

RADIOACTIVITY OF THE SOIL IN REPUBLIC OF SRPSKA

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ABSTRACT

In 2005-2006, surface soil samples (0-15 cm) were collected from different regions of Republic of Srpska (Banjaluka, Kupres, Glamoc, Ozren, Grahovo, Manjaca, Šamac, Novo Selo, Turšinovac, Škaric), in order to evaluate their radioactivity. During the War lasted from 1992 to 1996, it is known that these locations were imposed by NATO forces. Due to this reason the samples were taken from these locations in order the presence of depleted uranium to be checked in soil. Concentrations of radionuclides in soil samples were determined by gamma spectrometry (HPGe detector, relative efficiency 23%). Results showed the presence of natural radionuclides ^{226}Ra , ^{232}Th , ^{40}K , ^{235}U , ^{238}U as well as the produced radionuclide ^{137}Cs (from the Chernobyl accident).

Keywords: radioactivity, soil, gamma spectrometry

Introduction

Based on the fact that the soil is the first term in line: soil – plants – food – man, it is very important that to know activity of the soil.

It is well known that the main contributors to background radiation in the soil are the gamma ray from radioactive elements of the uranium and thorium series and from radioactive potassium.[1]

As a result of the accident in the Chernobyl nuclear power station, long-lived isotope ^{137}Cs ($T_{1/2}$ 30 years) is still eminent in the environment, predominantly in the surface soil.

The detection of eventual depleted uranium contamination by gamma spectrometry is mainly based on the determination of the $^{235}\text{U}/^{238}\text{U}$ ratio. The natural $^{235}\text{U}/^{238}\text{U}$ activity ratio is 0.046.[2] Only, if this ratio is higher than the given value it can be said that there is a presence of depleted uranium.

The main aim of this study was to evaluate the radioactivity of the soil samples collected from different locations in Republic of Srpska and to evaluate eventual the presence of depleted uranium.

Materials and Methods

Soil samples were collected during 2005-2006 from 11 locations in Republic of Srpska (Banjaluka, Kupreš, Glamoč, Ozren, Grahovo, Manjača, Novo Selo 1, Novo Selo 2, Turšinovac, Škarić, Šamac). The samples from Banjaluka were collected at 10 locations.

All soil samples taken from 0-15 cm depth were dried up to 105 °C, sieved, placed in the plastic 500 cm³ Marinelli beakers and left for four weeks to reach radioactive equilibrium.[3] The samples were counted using a high purity germanium detector (HPGe) with relative efficiency of 23 % and energy resolution of 1.8 keV for the 1332 keV ⁶⁰Co peak. Geometric efficiency for soil matrices in the Marinelli beaker was determined by a reference soil standard (National Office of Measures OMH, Budapest) spiked with a series of radionuclides (²²Na, ⁵⁷Co, ⁶⁹Co, ⁸⁹Y, ¹³³Ba, ¹³⁷Cs) with total activity of 1.5 kBq/kg on the day 01.07.1991. The spectra were analyzed using the GENIE program.

The activity of ²²⁶Ra and ²³²Th was determined by their decay products: ²¹⁴Bi, ²¹⁴Pb and ²²⁸Ac respectively. ²³⁵U was determined on 185.7 keV corrected for ²²⁶Ra (186 keV). ²³⁸U was determined by ²³⁴Th (63 keV) or estimated by its isotopic ratio with ²³⁵U. The activity of ¹³⁷Cs was determined from its 661 keV line. The activities of ⁴⁰K were measured from its 1460 keV γ -line.

Counting time interval was 80000 s. The background spectrum was recorded immediately after or before the sample counting.

Results and discussion

Natural and artificial radionuclides in soil samples were detected by gamma spectrometry. Results of measurements are given in the Fig. 1 and Table 1.

The results of the analysis off all the spectra obtained show that the concentrations of ²²⁶Ra, ²³²Th, ⁴⁰K, ¹³⁷Cs, ²³⁸U and ²³⁵U vary from 5.1 to 128 Bq kg⁻¹, 6.8 to 72 Bq kg⁻¹, 60 to 701 Bqkg⁻¹, 2.1 to 68 Bqkg⁻¹, 6.5 to 228 Bq kg⁻¹ and 0.40 to 9 Bq kg⁻¹, respectively.

Lower concentrations of radionuclides were found in soil sample from location Ozren, because this soil mainly composed of Si.[4] The highest detected value of ²²⁶Ra was 128 Bq kg⁻¹ in sample from location Grahovo. The highest values of ²³²Th, ¹³⁷Cs and ²³⁵U were detected in soil samples from location Kupreš. ⁴⁰K and ²³⁸U have the highest value in sample from location Glamoč and Novo Selo 2, respectively.

