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CHEMICAL CHARACTERISTICS OF THE UNDERGROUND WATERS FROM THE SURROUNDINGS OF THE BROD-GNEOTINO DIGGING, R. MACEDONIA

Orce Spasovski

Faculty of Natural and Technical Sciences, University "Goce Delchev" – Stip, Goce Delchev 89 MK-2000, Stip, Repubilc of Macedonia, orce.spasovski@ugd.edu.mk

ABSTRACT. It is of essential importance to have information about the flow of the water and its characteristics when opening and preparing the diggings.The hydro-geological researches should give reliable documentation, and not until these researches are done that the opening and the exploitation of the diggings can start. The underground waters cause problems during the opening and processing of the mining objects which in certain cases can set an economic limit of the exploitation of the mineral raw material or completely stop the exploitation that has been started. In order to define the hydro-dynamical parameters for the wells, i.e. in order to determine the capacity of the watering system (separate capacity for each well which will operate in a group) in all the well it was performed a separate pumping testing. At the end of the testing process, samples of water were taken from each well in order to make a complete physical-chemical analysis of the water. This paper presents the received results from the chemical content of the underground waters from the surrounding of the Brod-Gneotino digging.

Key words: Underground waters, digging, chemical content, exploitation wells, Brod-Gneotino, physical-chemical indicators, hydro-chemical type of water.

ХИМИЧЕСКИ ХАРАКТЕРИСТИКИ НА ПОДЗЕМНИТЕ ВОДИ ПРИ ИЗКОПНИТЕ РАБОТИ ПРИ БРОД - ГНЕОТИНО, РЕПУБЛИКА МАКЕДОНИЯ

Орче Спасовски
Университет "Гоце Делчев", Щип, Факултет по естествени и технически науки

РЕЗЮМЕ. От съществено значение при изкопните работи е да разполагаме с достатъчно информация за подземните води и техните характеристики. Хидрологическите проучвания би трябвало да предоставят документация и едва тогава след това да започнат изкопните работи и извличането на рудата. Подземните води могат да предизвикат големи проблеми . Минните работи и преработката на рудата, рефлектирайки върху икономическата страна на дейността и дори да спрат започнатите вече работи.
С цел определяне хидродинамичните параметри на сондите (капацитетът на всяка една от тях и в група) , във всички сонди бяха извършени изпитания. В резултат бяха взети проби от всяка сонда за цялостен физико- химичен анализ на водата. Докладът предоставя резултатите от химическото съдържание на подземните води от изкопните работи при Брод- Гнеотино.

Ключови думи: подземни води, изкопни работи, химическо съдържание, сонди, Брод- Гнеотино, физико- химически индикатори, хидро- химически тип вода.

Introduction

The area which is our research subject is located in the south-west part in the Selecka Mountain' valleys, which is low hilly and crosses into the Pelagonia flat area. It is located among these villages, Ribarci on the north, Tepavci and Brof on the east, Egri on the west and the river Crna Reka on the south, with an area of approximately 10 km^2, and with altitude above sea level of 510-650m (Picture 1). The hydro-graphic net is completely connected with the drainage-basin of the river Crna Reka. Through this digging there are a few occasional streams that flow through and they will influence the future exploitation, and depend on the climate factors, i.e. in the wet seasons they can be characterized with flood and in the dry periods they are usually waterless.

During the period of research, precisely in the period between 1974-2007, in the area Brod-Gneotino, a number of researches and testing had been realized (geological, hydro-geological, engineering-geological, geo-mechanic, technological).

Obtained results and discussion

With the samples of water taken from all the wells 12 complete physical-chemical analysis were performed. The analysis were done by the Republic Institute for health protection-Skopje, as a licensed laboratory for water analysis.

Samples from all the wells were also taken to make 12 technical analysis of the content of aggressive and free CO_2 in the waters of the wells. The analysis were made in the laboratory of the industrial complex of mining and energy-Bitola.

Based on the obtained results from the physical-chemical analysis of the underground waters from the well objects of

Brod Gneotino as well as the technical analysis of the gas in this waters, it is classified as follows:

As for the pH value parameter which is between the intervals of 5.8-7.0, these waters belong to the low acidic t neutral waters;

As for the minimalization (the total remains of the evaporation) this waters belong to the group of low mineralized (freshwater) waters, based on the classification of Ovcinikov with M<1g/l, with an exception of the wells B-9,10 and 12 where the mineralization is between the intervals of M=1.5-2.0g/l and the water belongs to the group of mineralized waters with increased mineralization;

As range of: low hard waters (well B-6, B-4, B-2, B-1) with 8.0-12.0°dH, medium hard waters (well B-3) with 12.0-18.0 dH, hard waters (well B-7, B-8) with 18.0-30.0 dH, very hard waters (well B-9, B-12, B-10) with >30.0°;

As for the physical-chemical content, the waters are determined by the Kurlov's formula (Table 1) based on the presence of macro components (the main cations and anions), the total dry remains as well as the content of free carbon dioxide;

As for the content of Fe, the waters have increased concentration, mainly 10 more times (or more) higher that MAC of Fe in the drinking water. Especially great concentration of Fe in the water has been found in the wells b-8 and B-10. As for the content of Mn in the water, it is also increased more than a few times than the MAC of Mn in the drinking water, very often more than 10 times higher than MAC;

