Distribution of ^{226}Ra in the surface soil in the vicinity of the thermal power plant Plomin (Croatia)

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Purpose of this study was to determine the long term influence of the thermal power plant (TPP) Plomin in Istria peninsula (Croatia) on the possible contamination of the surrounding soil by the radionuclides from the emitted coal ash. Coal naturally contains radionuclides of the ^{238}U and ^{232}Th decay series, as well as ^{40}K, which concentrate in ash due to coal combustion, several times more in comparison with their content in coal or surface soil (Dai *et al*., 2007). This preliminary study will focus only on the ^{226}Ra which is, along with its decay products, responsible for the largest part of the dose received by humans from the naturally occurring radionuclides. ^{226}Ra is an alpha emitter with a half-life of 1622 years. It has similar chemical characteristics to calcium which can lead to calcium replacement in bones if it enters in an organism and is therefore harmful for people. Furthermore, ^{226}Ra decays to ^{222}Rn, with a half-life of 3.8 days, which is a noble gas and can easily be inhaled into the human organism, known for causing lung cancer (Eisenbud & Gesell, 1997).

The main assumption of this research was that radionuclides could be dispersed into the environment from the plant stack and from the ash piles next to the TPP due to the rainfall and the wind flow. Considering that ^{226}Ra is a terrestrial radionuclide, present in all rocks and soils in variable amounts, the main purpose was to evaluate if the natural radioactivity of the area was elevated due to influence of the flying ash and/or bottom ash produced by the coal combustion. The results were compared with the control sample and with the average soil value.

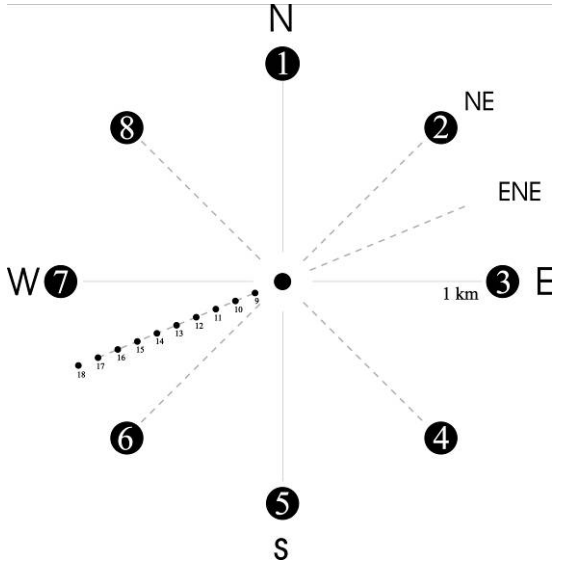

Fig. 1.: Sampling grid around the Plomin thermal power plant

Soil samples were collected around the TPP at 18 sampling stations from the surface soil layer, 0 – 10 cm depth. (Fig. 1.). Eight samples were radially collected at 1 km distance from the plant, and 10 soil samples were collected within 1 km distance every 100 m along the profile located in the prevailing wind direction (NE, ENE). Also, one control sample (K1) was collected, about 10 km away from the plant. All soil samples were of the same rock type, which is limestone (Šikić & Polšak, 1973). ^{226}Ra massic activity in soil samples was measured using gamma-ray spectrometry system with the HPGe detector and 609.3 keV line of its progeny ^{214}Bi was used to determine ^{226}Ra massic activity.

Sample identification	*a* (^{226}Ra) (Bq/kg)	Sample identification	*a* (^{226}Ra) (Bq/kg)
1	67.5	11	190
2	30.6	12	130
3	53.4	13	121
4	106	14	167
5	72.1	15	157
6	581	16	172
7	90.2	17	120
8	96.9	18	64.5
9	202	K1	105
10	127		

Table 1. ^{226}Ra massic activities in the soil samples

^{226}Ra massic activities in the soil samples (Table 1.) ranged between 30.6 Bq/kg and 581 Bq/kg with the mean value 142 Bq/kg. In all samples, except in sample 2, including the control sample, ^{226}Ra massic activities were increased compared to the world average of 40 Bq/kg (UNSCEAR, 1993), probably due to generally higher ^{226}Ra massic activities in carbonates (Cowart & Burnett, 1994). Samples at 1 km distance from the plant showed mainly lower ^{226}Ra massic activities than the control sample which points to the soil heterogeneity and the need to collect more control samples to obtain more representative control value. Samples within 1 km distance from the plant showed higher massic activities. ^{226}Ra massic activities in the samples within 1 km distance from the plant were higher than massic activities in the samples at 1 km distance and were generally decreasing with increased distance from the plant. Samples located NE from the plant (samples 1, 2, 3) showed lower activities than samples located on the SW (samples 5, 6, 7), with sample 6 showing four times higher ^{226}Ra massic activity than the average of all samples. The latter could be explained by the influence of the prevailing winds.

Increase of ^{226}Ra massic activities in the surface soil around the TPP could be related with the coal combustion. Moreover, the prevailing winds significantly affect the ^{226}Ra distribution in the soil. It should be noted that these are only preliminary results and further analyses will be taken to make more conclusions.

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