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CORRELATION BETWEEN BERYLLIUM-7 IN ATMOSPHERIC DEPOSIT AND GROUND LEVEL AIR IN SERBIA FOR 2014 YEAR

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Abstract. *Activity density of beryllium-7 in atmospheric deposit and in ground level air at five monitoring stations (MS Nis, Vranje, Zajecar, Zlatibor, Palic) in Serbia were determined during the period January-December 2014. Activity of cosmogenic radionuclide beryllium-7 was determined on HPG detectors (Canberra, relative efficienty 20%.) by gama spectrometry method. Activity density of beryllium-7 in aerosols were in range 0.5 - 9.8 mBq/m³ and in deposits were in range 1.8 - 233 Bq/m². Based on the obtained results correlation coefficient between aerosols and deposits was calculated and its value ranged from 0.15 to 0.59.*

Key words: *beryllium-7, gamma spectrometry, deposit, ground level air, correlation coefficient*

1. INTRODUCTION

Beryllium-7 is a naturally occurring radionuclide produced by spallation reactions through interactions of galactic cosmic rays with nitrogen and oxygen in the stratosphere (~70%) and upper troposphere (~30%) [1,2]. Production of beryllium-7 rate is high in the upper troposphere and decreases with atmospheric depth and its concentration in air increase with altitude [3]. Following production, beryllium-7 is promptly attached to aerosols with diameter of 0.3-0.6 μm whose residence time in the atmosphere is around 20 days [4]. The knowledge of natural radionuclide concentration in air is essential, because this information contributes to the study of atmospheric circulation of air masses [5]. Particle reactive radionuclide such as beryllium-7 has been used as atmospheric tracers for studying environmental processes such as cloud scavenging and precipitation [6,7], aerosol transit and residence times in the troposphere [8,9], aerosol deposition velocities [10-13] and the fate of pollutants [14]. The concentration of beryllium-7 in surface and rainwater is affected by both dry and wet processes. In wet deposit, precipitation transports beryllium-7 from the upper troposphere to the ground where the resident time of beryllium-7 is 10 days [15]. This process usually occurs in the spring and summer, when air transport from the stratosphere to the troposphere is easily induced by the heating of the earth's surface. This paper presents correlation between ^{7}Be activity density in atmospheric deposit, which means dust fallout by dry and wet processes, and ground level air.

2. EXPERIMENTAL

Activities of beryllium-7 in deposit and ground level air were monitored in 2014 year, as part of radioactivity monitoring at 5 locations in Serbia (Nis, Vranje, Zlatibor, Zajecar and Palic) by the Radiation and Environmental Protection Laboratory, Vinča Institute of Nuclear Sciences. GPS coordinates and altitudes of each of the sampling locations are given in the Table 1.

Table 1 GPS coordinates and altitudes of the sampling stations

Location	N	E	Altitude (m)
Nis	43°20'	21°54'	201
Vranje	42°32'	21°54'	432
Zajecar	43°56'	22°18'	144
Zlatibor	43°44'	19°43'	1028
Palic	46°06'	19°46'	102

Samples of deposit were obtained using an area deposit collector (0.1 or 0.2 m²) and were collected on a monthly basis. Samples of air were collected on filter papers (technical characteristics Whatman 41, relative efficiency for deposited dust80%) by constant flow rate samplers, ashed at temperatures below 400°C and a monthly composite sample was formed.

The activities of ^{7}Be were determined on HPGe detectors (Canberra, with 18%, 20% and 50%

relative efficiency) by standard gamma spectrometry.

On the obtained results statistical methods were applied and Pearson's correlation coefficient between ^{7}Be activity in aerosol and deposit was determined

3. RESULTS

Figure 1 and 2 present changes of ^{7}Be activity density in deposits and aerosols, respectively, at five different locations in Serbia for 2014. Minimum and maximum activity density of ^{7}Be in these samples, as well as Pearson's correlation coefficient between ^{7}Be activity in aerosol and deposit are given in table 2. Activities of both deposit and air were present on mid-point of the sampling interval, ie. middle of the month.

Activity density of ^{7}Be in deposits ranged from 1.8 Bq/m^{2} (Palic, March) – 233 Bq/m^{2} (Zajecar, July), and exhibited a maximum in spring/summer. Activity density of ^{7}Be in aerosols were in range from 0.3×10^{-3} Bq/m^{3} (Nis, February) – 9.8×10^{-3} Bq/m^{3} (Palic, August), and also exhibited a maximum in spring/summer. The highest ^{7}Be activity concentrations during the warm season in the region of investigation were attributed to more efficient vertical transport of air masses in the warm season. A phenomenon that advocates to the high observed values during summer is the elevation of the tropopause during the warm summer months for midlatitudes.

