KARST AQUIFERS AS A SOURCE OF WATER. CASE STUDY: BRATCA AREA

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Abstract

The source of water supply for the inhabitants of Bratca village is the underground water for the supply in centralized, as well as in individual system. The freatic waters, as well as the deep waters belong to the body ROCR02, out of which the inhabitants are supplied are accumulated in Triassic, Jurassic and Cretaceous deposits, represented through calcars and dolomites, intensely fractured and quarstified. The karst aquifers are susceptible to pollution. The quality of these waters makes the object of the present research. The quality was analyzed in relation to the Law no. 311/2004 (Law of drinkable water), modifying the Law no. 458/2002.

Key words: karst aquifers, quality, drinkability.

INTRODUCTION

The supply with water of a locality, irrespective of its size, represents a highly important issue. The local system of supply with water is specific to the rural area. It is formed if a multitude of individual installations, the water being transported directly from the source to consumers. The installations forming the local system are mainly the springs and the fountains. This is also the situation of water supply in the studied area.

The water supply source of inhabitants from Bratca village is the underground water for the supply in centralized, as well as individual system. The water body supplying the communities from the area studied was codified as the body ROCR02 (Zece Hotare, Pădurea Craiului Mountains). The freatic and deep waters are accumulated in Triassic, Jurassic and Cretaceous deposits, represented through calcars and dolomites, intensely fractured and quarstified. In certain European countries, the waters coming from karstic regions cover by 50% the necessary of water supply. There are also areas in which the only accessible resource is the water with such origin (Bensaoula et al, 2007). The karstic aquifers are susceptible to pollution. The vulnerability of underground waters represents a relative property, whose assessment is not related to physical-chemical measurements. The vulnerability term was introduced by the French researchers Albinet and Margat in 1970. The intrinsec vulnerability represents the inherent characteristics of hydrological and geological nature which determine the sensitivity of underground waters to contamination following antropic activities. (Doerfliger et al, 1999). There are today flexible methodologies through which the vulnerability of aquifers may be estimated. (Daly et al,2002)

In the village of Bratca there are 300 households which benefit of water supply in centralized system. The inhabitants which live on the hills, at larger distances from the village centre, do not benefit of water supply in centralized system from the source captured from Valea Brătcuței. Currently, they are supplied from their own fountains or through personal captures and adductions. The quality of these waters makes the object f the current research. The quality was analyzed in relation to the *Law no. 311/2004 (Law of drinkable water),* which brings modifications to the *Law no. 458/2002.*

MATERIAL AND METHODS

The determining indexes are part of the category of physical-chemical, global and pollution indexes: pH, electric conductibility, hardness and concentration of Calcium and Magnesium ions, concentration of Nitrite and Nitrate ions. The water was sampled from households of two families, from the tap. The water supply source is represented by a spring, captured by seven families, spring located at a distance of approximately 1-2 km from the dwellings. In order to make a discussion, we also sampled meteoric water from the respective area, which was subject to the same type of analysis.

At the moment of sampling the tests, we made pH, conductibility and mineralization tests. The samples for determination of hardness, Calcium and Magnesium were acidified with hydrochloric acid in order to preccipitate the carbonates during the transportation and maintenance of evidence in the laboratory

1.Determination of pH

In order to determine the pH of sampled test, we used the potentiometer method. The equipment used was the electronic pH Hach.

2.Determination of conductibility

Through this parameter we may accurately follow the modifications ocurring in the composition of water, in which concerns the content of ions. The conductmeter used in determining the conductibility and mineralization is of Hach type.

3. Determination of hardness and concentration of Calcium and Magnesium ions.

3.1. Determination of total hardness (amount of Calcium and Magnesium concentrations)

The principle of determination method of total hardness: the Calcium and Magnesium ions have the property to form chelate complexes with the Sodium salt of ethylene-dianomino-teraacetic acid (EDTA), without colour, soluble and non-dissociable, The end of reaction is marked by specific indexes, such as black erichrome T.

