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SOIL AND RADIONUCLIDES OF EASTERN HERZEGOVINA

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ABSTRACT

Soil is one of the most important natural resources. Measurement of natural radioactivity in soil is very important to determine the amount of change of the natural background activity with time as a result of any radioactivity release.

Coal mine and thermal power plant in Gacko field is a very important industrial facility. The content of radionuclides of the soil was examined at Gacko area, slag, ash and mullock dumps in the thermal power plant Gacko and soils of dumps in the process of re-cultivation. The gamma – spectrometric measurements were done in the Institute of Nuclear Sciences “Vinča” in Belgrade. Soil samples were collected in 2010/2014 at more locations in eastern part of Republic of Srpska. After removing the stones and vegetation, all soil samples for Gama spectrometric measurements dried up to 105⁰C, sieved, placed in the plastic 500 mL Marinelli beakers and left for four weeks to reach radioactive equilibrium.

Given that there are no specific regulations in the Republic of Srpska, the concentration of natural and produced radionuclides in samples from the working and living environment of thermal power plants, comparison with literature data from the region and the world is one way of evaluating the impact of the plant's operation on the soils.

The results point to the necessity of regular monitoring of radioactivity in eastern Herzegovina in order to assess the impact of the technologically increased natural radioactivity.

Key words: *Gacko field, radionuclides, ²¹⁰Pb*

INTRODUCTION

Soil is one of the most important natural resources. Soil represents a potential source of contamination of biota, which makes tracking of distribution of artificial radioactivity extremely important [1]. Monitoring of any release of radioactivity material to the environment is necessary for environmental protection. Measurement of natural radioactivity in soil is very important to determine the amount of change of the natural background activity with time as a result of any radioactivity release [2].

Republic of Srpska has about 0.85 ha of agricultural soil per capita, of which about 0.60 ha is arable (ploughland, gardens, orchards, vineyards, meadows) i.e. about 0.40 ha of ploughland and gardens.

Currently, only about 0.20 ha per capita is cultivated. The above data show that the degree of utilization of the natural resources in Republic of Srpska is low with a trend of reduction. Throughout the world, the surface of 0.10 ha of arable land per capita is considered the lower limit [3]. Annual losses of soil, in Republic of Srpska, in the process of its destruction, amount to more than 1,500 hectares [4]. In Bosnia and Herzegovina, according to [5] 900 ha disappears in open pits and 300 ha in dumps annually.

Gacko field is a karst field and is virtually the only oasis of arable land in the region studied. Nevertheless, nothing significant has been done in this area over the past decade to protect land resources from damage and permanent destruction. Coal mine and thermal power plant in Gacko field is a very important industrial facility not only for this region but also for the Republic of Srpska[6]. The available data in the field of research of soil damage and destroyed farmland by various activities, where the exploitation of mineral resources by surface mining leads, date back to the period of 20 or 25 years ago. It is obvious that the lasting conflicts in interests and rights of soil disposal in the technical and in ecological areas are gaining in importance. This is one of the important motives for undertaking research activities in Herzegovina, to shed light, as much as possible, on the current situation in the interests of individual land users. [7] makes the most elaborate discussion about the issue of the destruction of agricultural soil in Bosnia and Herzegovina.

The permanent destruction of soil in areas where it is below the existential agricultural minimum per capita is particularly important. The lack of official data on the situation of damaged or destroyed arable land in the past decade, actualizes this problem and puts it into the focus of attention, especially in mountainous and carstified zones.

MATERIAL AND METHODS

The content of radionuclides of the soil was examined at Gacko area, slag, ash and mullock dumps in the thermal power plant Gacko and soils of dumps in the process of re-cultivation. The gamma-spectrometric measurements were done in the Institute of Nuclear Sciences “Vinča” in Belgrade.



Figure 1. Thermal Power Plant Gacko [8]

