275
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HEAVY AND TOXIC METALS IN THE GROUND WATER OF THE PRILEP REGION FROM THE PELAGONIA VALLEY

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A b s t r a c t: The research presented in this study was carried out in order to test the quality of the ground water in the Prilep region within the Pelagonia valley. The investigations consisted of taking 12 individual samples of ground water and analysis of eleven elements from the group of toxic metals, such as: Mn, Fe, Zn, Pb, Cr, Cu, Cd, As, Al, Ni and Ag. Knowing the quality of ground water in this investigated region is of particular importance since the ground water from the analyzed wells is used by the locals of this region as drinking water and for irrigation of the surrounding arable land. The data we received indicates that in the majority of analyzed samples there were increased concentrations of Ni, As and Pb, which are most likely result of the composition of the geological environment where this ground water circulates.

Key words: ground water; heavy and toxic metals; Pelagonia valley

INTRODUCTION

In the Prilep region of the Pelagonia valley the ground water is being actively used by the local population for water supply and / or for irrigation of arable land.

Determining the quality of ground water is of special importance for water supply of the populated areas in this region as well as for irrigation of land.

The Pelagonia valley, that the investigated region is part of, is situated in the south-western part of the Republic of Macedonia (Figure 1). The plain is bounded by the Baba, Plakenska and Bushava mountains to the west, Dautica to the north and Babuna and Selechka mountains to the east.

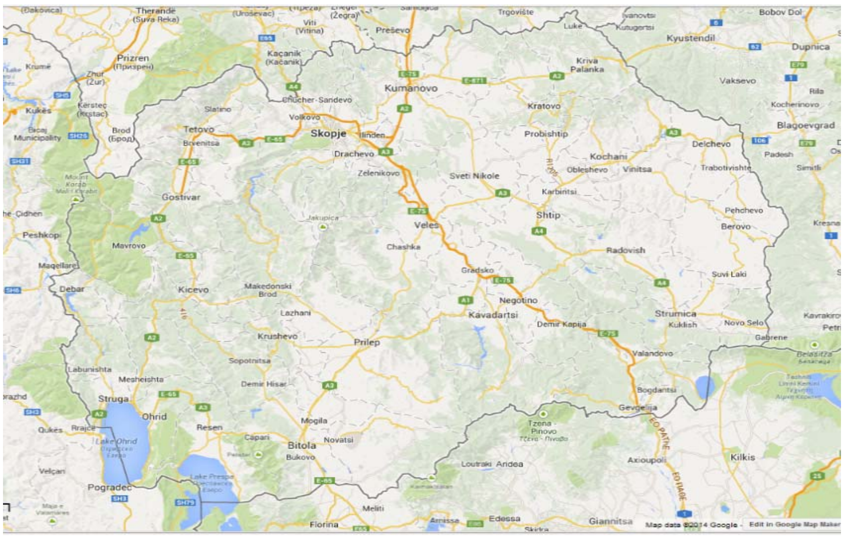

Fig. 1. Geographic position of the investigated region

GEOLOGIC-TECTONIC CHARACTERISTICS

According to the tectonic regionalization of the Republic of Macedonia by Arsovski (1997), the Pelagonia valley belongs to the Pelagonian horst anticlinorium. The Pelagonia basin is a neo-tectonic graben structure, whose formation according to Dumurdžanov et al. (2002) started towards the end of the Middle Miocene.

The Pelagonia basin is composed of Neogene terragene lake deposits represented by sandy aleurite, sandy clay and pure aleurite and predominant clays whereas the profile consists of less aleurite sand and gravel and more sparsely of pure layers of sand and gravel (Dumurdžanov et al., 2002).

On top of the lake sediments there are Quaternary alluvial sediments represented by alluvial lake sediments with predominant presence of coarser sandy gravel fraction and bog sediments. At the basin perimeter the Quaternary sediments are represented by proluvial and diluvial deposits composed of coarse clastic sediment composed of silt clayey sands and gravels with occasional presence of boulders.

The wider area of the investigated site is consisted of Precambrian and Paleozoic metamorphous rock mass which are layered – spread on the base of the surrounding mountains and in the base of the Neogene lake sediments (Dumurdžanov et al., 1979; Rakičević et al., 1965).