As for the usage of the drinking water according to the Regulations for the safety of the drinking water (Gazette of R. M. 57/2004) these waters do not correspond to the regulation of the Legal and professional law in terms of the tested parameters of the physical-chemical propriety due to the increased content of the dry remaining, Fe, Mn, Mg, Cl, Na, total Cr;

As for the content of carbon dioxide CO_2 in the water, as free is present in the water of all wells, especially in the wells B-1, B-7, B-8, B-11, B-12. As aggressive CO_2 it is present mainly in the water of the wells B-7 and B-5. The concentration of the aggressive CO_2 is mostly related to the amount of the present carbonated ion HCO_3 in the water. The results of the technical analysis for the content of gas in the water (free and aggressive CO_2 done in the laboratory of the industrial complex of mining and energy-Bitola);

From the content of the dissolved O_2 in the water depend the so called oxygenous aggressiveness of the water to metals. The content of free oxygen which does the process of oxidization of metals is crucial for the aggressiveness of the water to metal. This phenomena is more supported if there is aggressive CO_2 present in the water.

Fig.1. Map of the Republic of Macedonia with location of investigated area

Table 1. Hydro-chemical type of waters from the wells Brod-Gneotino, after Kurlov

Well	Ionic content of water, Kurlov's formula	Total hardness dH^0	Total mineralization [gr/l]	**pH**	Content of free **CO_2** [gr/l]	Hydro-chemical type of water
B – 1	$CO^2_{0.4}M_{0.286}\frac{HCO^3_{79}SO^4_{12}Cl_9}{Ca_{41}Mg_{36}Na+K_{23}}$	8.9	0.286	6.76	0.4	Hydro-carbonate-calcite-magnesium
B – 2	$CO^2_{0.05}M_{0.276}\frac{HCO^3_{81.2}SO^4_{10.4}Cl_9}{Ca_{49}Mg_{30}Na+K_{21}}$	9.5	0.276	6.68	0.05	Hydro-carbonate-calcite-magnesium
B – 3	$CO^2_{0.13}M_{0.323}\frac{HCO^3_{88}SO^4_7Cl_5}{Ca_{47}Mg_{47}Na+K_6}$	13.7	0.323	6.9	0.13	Hydro-carbonate-calcite-magnesium
B – 4	$CO^2_{0.04}M_{0.274}\frac{HCO^3_{82}SO^4_9Cl_9}{Ca_{42.5}Mg_{28.5}Na+K_{29}}$	9.5	0.274	6.8	0.04	Hydro-carbonate-calcite-magnesium
B – 5	$CO^2_{0.198}M_{0.275}\frac{HCO^3_{80}SO^4_{12}Cl_8}{Ca_{42}Na+K_{30}Mg_{28}}$	9.06	0.275	7.03	0.198	Hydro-carbonate-calcite-sodium potassium
B – 6	$CO^2_{0.058}M_{0.311}\frac{HCO^3_{79}SO^4_{11}Cl_{10}}{Ca_{42}Mg_{37}Na+K_{21}}$	10.4	0.311	6.64	0.058	Hydro-carbonate-calcite-magnesium
B – 7	$CO^2_{0.65}M_{0.698}\frac{HCO^3_{74}SO^4_{20}SO^4_6}{Na+K_{39}Mg_{21}Ca_{20}}$	20.7	0.698	6.17	0.65	Hydro-carbonate-sodium potassium-magnesium
B – 8	$CO^2_{0.4}M_{0.768}\frac{HCO^3_{73}Cl_{20}SO^4_7}{Ca_{24}Mg_{24}Na+K_{22}}$	23.76	0.768	5.85	0.4	Hydro-carbonate-calcite-magnesium
B – 9	$CO^2_{0.1}M_{1.971}\frac{HCO^3_{58}Cl_{29}SO^4_3}{Mg_{38}Na+K_{36}Ca_{26}}$	68.52	1.971	7.2	0.1	Hydro carbonate-chlorine-magnesium-sodium-potassium
B – 10	$CO^2_{0.155}M_{1.511}\frac{HCO^3_{67}Cl_{30}SO^4_3}{Na+K_{49}Mg_{28}Ca_{22}}$	39.27	1.511	6.19	0.155	Hydro carbonate-chlorine - sodium-potassium-magnesium
B – 11	$CO^2_{0.4}M_{0.98}\frac{HCO^3_{74}Cl_{22}SO^4_4}{Mg_{44}Ca_{28}Na+K_{28}}$	35.7	0.98	6.13	0.4	Hydro-carbonate-chlorine-magnesium
B – 12	$CO^2_{0.2}M_{1.95}\frac{HCO^3_{67}Cl_{29}SO^4_4}{Na+K_{51}Mg_{27}Ca_{22}}$	49.24	1.95	6.28	0.3	Hydro carbonate-chlorine - sodium-potassium-magnesium

Conclusion

Based on the entire research (field and laboratory) the following conclusions can be made:

As for the pH value parameter which is between the interval of 5.8-7.0 these waters belong in the low acidic to neutral waters. As for the minimalization (the total remains of the evaporation) this waters belong to the group of low mineralized (freshwater) waters. As for the total hardness based on the Klut's classification these waters belong to the wide range of: low hard waters, medium hard waters, hard waters and very hard waters.

As for the usage of the drinking water according to the Regulations for the safety of the drinking water (Gazette of R. M. 57/2004) these waters do not correspond to the regulation of the Legal and professional law in terms of the tested parameters of the physical-chemical propriety due to the increased content of the dry remaining, Fe, Mn, Mg, Cl, Na, total Cr.

Recommended for publication by Editorial board

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