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Radioactive strontium from the Fukushima Nuclear Power Plant accident observed at Tsukuba, Ibaraki, Japan

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Introduction

After the Chernobyl accident in 1986, the significant nuclear accident did not occur. Because of this concentration levels of the anthropogenic radionuclide in the atmosphere had been at the very low level for these two decades. However, the Fukushima First Nuclear Power Plant of Tokyo Electric Power Company was damaged by the earthquake and tsunami on March 11, 2011, resulted in a serious nuclear disaster, newly added the radioactive material to the atmospheric environment corresponding to some portions of those from the Chernobyl accident. By this large-scale contamination, the concentration level of the anthropogenic radionuclides in the atmosphere over Japan was significantly enhanced. At the Meteorological Research Institute (MRI), Tsukuba, Ibaraki (ca. 260 km far from the accidental site), air sampling and analysis of the radionuclides were continued before and after the accident. Only the result of the gamma-ray emitting nuclides has been so-far reported. Since the analysis of radioactive Sr was started after the accident, this presentation publicizes its air concentration and the month-long total deposition.

Outline of the analytical method

By using the high volume aerosol sampler (HV-1000F, Sibata Scientific Technology Ltd.) installed in the MRI observation field in Tsukuba, the collection the aerosol was carried out with a quartz fiber filter (Advantec QR100). Although the usual collection time is one week, since the accident was announced, collection duration was shortened at 6 hour to one day. The flow rate of the sampler was set at 700 L/min, thus the collected volume of the air was about 250, 500, or 1000 cubic meters (corresponding collection time of 6, 12, and 24 hours, respectively). One piece of the filter sample (about 2%) cut by a punch before the following pellet creation was subjected to the radioactive Sr analysis. The radiochemical separation composed of precipitation purifications including a fuming-nitric acid method etc., and, finally Sr was fixed as carbonate salt. In order to see growth of ^{90}Y and decay of ^{89}Sr, beta activity was repeatedly measured over the long period of time with a low-background 2pai gas-flow detector. On the other hand, gamma-ray emitting nuclides were determined by using a Ge semiconductor detector, after compressing a filter sample into a pellet with a hydraulic pressing device.

Sampling of the monthly total deposition sample was carried out at the MRI, Tsukuba and Mt. Haruna, Guma, without stopping before and after the accident. The deposition sample was evaporated to dryness and the gamma-ray emitting nuclides were measured by a Ge detector. After the measurement by applying the same chemical procedures as those for the filter sample, radioactive Sr was determined.

Results and discussion

Temporal changes in air concentration of the gamma-ray emitting nuclides exhibited two high concentration events during March, 2011 in Tsukuba. This features the remarkable advection and diffusion phenomena to the Kanto plain of radioactive plume from the Fukushima nuclear accident. The filter samples which contained significant amount of radioactive Sr were also only samples taken around March 15 and March 21 as expected. Also the served amount of the sample was too small to detect radioactive Sr in other samples. Since ^{89}Sr with a half-life of 50 days could decay out, it was difficult to detect ^{89}Sr in the filter samples. The ^{137}Cs/^{90}Sr activity ratio in the detection cases was about 1000, which agrees well with the figure from the emission inventory estimate by Nuclear and Industrial Safety Agency, Japan. Furthermore, between two radioactive plume advection events, there could be a difference in the discharged materials from the accident, which was turned out by a finding that the solubility to acid of radio-Cs on the filter contrasted.

Keywords: Radioactive strontium, Atmospheric samples, the Fukushima accident, Emission inventory