The Precambrian metamorphous rock mass present highly metamorphous rocks represented mainly by gneisses, mica-schists, then granodiorites, granites, calcite marbles and dolomite marbles.

The Paleozoic rocks are represented by: quartz-sericite and grafite-schists, metasandstones, quartzite and epidote-chlorite amphibolite-schists.

HYDROGEOLOGIC CHARACTERISTICS

The Prilep Neogene basin is composed of Quaternary and Pliocene sediments. The Quaternary sediments cover completely (except a small portion of 5–6 km^2 NE of Prilep) the Pliocene sediments.

From a hydrogeologic point of view, the Prilep Neogene basin can be regarded as one hydro-geologic unit, consisting of one region of water permeable lithological formations and one region of impermeable (mostly impermeable) lithological formations (Iliovski et al., 2000; Gjuzelkovski, 1997).

Water permeable rocks – Water permeable non-cohesive clastic deposits – condensed type of aquifers.

Water impermeable rocks – Water impermeable non-cohesive lithologic formations within the Neogene sediments.

Water permeable non-cohesive clastic deposits – condensed type of aquifers – This group consists of diluvial, proluvial, alluvial and Pliocene sediments. These sediments cover the whole Neogene basin and a part of the foot of the mountain massifs.

Water impermeable non-cohesive rocks – This group consists of the thick layers of clay and silt within the Neogene sediments in the basin. No presence was found at the surface of the terrain. These entirely impermeable layers create water bearing horizons – aquifers with level under pressure – artesian horizons.

APPLIED METHODOLOGY

The analysis of the heavy and toxic metals in the samples has been carried out at the University of Goce Delchev in Shtip with the ICP methods (inductively coupled plasma).

The tests were conducted on 12 samples of ground water taken from wells used for water exploitation. The sampling was made only once on 27. 8. 2013. The location of the wells where water samples were taken from can be seen in Figure 2. The coordinates of the measurement location have been shown in Table 1.

The location and technical characteristics of the wells have been shown in Table 2.

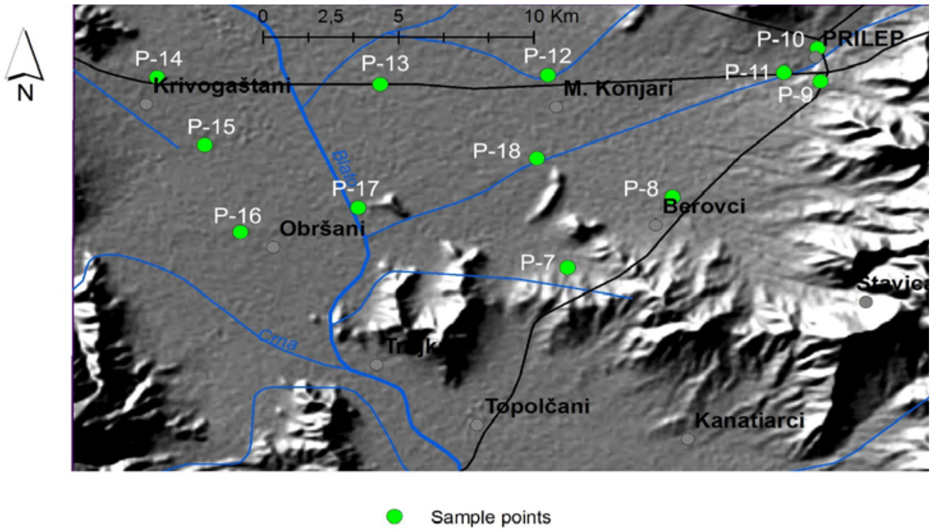

Fig. 2. Geographic position of the wells of the sampling

T a b l e 1

Sampling location

Sample	Location	y	x
P-7	v. Alinci	7 539 777	4 569 375
P-8	Factory Krin	7 542 680	4 572 205
P-9	Mogilata Prilep	7 546 777	4 576 877
P-10	Park munic. Prilep	7 546 683	4 578 218
P-11	Komunalec Prilep	7 545 752	4 577 241
P-12	v. Konjari, Prilep	7 539 189	4 577 097
P-13	v. Slavej, Prilep	7 534 529	4 576 702
P-14	v. Krivogashtani	7 528 325	4 576 955
P-15	v. Krusheani	7 529 668	4 574 248
P-16	v. Obrshani	7 530 676	4 570 751
P-17	v. Borotino	7 533 939	4 571 751
P-18	v.KadinoSelo	7 538 903	4 573 747

