J. Serb. Chem. Soc. 69 (12) 1153–1155 (2004)
JSCS-3241
UDC 549.781.004.55+504.3:543.4
Note

NOTE

Depleted uranium in the air during the cleanup operations at Cape Arza

MIRJANA RADENKOVIĆ,[1,*] TOMISLAV ANDJELIĆ,[2] MILOJKO KOVAČEVIĆ,[1] and PERKO VUKOTIĆ[3]

[1]Vinča Institute of Nuclear Sciences , P. O. Box 522, 11001 Belgrade, [2]Center for Eco-toxicological Research of Montenegro, Put R. Ivanovića 2, 81001 Podgorica and [3]Faculty of Mathematics and Science, University of Podgorica, P. O. Box 211, 81001 Podgorica, Serbia and Montenegro (e-mail: mirar@vin.bg.ac.yu)

(Received 22 April 2004)

Abstract. Cape Arza was contaminated with depleted uranium (DU) in the air strikes of NATO aeroplanes on May 30, 1999. The cleanup and decontamination of the site started in 2001. Here the results of air monitoring performed during the cleanup operations in Spring 2002. are presented. The collected air samples were analyzed by high-resolution alpha spectrometry. The obtained concentrations of airborne uranium are about ten times higher than the average value usually reported for air. The ratio of the $^{234}U/^{238}U$ activities indicates the presence of depleted uranium in the air during the cleanup action, due to resuspension and soil disturbance in the contaminated teritory.

Keywords: air, depleted uranium, alpha-spectrometry.

During the war conflict, in two NATO air attaks on May 30, 1999, A-10 Thunderbolt aeroplanes fired about 300 projectiles with depleted uranium penetrators (300 g of DU in each) into an area of about 16 000 m^2 of Cape Arza (Montenegro).[1] The cleanup operations of the contaminated territory started in January 2001 and lasted about 220 days in two phases. During these operations, 242 intact penetrators made of depleted uranium were found and removed with about 200 kg of surrounding soil with the activity level of 10^4 – 3.5 10^6 Bq/kg[2]. In this Note, the results of air monitoring in the period of 10 – 23 May, 2002 are presented.

The air pumps were on during the work time only, about 3 hours a day with an average flow of 80 – 90 m^3. The air was absorbed on 12 filter papers prepared as one sample for analysis. Prior fo the complex radiochemical separation procedure, the filters were ashed at 550 °C, dissolved in mineral acids (HNO_3 and HCl) and spiked with 0.1 Bq of ^{232}U tracer solution. Uranium was precipitated as hydroxyde, separated and purified from other alpha emitting radionuclides by anion ex-

* Author for correspondence.

change using DOWEX 1x8 (100 mesh) resin.[3,4] A homogeneous thin layer radioactive source with alpha emitting uranium isotopes was obtained by electroplating, according to the procedure of Talvites.[5] The chemical yield for the overall procedure was 81 %.

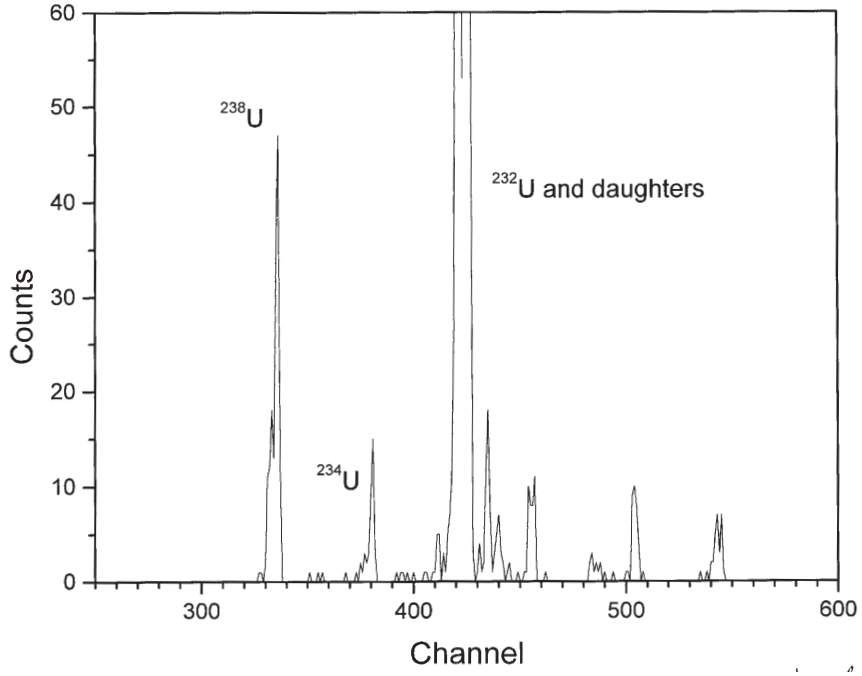

Fig. 1. Alpha spectrum of the uranium isotopes in the air sample.

