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Assessment of the Radionuclide and Chemical Composition of Natural Waters in the Area Affected By a Uranium Technogenic Object

Muzafarov Amrullo Mustafoevich.[1] Kulmatov Rashid Anvarovich.[2] Urunov Isoqul .Oblokulovich[3]

[1]Chief Engineer of TsNILNGMK, Ph.D. Navoi, Uzbekistan
[2]Professor of NUUz, Doctor of Chemical Sciences, Tashkent city, Uzbekistan
[3]Head of Physics Department, Navoi state mining institute. Navoi, Uzbekistan
amrullomuzafarov@gmail.com

Abstract *This article presents the results of assessing the radionuclide and chemical composition of natural waters. There are numerous chemical, physical, physicochemical and nuclear-physical methods for analyzing the radionuclide and chemical composition of natural waters in the area affected by a uranium technogenic object. In natural waters, the following are determined - radiation indicators - total specific alpha and beta activity, radionuclide composition - uranium decay chains - U^{238}, U^{234}, Th^{230}, Ra^{226}, Rn^{222}, Bi^{214}, Pb^{214}, Po^{210}, etc., dry residue, pH values, anions - Cl^-, NO_2^-, NO_3^-, CO_3^{2-}, HCO_3^-, SO_4^{2-},and their sum, cations - Ca^+, Mg^+, Na^++K^+, Fe^{3+}, NH_4 and their sum and concentration of some metals - Mn, Pb, Cu, Zn, Co, Cr, Ni.*

Keywords: total specific alpha and beta activity, radionuclide composition of natural radionuclides, radiometric methods of analysis, chemical composition, natural waters, chemical methods, dry residue, pH values, anions and their sum, cations and their sum, metal concentration.

1. INTRODUCTION

Relevance Industrialized regions of the world, including the industrial regions of the Republic of Uzbekistan, are polluted to varying degrees of natural water by harmful chemical elements [1-3]., And in industrial regions where uranium mining enterprises operate with radionuclides of the uranium decay chain - U^{238}, U^{234}, Th^{230}, Ra^{226}, Rn^{222}, Bi^{214}, Pb^{214}, Po^{210}, etc. The reason for this pollution is non-observance of technological regulations, negligence with the requirements of International and Republican regulatory documents, and incorrect organization of nature conservation measures.

Pollution of natural waters with the above radionuclides and chemical elements adversely affect the radiation and chemical states of ecosystem objects in this region, in which it will lead to the death or degradation of vegetation, loss of fertile properties, changes in the structure of the earth's surface and deterioration of the quality of natural waters.

In addition, a limit for the permissible concentration of radionuclides and chemical elements has been established in natural waters, as well as their upper values are regulated by international and national normative documents [10].

Determination of the concentration of radionuclides and chemical elements in natural waters in the area affected by a uranium technogenic object is an urgent task of analytical chemistry, applied nuclear physics and radioecology [4-9,11-14].

The purpose of this study was to determine the concentration of radionuclides and chemical elements in natural waters sampled from the point of sampling the area affected by a uranium technogenic object.

To achieve this goal, the samples taken from the point of sampling of various natural waters in the area of the influence of the uranium technogenic object - the Zarafshan river, the Amu Darya, Domkhodzha and Amu-Bukhara canal were studied and the concentrations of radionuclides and chemical elements were determined in them, and their distribution and dynamics were studied. changes during different periods of the year.

Technique and experimental methodology In natural waters, the following were determined - the total alpha and beta activity on the device - UMF-2000, the radionuclide composition on the device "Gamma-progress" by the gamma-spectrometric method, anions - Cl^-, NO_2^-, NO_3^-, CO_3^{2-}, HCO_3^-, SO_4^{2-} and their sum, cations - Ca^+, Mg^+, Na^++K^+, Fe^{3+}, NH_4 and their sum - photocolorimetric method, dry residue, pH values, hardness and metal concentrations - Mn, Pb, Cu, Zn, Co, Cr, Ni - by atomic absorption method.

2. THE RESULTS OBTAINED AND THEIR DISCUSSIONS

The total mineralization of natural waters has been preliminary determined. The total mineralization for the water of the Zarafshan river is 1.2 g/l (Navoi city), the Amu Darya river is 1.6 g/l (Sarimy settlement), 1.8 g/l (Cholishkupir bridge), –2.1 g/l (Yumirtov), Domkhoja - 0.85 g/l (Navoi) and Amu-Bukhara canal (Gijduvan bridge) - 1.12 g/l (Gijduvan bridge) at the established rate - 1 g/l. In all the samples taken except Domkhoja, the total mineralization of natural waters is higher than the established norm.

This fact interested us in identifying the main factor in increasing the total mineralization of natural waters. On the basis of this fact, the determination of the anionic and cationic composition and their sum in the selected samples of natural waters was carried out.

The results obtained for determining the anionic and cationic composition of the selected samples of natural waters are given in table1.

