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THE QUALITY OF GROUNDWATER RESOURCES USED FOR HUMAN CONSUMPTION IN TERMS OF THE CONTENT OF SELECTED HEAVY METALS AND TOTAL MINERALIZATION

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ABSTRACT

We have been assessing the volume of Pb, Cd and Cr in samples taken from groundwater sources Svorad spring, Šindolka spring and Buganka spring in the city of Nitra for 8 months, from April to December 2013. These water sources are used for human consumption. We also watched the total mineralization. We determined the contents of the selected heavy metals by the ASS method and conductivity.

Throughout the period, the average mineralizations were: the Svorad spring 597.7 µS, the Šindolka spring 855.1 µS and the spring Buganka 1315.1 µS. The average Pb content in the samples from the Svorad spring was 0.016 mg.dm^{-3}, the Šindolka spring 0.022 mg.dm^{-3} and the spring Buganka 0.025 mg.dm^{-3}. The concentration of Cd was found on average in the Svorad spring: 0.003 mg.dm^{-3}, the Šindolka spring: 0.003 mg.dm^{-3} and the Buganka spring: 0.004 mg.dm^{-3}. The average concentration of chromium in water was in the source of the Svorad spring 0.002 mg.dm^{-3}, the Šindolka spring was 0.001 mg.dm^{-3} and the Buganka spring was 0.003 mg.dm^{-3}. Based on the high measured values of monitored parameters - especially Pb in the Svorad spring, Cr and Pb in the Šindolka spring and Pb and Cd in the Buganka spring - we do not recommend to use the water for human consumption. The total mineralization was also above the limit.

Keywords: groundwater, water springs, heavy metals, mineralization, quality, Nitra

INTRODUCTION

The origin and evolution of the hydrosphere is closely associated with the development of other parts of the country. Between the casing and the earth´s crust, the hydrosphere, atmosphere, lithosphere and biological material occurs continuously exchanged water **(Wen, *et al*., 2009)**, which causes changes in the chemical and isotopic composition of water **(Harris, *et al.,* 2006)**. It is a stable water cycle (hydrological cycle) on the Earth, driven by a solar radiation and a gravitational forces of the Earth. We can divide water naturally occurring by the origin on the precipitation (atmospheric), surface and subsurface.

Processes determining the qualitative and quantitative composition of natural waters are the nature of physical, chemical and biochemical **(Gemitzi, Stefanopoulos, 2011)**. Moreover, the character of natural waters affects the climatic conditions, the overall landscape, density and type of the settlement etc. (**Turnbull, Jin, Clancy, 2007**).

Subsurface (underground) water occurs below the surface in all forms and state **(Gordon Peterson, Bennett, 2008)**. According to the origin of such waters are divided into fleet (resulting from leakage - infiltration of precipitation and surface water into the ground **(Harris, Hobbs, Higgs, 2006)** and small extent by condensation of atmospheric origin **(Jenkins, *et al*., 2011)** below the surface and juvenile (resulting from the condensation of water vapor emitted from the getting colder magma inside the earth), which can get along fissures in the earth's crust to the surface and jet as thermal springs, springs or geysers **(Harris, Hobbs, Higgs, 2006)**.

Underground water in the profile is bounded chemically and mechanically. From the hydrological point of view, chemically bound water is unusable **(McFarlane, *et al*., 2012)**. Mechanically bound water occurs both in the zone of saturation as groundwater, as well as in the aeration zone as soil water **(Bond, Lake, Arthington, 2008)**.

Groundwater is that portion of the subsurface water that fills the cavity of water-bearing rocks, regardless of whether it creates or does not create a continuous surface, and forming part of a continuous surface soil **(Bekesi, Moiler, 2009)**. According to mineralization (total dissolved solids), and gas content can be groundwater divided to regular and mineral.

Regular groundwaters are waters low in dissolved solids, gases and micro-organisms, which do not meet any of the criteria for mineral water. Regarding to the water, which occurs in normal earthworks **(Barron, *et al*., 2012)**. Groundwater reserves are added to soak atmospheric and surface water permeable layers, condensation of water vapor in the soil and condensation of vapor from the magma **(Aguilera, Fernandez, 2011)**.