T a b l e 2

Location and technical characteristics of the wells

Sample	Location and technical characteristics
P-7	v. Alinci, Prilep, well drilled at a depth of 45 m, capacity of 4.5 l/s, flowing well 1 l/s.
P-8	Krin factory for processing of marble and granite, well drilled at a depth of 55 m, capacity of 3.0 l/s.
P-9	Park Mogilata Prilep, well drilled at a depth of 85 m, capacity of 3.5 l/s.
P-10	Park in the center of Prilep, well drilled at a depth of 65 m, capacity of 4.5 l/s.
P-11	On the grounds of Komunalec Prilep, well drilled at a depth of 65 m, capacity of 4.0 l/s.
P-12	v. Konjari, Prilep, well drilled at a depth of 85 m, capacity of 3.5 l/s.
P-13	v. Slavej, Prilep, well drilled at a depth of 135 m, capacity of 0.5 l/s, flowing well.
P-14	v. Krivogashtani, built well at a depth of 8 m, capacity of 0.5 l/s.
P-15	v. Krusheani, Prilep, well drilled at a depth of 70 m, the water is mineral water, capacity of 3.5 l/s.
P-16	v. Obrshani, Prilep, well drilled at a depth of 35 m, capacity of 2.0 l/s.
P-17	v. Borotino, Prilep, built well at a depth of 9 m, capacity of 0.5 l/s.
P-18	v. Kadino, Prilep, well drilled at a depth of 90 m, capacity of 0.3 l/s, flowing well.

RESULTS AND DISCUSSION

The results from the analysis of the contents of heavy and toxic metals have been shown in the diagrams in Figures 3 – 13.

The data measured has been compared to Macedonian standards of the quality of drinking water (Water-safety regulation book, *Official Gazette of R. Macedonia,* Nr. 46 of 7. 4. 2008).

The comparison has been shown graphically in the form of diagrams in Figures: 3–13.

From the performed comparison according the Macedonian drinking water standard is obvious that the percentage of Zn, Cr, Cu, Al and Ag are below the maximum allowed concentrations (MDK) for this standard.

The content of Fe shows increased concentrations than MDK at 1 sample, Mn at 3 samples, Pb at 5 samples, As at 9 samples and Ni at 11 samples. Mostly the increased concentrations are in regard to Pb, As and Ni. Because of the fact that there are no industrial pollutants that could be polluting the underground water, we can conclude that the higher increased concentrations of Mn, Fe, Pb, As and Ni are result of the mobilizing of these elements in the geologic environment where this water circulate.

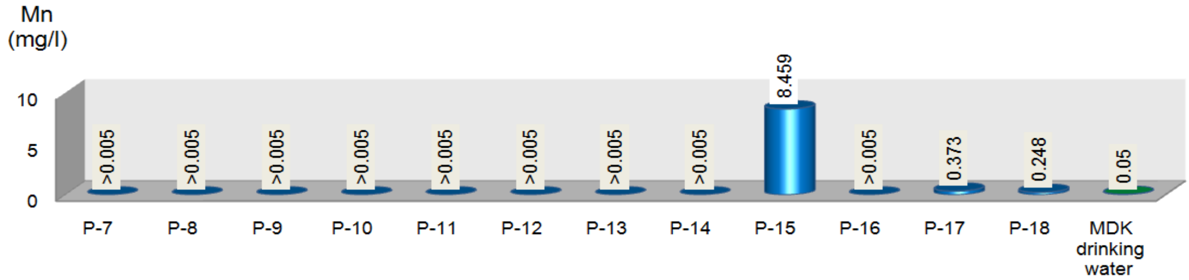

Fig. 3. Graphic presentation of the concentration of Mn.

