Surface Water Quality Assessment from a Mining Area

Case study, Groapa Burlacu lake, Targu Ocna, Romania

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This paper presents a study on assessment of water quality. According to a study, mining activities have a significant impact on water quality (lakes, surface water and groundwater), which has become a major problem globally. Due to mining and exploitation processes, lakes can be formed around these mines. Also, these lakes have been formed around the world and are steadily increasing. The purpose of this study is to watch the quality of water from the area around mining activities. This study refers to the, Groapa Burlacu lake around the mining exploitation Targu Ocna, Romania. This lake was formed on the northern bottle of the massive salt, strongly affected by the underground activities. Sampling for the determination the concentrations of Cl^- and NaCl from the studied area was made at different depths (0 m, -5 m, -10 m, -15 m, -20 m, -25 m, -30 m, -35 m -40 m). Besides these concentrations, physical parameters of the water (pH, turbidity, electrical conductivity, dissolved oxygen and temperature) were also measured. To determine the physical parameters in the monitored area, sampling was done from four different points of the area and then put together for analysis. These parameters were measured on site using portable equipment. The data on the analyzed concentrations indicate that at depths of less than 5.0 m, the NaCl concentration values are more than 250 g/L.

Keywords: mining activities, water quality, Cl^-, NaCl, physical parameters

Water quality is a significant global problem in terms of its importance on living organisms, animals and humans. What leads to the decrease of the quality of the water both the surface and the underground are the different mining activities, industrial and municipal, the wastewater discharge, the improper storage of the different categories of waste. For a more efficient management of water quality it is necessary to monitor it regularly [1-10].

According to a study, mining activities have a significant impact on the quality of water (lakes, groundwater, surface water) and which has become a major problem globally. Mining activities on water quality can have a significant impact from the time of mine exploitation but also after its cessation [11-19].

Due to mining and mining processes, lakes can be formed near these mines. Also, such lakes have formed around the world and are constantly growing. As a result of anthropogenic activities, lakes can often undergo changes of composition [13].

The purpose of this study is to watch the quality of water from the area around mining activities. This study refers to the, Groapa Burlacu lake around the mining exploitation Targu Ocna, Romania. This lake was formed on the northern bottle of the massive salt, strongly affected by the underground activities.

Experimental part

Materials and methods

The study area

In 1976, due to a hydraulic fracturing that occurred at the S259 well, resulted in the formation of Groapa Burlacu lake. It was formed on the northern vial of the salt massif, intensely affected by the underground developments in the confluence area of the Slanic River with the Trotus River. In time, the size of the lake has suffered various changes due to the activity of extraction of the salt through the wells, thus producing breaths and collapses. With the completion of the extraction activity, the production of breaths has been reduced [20].

From the tectonic point of view, the individualization of the structural units has occurred successively, from V to E, along lines of deep directional fractures which also constitute saddle planes. As regards the stratigraphic sedimentary package within the perimeter, it is composed of detritic marine deposits and halogenous lagoon formations that belong to three structural units instead of the sub-Carpathian depression (Fig. 1) [21].

Fig.1. Location of the study area [21]

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Determination of physical parameters

Besides these concentrations, physical parameters of the water (*p*H, turbidity, electrical conductivity, dissolved oxygen and temperature) were also measured. To determine the physical parameters in the monitored area, sampling was done from four different points of the area and then put together for analysis. These parameters were measured on site using portable equipment (Oxi 3210 *p*H 3210, Cond 3210, TURB 430 are made in Germany by WTW GmbH companies, Weilheim).

Sampling for the determination the concentrations of Cl^- and $NaCl^-$ from the studied area was made at different depths (0 m, -5 m, -10 m, -15 m, -20 m, -25 m, -30 m, -35 m -42 m).

Results and discussions

The evolution in time of the Groapa Burlacu lake

In Figures 2 and 3 are presented the evolution in time of the surface and the total volume of the Groapa Burlacu lake. The data were collected from SNS SA Salina Targu Ocna and the measurements were performed over a long period and at different interval: 1983, 1989, 1994, 1995, 1998, 1999, 2000-2005, 2014-2017), recording different values for each year specified above. As shown in Figures 2 and 3 at the beginning, the measured surfaces recorded lower values, compared to the middle of the determination period, respectively the interval between 1998-2005, where the measured surface recorded maximum values (10016-11240 m^2).

Since the period of 1995, we can see an increase in the volume of the pit compared to previous years, after which for two years this increase has stopped partially. Due to the fact that the lower part of the pit is not flat, in 2017 this volume increased by 2% compared to 2016.