Chemical changes in groundwater are the result of complex processes occurring in the system water - rock - atmosphere. These are the processes of physical, chemical and biochemical, ongoing simultaneously or closely together **(Eamus, *et al*., 2006)**. For the formation of the chemical composition is critical dissolution, hydrolysis, adsorption, ion exchange, oxidation and reduction, diffusion and osmosis **(Harris, Hobbs, Higgs, 2006)**.

Groundwaters are classified from different perspectives. By the amount of dissolved substances **(Gordon, Peterson, Bennett, 2008)** are groundwaters divided to ordinary, containing dissolved substances in 1000 mg.dm^{-3}, poorly mineralized (1000-5000 mg.dm^{-3}), mineralized (5000-15000 mg.dm^{-3}) and strongly mineralized (above 15000 mg.dm^{-3}). By the main ionic components are groundwaters classified in class bicarbonate waters, sulfate water and chloride water. Individual classes are divided into groups with predominant cation Na^+, Mg^{2+} and Ca^{2+}.

Contamination of groundwater with heavy metals and specific organic compounds in Slovakia has mostly local nature. The increased content of heavy metals in groundwater is related partly from natural background given by a rock even with an industrial and agricultural activity in the area. From the trace elements are detected higher concentrations of metals: Al, As, Pb, Hg and Ni.

Heavy metals are among the core group of contaminants. The term heavy metals is usually associated with elements that cause undesirable toxic effects and contaminate the environment **(Morrongiello, *et al*., 2011)**. Most harmful for animals and humans are considered: Hg, Cd, Cr and Pb, while their demonstrable toxic effect on the human body depends on several factors.

On the legislative front of the Slovak Republic, requirements for the quality of drinking water defined by the Act No. 355/2007 Coll. on protection, promotion and development of public health and amending certain acts, as amended and Government Regulation No. 354/2006 establishing requirements for water intended for human consumption and quality control of water intended for human consumption as amended by the Government. 496/2010 Coll..

MATERIAL AND METHODS

We solved out the mentioned issues in our work given the current lack of available literature sources and information dealing with the analogous problem with a particular analytical outcomes for residents in the city of Nitra. Goal of this study therefore was to gain knowledge about the quality of existing groundwater sources demonstrably used also for human consumption (not excluding even for drinking purposes for adults and toddlers) in the cadastral area of Nitra and Zobor, in terms of the content of selected heavy metals and total mineralization. All monitored sources are steady, with an average steadiness.

From these more or less year-round functional groundwater resources, we chose for the goal of our work the Svorad spring, the Šindolka spring and the Buganka spring in the period from April 2012 to April 2013. We collected water samples intended for chemical analysis in polyethylene sample bottles volume of 500 cm^3, which were first rinsed with water and then filled up to the cap. We determined the contents of Pb, Cd and Cr by the AAS method (AAS Varian AA Spectr Duo 240FS / 240Z / Ultra A). We expressed a total mineralization as conductivity and measure the conductivity (Conductometer Thomson).

The Svorad spring φ = 48020'47", λ = 18005'27" is located at the highest altitude (305 meters above sea level) from all sources in the cadastral area of Zobor. The spring is located in the woods, on the hiking trail to Zobor and the Svorad cave, near Medical Institute under the hill Zobor (586.9 m) in relatively pure nature. Seepage water is secured by a PE pipe with a diameter of 110 mm. There is a built roofing. On the site, it does not say any indication whether the water is wholesome, respectively defective.

The Šindolka spring is located φ = 48019'50", λ = 18005'00". Located on the Orava street. It is maintained and roofed. From the assessment of groundwater resources is the lowest altitude just 158 m asl. This spring is a significant source of power flow throughout the year. It is the only designated announced that water is the source of drinking water. People often use this water to irrigate their crops and also for direct consumption. Nearby of the spring is more potential polluters (Secondary agricultural school, roads, proximity of land used for agriculture and gardens). Seepage water is secured with an iron pipe with a diameter of 50 mm.

The Buganka spring φ = 48019'50", λ = 18006'04". It is located at Panská dolina, close to the Buganka restaurant. Located on private land at an altitude of 214 m above sea level, but access to it is allowed. Water quality is threatened mainly fertilizers and sprays used in nearby gardens and by the traffic. Other potential pollutants can be Buganka restaurant, Vetchem, Golden key hotel etc. . The spring is built-up, which do not allow to grow wild plants, so nature is represented here only with moss and ivy. The spring is missing the indication if the source is drinking water or not.

