SALINE WATER RESOURCES IN CLUJ-NAPOCA SURROUNDINGS

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ABSTRACT. – Saline water resources in Cluj-Napoca surroundings. Saline waters are usually researched in those places where it is used for balneotherapy or other industrial purposes. The aim of this study is to describe the saline water sources from less known areas, as they are an important natural mineral water resource. Twenty nine water samples were analyzed from Cojocna-Pata-Sopor region, thirteen of them can be considered saline waters. The visited locations are 21, 15 and 3 km far from Cluj-Napoca. Highly concentrated springs are to be found in the old mine area from Pata village and in the slough from Cojocna. Beside the well known saline lakes from Cojocna, five other saline lakes were identified; most of them are having artificial origin.

Keywords: saline water, springs, lakes, water chemistry, Cojocna-Pata-Sopor region.

1. INTRODUCTION

It is well known the presence of salt as a natural resource in the Transylvanian Basin, mainly at the peripheral territories where salt diapirs can be found on the surface. Due to these structures underground water can easily dissolve the sodium-chloride and emerge as saline water springs.

Alexe (2010) has pointed out that the big quantity of salt that can be found in the Transylvanian Basin can't be explained by evaporation of shallow marine water. Based on microfauna and algae sediments present or absent in different sediment layers of the Traylvanian Basin, Krézsek and Filipescu (2005) have demonstrated that salt deposition (in about 300 meter thickness) happened in deep marine environment in late Mid-Badenian and was initiated by brine formation. The massive salt formation was characteristic to the inner and eastern part of the basin, while in the western part mainly gypsum was deposited above the salt or it is overlayed by the salt (Krézsek and Filipescu, 2005). The salt extrusion in the western part of the basin is related to the Mio-Pliocene thrust system (Krézsek and Bally, 2006).

In the last centuries some settlements or towns became famous not only because of the salt mines, but also for the saline water used in balneotherapy.

At the beginning of the 19th century about 84 thousands of tons of salt were transported from Transylvania to big cities in Western Europe. (Petráss, 2003) The

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salt mining trend shows a positive evolution until the beginning of the 20th century by doubling the quantity of salt extracted (153 thousands of tons). In contrast to the Maramureș area, in Transylvania a massive fall can be observed in the middle of the 20th century, when only 55 thousands of tons were extracted (Schmidt, 1941).

The salt mines from Cojocna were already mentioned in 1291, but during the 19th century these establishments didn't have an important status (Schmidt, 1941). Sorocovschi et al. (2001) mentions four saline water lakes in Cojocna that were formed by gathering the water in old mine pits. Topographic maps edited in the 1970's show three lakes and two waterlogged areas with saline water. Field observations made by the authors in 2015 have demonstrated that one of the lakes was filled up (parking lot in present day), while two of the lakes (Toroc Lake and Bathing Lake) are used for wellness and balneotherapy. These water bodies are exposed to lake succession processes by filling up with sediments. Sorocovschi et al. (2001) has demonstrated a difference of 3 meters in case of Toroc Lake depth from 1971 to 2001.

The water chemistry of the lakes was first analyzed by Hankó (1891), who has demonstrated the presence of calcium and magnesium ions, calcium-sulfate and lithium-chloride beside the most common sodium-chloride. Their concentration was 219.5 g/l (Hankó, 1891).

In the surrounding area several other documented saline water resources can be found, some of them in Someșeni, where D. Stanca has made comprehensive analyses in the 1930's (Zsakó, 1966). The geological background of these springs was presented by Szádeczky (1932) and Wanek (2010). Saline water springs located east to Someseni were identified by Hankó (1891).

Our work focuses on the less known saline water occurrences and emergences in Cluj-Napoca surroundings like Sopor District (Colonia Sopor), Pata and Cojocna villages.

2. METHODOLOGY

The goal of our study was to identify and give a simple and standard characterization of saline water occurrences that are located south-east to Cluj-Napoca.

Field observations and measurements were carried out in March and April, 2015. The exact location of the springs was determined by Garmin 60 CSX handheld GPS. The physical and chemical parameters of the water samples were measured using Thermo Orion Star portable multi-parameter meter. Water temperature, pH, electric conductivity and TDS (Total Dissolved Solids) parameters were analyzed.

Recorded data were interpreted and displayed on maps that were edited using GPS Track Maker, Global Mapper and Surfer geoinformatic softwares.

3. DESCRIPTION OF SALINE WATER SPRINGS

Pata village area

During field observations we have identified several springs, emergences and an artificial lake as well. These resources can be classified in three groups: (1) the saline water lake and springs that feed it, (2) low concentration springs that feed a freshwater waterlogged area, (3) high concentration springs that are found in the area of the old mine (Fig. 1.). All the resources can be found west to Pata village.