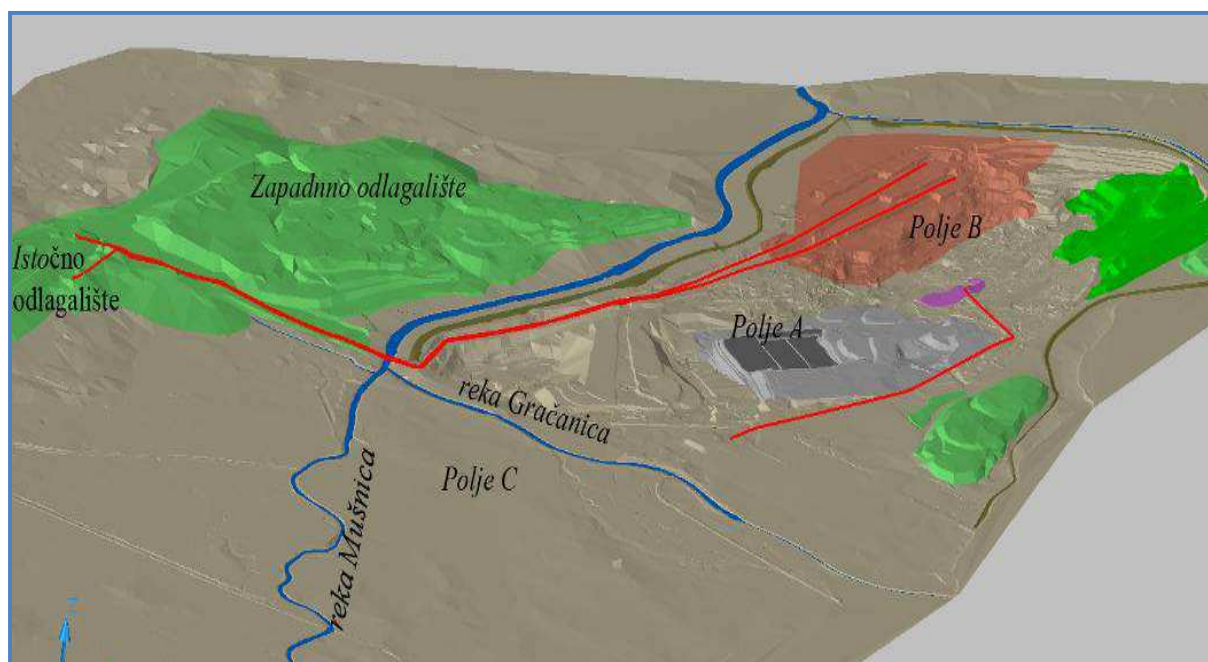


Figure 2. Location of existing landfills and surface mine fields [9]

Soil samples were collected in 2010/2014 at more locations in eastern part of Republic of Srpska. After removing the stones and vegetation, all soil samples for Gammaspectrometric measurements dried up to 105 °C, sieved, placed in the plastic 500 mL Marinelli beakers and left for four weeks to reach radioactive equilibrium [10].

Spectrometry of gamma emitters was done on HPGe detectors of relative efficiency of 20% and 23%, the firms Canberra and ORTEC. Detector resolution is 1.8 keV to 1332 keV energy. The calibration of the detector was made with referent radioactive material, the matrix of the soil, instilled with ^{22}Na , ^{57}Co , ^{60}Co , ^{89}Y , ^{133}Ba , ^{137}Cs , National Office of Measures, Budapest. The Time of measurements of samples is 60ks. The spectra were analyzed using the program GENIE 2000 certified.

RESEARCH RESULTS AND DISCUSSION

Graphical representations of change in the concentration of natural radionuclides in samples of natural soils, soils of dumps in the process of re-cultivation, slag, ash and mullock dumps are presented in Chart 1.

Given that there are no specific regulations in the Republic of Srpska, the concentration of natural and produced radionuclides in samples from the working and living environment of thermal power plants, comparison with literature data from the region and the world is one way of evaluating the impact of the plant's operation on the soils.

The highest values of concentration of natural radionuclide ^{210}Pb were measured on ash dumps 105.50 Bq/kg at a depth of 0 to 20 cm and 110.50 Bq/kg at a depth of 20 to 40 cm. Somewhat higher values of ^{210}Pb were measured in natural soils 90.00 Bq/kg at a depth of 0 to 10 cm. The minimum values were measured on the mullock dumps 2.67 and 3.33 Bq/kg at depths of 0 to 20 cm ie. 20 to 40 cm (Chart 1). ^{210}Pb is 20×10^6 times more toxic than its stable offspring ^{206}Pb . Absorption of natural radionuclides over gastroinsterile tract is increased so thanks to technological development, the amounts of deposited radionuclides in the bodies of people are now 100 to 500 times higher than 5000 years [11]. The content of natural radionuclides ^{210}Pb in coal in Germany is 25.00 Bq/kg. In coal in Italy it ranges from 25.00 to 50.00 Bq/kg, and in coal in the United States it is in the range of 10.00 to 36.00 Bq/kg [12].

The values of natural radionuclides ^{210}Pb in slag in USA range from 25.90 to 207.20 Bq/kg, and 444.00 Bq/kg in the USSR. The values of ^{210}Pb in the ashes in Germany are in the range from 200.00 to 3000.00 Bq/kg, in the USA from 78.00 to 629.00 Bq/kg [13].