RESULTS AND DISCUSSION

We determined Pb, Cd, Cr and total mineralization in samples of groundwater in the period from April 2012 to April 2013. We processed the results in Table 1 which shows that:

Table 1 Concentration of heavy metals ($mg.dm^{-3}$) and conductivity in the period from april 2012 to april 2013 in water springs

WS	DP	Month/year												
		IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV
SS	Pb	0.018	0.018	0.014	0.013	0.015	0.012	0.028	0.030	0.016	0.012	0.004	0.008	0.016
	Cd	0.003	0.004	0.001	0.002	0.003	0.002	0.003	0.005	0.003	0.004	0.003	0.002	0.003
	Cr	0.006	0.004	0.002	0.002	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.007
	µS	595.0	608.0	612.0	605.0	587.0	594.0	605.0	596.0	586.0	597.0	604.0	587.0	594.0
ŠS	Pb	0.026	0.016	0.020	0.022	0.025	0.027	0.036	0.030	0.022	0.018	0.010	0.010	0.018
	Cd	0.004	0.002	0.003	0.003	0.002	0.004	0.004	0.003	0.003	0.004	0.003	0.003	0.004
	Cr	0.000	0.004	0.002	0.002	0.001	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.002
	µS	863.0	856.0	860.0	828.0	878.0	861.0	848.0	845.0	837.0	840.0	864.0	866.0	870.0
BS	Pb	0.022	0.020	0.018	0.020	0.029	0.032	0.038	0.032	0.038	0.030	0.004	0.024	0.020
	Cd	0.005	0.004	0.004	0.005	0.006	0.004	0.004	0.005	0.002	0.003	0.002	0.003	0.005
	Cr	0.006	0.008	0.006	0.005	0.004	0.004	0.000	0.000	0.000	0.002	0.004	0.000	0.004
	µS	1393.0	1427.0	1333.0	1376.0	1347.0	1360.0	1297.0	1308.0	1311.0	1100.0	1279.0	1245.0	1320.0

Legend: WS – water spring, DP – Determined parameter, SS – Svorad spring, ŠS – Šindolka spring, BS – Buganka spring

Found conductivity values are in the range from 612.0 µS (June 2012) in the Svorad spring to 1427.0 µS in the Buganka spring (May 2012). The conductivity values are ranged from 612.0 µS in the Svorad spring (June 2012) to 586.0 µS (December 2012). It represented 828.0 µS in the Šindolka spring (July 2012) to 878.0 µS (August 2012). The Buganka spring in terms of conductivity of the water samples showed the highest values of mineralization compared to the Šindolka spring and the Svorad spring. We found that in January 2013, the overall conductivity was from 1100.0 µS to a maximum of 1427.0 µS in May 2012.

The average value of mineralization observed throughout the entire period represented in the samples from the Svorad spring was 597.7 µS, the Šindolka spring was 855.1 µS and the Buganka spring was 1315.1 µS.

When we compared the measured values (µS) with a current legislation, which provides drinking water indicator value 1250 $µS.cm^{-1}$ we found, that the limit was exceeded in samples of water from the Buganka spring an average of 65 µS. Those could be mainly due to the location of the source in relation to fertilizer and spray used in nearby gardens and also the traffic. It is not recommended the use the water for human consumption from the source for drinking purposes.

The mineralization caused by dissolved inorganic substances which are usually present in the form of ions greatly increases the electrical conductivity of water (**Boulton, 2003**). The value of the electrical conductivity of water is thus an indicator of the amount of ions in water (aqueous solution) and can be used for continuous monitoring of its pollution (**Boulton, 2005; Eamus, Froend, 2006**).

Total mineralization of ground and surface water can form especially Ca, Mg, Na and K (especially in the form of cations, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}), anions HCO_3^-, SO_4^{2-}, Cl^-, NO_3^-, and silicon (Si). Nitrate ion, if present in groundwater, it has a regional character. However, they are present in the atmospheric or surface waters (**Nielsen, Brock, 2009**).

Measured values may be affected by the fact that the core of the massif Zobor build primary rocks, especially deep igneous rocks (eg. granite), which largely overlap the Mesozoic cover rocks. The predominant geological environment are massive Mesozoic quartzite and limestone, and the limestone are usually karsted, which explains the decrease of the average conductivity of the water samples with increasing distance from the Massif itself. Small karst forms, including small fissure caves can be found in different places (the Svorad cave, 355 m asl).