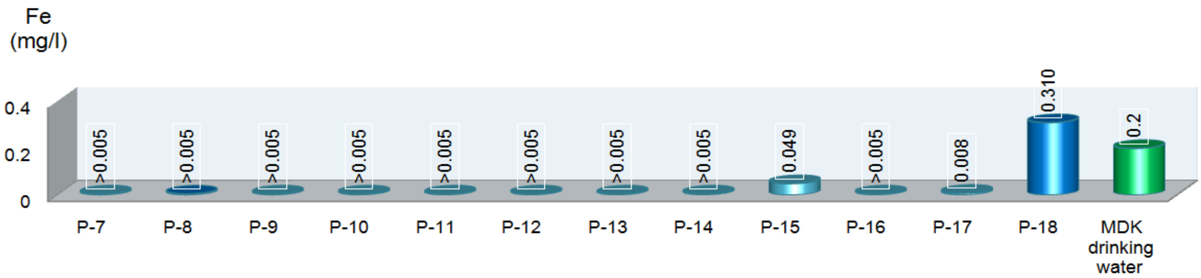

Fig. 4. Graphic presentation of the concentration of Fe

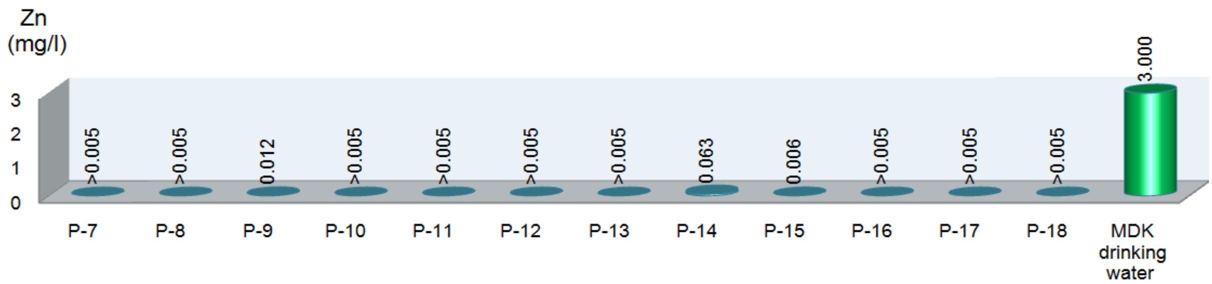

Fig. 5. Graphic presentation of the concentration of Zn

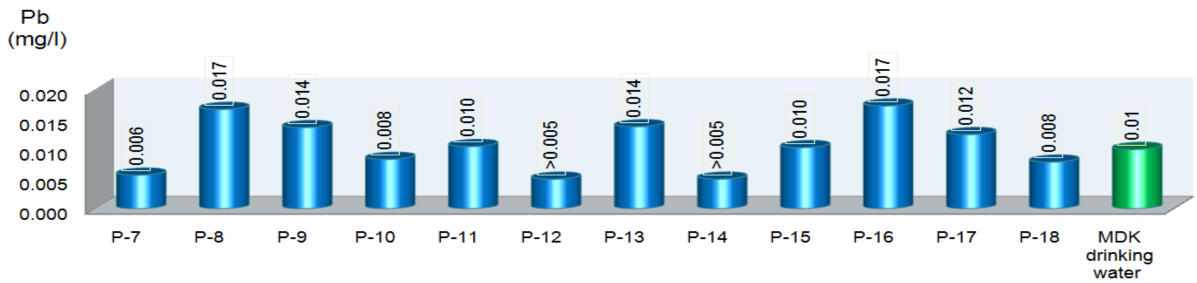

Fig. 6. Graphic presentation of the concentration of Pb

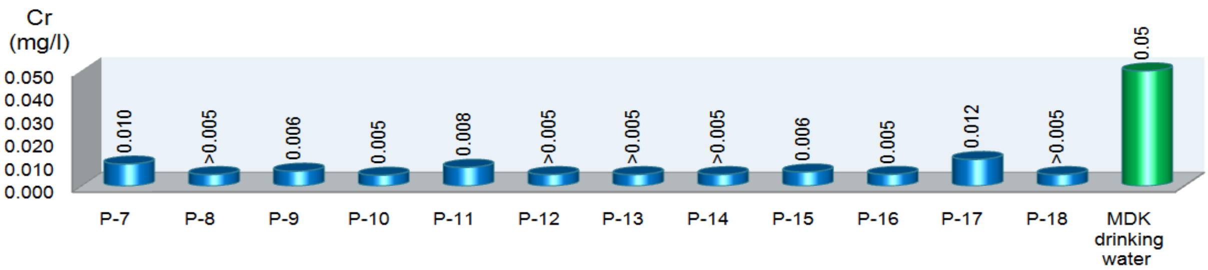

Fig. 7. Graphic presentation of the concentration of Cr

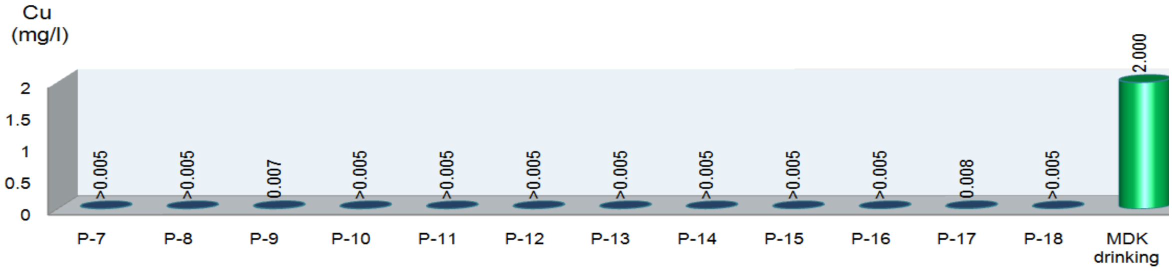

Fig. 8. Graphic presentation of the concentration of Cu

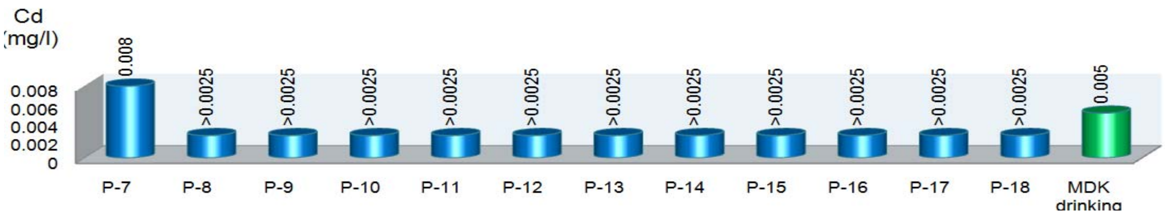

Fig. 9. Graphic presentation of the concentration of Cd

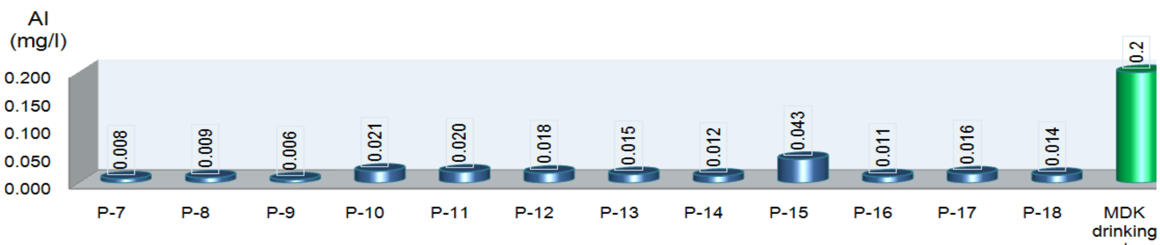

Fig. 10. Graphic presentation of the concentration of Al

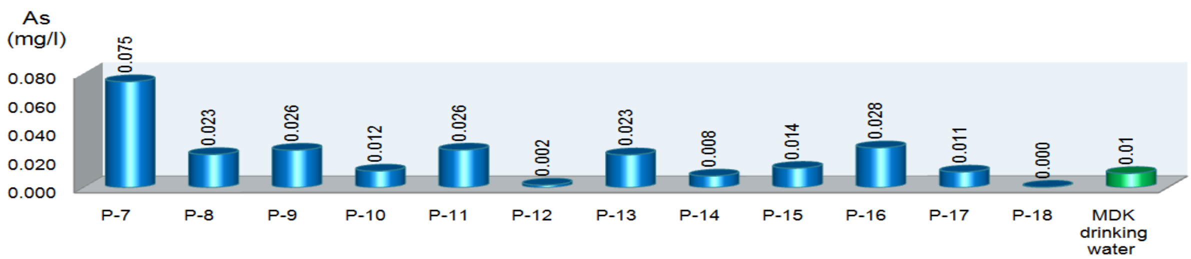

Fig. 11. Graphic presentation of the concentration of As

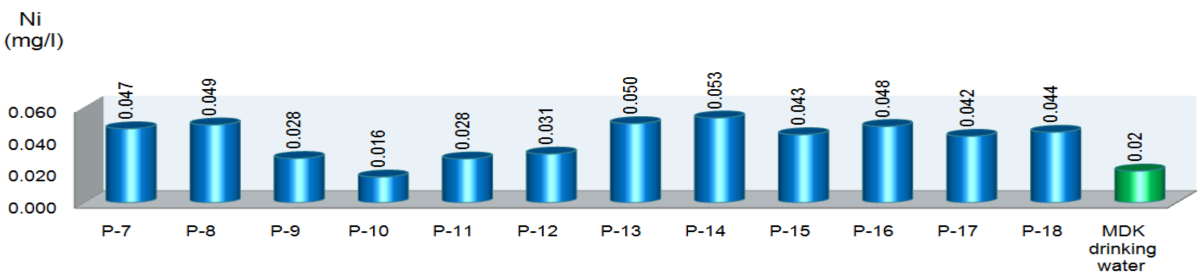

Fig. 12. Graphic presentation of the concentration of Ni

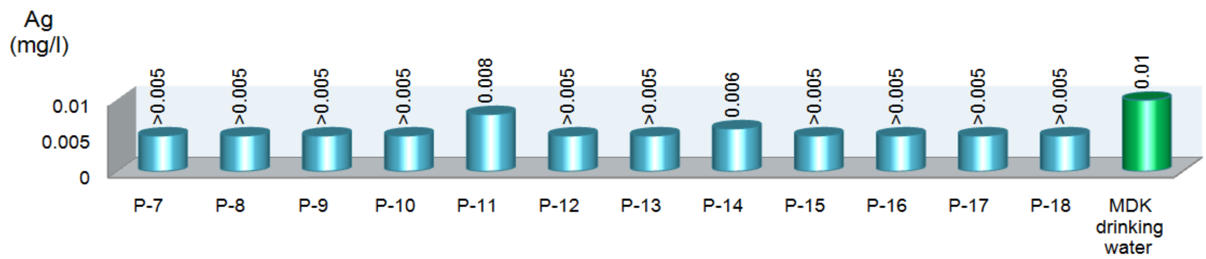

