

Radiochemical Analysis of Fission Products Contained in the Soil Collected at Tokyo, May, 1954

by

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1. Introduction

Since the middle of May, 1954, we detected rather strong artificial radioactivity in rain water at Tokyo and other places in Japan. It was proved that radioactive substance which had been scattered in the air by atomic explosion at Bikini Atoll in the spring 1954 fell on the earth in Japan. As a matter of course, a part of the radioactive substance in the rain might be retained in soil by adsorption or ion exchange. Needless to say, the study on radioactive contamination of soil is important in agriculture. On the other hand, radiochemical assay of soil will give also an alternative method to the direct analysis of rain or fall-out, because we can collect easily a sufficient amount of soil samples. Even in the case of sudden occurrence of radioactive contamination of rain water or falling dusts, the soil assay may give the most convenient method for detecting artificial radionuclides contained in precipitation.

Amount of radioactivities retained in the soil will naturally depend on many factors, such as specific radioactivity and species of the radionuclides in rain water, total amount of precipitation, surface conditions of the ground, nature of the soil, etc. Though we have not examined these factors in detail, the possibility of detection of artificial radioactivity in rain-out by means of soil assay has been more or less assured.

2. Sampling and extraction of radionuclides

Though we had observed fairly strong radioactivity in rain water precipitated in Tokyo area on May 17th, 1954, the total amount of rain-fall was too small to permit satisfactory radiochemical analysis. Therefore, on the next day, 300 grams of soil was collected from the surface of the ground at the Meteorological Research Institute.

The soil sample was leached with 50 ml of 6N HCl on a steam bath, and filtered solution was evaporated to dryness. The residue was dissolved in distilled water and an aliquot of the solution was subjected to chemical analyses. The radioactivity measurement was started on 25th May, therefore, values of the activity were reduced to those on that day.

3. Results of radiochemical analysis

Next, the total activity of the extract was measured. The sample was dried

on a planchet made of stainless steel and its β -rays were counted by G-M counter. The result was about 5 dpm/gr , soil, assuming that the extraction efficiency was 100%. The calculation to obtain dpm from observed cpm was carried out under the rough estimation of β -ray energy determined in the following analysis of radionuclides.

The group separation of extract based on the ordinary scheme of qualitative analysis was made after adding carriers of Ce, Ba and Sr. Precipitate with hydrogen sulphide showed very weak activity which was only a few percent of the total activity. Hydroxide group contained an appreciable amount of radionuclides, but, most of them were insoluble when they were changed into fluoride forms. The filtrate of fluoride solution showed only a weak activity as in the hydrogen sulphide group. The composition of the active fluoride might mainly consist from rare earth elements. The decay curve of the activity showed the existence of short-lived nuclides as well as long-lived ones (about 30d). The activity of these precipitated nuclides was 2.1 dpm/gr , soil. The radionuclide obtained in the carbonate fraction was separated into calcium, strontium and barium. The calcium fraction was separated by concentrated nitric acid and barium fraction was obtained by precipitation as chromate. While the calcium fraction had no activity, barium and strontium fractions indicated appreciable activities. The observed half-life of barium activity was about 15 days and that of strontium was 40~80 days. E_{max} estimated by the absorption of β -rays was about 1.2 Mev and 1.5 Mev for barium and 1.5 Mev for strontium. Thus, it may be said that the radionuclides of radiostrontium and radiobarium mainly consisted of Sr-89 and Ba-140. The calculated amount of these radionuclides in the original soil samples was as follows:

Sr; 0.7 dpm/gr , soil Ba; 1.6 dpm/gr , soil.

4. Conclusion

As a result of the semi-quantitative analysis of radionuclides in the soil some appreciable radioactivities in the fractions of rare earth elements and alkali earth elements were found. The rough estimations on the content were done on these radionuclides contained in the soil of 1 gram. The results were as follows:

radionuclides of rare earth:	9×10^{-13}	curie/gr
Sr-89	3×10^{-13}	"
Ba-140	7×10^{-13}	"

The radiochemical assay of rain water may be replaced by the soil assay using 100~1000gr of the soil sample, when direct analysis of rain water is difficult. A direct activity measurement on the extracts gives only a poor result due to self-absorption by a larger amount of extracted materials, and therefore, the measurements must be performed after the separation of rare earth elements, barium and strontium etc.