Radioactivity of drinking waters from regions exposed to depleted uranium ammunition bombing in 2003 end 2004

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Abstract

Due to the military application of the depleted uranium in our country, the problem of its radioactivity and hemotoxicity is actualized. The locations verified to be contaminated by depleted uranium ammunition were at the South part of Serbia (Pljackovica, Bratoselce, Borovac and Reljan). The soluble forms of uranium could translocated and dispersed from soils and sediments into surface waters and groundwater. The environmental presence of depleted uranium is considered as potential threat to human health. The study presents the results of radiological safety analisis of drinking water in 2003 and 2004. All samples were analyzed by gammaspectrometry and measurements of alpha and beta activity.

Key words: depleted uranium, contamination, drinking water

Introduction

The possibility of internal contamination of population, resulting in adverse effects on human health, includes mandatory monitoring of radioactivity concentration. In the immediate vicinity of contaminated ground, there are a number of wells used for drinking water by local population. Within the systemic analysis of radioactive contamination of different environmental samples that have been already performing at the Institute for Occupational Medicine and Radiological Protection for 40 years, planned sampling of drinking water was carried out in 2003 and 2004. Pursuant to recommendations of the World Health Organization and International Commission for Radiological Protection on Drinking Waters Quality, new legal regulations have been passed in our country [2,3,4,5].

Methods

Gammaspectrometry is carried out on pure germanium detector manufactured by EG&G "ORTEC", relative efficiency of 25% and energy resolution of 1.85 keV (1332.5 keV ^{60}Co). Detector is connected with multichannel analyzer (8192 channels) produced by the same manufacturer and with adequate computer facilities. Energetic calibration, as well as calibration of detector efficiency is performed by means of Amersham radioactive standard .. The time of measurement for a single sample is 200000 s, while it is 250000 s for basic radiation [7]. The volume of 2 l is necessary for analysis of gross alpha and beta activity of water. The sample is evaporated to dryness, heated at 500^{o}C and then it is measured [6]. The measurement of gross alpha and beta activity is carried out by α-β-proportional gas counter "COUNTMASTER-ORTEC". The level of basic radiation is from 1-1.5 imp/min.

Results and Discussion

A total of 33 drinking water samples were examined in 2003 and 2004. The results of measurement of total alpha and beta activity of drinking water from the bombed regions were illustrated in Table I. Specific total alpha and beta activity was within legal limits (proposed levels of alpha activity – 0.1 Bq/1,and beta activity – 1 Bq/1).

Table I. Gross alpha and beta activity of drinking water

Sampling date	Number of samples	Gross alpha activity	Gross beta activity
		max (Bq/l)	max (Bq/l)
May 2003	4	0.024 ± 0.004	0.352 ± 0.053
September 2003	6	0.012 ± 0.002	0.575 ± 0.086
October 2003	3	< 10	0.206 ± 0.031
February 2004	4	< 10	0.216 ± 0.032
May 2004	3	< 10	0.370 ± 0.056
July 2004	4	0.054 ± 0.008	0.285 ± 0.044
September 2004	5	< 10	0.236 ± 0.035
December 2004	5	0.061 ± 0.009	0.180 ± 0.027

The results of gammaspectrometry of all samples were presented in Table II and Table III. The locations of sampling were demarcated, covering the ground in the close vicinity of hits of missiles. The analysis of results verified that the activity of specific radionuclides was not beyond permissible legal limits. ^{238}U and ^{235}U activities were below detection limit, and the obtained values were within the range of proposed values for drinking water in Serbia.

Table II. Specific activity of different radionuclides in drinking water in 2003

Sampling site	Water type	^{232}Th (Bq/l)	^{238}U (Bq/l)	^{235}U (Bq/l)	^{226}Ra (Bq/l)	^{137}Cs (Bq/l)
Balinovac	Local water supply system	< 0.01	< 0.06	< 0.005	< 0.08	< 0.005
Bratoselce	Well water	< 0.01	< 0.06	< 0.004	< 0.06	< 0.004
Borovac	Local water supply system	< 0.01	< 0.06	< 0.004	<0.06	< 0.003
Vranje	Local water supply system	< 0.01	< 0.07	< 0.006	< 0.09	< 0.004
Pljackovica	Local water supply system	< 0.02	< 0.08	< 0.004	< 0.08	< 0.004
Bratoselce	Well water	<	< 0.06	< 0.004	< 0.06	<