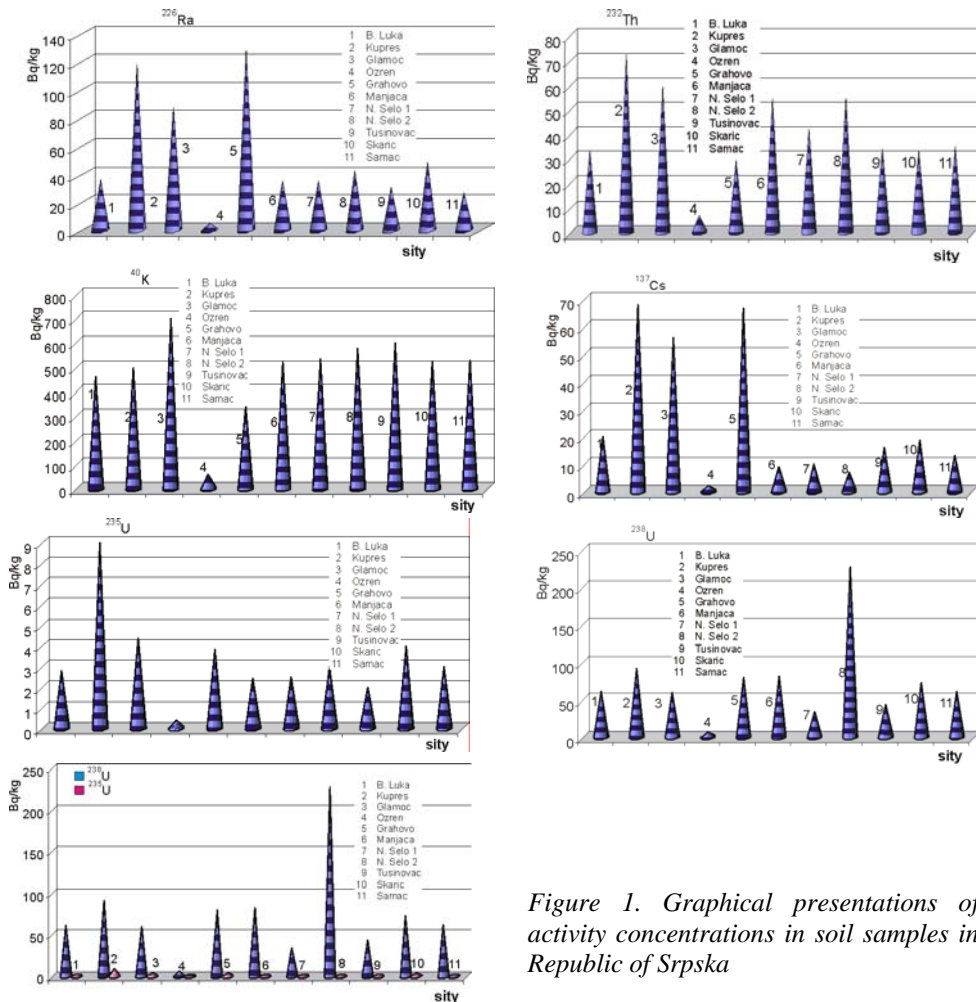


Figure 1. Graphical presentations of activity concentrations in soil samples in Republic of Srpska

The activity concentrations of ^{226}Ra and of the natural radioactive series of ^{232}Th are similar with the concentrations obtained in other studies.[5]

The relatively high concentrations of ^{40}K which were obtained in this work are also similar with the concentrations obtained in other studies.[5-10]

The radionuclide ^{137}Cs was identified in all soil samples, but obtained values are not high. This radionuclide originates from nuclear weapons test fall-out and after 1986, mostly from the accident of the nuclear power plant "Lenin" in Chernobyl.

The $^{235}\text{U}/^{238}\text{U}$ ratio in all analyzed samples was found to be in the range from 0.013 to 0.097. Since, the natural $^{235}\text{U}/^{238}\text{U}$ activity ratio is 0.046, it can be concluded that only natural uranium was detected in the measured samples.

Table 1. Activity concentrations of radionuclides in soil samples in Republic of Srpska

Locations	Activity concentrations of radionuclides (Bq kg ⁻¹)						
	²²⁶ Ra	²³² Th	⁴⁰ K	¹³⁷ Cs	²³⁸ U	²³⁵ U	²³⁵ U/ ²³⁸ U
Banjaluka	36 ± 6	33 ± 4	459 ± 39	20 ± 2	61 ± 20	2.8 ± 0.4	0.046
Kupreš	117 ± 11	72 ± 7	496 ± 50	68 ± 6	92 ± 18	9 ± 1	0.097
Glamoč	87 ± 8	59 ± 5	701 ± 63	56 ± 6	60 ± 16	4.4 ± 0.4	0.073
Ozren	5.1 ± 0.5	6.8 ± 0.8	60 ± 6	2.1 ± 0.2	6.5 ± 4.2	0.40 ± 0.07	0.062
Grahovo	128 ± 12	29 ± 3	340 ± 30	67 ± 6	80 ± 23	3.8 ± 0.4	0.048
Manjača	35 ± 4	54 ± 6	520 ± 50	9 ± 1	82 ± 23	2.4 ± 0.3	0.029
Novo Selo1	35 ± 4	42 ± 5	532 ± 53	10 ± 1	34 ± 16	2.5 ± 0.8	0.074
Novo Selo2	42 ± 5	54 ± 6	574 ± 58	7 ± 1	228 ± 53	3 ± 1	0.013
Turšinovac	30 ± 4	34 ± 4	598 ± 60	16 ± 2	44 ± 14	2.0 ± 0.9	0.045
Škarić	48 ± 5	33 ± 4	524 ± 58	19 ± 2	73 ± 18	4 ± 1	0.055
Šamac	27 ± 3	35 ± 4	529 ± 56	13 ± 1	62 ± 20	3 ± 1	0.048

Conclusions

The average concentrations of the radionuclides in soil samples collected in Republic of Srpska are at the normal environmental levels and they are similar with the concentrations obtained in the surroundings countries.

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