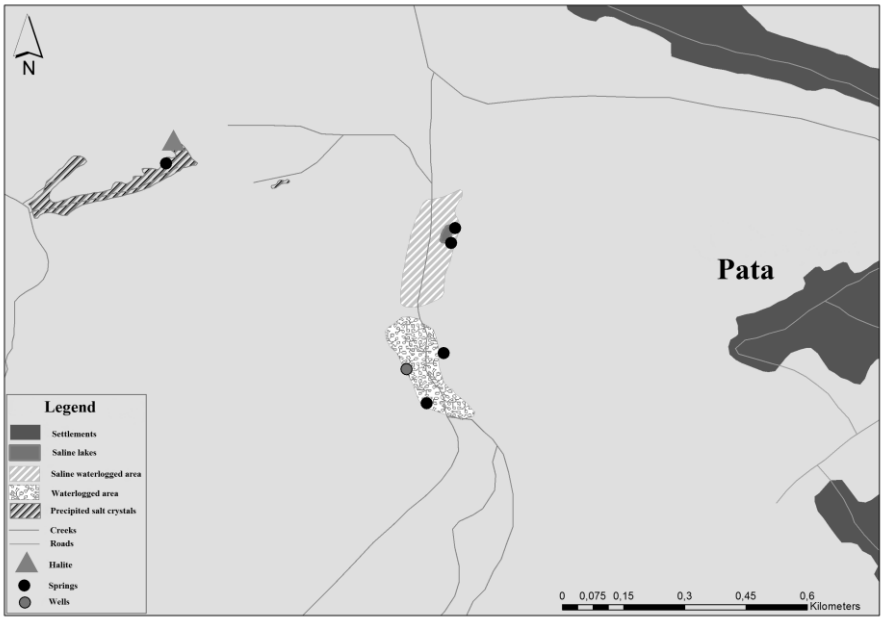

Fig. 1. ***Thematic map illustrating saline springs location in Pata area***

The small sized artificial lake is fed by two concentrated saline water springs and several emergences. The springs have small discharge; their TDS content vary from 50 to 66 g/l. The lake's water has a lower concentration, but taking into account its small size, we consider that it is strongly influenced by meteorological events.

The freshwater slough can be found in the near vicinity of the lake. There were analyzed three springs that are discharging into the slough. These are low concentration springs (1 to 2 g/l); their TDS content shows a decreasing trend as the distance from the lake increases.

In the old salt mine area a gully has formed. This area can be characterized by the precipitation of salt crystals that is shown also by the absence of vegetation. One high concentration spring (261.5 g/l) was identified here with great discharge and several saline emergences (Fig. 2.).

Fig. 2. ***Photo of saline spring from old mine area, Pata, 2015***

Cojocna village area

Cojocna is the village where saline water is used in free time activities like bathing, wellness, balneotherapy and household utilization, like cooking and canning.

Saline water resources from Cojocna area can be classified into three groups based on their location: (1) two lakes and a slough from the eastern side of the village, (2) saline emergences located to south from the village, in the Salty-creek valley, (3) artificial lakes from the south-western area of the village (Fig. 3.).

Toroc Lake and Bathing Lake are located in the eastern side of the village and are used for balneotherapy. The physical-chemical properties of these two lake's water are similar having a TDS content of around 25 g/l, electrical conductivity of 49-50 mS/cm.

In the near vicinity of the lakes a slough can be identified that is fed by several springs and emergences. On its north-western side a community well can be found, its water (191.1 mS/cm) is used by local people. On its south-eastern part there are three high concentration springs located close to each other. The electrical conductivity of the spring waters are 248.9 mS/cm, 56.6 mS/cm and 35.9 mS/cm respectively.

In the Salty-creek (pârâul Sărat) valley there are no springs, but many saline emergences cause salt crystal deposition on the surface. A man-made shallow basin gathers the saline water. Along the western tributary of the Salty creek we have analyzed several water samples from common wells. Results show low concentration waters (EC: 1.1 – 3.5 mS/cm) that may have small connection to salty sediments in the underground.

In the south-western part of the village there are two artificial lakes that were made by people working on the rehabilitation of railway lines in 2010. Water samples from these two lakes have different concentration. Their electrical conductivity is 34 and 12.7 mS/cm respectively. Local people described a simple saline water pool that was located here at the beginning of the 20th century and used for balneological treatment.