3.2. Determination of Calcium concentration

The principle of method: the Calcium ions have the property to form stable complexes with the Sodium salt of ethylene-dianomino-teraacetic acid (EDTA) at a pH ranging between 12-13. The end of reaction is shown by the index murexid (Ammonium salt of purpuric acid), going from pink to violet.

3.3. Determination of Magnesium concentration

The Magnesium concentration was not effectively determined, but calculated as difference.

4. Determination of Nitrite and Nitrate concentration

Determination was done specto-photo-metrically. The equipment used was the spectometer DRELL 2000.

RESULTS AND DISCUSSION

Bratca locality is located in the Eastern part of Bihor County. From a hydrological point of view, the territory is governed by Crişul Repede which accumulates the waters of the 3 hydrographical basins: Valea Beznii, Brătcuța and Boiul and, at the same time, divides the locality in 2 parts.

Currently, Bratca locality has available a centralized water supply system, by capturing a source situated on the left shore of Brătcuța valley. The system was done in the year of 1971.

The source captured on Brătcuța for water supply of villages *Bratca şi Beznea*, has a debit of minim 61,0 l/s following the measurements done on the period of 2 years, with the specification that, during rainy periods, the source is unsettled and is out of the drinkability area, reason for which the regulation of this situation is imposed. Currently, the

system's equipments, at the level of the 70's, do not match anymore the nowadays requirements.

The underground waters from Bihor county were identified and delimited taking into account the geological and hydrodynamic criteria, as well as the status of water body, determined from a quantitative, as well as qualitative point of vie.

On the territory of Crişuri Water Department were identified, delimited and described a number of 9 underground water bodies. The water body supplying the communities from the studied area was codified as the ROCR02 body (Zece Hotare, Pădurea Craiului Mountains).

The freatic and deep waters bolonging to this body are accumulated in the Triassic, Jurassic and Cretaceous deposits, represented through calcars and dolomites, intensely fractured and karstified. The carbon mesosoic rocks crop out on a surface of approximately 330 km^2. The karstic systems are numerous and of various sizes; the total surface of karst is of approximately 452 km^2. The important resources of underground waters are located in the major karstic systems. The local underground aquiferous networks are supplied from rainfall, as well as from underground waters, the infiltration ways being represented through the intensely fractured and cracked areas. The discharges are linear, punctual or diffuse, being signalled springs whose flows range between subunit values (0,33 l/s) and very large values (cca 600 l/s). The aquifer carbon deposits, with Triassic-Cretaceous age, are covered, in various places, with permo-mesosoic deposits (sand stones and conglomerates with additions of clay shales) with various permeabilities.

The features of ROCR02 water body are:

- Surface: 452 km^2;
- Area: mountains;
- Type: karstic, cracks;
- Pressure: mixed;
- Covering layer: variable thickness;
- Use of water: population supply;
- Pollution agents: free;
- Global protection degree against pollution: unsatisfactory up to very satisfactory.

Table 1

Values of indexes for underground water

Current no.	Indicator	Measure unit	Value
1.	pH	Unit. pH	6,3
2.	Electric conductibility	µS/cm.	40,000
3.	Mineralization	Mg/l	20,300
4.	Total hardness	German degrees	0,896
5.	Concentration Ca^{2+}	Mg/l	5,200
6.	Concentration Mg^{2+}	Mg/l	0,750
7.	Concentration NO_2^-	Mg/l	0,050
8.	Concentration NO_3^-	Mg/l	3,800

Table 2

Values of indexes for the meteoric water

Current number	Index	Measure unit	Value
1.	pH	Unit. pH	5,5
2.	Electric conductibility	μS/cm.	10,000
3.	Mineralization	Mg/l	12,300
4.	Total hardness	German degrees	0,102
5.	Concentration Ca^{2+}	Mg/l	1,560
6.	Concentration Mg^{2+}	Mg/l	0,230
7.	Concentration NO_2^-	Mg/l	s.l.d.
8.	Concentration NO_3^-	Mg/l	1,410

