

The Artificial Radioactivity in Rain Water Observed in Japan, from Autumn 1954 to Spring 1955

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Abstract

At about midnight of 18th September, 1954, a typhoon (No. 14, 1954) ran away toward the sea after attacking Japan. In place of the typhoon a colder and less moist air flowed in from the north. Just at the time, a new activity of artificial origin was detected in rain water at Niigata and Hirosaki, both situated along the Japan Sea coast of the northern part of the Main Island. From 22nd to 24th of September, the activity increased rapidly, spreading over a wide area in Japan and finally an activity as strong as 0.3×10^{-6} curie/l was counted in rain water at Yamagata.

At the beginning of November 1954, another new activity almost comparable to that in September visited again. The estimated dates of explosion were respectively 13th-16th September and 28th-30th October. As air trajectories at 700 mb and 500 mb extended from Siberia to Japan, it might be supposed that the explosion tests would have taken place somewhere in USSR.

Presence of fission materials was confirmed. It is to be noted, S. KOYAMA at Niigata Univ. estimated the presence of Np-239 and U-237 in rain water precipitated on 24th September. In autumn 1954, the activity was stronger along the coast of the Japan Sea than that on the Pacific side.

Since the middle of March 1955, the radioactivities which might be attributed to Nevada experiments were detected several times both in rain water and the air at Tokyo and other places.

1. The radioactivity in rain water, from September to November, 1954

At about midnight of 18th September, 1954, a typhoon (No. 14, 1954) ran away toward the Pacific Ocean after attacking Japan. In place of the typhoon a colder and less moist air flowed in from the north (Fig. 1). Just at the time, a new activity of artificial origin was detected in rain water by H. WATANABE at Niigata University and S. SUZUKI at Hirosaki University, both situated along the Japan Sea coast of the northern part of the Main Island. It seems that the rain which had a higher level of radioactivity fell mostly along the cold front as shown in the weather chart (Fig. 3). This was a few days after TASS had reported that atomic weapon tests in USSR had been finished some days ago. From 22nd to 24th of September, the activity increased rapidly, spreading over a larger area of Japan and finally an activity as strong as 0.3×10^{-6} curie/l was counted

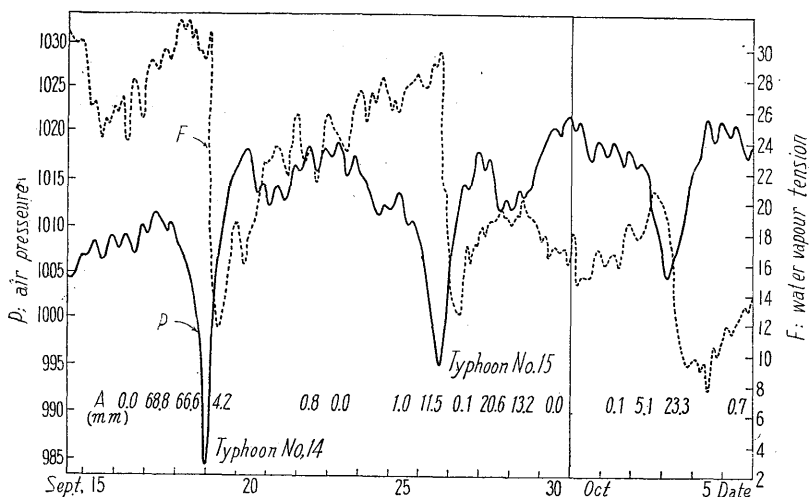


Fig. 1. Air pressure (P), vapour tension (F) and rainfall amount (A) in September and October 1954 observed at Tokyo.

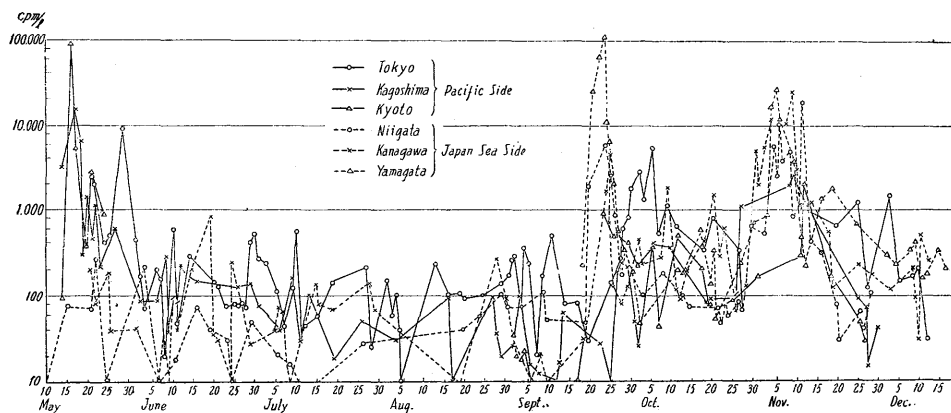


Fig. 2. Change of radioactivity in rain-water fell in Japan from May to December 1954.

in rain water on 22nd September by T. TERAZAKI at Yamagata University. The activity decreased when the warmer air from the south flowed in company with the Typhoon No. 15 (1954) on 25th September and increased again at the beginning of October along with the incoming colder air mass from the north (Fig. 1).

At the end of October and the beginning of November, another new activity almost comparable to those in May and September visited Japan from the north again (Fig. 2).