		0.01				*0.002*
Bratoselce	*Spring water*	*< 0.03*	*< 0.12*	*< 0.009*	*< 0.06*	*< 0.007*
Bujanovac	*Local water supply system*	*< 0.01*	*< 0.07*	*< 0.005*	*< 0.08*	*< 0.006*
Leskovac, Vranje	*Local water supply system*	*< 0.01*	*< 0.06*	*< 0.005*	*< 0.08*	*< 0.003*
Bratoselce	*Spring water*	*< 0.04*	*< 0.14*	*< 0.010*	*< 0.08*	*< 0.008*
Bratoselce	*Well water*	*< 0.01*	*< 0.02*	*< 0.002*	*< 0.03*	*< 0.003*
Bratoselce	*Well water*	*< 0.01*	*< 0.03*	*< 0.003*	*< 0.04*	*< 0.001*
Surdulica	*Local water supply system*	*< 0.01*	*< 0.06*	*< 0.005*	*< 0.07*	*< 0.004*

Table III. Specific activity of different radionuclides in drinking water in 2004

Sampling site	*Water type*	*^{232}Th (Bq/l)*	*^{238}U (Bq/l)*	*^{235}U (Bq/l)*	*^{226}Ra (Bq/l)*	*^{137}Cs (Bq/l)*
Bratoselce	*Spring water*	*< 0.01*	*< 0.06*	*< 0.005*	*< 0.08*	*< 0.006*
Bratoselce	*Well water*	*< 0.01*	*< 0.06*	*< 0.003*	*< 0.05*	*< 0.003*
Bujanovac	*Local water supply system*	*< 0.02*	*< 0.01*	*< 0.008*	*< 0.10*	*< 0.007*
Vranje	*Local water supply system*	*< 0.01*	*< 0.14*	*< 0.006*	*< 0.10*	*< 0.006*
Bratoselce	*Well water*	*< 0.01*	*< 0.03*	*< 0.003*	*< 0.04*	*< 0.002*
Bujanovac	*Local water supply system*	*< 0.02*	*< 0.10*	*< 0.007*	*< 0.09*	*< 0.008*
□□□□□	*Local water supply system*	*< 0.06*	*< 0.13*	*< 0.009*	*< 0.09*	*< 0.007*
Bratoselce	*Well water*	*< 0.01*	*< 0.06*	*< 0.004*	*< 0.07*	*< 0.004*
Pljackovica	*Local water supply system*	*< 0.02*	*< 0.05*	*< 0.004*	*< 0.07*	*< 0.004*
Pljackovica	Well water	*< 0.01*	*< 0.07*	*< 0.007*	*< 0.04*	*< 0.004*
Pljackovica	*Local water supply system hotel Przar*	*< 0.03*	*< 0.06*	*< 0.004*	*< 0.07*	*< 0.005*

Bratoselce	*Well water*	*< 0.01*	*< 0.04*	*< 0.002*	*< 0.06*	*< 0.003*
Bujanovac	*Local water supply system*	*< 0.01*	*< 0.05*	*< 0.002*	*< 0.05*	*< 0.004*
Vranje	*Local water supply system*	*< 0.02*	*< 0.14*	*< 0.005*	*< 0.08*	*< 0.006*
Pljackovica	*Local water supply system*	*< 0.01*	*< 0.04*	*< 0.008*	*< 0.05*	*< 0.003*
Pljackovica	*Well water*	*< 0.01*	*< 0.03*	*< 0.008*	*< 0.04*	*< 0.005*
Vranje	*Well water*	*< 0.01*	*< 0.04*	*< 0.003*	*< 0.04*	*< 0.002*
Pljackovica	*Local water supply system*	*< 0.01*	*< 0.04*	*< 0.003*	*< 0.05*	*< 0.003*
Vranje	*Local water supply system*	*< 0.01*	*< 0.06*	*< 0.004*	*< 0.08*	*< 0.005*
Bratoselce	*Well water*	*< 0.01*	*< 0.04*	*< 0.002*	*< 0.04*	*< 0.002*
Bujanovac	*Local water supply system*	*< 0.01*	*< 0.06*	*< 0.004*	*< 0.07*	*< 0.004*

Conclusion

All the studied drinking water samples from the regions bombed by depleted uranium ammunition were safe for human consumption from the radiological point of view. Based on the results obtained so far it may be concluded that depleted uranium has not come yet into drinking water wells. We recommend further monitoring of radioactivity of drinking water from this region.

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