CONTINUOUS OBSERVATION OF ATMOSPHERIC RADIONUCLIDES USING DISK STANDARD SOURCE

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An analytical method for determination of atmospheric radioactive nuclides using gamma-ray spectrometry combined with disk sources prepared commercially available chemical reagents was developed. The gamma-ray standard source shaped a membrane disk was prepared by dripping the solution of potassium chloride and gelatin reagents on a glass fiber membrane. Aerosol samples were collected at Kawasaki, Japan, on glass fiber filters using a high-volume air sampler. Detection efficiency curve were calculated for gamma ray from the disk standard source and small shielded source of europium-152. Several short-lived radionuclides in aerosol sample were identified and determined on the gamma-ray spectra by an HP-Ge spectrometer. The present method using disk of gamma-ray standard sources was applicable to the determination of atmospheric short-lived radionuclides outside a radiation controlled area.

I. INTRODUCTION

Radon nuclides and these progenies are used as tracers in several kinds of geological and atmospheric studies.[1,2] Atmospheric these radionuclides have been observed many area, and showed various concentration distribution and time fluctuation with atmospheric moving.[1,2] The short-lived decay products of radon nuclides (^{220}Rn and ^{222}Rn) generated from earth crust have been used as a tracer to estimate the degree of vertical mixing of atmosphere within the surface air layer.[3] A half-life of those radionuclides are very short time from several microseconds to a few minutes. The variations in atmospheric concentrations of those short-lived radionuclides were observed to depend strongly to the local meteorological conditions in a short period.

The analytical method for radionuclides in aerosol samples using a gamma-ray spectrometry combined with disk sources prepared chemical reagents has been developed. This rapid method was applicable to determination for short-lived radionuclides in aerosol samples. The discussion will be extended to the contribution of the local meteorological conditions to the atmospheric concentrations of the several short-lived radionuclides, having significantly different half-lives.

II. EXPERIMENTAL

The gamma-ray standard sources shaped a disk was prepared by dripping the aqueous solution of KCl, a gelatin reagent, and a red artificial color on a glass fiber filter (ADVANTEC, GB-100R). The laminated coating disk standard source and aerosol collected on glass fiber filters were measured by a high purity Ge semiconductor detector (HP-Ge; PGT inc., IGC-10200). A detection efficiency curve for determination of aerosol samples was calculated with gamma ray from ^{40}K in the disk standard source and ^{152}Eu in small shielded source (Japan Radioisotope Association, 60 mmϕ, 4 mmH).

Collection of aerosol sample was made on a terrace of a building of Meiji University, Kawasaki, on glass fiber filters using a high-volume air sampler (SIBATA, HVC-500). The aspirating speed was 0.5 m^3/min.

III. RESULTS AND DISCUSSION

The short-lived radionuclides such as ^{7}Be, ^{208}Tl, ^{212}Pb, ^{214}Pb and ^{212}Bi in aerosol sample were identified and determined on the gamma-ray spectra by an HP-Ge spectrometer. Activities of ^{7}Be ($T_{1/2}$ = 53.12 day), ^{212}Pb ($T_{1/2}$ = 10.64 hour), and ^{214}Pb ($T_{1/2}$ = 26.8 min) in aerosol samples by the directly method using disk sources were 0.29 ± 0.04 Bq, 0.65 ± 0.02 Bq, and 0.40 ± 0.02 Bq, respectively. The determination results were correspond well with the conventional method, the sample filter was cut out to make four disks of 38 mm diameter and pressurized to prepare the source of 3.2 mm thick, and packed into an acrylic canister having a window of a thin Mylar film (Chemplex, 3.6 μm thick). ^{208}Tl ($T_{1/2}$ = 3.053 min) and ^{212}Bi ($T_{1/2}$ = 60.55 min) could be only detected by the rapid method for short-lived nuclides.

