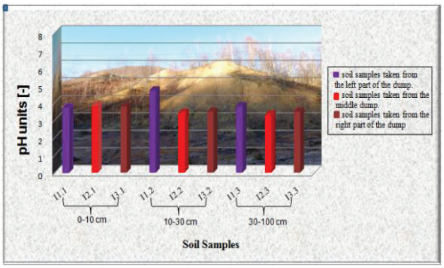

Figure 6. The pH values in the Rades dump

On the left side of the Rades dump, at a depth of 0-10 cm pH indicate a value of 3.7 pH units, to the depth of 10-30 cm it indicates a value of 4.7, and the depth of 30-100 cm is 3.8 pH units. In this part of the dump the pH value of 3.7 increases on the second depth (10-30 cm) at 4.7, but decreased again on the depth of 30-100 cm reaching to 3.8 pH units.

After analysing the pH of samples taken from the surface dump Rades, was consisted that the lower the pH value was found in the middle of the dump, at the depth of 30-100 cm. At the depth of 10-30 cm, the pH value showed 3.4 pH units, and in the first layer (0-10 cm) a little higher value, such as: 3.8 pH units. Therefore, after the pH measurements performed on material taken from the middle of the Rades dump was observed that the pH value decreases with the depth. Following pH values obtained at analyses performed on the samples of tailings material taken, we wanted to realize analyses on the soil pH in the forest, which is very close to the Rades dump (approximately 50 m). This analysis was conducted in order to see if the wind can carry the particles on the surface of the dump in the forest, and after it, when the rains penetrate the soil, contributing to pH decreasing.

Figure 7 shows the pH soil at the analysis performed on samples taken from forest.

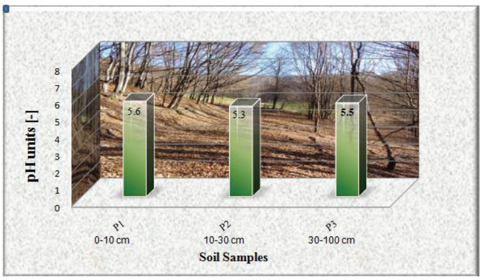

Figure 7. pH values in forest

In the forest the lowest pH value is 5.6 at the depth of 0-10 cm. Then, at the depth of 10-30 cm the pH decrease least until at 5.3 pH units, and then increase a little until at 5.5 at the depth of 30-100 cm.

CONCLUSIONS

Following the experiments performed was found that the humidity determined from the surface tailings of Rades dump is higher in the left part and right part of the dump (14.15%-22.39%) than the middle dump (14.28%-19.39%).The forest soil humidity are within the values: 18.34%-34.77%.

The soil in the forest is partially structured and the dump material is poorly or very poorly structured.

Regarding the pH of samples taken from the Rades dump surface, the lower one value was found in the middle of the dump (3.3 pH units) and the higher was found in the left part of the dump (4.7 pH units). It shows that the material dump is acid to strongly acid. Also, the forest soil is acidic, the lower pH value being of 5.3.

The sterile material and soil texture is characterized by a high content of coarse sand (51%-71.86%) and low of fine sand (30.62%-48.5%), fact that causes an intense leaching of soil, hence resulting lower moisture content in I2.1 and I3.3 samples.

The general conclusion of the study is that the soil is very acid in Rades mine area. In the future is necessary to determine the heavy metals concentrations as to ascertain the degree of pollution and measures that can be adopted for ecological restoration of the studied area.

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