Figure 3. Power plant Gacko and dumps in the process of recultivation [14]

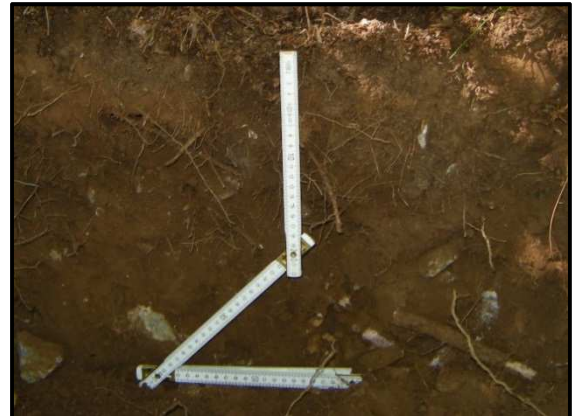


Figure 4. Soil profile [14]



Figure 5. Mullock profile [14]



Figure 6. Soils of dumps in the process of recultivation [14]



Figure 7. Ash profile [14]



Figure 8. Slag profile [14]

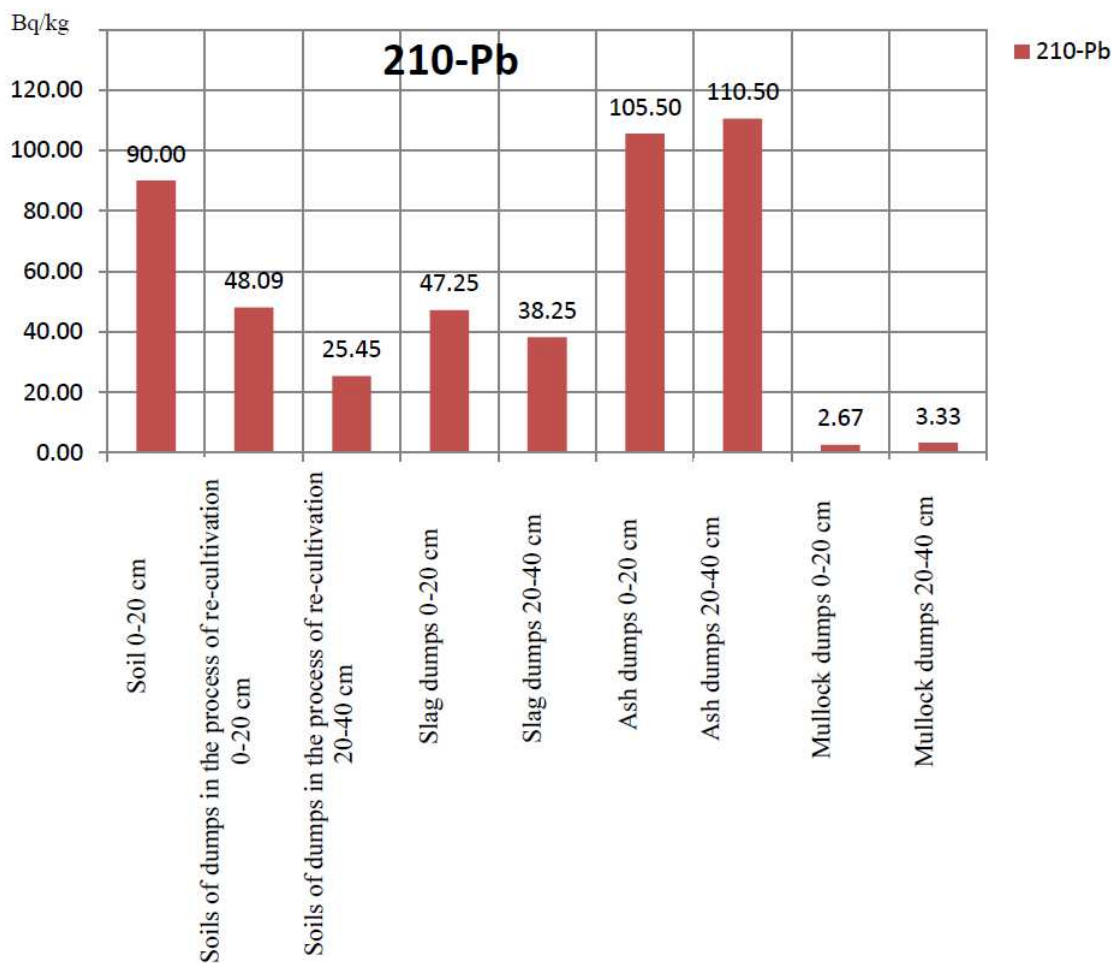


Figure 9. Concentrations of ^{210}Pb (Bq/kg) [14]

Coal-fired power plants are the main coal consumers and consequently the major releasers of radioactive material originated from coal combustion products. According to the estimation of the International Atomic Energy Agency [15] the concentrations in coal worldwide are in the range (4 Bq/kg – 785 Bq/kg) for ^{40}K , (20 Bq/kg – 210 Bq/kg) for ^{210}Pb , (8 Bq/kg – 206 Bq/kg) for ^{226}Ra , (7 Bq/kg – 97 Bq/kg) for ^{232}Th , and (7 Bq/kg – 480 Bq/kg) for ^{238}U .

CONCLUSION

The results of gamma emitters spectrometry indicate that the concentrations of natural radionuclides are of the same order of magnitude, as in power plants in other countries. The results point to the necessity of regular monitoring of radioactivity in eastern Herzegovina in order to assess the impact of the technologically increased natural radioactivity. At the same time, the obtained results represent the initial basedata based on which could be predicted levelradioactivity since such studies have so far not been carried out in the Republic of Srpska.

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