It is known from the literature that, in relation to the content of Ca and Mg in ground and surface water is usually the calcium concentration is usually 2 to 5 times higher than that of magnesium (**Eamus, Froend, 2006**). Concentration of Ca^{2+} in groundwater and surface water is usually in the range of several to hundreds $mg.dm^{-3}$, the concentration of Mg^{2+} ones to tens of $mg.dm^{-3}$. Also, salts of calcium and magnesium affect the taste of water (**Turnbull, Jin, Clancy, 2007**). The best taste characteristics have waters containing ions Ca^{2+} a HCO_3^-.

The lead content was recorded at concentrations from 0.004 $mg.dm^{-3}$ (February 2013) to 0.030 $mg.dm^{-3}$ (November 2012) in samples from the Svorad spring. In the Šindolka spring, this represented 0.010 $mg.dm^{-3}$ (February, March 2013) to the maximum measured value of 0.036 $mg.dm^{-3}$ (October 2012). In the spring Buganka we measured the concentration of lead in the range from 0.004 $mg.dm^{-3}$ (February 2013) to 0.038 $mg.dm^{-3}$ (October, December 2012). Buganka spring in terms of detected concentrations of lead in water samples showed the highest values compared with the Šindolka and the Svorad spring. On the other hand, the measured differences between the springs in the maximum concentrations of lead are low, averaging to 0.006 to $mg.dm^{-3}$ of Pb^{2+}.

The average value of total Pb recorded throughout the period represented in the samples from the Svorad spring was 0.016 $mg.dm^{-3}$, the Šindolka spring was 0.022 $mg.dm^{-3}$ and the Buganka spring was 0.025 $mg.dm^{-3}$ of the water samples.

We found out that the limit was exceeded in samples of water from all sources, during the comparison measured values of Pb concentration with the legislation in Slovakia, which provides drinking water limit value of 0.01 $mg.dm^{-3}$. On average, it represented 0.006 $mg.dm^{-3}$ for the Svorad spring, the Šindolka spring was 0.012 $mg.dm^{-3}$ and the Buganka spring was 0.015 $mg.dm^{-3}$ of Pb.

We do not recommended to use water for human consumption from the sources Given that the measured values of concentrations of lead throughout the period shows the increased amount above the limit value.

The literature shows that the concentration of lead in groundwater is of the order only ones to tens of µg/l (**Vanloon, Duffy, 2005**). Higher content was found in areas where the water comes into contact with lead ores (there might lead to achieve a concentration higher than 5 $mg.dm^{-3}$). Natural sources of lead in groundwater are anglezit minerals and pencil mineral. The most widespread lead ore is a galena, which only a minor subject to chemical and biochemical oxidation (unless in the presence of other sulphide ores, where arise by oxidation a sulfuric acid).

Acute lead poisoning tend to be very rare, however, there are chronic poisoning because lead accumulates in the bones and liver. Children are more sensitive to some extent to the low lead content in the exhaust gases and contaminated drinking water (**Woolf, Goldman, Bellinger, 2007**).

From a toxicological point of view, lead linked with a variety of body processes and is toxic to organs and tissues, including the heart, bones, kidneys, and reproductive and nervous system (**Meyer, Brown, Falk, 2008**). **Woolf, Goldman, Bellinger** (**2007**) notes that interferes with the development of the nervous system and is therefore very toxic to children. It also causes potentially permanent changes and behavioral disorders (**Flora, 2002**). Dangerous group of lead compounds is soluble lead carbonate (dissolved in gastric juices), when lead ions (Pb^{2+}) cross the placenta and affect embryotoxic and teratogenic. From the organic compounds, it is particularly tetraethyl-lead and tetramethyl lead, which due to its lipophilic properties easily pass through intact skin (**Robbins, *et al.*, 2010**).

Found levels of Cd in the samples varied between 0.001 $mg.dm^{-3}$ (June 2012) in the Svorad spring to 0.006 $mg.dm^{-3}$ (August 2012) in the Buganka spring. In the Svorad spring, levels of cadmium ranged from 0.001 $mg.dm^{-3}$ (June 2012) to 0.005 $mg.dm^{-3}$ (November 2012). We had the same values over several months in the Šindolka spring. Concentration of Cd was varied in the range from 0.002 $mg.dm^{-3}$ (May-August 2012) to 0.004 $mg.dm^{-3}$ (April, September 2012 and January, April 2013). The source of Buganka in terms of Cd content in the samples showed the highest average compared to springs of the Šindolka and the Svorad. Specifically, it was a concentration of 0.002 $mg.dm^{-3}$ (December 2012) to 0.006 $mg.dm^{-3}$ (August 2012).

