SOIL GAS MAPPING IN THE VICINITY OF NIKOLA TESLA THERMO POWER PLANT DISPOSAL FIELD

by

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This paper presents the results of identification of natural ionizing irradiation in the vicinity of Nikola Tesla B power plant ash disposal field. The investigations have comprised the determination of natural gas (radon and thoron) activities with a passive discriminative nuclear track detector (CR 39) in the air column of the depth of 80 cm in the soil. The determination of gamma dose rate has been given as well, including the corresponding GPS coordinates of 28 measuring points.

Key words: radon, thoron, gamma dose rate, passive radon-thoron discriminative detector, coal power plant

INTRODUCTION

Nikola Tesla Power Plant B (TENT B) is one of six power plants in Serbia using low energy coal, lignite. The plant was built in the vicinity of Obrenovac, 37 km southwest of Belgrade (fig. 1). The geological profile of the TENT B surroundings shows the presence of a main sandy gravel aquifer between two formations of shallow alluvial clay-like sediments and Miocenic marly clay. A targeted investigation of the concentrations of the natural radionuclides of uranium, thorium, and potassium was performed in 1996 in order to determine the potential contamination of the soil and underground waters originating from the power plant industrial waste: ash and dross, however, no significant quantities of these radionuclides were found [1]. The concentrations of natural radionuclides were measured again in 2004 in a short-term investigation by an active method (Alpha Guard), when low concentrations of radon and thoron were found, indicating that the TENT B zone was a low natural radiation area [2]. In a preliminary investigation, performed in the period of 2005-2007, the low concentration of natural radionuclides in the vicinity of TENT B was confirmed [3].

The natural radioactivity measurements given in this paper (normal occurring radioactive material – NORM) comprise technologically advanced and more detailed investigations of certain natural ionizing irradiation components, predominantly those of radon and thoron, which comprise more than 51% of natural radioactivity [4]. Gamma dose rates were measured on the same locations with scintillation counter at the height of 80 cm above the ground.

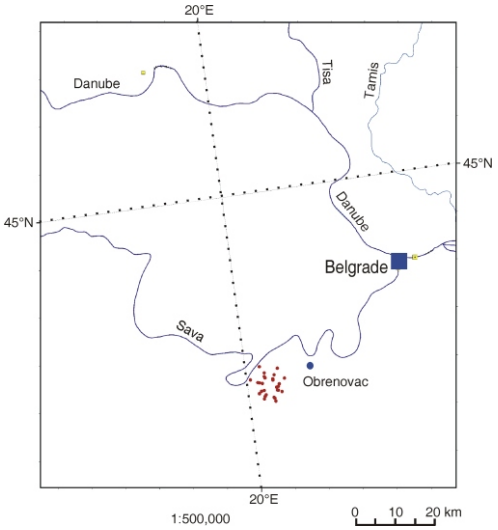

Figure 1. Ash disposal field of TENT B

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The experimental procedure based on the use of passive radon/thoron discriminative detectors (with the commercial name of RADUET [5]) aiming of determining the concentration of these radioactive gases in soil has been used in the investigation of an ash disposal field in Serbia and in the world for the first time. The field work results are systematized as the data on the measuring point coordinates, their height above the sea level, measured radon and thoron activities, and gamma dose rate.

MATERIALS AND METHODS

Soil radon and thoron concentrations were determined with the passive radon/thoron discriminative detectors. The detectors used for measurements of the concentration of both gases, radon and thoron, have been developed and calibrated in the National Institute of Radiological Sciences (NIRS), Chiba, Japan [5].

The detectors were deployed at 28 measuring points in the vicinity of the TENT B ash disposal field, and immersed into air columns of the depth of 80 cm in the ground. The measuring points, shown in fig. 2, were located radially in the TENT B vicinity, and the geographical position and the height above the sea level were determined for each of the points.

The detectors were installed in the survey area as shown in fig. 3(a). First, holes of depth 80 cm were drilled in the soil with a specially designed iron drill. The depth of the holes was affected by the soil hardness and sometimes its higher humidity, though these factors did not present an obstacle in the experiment. Each detector was tied with an elastic string to the stick placed over the hole, so that it could hang down and reach the bottom. The hole opening of about 10-15 cm in diameter was covered with a polyethylene bag, and then a loop of mud was made into which a piece of knauf of 20 20 cm was inserted and the soil previously dug placed over it. Thus, an air column of 70-80 cm was formed and tightly sealed.

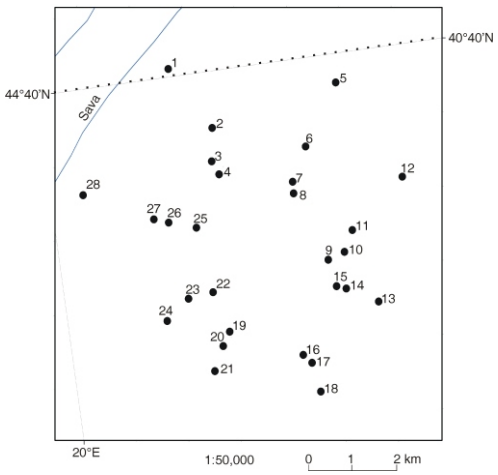

Figure 2. Sample locations – the measurement points

The influence of humidity on radon and thoron concentration measurements has been investigated in NIRS on the basis of the experimental procedure conducted in this paper and it has been shown that humidity does not have any significant influence on the measurements [6]. The detectors in the air columns were exposed to radon and thoron for seven days, after which they were pulled out, fig. 3(a) and sent to be etched in their originating NIRS laboratory. In order for alpha particle tracks to be obtained, the etching process was performed by a standard chemical method lasting six hours in 6.25 M NaOH solution at 90 °C [7].