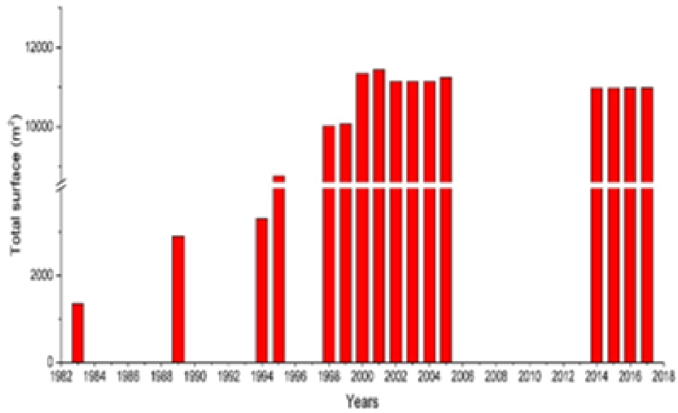

Fig. 2. Evolution in time of the total surface, Groapa Burlacu lake, Targu Ocna

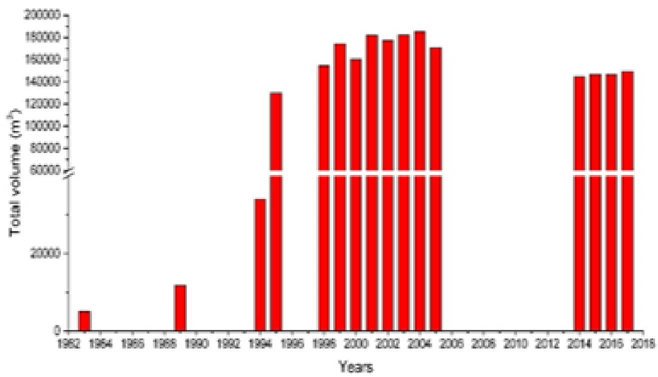

Fig. 3. Evolution in time of the total volume Groapa Burlacu lake, Targu Ocna

Analysis of Cl^- and NaCl concentration variation

For the analyzes to determine the concentrations of Cl^- and $NaCl^-$, 9 samples were taken from the studied area. The results of the Cl^- analysis during the year 2017 are presented in figure 4 [20].

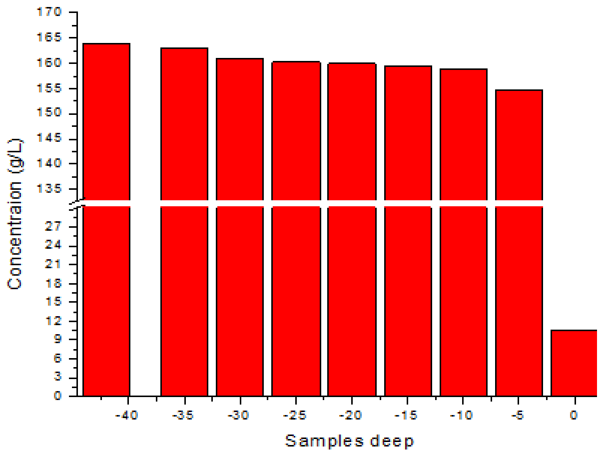

Fig. 4. The Cl^- concentration variation at different depths in 2017

As can be seen in figure 4, the concentration of Cl^- present an increase in concentration with increasing depth as the sampling of the research. From the depth of -5 m, to the value of 154.58 g/L the chlorine concentration increases significantly up to 163.80 g/L at the depth of -42 m.

Figures 5 and 6 present the NaCl concentration variation during period 2000-2005 and respectively 2014-2017.