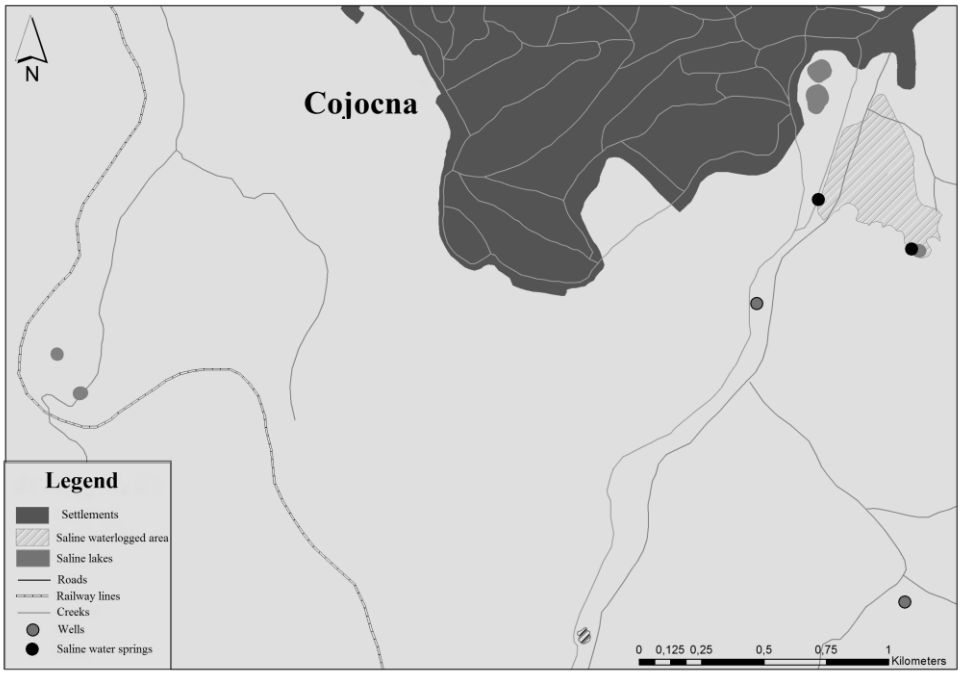

Fig. 3. ***Thematic map illustrating saline springs location in Cojocna area***

Sopor region

Sopor region (Colonia Sopor) is located in the administrative territory of Cluj-Napoca city and can be described as a marginal district with wide green zones. Two saline lakes were identified here. One of the lakes is fed by a saline water spring, while the other by groundwater and saline emergences. TDS contents show different values, 86 g/l and 8.9 g/l respectively.

4. DISCUSSION

During field observations some physical and chemical properties of the saline waters were also analyzed.

The pH of the water samples from Pata area shows lower values; in Cojocna area saline waters are characterized by higher pH values. The pH of

springs and lakes vary from 6.5 to 8.9. No significant trend or correlation can be observed.

The temperature of the water samples range from 7 to 17 ^{o}C. Higher temperatures are characteristic to shallow lakes (stagnant water), while springs with active discharge have lower temperatures (Fig. 4.).

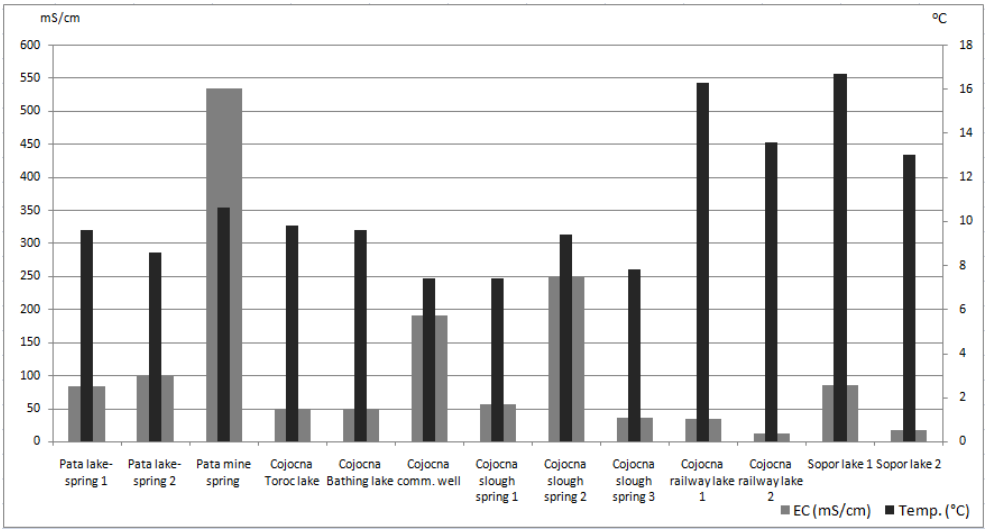

Fig. 4. ***Diagram showing water temperature and electric conductivity in case of the saline water sources***

We will present the concentration of water samples trough electric conductivity data, since TDS content could not be measured in all the cases (Fig. 4.). Generally lakes can be characterized by lower electric conductivity and lower TDS content subsequently. If we consider the evaporation factor in case of all stagnant water bodies, the lakes water should be more concentrated. Thus it can be presumed that all the lakes are fed by groundwater as well (beside the saline springs).

