PAPER III

Radioautographic Studies of the Radioactive Ashes Obtained from the No. 5 Fukuryu Maru

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INTRODUCTION

Radioautographic studies have been made of the radioactive ashes obtained from the No. 5 Fukuryu Maru in order to investigate the distribution and nature of the radioactivity in the particles of the ashes.

MATERIALS

The radioactive ashes were provided by the courtesy of Prof. T. Shiokawa, Faculty of Science, Shizuoka University, and Dr. T. Maekawa, Chief of Sanitation Division of Shizuoka Prefecture. The ashes seemed to be in a relatively pure state.

METHODS

Survey autography, using Fuji X-ray film, and detail autography, using Fuji ET-2E stripping plate and Ilford C-2 plate, were made.

1) Procedure of preparing samples.

Two per cent celloidin methanol solution was pipetted onto slides to make thin films of celloidin. The radioactive ashes were placed on the films and dried for 24 hours at room temperature. For the study of alpha-tracks, celluloid films were used instead of glass slides.

2) Survey radioautograph.

The samples prepared as described above were placed in contact with Fuji X-ray films and exposure was given for 48 hours. During the exposure the films were kept in a desiccator. The films were developed with Kodak D19 developer for 30 minutes at 20°C. Fixing took place in 30 % acid sodium thiosulfate for 10 minutes at 20°C. After careful washing for 2 hours, the films were allowed to dry and then the samples were compared with the radioautographs under the microscope.

3) Detail radioautograph.

a) The emulsions of Fuji stripping plates, 15 μ thickness, were peeled off and floated on water, and the samples were covered with the emulsions. After drying,

the samples were kept at 0° to 5°C. in a desiccator, containing calcium chloride as a drying agent, in a refrigerator. For the particles with strong radioactivity, 1 to 2 day exposure was sufficient to produce adequate blackening, but in order to give sufficient exposure even for the particles with weak radioactivity, the length of exposure time was fixed for 14 days. Developing was carried out with Kodak D19 developer at 19°C. for 2 minutes. After gentle washing in water for 30 seconds, fixing took place in 35% sodium thiosulfate at 19°C. for 10 minutes. To prevent calcium salts from dissolving, acid solution was not used for fixing. After careful washing in water for 20 minutes, the samples were allowed to dry at room temperature for 5 hours. The samples were then dipped in xylol for 3 minutes, covered with cover slips by Canada balsam, and observed under the microscope and photographed.

b) Alpha-tracks. The radioactive ashes were mounted on celluloid films with 2% celloidin methanol. Glass slides were not used for mounting samples, because they contained natural alpha emitters, which would affect the results. The samples were placed in contact with Ilford C-2 plates, 200 μ thickness, and exposure was given for 4 to 7 days. The plates were developed with Kodak D19 developer at 0°C. for 60 minutes, and then at 19°C. for 10 minutes. After gentle washing in water, the plates were dipped in 2% acetic acid for 5 minutes to break the developing. Fixing took place in 40% sodium thiosulfate at 0°C. for 30 minutes, and then at 5° to 10°C. for 8 to 10 hours. The sodium thiosulfate solution was renewed every 20 minutes at the beginning and every one hour at the latter period of the fixing. The plates were then washed in water at 15°C. for 5 hours and allowed to dry at room temperature for 40 hours.

RESULTS

1) Survey radioautograph (Figs. 1 a, b).

Fig. 1 a shows the photomicrograph of the radioactive ashes and Fig. 1 b shows the radioautograph of the same sample. As seen in these figures, the radioactivity was not always proportional to the size of the particles, and there were found some particles, which showed practically no radioactivity.

2) Detail radioautograph.

a) Fig. 2 shows one of the radioautographs taken by Fuji ET-2E stripping plates, 15 μ thickness. As shown in this Fig., blackening was seen around the particles. The blackening around the particles was not uniform, and in some cases blackening was seen only at one corner of the particle. Fig. 3 shows a photomicrograph of the radioautograph, taken with a high power lens. Alpha tracks were not seen in this radioautograph.

b) Fig. 4 shows the radioautograph of the ashes taken by an Ilford C-2 plate, 200 μ thickness. In this radioautograph 4 to 10 alpha tracks per one particle were

found. Some particles showed starlike alpha tracks emitted from one corner of the particle. Table 1 shows the distribution of the ranges of 250 alpha tracks as measured under the microscope. As the shrinkage factor 2.4 was used[1]. The ranges of alpha tracks were distributed between 6 and 30 μ, mostly between 16 and 18 μ.