Fig. 13. Graphic presentation of the concentration of Ag

CONCLUSION

After the executed investigations a conclusion can be drawn that only Ni, As and Pb show increased content in the majority of the tested samples while Mn and Fe show increased content only locally at part of the samples. It is mostly possible that the higher concentrations of particular elements from the group of heavy and toxic metals is result to the geological composition of the terrain where these ground waters circulate, in particular the origin of these elements is not anthropogenic but result to the actual geologic environment.

The water from the wells where increased presence of heavy and toxic elements – metals of MD/K is detected before use for drinking and/or irrigation must be properly treated.

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Р е з и м е

ТЕШКИ И ТОКСИЧНИ МЕТАЛИ ВО ПОДЗЕМНИТЕ ВОДИ НА ПРИЛЕПСКИОТ РЕГИОН ОД ПЕЛАГОНИСКАТА КОТЛИНА

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Клучни зборови: подземни води; тешки и токсични метали; Пелагониска Котлина

Истражувањата што се направени во овој труд имаа за цел да се испита квалитетот на подземните води во прилепскиот регион на Пелагониската Котлина. Испитувањата се направени со 12 поединечни проби на подземни води со анализа на единаесет елементи од групата на тешки и токсични метали, и тоа: Mn, Fe, Zn, Pb, Cr, Cu, Cd, As, Al, Ni и Ag. Познавањето на квалитетот на подземните води на истражуваниот простор е од посебно значење, бидејќи подземните води од анализираните бунари се користат од страна на жителите од овој регион како вода за пиење и за наводнување во земјоделството. Добиените податоци покажуваат дека во поголем број од анализираните проби има зголемена концетрација на Ni, As и Pb, што најверојатно е резултат на составот на геолошката средина низ која циркулираат подземните води.