The most concentrated saline water is discharged by the spring located in the old mine area from Pata village and has a TDS content of 261.5 g/l. Higher concentration saline water is characteristic to the community well from Cojocna and one of the springs from Cojocna slough, even so their electrical conductivity (EC) vales are much more lower than in the case of the salt mine area spring.

The minimum EC values were measured in the case of the lakes located near the railway lines in Cojocna area and one of the lakes from Sopor area. These water bodies are mostly fed by groundwater. In all this region groundwater can easily meet salty sediments in the underground and can be filled up with small quantities of sodium-chloride.

Table 1. presents some of the measured parameters at the saline water samples from Cojocna-Pata-Sopor area. Our discussion is based on the electric conductivity values because TDS and salinity are both derived from conductivity measurements.

Table 1. ***Measured physical and chemical parameters of the saline water samples from Cojocna-Pata-Sopor area***

Name/origin of sample	Temperature (°C)	pH	Electric conductivity (mS/cm)	Salinity (ppt)
Pata lake-spring 1	9.6	7.4	83.2	54.9
Pata lake-spring 2	8.6	7.3	98.8	66.5
Pata old mine spring	10.6	7.4	533.4	333.2
Cojocna Toroc lake	9.8	8.8	50.6	31.4
Cojocna Bathing lake	9.6	7.9	49.5	31.2
Cojocna comm. well	7.4	6.6	191.1	-
Cojocna slough spring 1	7.4	9.0	56.6	35.0
Cojocna slough spring 2	9.4	6.5	248.9	-
Cojocna slough spring 3	7.8	8.3	35.9	21.2
Cojocna railway lake 1	16.3	8.3	34.0	20.9
Cojocna railway lake 2	13.6	8.4	12.7	7.1
Sopor lake 1	16.7	7.9	86.0	17.3
Sopor lake 2	13.0	7.5	18.3	10.5

Using the electrical conductivity data and orthographic interpolation (Taghizadeh-Mehrjardi, 2014) the fallowing map was created (Fig. 5.). Isolines show the distribution of EC values in the region from Cojocna to Sopor.

The high concentration water from Pata salt mine spring can be easily identified. Starting from this point to the west and east electrical conductivity values are decreasing. The second highest EC values were identified at saline emergences from Salty creek valley and at the Cojocna slough spring.

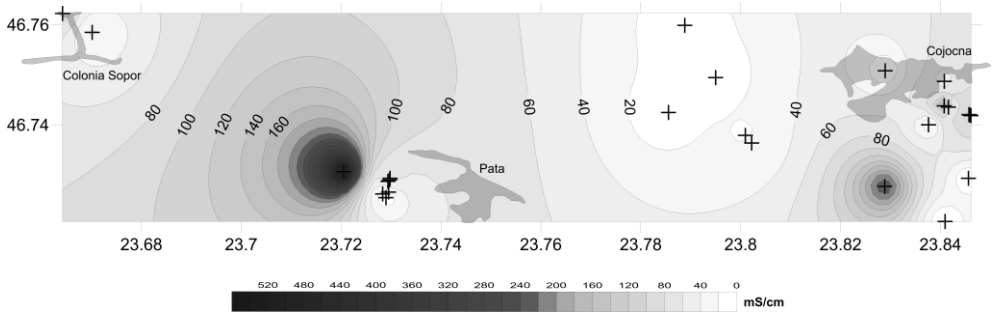

Fig. 5. ***Isoline map illustrating the distribution of underground water electrical conductivity parameters from Cojocna-Pata-Sopor region***

5. CONCLUSIONS

This study focuses on the saline water resources from the north-western part of the Transylvanian Basin, Cojocna-Pata-Sopor region. Several saline water springs and lakes were observed and described.

The exact location of the sources was determined and is presented on thematic maps. Based on electrical conductivity values (and salinity) that was

measured on field, it turned out that the saline water source with the highest concentration can be found in Pata area, at the old salt mine.

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