The results of analysis are presented in tables 1 and 2. The values for underground water are, in fact, the average of values obtained for the two waters sampled from inhabitants‘ taps.The determined values of parameters were so close, that a separate discussion was useless. As expected, the waters studied have a very low mineralization rate. This not special for karstic areas in which the carbon rocks are predominant. The small content of mineral substances dissolved is the expression of the fact that the route of meteoric water coming back as springs is relatively short. Another explanation would be the fact that the drainage is probably partially done on the permo-mesosoic gritstones. The Calcium and Magnesium, next to bicarbonates, are the major components of carbon water. The bicarbonate results from the contact of carbon dioxide with carbon rocks. The carbon system: $CO_2/HCO_3^-/CO_3^{2-}$ plays the role of buffer in order to maintain the pH within certain limits. At the determined value of pH is of 6,3 the carbon acid and bicarbonate are equal. The meteoric water has a slightly acid pH, but absolutely normal. In which concerns the concentration of Nitrates in underground waters, we might say that their natural fund is usually smaller than 3 mg/l. **(**Peterson et al, 2002). In the case of analyzed water, the medium average concentration is slightly exceeded. This unsignificant excess may be explained by the existence of poluution sources of an agricultural nature, mainly cattle keeping and wheat, corn and potato crops, occupations which are usual in the respective area.

The underground waters which represent supply waters for the inhabitants of the village are similar from a qualitative point of view with the meteoric waters. The comparative values of determined parameters are presented in image 1.

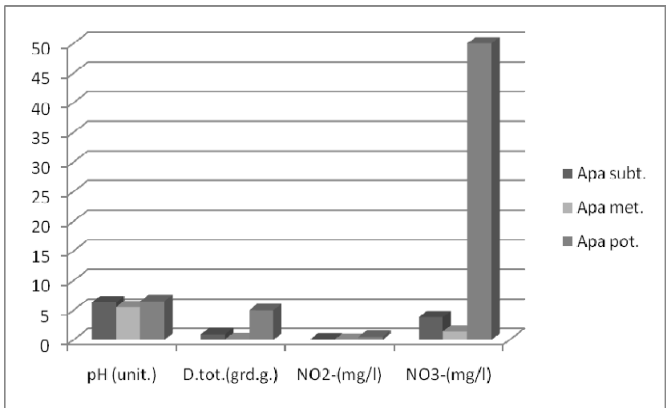

Image 1. The values of parameters of studied waters, studied comparatively with the values regulated in the Drinkable water law

CONCLUSIONS

By comparing the values determined of chosen parameters to the ones from the Drinkable water law we might draw the following conclusions.

- The supply water of inhabitants is, generally, of good quality;
- The water analyzed is slightly more acid than the minimum value accepted (6,5);
- The electric conductibiliy is significantly smaller than the maximum value allowed, fact which is in compliance to the small value of hardness. The degree of mineralization of water is smaller;
- The concentration of Calcium and Magnesium ions, respectively the hardness of water are smaller. The water is vey soft. Soft waters do not offer protection to the cardiovasculary system, being incriminated, next to other factors in the ocurrence of cardiovasculary diseases. Also, soft waters do not offer protection against the corrosion of metallic installations. This fact may be important for the protection of metallic installations of storage and distribution of waters, which are old.
- The concentrations of Nitrites and Nistrates are small, which does not cause problems to the health of inhabitants.

The local system of water supply and especially those coming from karstic aquifers may present a series of disadvantages:

1. The water necessary for the supply cannot be insured, from a quantitative point of view, during the drought, and from a qualitative point of vie, during heavy rain, when the sources are unsettled. There are solutions for artificial recharge of aquifers. (Borivoje,1993)
2. The water cannot be adequately treated;
3. The possibility to control the quality of water is very reduced; the characteristics of karstic aquifers have consequences on the possibilities to pursue and recognize, following the spatial and temporal non-homogeneities. (L.Calier et al,2005)

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