Table 1. Results of determining the anionic and cationic composition of the selected samples of natural waters

№	CATIONS, (mg/dm^3)						ANIONS, (mg/dm^3)						
	a^{2+}	g^{2+}	Na^+ +K^+	e^{3+}	H_4^+		O_3^{2-}	CO_3^-	O_4^{2-}	I^-	O_2^-	O_3^-	
	52,2	4,7	143 ,2+7,3	,25	,24	28,9	,5	28,8	05,8	44,6	0,02	,6	07,3
	67,2	1,8	169 ,0+7,7	,27	,37	11,3	,5	28,8	10,3	73,7	0,02	3,0	30,4
	82,2	03,4	134 ,4+6,0	,31	,33	28,9	20,0	14,2	00,5	08,1	1,1	0,1	87,3
	62,3	4,2	142 ,9+6,5	,34	,27	72,3	20,0	38,6	37,2	08,1	3,3	0,1	98,4
	11,2	2,3	124 ,6+7,3	,17	,27	89,3	,5	20,7	11,6	200,5	0,02	,3	71,3
	22,2	2,3	244 ,6+7,3	,25	,67	27,3	,5	22,7	11,6	37,5	0,02	,3	05,6

* Note - 1 - Navoi, 2 - Sarimoy, 3 - Cholishkupir bridge, 4 - Yumirtov, 5 - Domkhojai 6 - Gijduvan bridge.

From the above results in Table 1, it can be seen that the lowest values of cations are Ca^{2+}, Mg^{2+}, Na^++K^+, Fe^{3+}, NH_4^+, the sum of cations, the values of the anions CO_3^{2-}, HCO_3^-, SO_4^{2-}, Cl^-, NO_2^-, NO_3^-, the sum of anions was found in the samples5 - Domkhoja. And the highest cation values are Ca^{2+}, Mg^{2+}, Na^++K^+, Fe^{3+}, NH_4^+, the sum of cations, the values of the anions CO_3^{2-}, HCO_3^-, SO_4^{2-}, Cl^-, NO_2^-, NO_3^-, the sum of anions was found in samples 4 - Yumirtov.

According to the standard method, the samples of these natural waters were determined - the entire dry residue, pH and hardness values.

The results obtained for determining the weight of the dry residue, the pH value and the hardness of the selected samples of natural waters are given in table 2.

Table 2 Results of determination of dry residue weight, pH value and hardness of taken samples of natural waters

проб	Dry remainder, (mg/l)	pH	Rigidity general, (meq/l)	Enlightened substances, (mg/l)	SiO2, (mg/l)
	1200,0	7.84	7.60	2,59	8,44
	1600,0	8,21	8,20	3,10	8,27
	1800,0	8,32	8,60	3,71	9,15
	2100,0	8,64	8,90	4,23	9,98
	850,0	7,01	6,80	2,07	7,02
	1120,0	7,34	7,40	2,48	8,12

From the above results in Table 2, it can be seen that sample 4 has the highest total dry residue of 2100 mg/l, and sample 4 has the lowest dry residue of 850.0 mg/l. Also, sample 4 has the highest hardness of 8.9 mg/l. and sample 5 has the lowest hardness of 6.8 mg/l.

In addition to the anionic, cationic composition and their sum in these samples, the concentrations of metals were determined - Mn, Pb, Cu, Zn, Co, Cr, Ni. The results are given in tab. 2.

Table 3 shows the results of atomic absorption analysis of the concentration of metals in selected samples of natural waters.

Table 3: Results of atomic absorption analysis of the concentration of metals in selected samples of natural waters

№	Analysis results, (mg/dm^3						
п	M	Pb	C	Zn	Co	Cr	Ni

роб	n		u				
1	4,90	0,13	0,02	0,04	0,10	0,04	0,02
2	0,58	0,11	0,02	0,06	0,07	0,03	0,06
3	0,54	0,10	0,02	0,02	0,06	0,02	0,06
4	1,30	0,15	0,03	0,03	0,09	0,04	0,08
5	0,53	0,11	1,10	0,02	0,29	0,04	0,74
6	0,83	0,16	0,03	0,04	0,12	0,04	0,07
МРС *	---	0,10	1,00	1,00	1,00	0,10	0,10

MPC * - for cultural and household water. An expert ecologist's guide. Tashkent 2009 State Committee for Nature Protection.

From the above results tab3 it can be seen that, from the analyzed metals - Mn, Pb, Cu, Zn, Co, Cr, Ni, the highest concentration for Mn has 1 sample - 4.90 mg/dm^3, for Cu it has 5 sample - 1.10 mg/dm^3 and for Ni has a 5th test - 0.74 mg/dm^3.

In addition to the above analyzes of natural waters, the distribution of anions, cations, radionuclides and the dynamics of changes during different periods of the year were also studied. On the basis of the data obtained, the dependences of the change in the concentration of the sum of anions, cations and radionuclides in the spring, summer, autumn and terrestrial periods of the year were built over 3 years.

As seen from Fig. 1 changes in the concentration of the sum of anions, cations and radionuclides depends on the period of the year. That is, during the terrestrial periods of the year, the sum of anions, cations and radionuclides in natural waters decreases as much as possible. The reason for this process is likely to be the dilution or increase in the volume of natural waters due to precipitation, rain and snow. And during the summer periods of the year, the sum of anions, cations and radionuclides in natural waters increases as much as possible. The reason for this process is probably the evaporation of a certain volume of natural waters due to temperature and the enrichment of anions, cations and radionuclides occurs.