Additionally, at the same locations, five gamma dose rate measurings were performed. A scintillation counter was used, and the counting time was 100 seconds for each measuring.

Figure 3. Installation (a) and collection (b) of the passive radon-thoron discriminative detectors

RESULTS AND DISCUSSIONS

The measuring results obtained from 28 locations are given in tab. 1.

Based on the data processing and result analysis, the arithmetic means of radon activity of 6600 Bq/m^3, thoron activity of 1600 Bq/m^3, and gamma dose rate of 114 nGy/h were calculated. Regarding the geological profile of the TENT B surroundings (alluvial sediment), these values identify the investigated TENT B ash disposal field surroundings as a low natural radiation area. The results are in accordance with the previous investigations performed in the period of 1996-2007, when the low concentrations of natural radionuclides of uranium, radium, thorium, and potassium were measured in the soil and underground waters. This conclusion is con-

Table 1. Radon and thoron activities, and the gamma dose rate

No. of sample position	North latitude	East longitude	Elevation [m]	Radon (^{222}Rn) [Bqm^{-3}]	Thoron (^{220}Rn) [Bqm^{-3}]	Gamma dose rate [nGyh^{-1}]
1	44°40'05.35"	20°02'18.33"	82.4	18051 450	n. d.*	131
2	44°39'17.93"	20°02'57.39"	88.6	7038 283	3	120
3	44°38'53.49"	20°02'52.80"	84.2	23835	n. d.	117
4	44°38'43.69"	20°02'58.91"	81.8	5922 259	n. d.	123
5	44°39'37.92"	20°05'11.02"	84.2	24917 530	n. d.	109
6	44°38'55.40"	20°04'30.47"	82.0	1714 141	649	121
7	44°38'30.07"	20°04'13.03"	83.1	3088 188	n. d.	109
8	44°38'21.03"	20°04'12.45"	79.3	2253 161	179	119
9	44°37'28.71"	20°04'39.33"	92.3	4638 230	n. d.	131
10	44°37'33.04"	20°04'57.51"	85.3	83398	n. d.	127
11	44°37'48.88"	20°05'09.42"	82.0	5960 260	n. d.	118
12	44°38'22.85"	20°06'07.35"	111.5	9143 321	n. d.	105
13	44°36'53.43"	20°05'25.58"	79.0	2574 173	1655	102
14	44°37'06.56"	20°04'53.61"	61.0	839 102	1677	118
15	44°37'08.20"	20°04'44.56"	73.0	1477 132	1884	122
16	44°36'21.41"	20°04'00.52"	84.0	1503 132	n. d.	101
17	44°36'15.31"	20°04'08.56"	79.0	5078 240	n. d.	109
18	44°35'53.48"	20°04'13.76"	79.0	10208 340	1599	113
19	44°36'46.96"	20°02'47.56"	80.0	2836 180	132	105
20	44°36'37.04"	20°02'36.56"	83.4	3447 199	53	119
21	44°36'19.42"	20°02'26.19"	82.9	8788 315	n. d.	93.9
22	44°37'18.03"	20°02'35.12"	89.0	10768 161	n. d.	107
23	44°37'14.76"	20°02'08.35"	77.9	2235 185	472	112
24	44°37'00.71"	20°01'43.90"	84.0	5134 242	43	106
25	44°38'07.61"	20°02'26.45"	80.7	8186 304	7	104
26	44°38'14.24"	20°01'58.65"	86.4	2858 181	203	106
27	44°38'17.87"	20°01'42.93"	84.3	856 103	1944	117
28	44°38'43.63"	20°00'34.72"	88.8	2475 169	509	109

*n. d. – non-detectable

firmed by the measured maximum radon activities of 24917 Bq/m^3 and thoron activities of 1944 Bq/m^3, as well as the maximum gamma dose rate of 131 nGy/h.

Soil gas mapping in the vicinity of a coal power plant disposal field conducted with CR 39 passive radon/thoron discriminative nuclear track detectors with the parallel gamma dose rate measuring completes the picture of high and low radiation areas in Serbia, already marked by the several years of investigation [8, 9].

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МАПИРАЊЕ ЗЕМНОГ ГАСА У ОКОЛИНИ ОДЛАГАЛИШТА ПЕПЕЛА ТЕРМОЕЛЕКТРАНЕ „НИКОЛА ТЕСЛА“

У раду су приказани резултати идентификације јонизујућих зрачења из природе у околини одлагалишта пепела термоелектране „Никола Тесла“ Б. Истраживања су обухватила одређивање активности природних радиоактивних гасова радона и торона пасивним дискриминативним нуклеарним траг детекторима (CR 39) у ваздушном стубу на дубини од 80 cm у земљишту. Такође, одређена је јачина дозе гама зрачења укључујући одговарајуће GPS координате 28 мерних тачака.

Кључне речи: радон, торон, јачина гама дозе, пасивни радонско-торонски дискриминативни детектор, термоелектрана