Table 1. Distribution of the ranges of alpha tracks

Range μ	%
0— 5.9	0.4
6.0— 7.4	2.0
7.5— 8.9	5.2
9.0—10.4	4.4
10.5—11.9	5.6
12.0—13.4	6.0
13.5—14.9	7.2
15.0—16.4	11.2
16.5—17.9	15.6
18.0—19.4	8.8
19.5—20.9	9.6
21.0—22.4	8.0
22.5—23.9	5.6
24.0—25.4	4.4
25.5—26.9	2.0
27.0—28.4	2.0
28.5—29.9	1.6
30.0—31.9	0.4
31.5—32.9	0.0
33.0—	0.0

DISCUSSION

By radioautographic technique it has been shown that there was no correlation between the radioactivity and size of the particles, and that the distribution of radioactivity in the particles was not uniform. These results are in keeping with the observation reported in the previous paper, in which the measurements of the size and radioactivity of the particles were made. As a rule there was a parallelism between beta and alpha particles. Some particles, however, showedm ore alpha particles than beta, and there were also some particles, in which alpha tracks seemed to be emitted from one corner of the particle. Taking these findings into consideration, it might be concluded that some of the fission products were attached to the fragments of the atoll, although there is no doubt that the fission products were mixed with the fragments of the atoll. The energy of the alpha particles could not be determined, because it was impossible to calculate the loss of energy in the particles.

SUMMARY

Radioautographic studies have been made of the radioactive ashes obtained from the No. 5 Fukuryu Maru, using X-ray films, radioautographic stripping plates and plates for alpha emitters. The radioactivity was not proportional to the size of the particle, and the distribution of radioactivity in each particle was not uniform.

ACKNOWLEDGEMENT

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REFERENCE

1) Beiser, A.: Nuclear emulsion technique. Rev. Mod. Phys., **24**, 237-311, 1952.

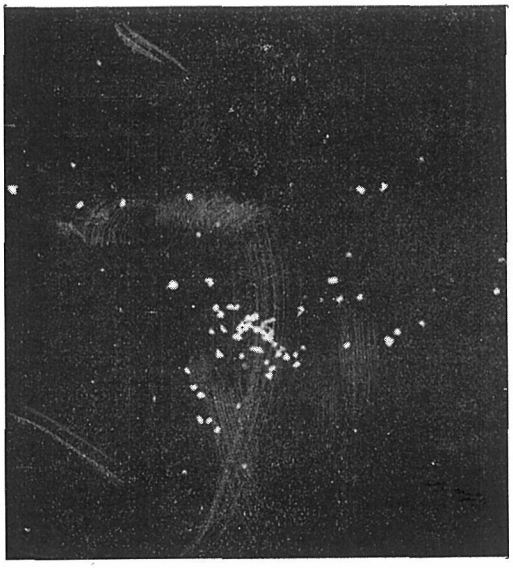

Fig. 1 a. Photomicrograph of the radioactive ashes (×5).

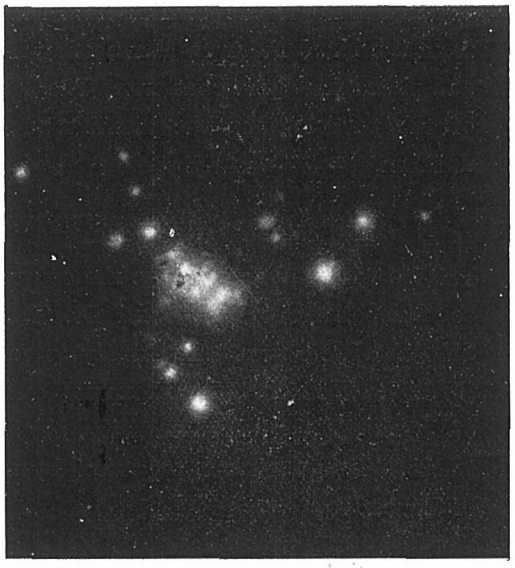

Fig. 1 b. Radioautograph of the radioactive ashes (Fuji X-ray film, exp. 2 days) (×5).