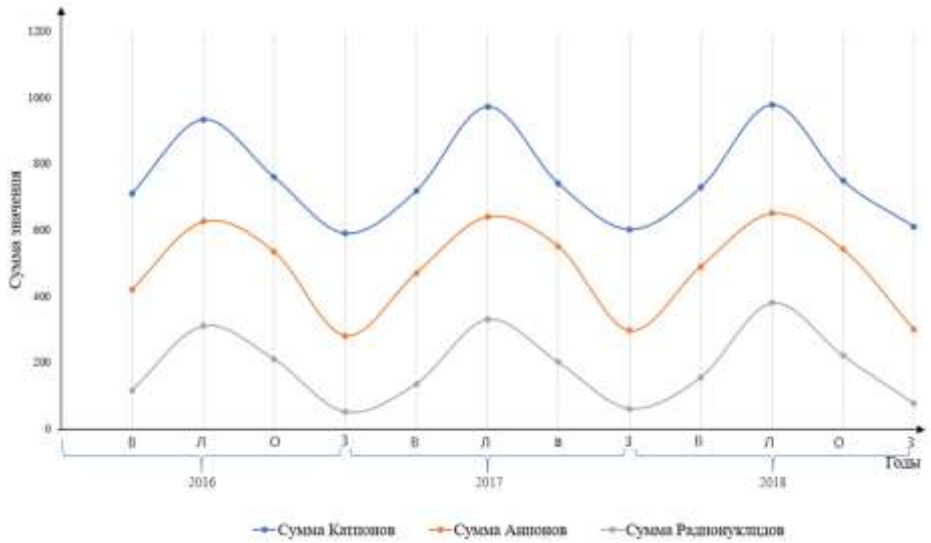

Figure 1. Changes in the concentration of the average sum of anions, cations and radionuclides in the spring, summer, autumn and terrestrial seasons

To assess the values of the influence of a uranium technogenic object on natural waters, the most accessible methods are to determine the specific activity of radionuclides - U^{238}, Th^{230}, Ra^{226}, Rn^{222}, Bi^{214}, Pb^{214}, Po^{210} and a preliminary assessment of the total specific alpha (A_α) - and beta (A_β) -activity, which should not exceed 0.2 and 2.0 Bq/kg, respectively. The total alpha and beta activities of the dry residue obtained from natural water samples were measured on a UMF-2000 radiometer.

The results of determining the specific volumetric activity of radionuclides and the total specific alpha and beta activity of natural waters sampled from various water bodies are given in Table 4.

As can be seen from the above results in Table 4, it can be seen that, from the analyzed water samples, the highest specific activity is in the U^{238} radionuclide in sample 4 - 0.47 Bq/l and in this sample the highest total specific activity of 0.22 Bq/l was found. And the lowest specific activity has radionuclide U^{238} in the 5th sample - 0.18 Bq/l and in this sample the lowest total specific activity of 0.15 Bq/l was found.

This fact shows that the value of the total specific activity has a directly proportional relationship with the ship activity of radionuclides. In addition to this, the value of the total specific activity depends on the mineralization of natural waters, that is, the more mineralized the water, the greater the value of the specific activity.

Table 4: Results of the activity of natural radioisotopes and the total specific alpha and beta activity of waters

	Specific volumetric activity, (Bq/l)				Total specific activity, (Bq/l)	
	U^{238}	Ra^{226}	Th^{230}	Po^{210}	alpha radiation	beta radiation
	0,21	0,016	0,18	0,019	0,17 ± 0,05	0,41 ± 0,13
	0,37	0,019	0,26	0,021	0,20 ± 0,09	0,57± 0,18
	0,41	0,020	0,28	0,022	0,21 ± 0,10	0,56 ± 0,21
	0,47	0,024	0,29	0,023	0,22±0,11	0,59±0,23
	0,18	0,014	0,18	0,014	0,15± 0,05	0,37 ±0,11
	0,20	0,018	0,21	0,022	0,19± 0,06	0,42 ±0,12

The method for determining natural radionuclides is absolutely necessary not only to confirm the correctness of the analysis performed, but also to resolve the issue of the source of the appearance of a particular radioisotope in a particular natural object. Thus, solving the problem of background monitoring is a necessary stage in determining the source of pollution.

3. CONCLUSION

Thus, on the basis of the studies carried out and the results obtained, it can be concluded that the above methods of analysis are acceptable for assessing the determinations of the radionuclide and chemical composition of natural waters.

It has been established that in water samples - the city of Navoi, - the village of Sarimoy, - the Cholishkupir bridge, - Yumirtov, - Domkhodzha and - the Gijduvan bridge differs among themselves in anionic, cationic composition and their amounts. The activity of natural radioisotopes and the total specific alpha and beta activity of the waters of these waters also differ from each other. These facts confirm that the concentrations of radionuclides and chemical elements are not evenly distributed and does not obey any regularity.

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