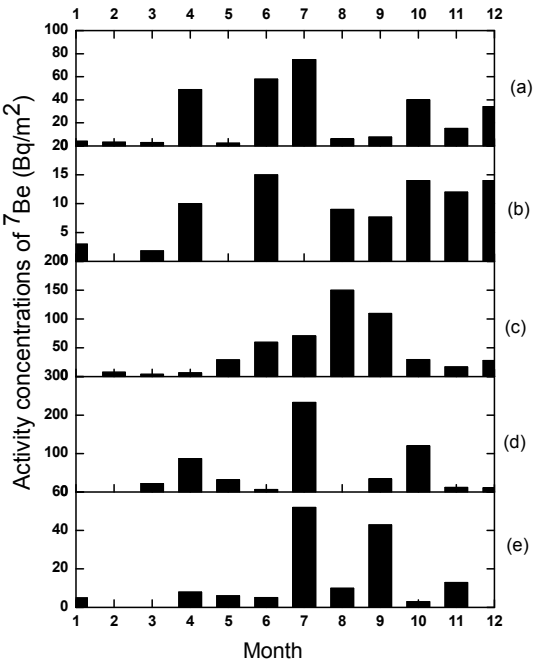

Fig. 1 Activity concentration of ^{7}Be in deposits at locations: (a) - Vranje, (b) - Palic, (c) - Zlatibor, (d) - Zajecar, (e) - Nis

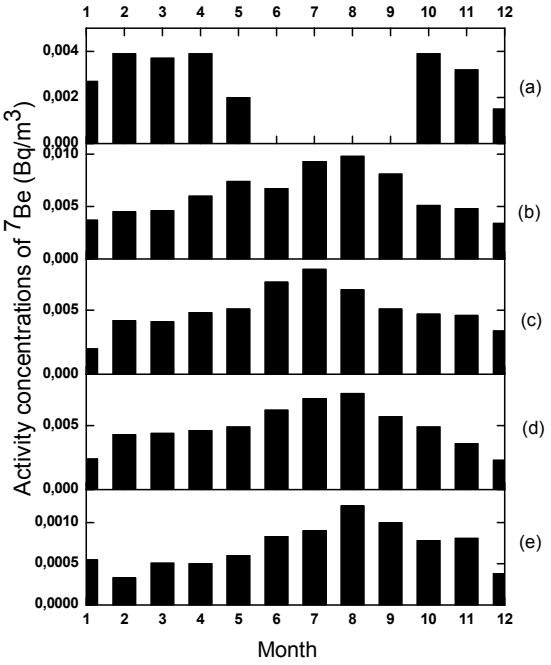

Fig. 2 Activity concentration of ^{7}Be in aerosols at locations: (a) - Vranje, (b) - Palic, (c) - Zlatibor, (d) - Zajecar, (e) – Nis

Table 2 The range of ^{7}Be activities in aerosols and deposits, as well as Pearson's correlation coefficient between ^{7}Be activity in aerosols and deposits

Location	^{7}Be in aerosols 10^{-3} Bq/m^{3}	^{7}Be in deposits Bq/m^{2}	Pearson's correlation coefficient (r)
Nis	(0.3-1.2)	(2,9-52)	0.42
Vranje	(1.5-3.9)	(2.4-49)	0.15
Zajecar	(2.3-7.5)	(6,6-233)	0.33
Zlatibor	(3.4-8.2)	(4.1-150)	0.59
Palic	(3.4-9.8)	(1.8-15)	0.07

As can be seen from table 2, there are no correlation for samples collected in Palic. On the other hand in Zajecar and Vranje correlation is weak, whereas in Nis is moderate. The highest value was obtained for Best on Zlatibor and this is strong correlation.

We can assume that the causes of the relatively poor correlation are differences in the impact of geographical and meteorological characteristics of the movement of beryllium-7 in aerosol and deposits, and because of the different characteristics of each sampling level. Also, presented results are influenced by the insufficient number of samples, so we will continue to monitoring these changes, compared them, and to examine the impact of

different geographical and meteorological characteristics of individual sampling places.

CONCLUSION

The knowledge of natural radionuclide concentration in air is essential, because this information contributes to the study of atmospheric circulation of air masses. In this paper, changes of activity density of cosmogenic ^{7}Be in atmospheric deposit and ground level air at different locations in Serbia were investigated. The obtained results are used to do a linear correlation between ^{7}Be activity in aerosol and deposit.

The typical pattern of seasonal variations was observed for ^{7}Be. The obtained values of ^{7}Be activity density show a fluctuation which has oscillatory characteristics with enhanced activity in spring-summer months. This fluctuation likely relates to the seasonal thinning of tropopause, which facilitates and enhances the stratosphere – troposphere vertical air mass mixing.

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