High-resolution alpha spectrometry mesurements were performed using a Canberra 2004 vacuum chamber with a PIPS detector (surface 100 mm^2, efficiency 7 %, resolution 20 keV for ^{241}Am). The obtained uranium alpha spectrum is presented in Fig. 1. In the spectrum, alpha energy lines pertaining to the isotopes ^{238}U (4.15 MeV; 4.20 MeV) and ^{234}U (4.72 MeV; 4.77 MeV), with an indication of ^{235}U at 4.72 MeV can be seen. At an energy of 5.32 MeV and higher, the alpha lines of ^{232}U tracer and its daughters are located. Although traces of ^{236}U were present in the depleted uranium ammunition,[1] this isotope was not detectable in the air.

The results of alpha spectrometry isotopic analysis[3,4] are given in Table I.

TABLE I. Content of uranium isotopes in the air during the cleanup operations at Cape Arza, obtained by high-resolution alpha spectrometry

Isotope	Specific activity/(μB1/m^3)	LLD*/μBq	Concentration/(mg/m^3)	$^{234}U/^{238}U$ activities ratio
^{238}U	10.0+/–1.0	0.2	0.81+/–0.08	
^{235}U	0.2	0.2	<0.002	0.23
^{234}U	2.3+/–9	0.6	$(10+/–4)10^{-6}$	

*the lowest detection level

The obtained ^{238}U concentration is about 10 times higher than 1 μBq/m^3 +/–10 % usually reported as the average airborne uranium concentration.[1] The $^{234}U/^{238}U$ activity ratio in natural uranium is about 1 and here it is 0.23, indicating the presence of depleted uranium in the air. This was to be expected as the consequence of resuspension due to soil disturbance during the removal of penetrators and soil from the contaminated territory. Local meteorological conditions play a certain role which will not be discussed here.

The evidence of the presence of depleted uranium even at very low concentrations during the cleanup operation have to be taken serously into consideration during protection planning since inhalation is regarded as one of the most dangerous pathway of uranium intake.[6]

ИЗВОД

ОСИРОМАШЕНИ УРАНИЈУМ У ВАЗДУХУ ТОКОМ ДЕКОНТАМИНАЦИЈЕ ТЕРЕНА НА РТУ АРЗА

МИРЈАНА РАДЕНКОВИЋ[1], ТОМИСЛАВ АНЂЕЛИЋ,[1] МИЛОЈКО КОВАЧЕВИЋ и ПЕРКО ВУКОТИЋ[2]

Институт за нуклеарне науке "Винча", п. пр. 522, 11001 Београд, [1]Центар за екотоксиколошка испитивања, Пут Р. Ивановића, 81000 Подгорица и [2]Факултет за математику и науку, п. пр. 211, 81001 Подгорица

Рт Арза је контаминиран осиромашеним уранијумом у току ваздушних напада НАТО авиона, 30. маја 1999. године. Операције чишћења и деконтаминације терена започете су 2001. године. Овде су приказани резултати мониторинга ваздуха током акције чишћења у пролеће 2002. Прикупљени узорци ваздуха анализирани су високорезолутивном алфаспектрометријом. Добијена вредност за концентрацију уранијума је око десет пута већа од просека који се реферише за ваздух. Однос активности $^{234}U/^{238}U$ указује на присуство осиромашеног уранијума у ваздуху, што је последица процеса ресуспензије са контаминираног земљишта током акције чишћења терена.

(Примљено 22. априла 2004)

REFERENCES

1. *Depleted Uranium in Serbia and Montenegro, Post-conflict Environmental Assessment,* UNEP, Geneva, 2002, p. 70, 153, 134.
2. P. Vukotić, T. Andjelić, R. Zekić, M. Kovačević, V. Vasić, N. Ristić, *Nucl. Techn. Rad. Prot.* **18** (2003)1
3. *Annual Book of ASTM Standards*, C1000-90, 12.01(1999)
4. M. Radenković, D. Vuković, V. Šipka, D. Todorović, *J. Radioanal. Nucl. Chem.* **208** (1996) 467
5. N. A. Talvite, *Anal. Chem.* **44** (1972) 280
6. *Depleted Uranium, Sources, Exposure and Health Effects*, World Health Organization, Geneva, 2001.