The average measured values of total Cd during the whole period 2012 - 2013 was 0.003 $mg.dm^{-3}$ in water samples from the Svorad spring and the Šindolka spring was 0.003 $mg.dm^{-3}$. The lowest Cd content was recorded in the Buganka spring just 0.004 $mg.dm^{-3}$ of the water samples.

The limit value is for Cd in relation to the contents in water intended for human consumption in accordance with applicable legislation 0.003 mg Cd per liter of water. When comparing the measured values of the concentrations of Cd, we found out that the limit was exceeded in samples of water from the Šindolka spring of 0.0002 $mg.dm^{-3}$ and the Buganka spring of 0.0010 $mg.dm^{-3}$. In the Svorad spring were recorded below contents of Cd in the range to 0.0001 $mg.dm^{-3}$.

We recommended do not use this water for the drinking purpose on the base of the measured values of concentrations of Cadmium during the whole period shows the increased content of the Šindolka spring and the Buganka spring above the limit value.

The groundwater is of the order of Cd is about ones to tens of µg/l depending on the conditions in the groundwater may occur contents of Cd up to180 $mg.dm^{-3}$. Natural source of cadmium in groundwater are mainly position with zinc mineralization, that accompanies cadmium (**Vodela, *et al.*, 1997**). **Samunding,** (**2009**) notes that secondary sources are primarily conducted emissions from the steel industry, combustion of fossil fuels and waste containing plastics, and some types of wastewater.

Cadmium in the aquatic environment is relatively mobile element. Occurs as a simple ion Cd^{2+}, in the complex form $[Cd(OH)_2(aq)]^0$, $[Cd(OH)_3]^0$, $[Cd(OH)_4]^{2-}]$ and $[CdCO_3(aq)]^0$, but also in various other inorganic and organic complexes (**Samunding, *et al.*, 2009**). In natural waters is the affinity of ligands to the formation of Cd complexes in the order: humic acid, CO_3^{2-}, OH^-, Cl^-, SO_4^{2-} .

Öztürk, *et al.* (**2009**) reported that Cd element is rarely represented in groundwater (about 95% of the analyzed samples it does not contain). Local anomalies in the SR bind to particular occurrences of mineralization confined to in Neovolcanites and Spišsko - gemerské Rudohorie mountains. Other anomalies occur in urban areas with a high concentration of industry and groundwater alluvial sediments, particularly in Vah river.

Cadmium and its salts are of toxicological concern very dangerous (**Matović, Buha, Bulat, 2011**). Cadmium salts are accumulate in the liver, kidneys, brain, lungs, heart, testis and nervous tissue (**Cuypers, Plusquin, 2010**). Cadmium ions blocked-SH groups of enzymes (**Wang, Shao, Li, 2011**) and biological macromolecules interfere with carbohydrate metabolism and inhibit insulin secretion (**Martinez, Zamudio, 2011**).

Measured levels of chromium in samples of groundwater in selected sources are ranged from zero values up to 0.008 $mg.dm^{-3}$ (May 2012) in the Buganka spring. Chrome values was recorded in the range from 0.000 $mg.dm^{-3}$ (October, November, December 2012 and February and March 2013) to 0.007 $mg.dm^{-3}$ (April 2013) in the Svorad spring. We also measured levels of Cr zero over several months (April, October-December 2012, March 2013) in samples from the Šindolka spring. The concentrations of chromium were moving to 0.004 $mg.dm^{-3}$ (May 2012). We found the highest content of cadmium 0.008 $mg.dm^{-3}$ (May 2012) in the Buganka spring for the entire period compared to springs of the Šindolka and the Svorad. Concentrations of chromium from this source were changing in the range of 0.000 $mg.dm^{-3}$ (October to December 2012) to 0.008 $mg.dm^{-3}$ (May 2012).

The average concentration of Cr throughout the period 2012 - 2013, was 0.002 $mg.dm^{-3}$ in the samples taken from the Svorad spring, the Šindolka spring was 0.001 $mg.dm^{-3}$ and the Buganka spring was 0.003 $mg.dm^{-3}$ of the water.