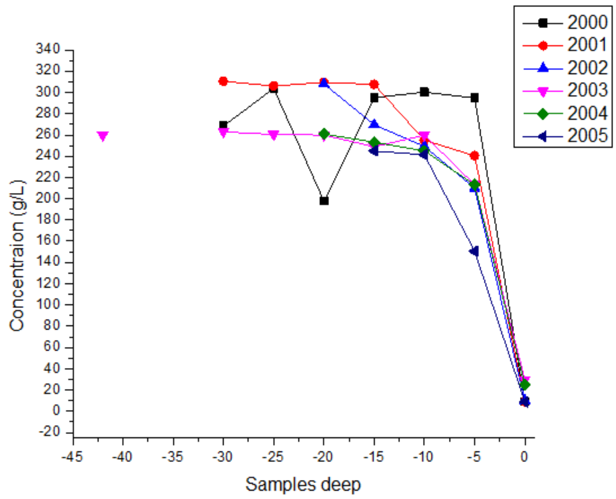

Fig. 5. NaCl concentration variation during period 2000-2005

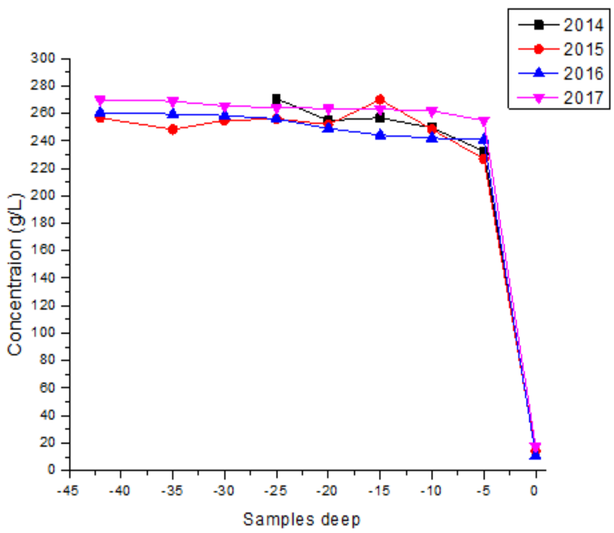

Fig. 6. NaCl concentration variation during period 2014-2017

According to the results presented in figures 5 and 6, the NaCl concentration recorded higher values than 250 g/L at depths higher than 5 m. The concentration range of NaCl reaches a high enough value monitoring in the last year, respectively 2017 (270 g/L at a depth of -42 m). At the beginning of the measurement (2000), the NaCl concentration registered only 8.85 g/L at the water surface.

In the first measurement interval (2000-2005) only a sample under -30 deep were performed. Also, in the same interval were recorded the lower concentration in the deep under -20 m.

Analysis of physic-chemical water parameters

The pH value was determined by the electrometric method according to SR EN ISO 10523 using a 3210 WTW digital pH meter. The value recorded after the measurement carried out in situ regarding the *p*H was 8.53 (table 1), indicating that this sample of water is weak alkaline.

Table 1
PHYSICO-CHEMICAL WATER PARAMETERS MEASURED

Parameters	Value
pH	8.53 pH unit
Conductivity	19.01 mS/cm
Dissolved oxygen	6.23 mg/L
Turbidity	3.98 FTU

The determination of the conductivity of the water sample within the lake Groapa Burlacu was performed according to SR EN 27888, ISO 7888. The Cond 3210 WTW digital conductometer was used for the determination. The electrical conductivity (table1) for the water sample analyzed within the lake, Groapa Burlacu, registered a value of 19.01 mS/cm.

The dissolved oxygen for the analyzed sample was determined according to SR EN ISO 5815:2013, using the Oxi 3210 WTW digital equipment. As shown in table 1, the value of dissolved oxygen in the water sample recorded a value of 6.23 mg/L.

The method used to determine the turbidity was the colorimetric one, according to STAS 6323/88 which is based on the Tyndall effect, using the TURB 430 WTW digital equipment. According to the turbidity determination method, the admissible value for turbidity should be ≤5. Based on the analyzes performed, the value recorded after the in situ analyzes was 3.98 FTU.

Conclusions

Following the monitoring of the Groapa Burlacu lake, from 1983 to 2017, an irregular increase of its size could be observed. Anyway, between 1983 and 1993, Groapa Burlacu underwent various changes due to collapses and potholes. In the years 1994 to 1999, the size of the pit evolution was realized due to the collapses caused by the created overhangs.

From the period of the year 2000, has been observed a stagnation in the evolution of the pit, which leads to a significant decrease of the surface. In the next two years, the modification of the lake Groapa Burlacu was carried out in the south-east extremity.

In the period 2002-2004 can be observed an increase in the volume due to the fact that the surplus material reached the bottom of the pit, partially it was moved to underground dissolution gaps.

In 2014, we can see a significant reduction in the volume of the lake pit compared to 2004 (26,177 m^3) and in the following year the volume of the pit increased by 1.3% compared to the previous year. In 2016, the volume of the pit increased by 0.04% compared to 2015 due to the landslides. In the following year, the volume increase of the pit compared to the previous year is about 2%.

Regarding the concentration of NaCl, the highest values were recorded in the years 2000-2001.

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