Analysis of Natural Radionuclides Concentration in Jeju Atmospheric PM_{10} Aerosols During the Period of Asian Dust in 2015

Chung-Hun Han[1*], Duk-Woo Kim[1], and Jae-Woo Park[2]

[1*]Institute for Nuclear Science and Technology, Jeju National University, 102, Jejudaehak-ro, Jeju-si, Jeju-do, Korea

[2]Department of Nuclear & Energy Engineering, Jeju National University, 102, Jejudaehak-ro, Jeju-si, Jeju-do, Korea

[*]tang007@jejunu.ac.kr

1. Introduction

In this study, we have measured, using the ICP-DRC-MS, radioactivity concentrations of ^{40}K, ^{232}Th and ^{238}U contained in the atmospheric PM_{10} aerosols which were collected at the Gosan during the period of Asian Dust in 2015.

2. Materials and methods

2.1 Air sampling locations

Air sampling for aerosols was conducted at the Gosan of Jeju Island, Korea. The samples have been collected using PM_{10} sampler at 24 hour during the period of Asian Dust in 2015. On collecting samples, the air flow rate was kept to about 16.7 L/min, and total air flow was calculated from the flow rate and running time.

2.2 Sample Analysis

For the analysis of PM_{10} elemental species, the aerosol samples were decomposed with acids using a microwave digestion system 10 mL acid solution (5.55% HNO_3/16.75% HCl). The vessel was heated at 180°C for 15 minutes with 1000 W microwave radiation to digest the PM_{10} aerosols [1]. The number of elements determined by ICP-DRC-MS instruments was 3 species such as ^{39}K, ^{232}Th and ^{238}U. For the elemental analysis, the instrumental detection limits (IDL) of ^{39}K, ^{232}Th and ^{238}U were 27.12 μg/L, 2.98 ng/L and 3.23 ng/L, respectively.

The radioactivity concentrations of the isotopes ^{40}K, ^{232}Th and ^{238}U in the collected fine dust were calculated using the following Eq. (1) (Ref. 2):

$$A_i = \frac{\ln 2}{T_{1/2}} \times \frac{\rho_i \times m_e}{M_i} \times N \qquad (1)$$

where A_i, $T_{1/2}$, ρ_i, m_e, M_i, and N are the radioactivity concentration (Bq/m^3), half-life time (s) of isotope i, isotopic ratio (natural abundance) of isotope i, the mass concentration of element e corresponding to isotope i (g/m^3), atomic mass (g/mol), and the Avogadro's number, respectively. The isotopic ratios for ^{40}K, ^{238}U and ^{232}Th were 0.000117, 0.99275 and 1.0, respectively.

3. Results and discussion

We have measured, using the ICP-DRC-MS, radioactivity concentrations of ^{40}K, ^{232}Th and ^{238}U contained in Jeju atmospheric PM_{10} aerosols during the period of Asian Dust in 2015 (Fig. 1).

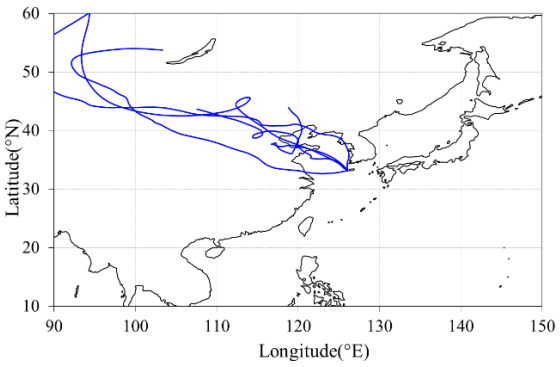

Fig. 1. 5-Day backward trajectories at the Gosan Site of Jeju Island during the study period.

Table 1. The natural radionuclides concentrations in Jeju PM_{10} aerosols during the period of Asian Dust in 2015

Date	PM_{10} ($\mu g/m^3$)	^{40}K (pg/m^3)	^{232}Th (pg/m^3)	^{238}U (pg/m^3)
02-22	198.86	134.60	651.80	165.30
02-23	194.34	167.41	895.93	176.83
03-21	191.37	153.05	336.94	115.82
03-22	124.79	123.28	364.59	101.10
06-12	114.74	95.93	259.51	112.40
Average	164.82 ±41.37	134.85 ±27.57	501.75 ±265.78	134.29 ±34.25

Table 2. The radioactive concentrations in Jeju PM_{10} aerosols during the period of Asian Dust in 2015

Date	^{40}K ($\mu Bq/m^3$)	^{232}Th ($\mu Bq/m^3$)	^{238}U ($\mu Bq/m^3$)
02-22	35.65	2.64	2.04
02-23	44.34	3.63	2.18
03-21	40.53	1.37	1.43
03-22	32.65	1.48	1.24
06-12	25.41	1.05	1.38
Average	35.71±7.30	2.03±1.08	1.65±0.42

The mean mass concentration of PM_{10} was 164.82 $\mu g/m^3$ (Table 1). During the study period, the mean concentrations of ^{40}K, ^{232}Th and ^{238}U were 134.85, 501.75 and 134.29 pg/m^3, respectively.

During Asian Dust periods (5 samples), the radioactive concentrations of ^{40}K, ^{232}Th and ^{238}U were 35.71, 2.03 and 1.65 $\mu Bq/m^3$, respectively (Table 2). The $^{232}Th/^{238}U$ activity ratio of Asian Dust was 1.23.

4. Conclusions

The atmospheric PM_{10} aerosols were collected at Gosan of Jeju Island, which is one of the natural background sites of Korea, during the period of Asian Dust in 2015. This study analyzed using ICP-DRC-MS the concentrations of potassium, thorium and uranium. The mean radioactive concentrations of ^{40}K, ^{232}Th and ^{238}U were 35.71, 2.03 and 1.65 $\mu Bq/m^3$, respectively. The $^{232}Th/^{238}U$ activity ratio of Asian Dust was 1.23.

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