The currently valid legislation in the Slovak Republic is 0.05 $mg.dm^{-3}$. This limit is for Cr content in water destined for human consumption. During the comparison the measured values, we found out that the limit is not exceeded on average at any sampling point.

The literature suggests that natural sources of chromium in groundwater are mainly minerals and chromite Crocoite, secondary sources are industrial waste waters. Chromium may be present in the waters of the oxidation state +III and +VI (**Samunding, , 2009**). The main forms of chromium is Cr^{3+} and hydroxokomplexy as $CrOH^{2+}$, $[Cr(OH)_2]^+$ and $Cr(OH)_4^-$. Solubility of Cr^{3+} is very small and is given by the solubility of hydrated. Anionic forms of Cr^{6+} is pH dependent, in particular concerning CrO_4^{2-}, $HCrO_4^{-1}$ and $Cr_2O_7^{2-}$, most compounds are readily soluble in water with the exception of lead chromate, barium and silver (**Gordon Peterson, Bennett, 2008**).

Oxidation of Cr^{3+} to Cr^{6+} dissolved oxygen in natural waters is very slow, but in the presence of MnO_2 can be accelerated, but the reaction rate depends on the content of dissolved oxygen. Conversely reduction of Cr^{6+} to Cr^{3+} is in natural waters, perhaps especially in the presence of Fe^{2+}, sulphites or H_2S in acidic conditions (**Gatto, Kelsh, Mai, 2010**).

Beaumont, Sedman, Reynolds (2008) in the work states that the degree of toxicity of chromium depends on its oxidation stage, the cation Cr^{6+} is more toxic than Cr^{3+}. Cr^{6+} is generally only slightly toxic to aquatic plants, but are known cases of acute poisoning fish. Water-soluble components Cr^{6+} have mutagenic and carcinogenic effects (**Smith, Steinmaus, Craig, 2009**). The concentrations of 1,0 $mg.dm^{-3}$ and 3.0 $mg.dm^{-3}$ Cr affects the taste and the color of water.

CONCLUSION

We have been collecting water samples from groundwater resources in the city of Nitra for 12 months, from April to December 2013. They are also used for human consumption determined the contents of Pb, Cd, Cr and total mineralization. The results obtained suggest that:

Total mineralization, which is caused by dissolved inorganic substances and may also serve to continuous control of water pollution was in the Svorad spring in the interval from 612.0 to 586.0 µS, it represented from 828.0 to 878.0 µS in the Šindolka spring and the Buganka spring from 1100.0 to 1427.0 µS. Indicating value of 1250 $\mu S.cm^{-1}$ was exceeded in samples of water from the Buganka spring an average of 65 µS.

The content of Pb was found in concentrations from 0.004 to 0.030 $mg.dm^{-3}$ in samples from the Svorad spring. It represented from 0.010 to 0.036 $mg.dm^{-3}$ in the spring Šindolka and the Buganka spring from 0.004 to 0.038 $mg.dm^{-3}$, which showed the highest values compared to springs of the Šindolka and the Svorad. The limit value of Pb 0.01 $mg.dm^{-3}$ exceeded samples of the water from all sources, which on average accounted for the Svorad spring was 0.006 $mg.dm^{-3}$, the Šindolka spring was 0.012 $mg.dm^{-3}$ and the Buganka spring was 0.015 $mg.dm^{-3}$ of Pb.

The measured concentrations of Cd in the samples moved in the Svorad spring in the range from 0.001 $mg.dm^{-3}$ to 0.005 $mg.dm^{-3}$, it was from 0.002 to 0.004 $mg.dm^{-3}$ in the Šindolka spring and the Buganka spring was from 0.002 to 0.006 $mg.dm^{-3}$. The limit value for Cd in water intended for human consumption is 0.003 $mg.dm^{-3}$. The limit was exceeded in samples of the water from the Šindolka spring for 0.0002 $mg.dm^{-3}$ and the Buganka spring for 0.0010 $mg.dm^{-3}$. We had a sub-limit Cd content in the Svorad spring.

Determined content of Cr in groundwater, it was the Svorad spring in the range from 0.000 to 0.007 $mg.dm^{-3}$, it was from 0.000 to 0.004 $mg.dm^{-3}$ in the Šindolka spring and it was from 0.000 to 0.008 $mg.dm^{-3}$ in the Buganka spring. Indicating limit for Cr content 0.05 $mg.dm^{-3}$ water is not exceeded at any of the sampling point.

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