Fig. 1 shows the variation in the every one hour concentration of atmospheric short-lived radionuclides at Kawasaki, Japan. The same atmospheric behavior was indicated during the respective short-lived radionuclides: maxima appeared in the every early morning (8:00-9:00) due to the stable atmosphere caused by the nocturnal inversion layer, which has previously been suggested.[4] The aerosol sample collected on filter could be directly measured by γ-ray measurement for one hour. The present method is simpler than the conventional method, and is applicable to investigation for atmospheric behavior of short-lived radionuclide.

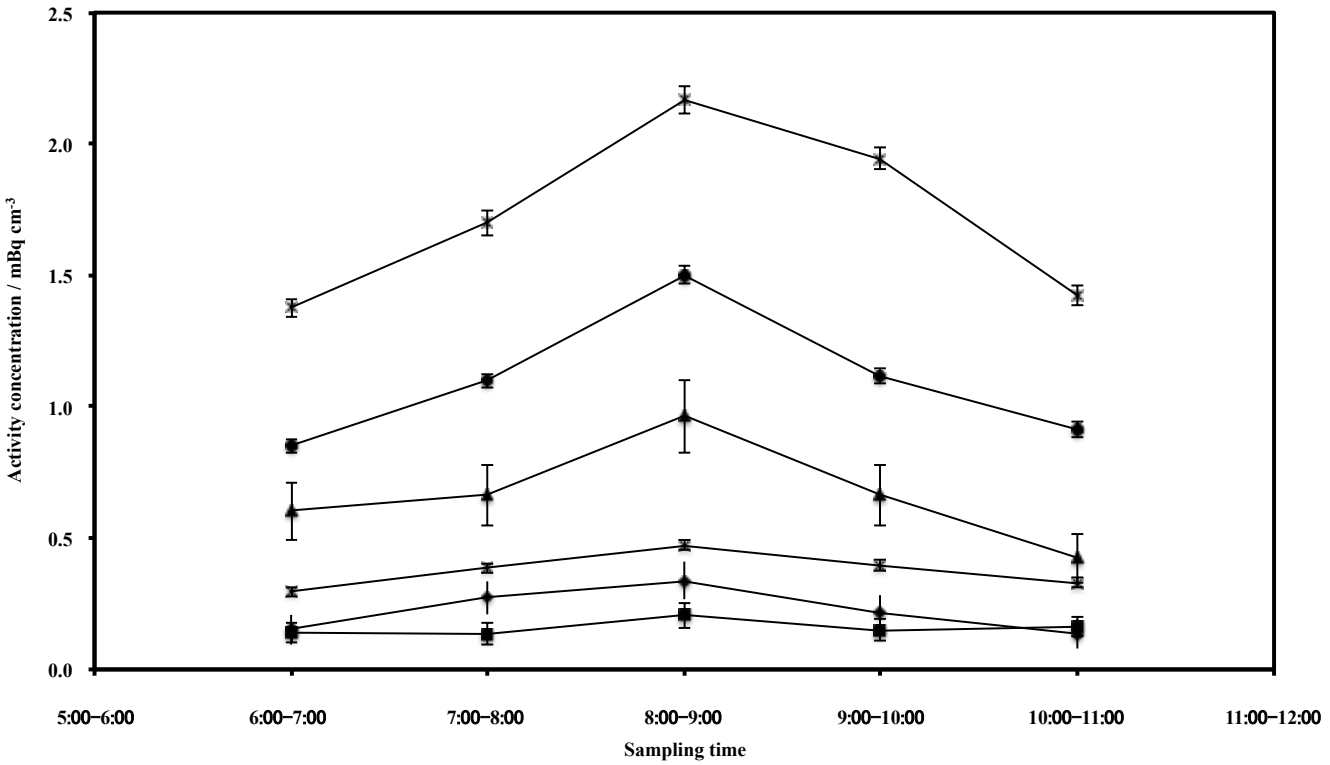

Fig.1. Every one hour concentrations of atmospheric ^{7}Be (△), ^{208}Tl (×), ^{212}Pb (◆), ^{214}Pb (■), ^{212}Bi (∗), and ^{212}Bi (●) at Kawasaki, Japan, on 16 July 2016.

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