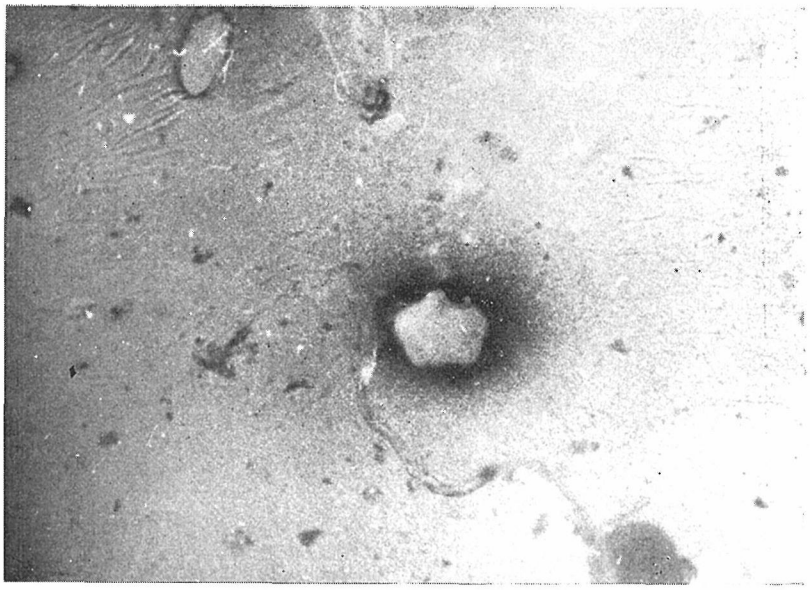

Fig. 2. Radioautograph of the radioactive ashes (Fuji stripping plate ET-2E, 15μ, exp. 14 days) (×60).

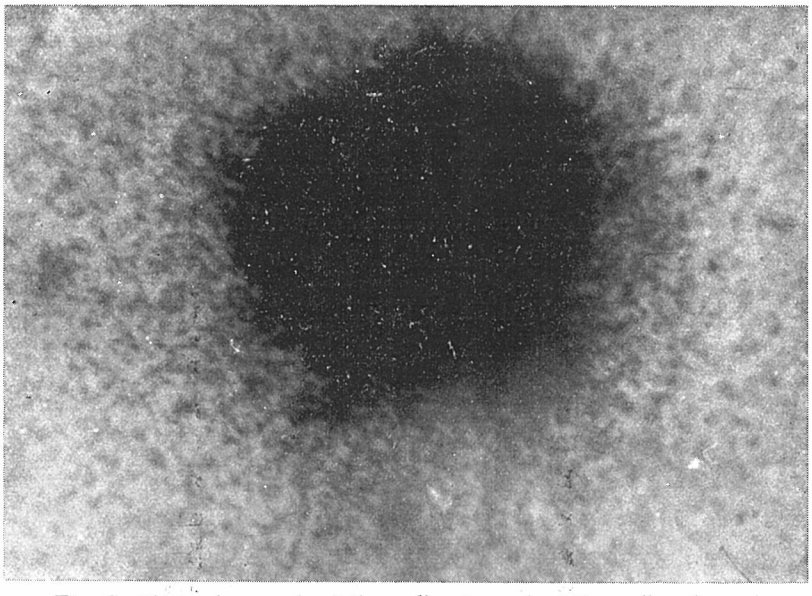

Fig. 3. Photomicrograph of the radioautograph of the radioactive ashes (Fuji stripping plate ET-2E, 15μ, exp. 14 days) ($\times$300).

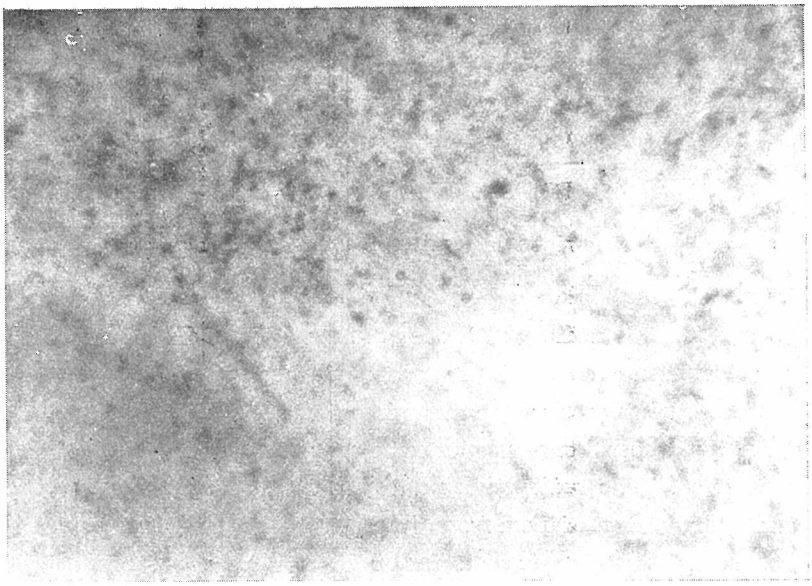

Fig. 4. Radioautograph of the radioactive ashes (Ilford C-2 plate, exp. 6 days).