As in the case of September, it was recognized at first only at a few places in the north-eastern part of Japan especially along the Japan Sea coast. But, on 4th and 5th of November peaks in the activity appeared at many places. For example, T. KIBA of Kanazawa University detected an activity of 36 $\mu\text{C}/\text{l}$ and 72 $\mu\text{C}/\text{l}$ respectively on 4th and 9th November. An activity of the order of 10 $\mu\text{C}/\text{l}$ was measured also at many other stations during the period from 4th to about

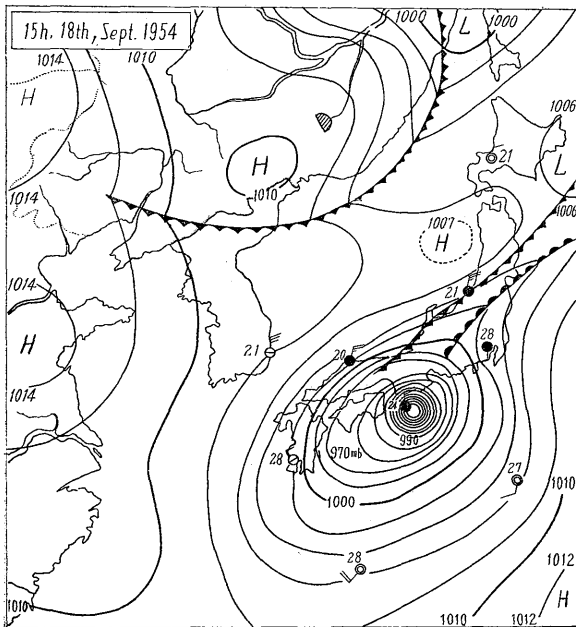


Fig. 3. Weather chart on 18th September, 1954.

10th of November. At Tokyo there was no rain at that time, but a radioactivity of about $5 \text{ m}\mu\text{C}/\text{m}^2/\text{day}$ was observed in falling dusts as the value for 24 hours from 4th to 5th of the month. At the same time, K. IROO and N. YANO at our institute also measured an activity of the order $10^{-12} \sim 10^{-10} \text{ curie}/\text{m}^3$ in the air near the ground by means of the electrical dust collector which was devised by them and seems more efficient than ordinary filtration or impinger method.

The estimated dates of explosion were respectively 13th~16th of September and 28th~30th October, assuming that the gross activity decreases proportionally to the

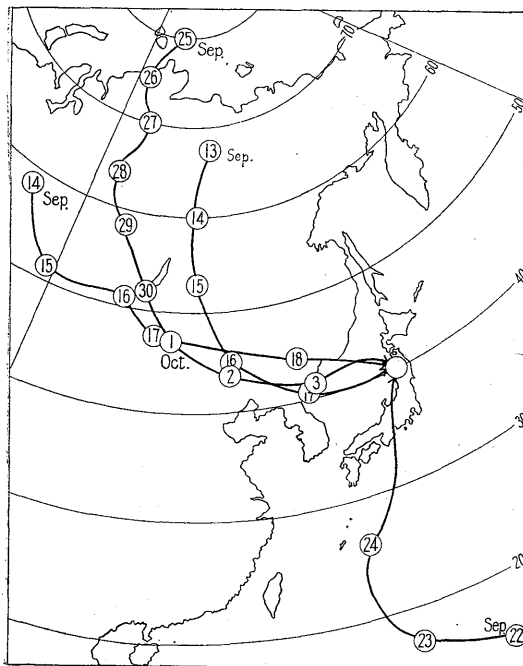


Fig. 4. Air trajectories at 700 mb during from 13th September to 3rd October, 1954.

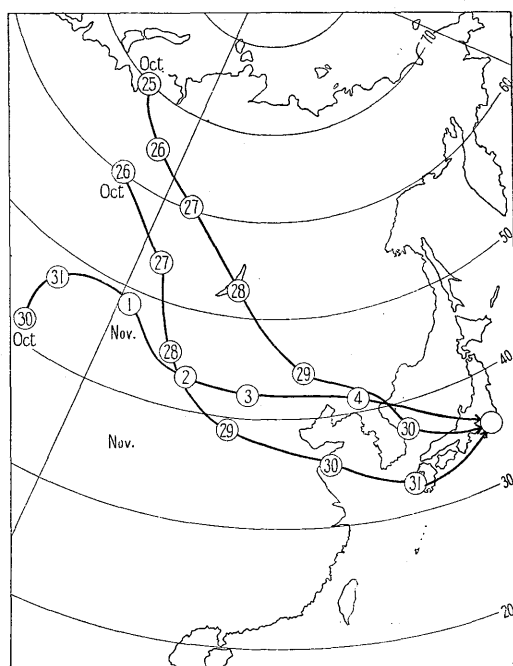


Fig. 5. Air trajectories at 700 mb during from 26th October to 5th November, 1954.

negative power of about 1~2 of the time. The sites of explosion were unknown, but as air trajectories at 700 mb and 500 mb extended from Siberia to Japan (Figs. 4 and 5), it might be supposed that the radioactivities in rain water were caused by some explosion tests which would have taken place somewhere in USSR.

Presence of fission materials was also confirmed in both cases in the autumn by several researchers including Miss K. SARUHASHI at our laboratory, S. KOYAMA at Niigata University, T. KATO at Yamagata University, N. SATO at Hirosaki University, T. SHIOKAWA at Shizuoka University, K. NISHIO and S. HAYASHI at Kagoshima Prefectural University. In May, Y. YOKOYAMA of Tokyo University estimated the presence of considerably larger amount of Np-239 (45%) and U-237 (20%) in rain water precipitated on 17th May in Tokyo. It is to be noted that as in the case of rainfalls in May, S. KOYAMA also found Np-239 and U-237 in rain water precipitated at Niigata on 24th September. This suggested that U-238 would have been contained in the bombs.

Contrary to the case in May, the activity in rain or snowfall was stronger in the autumn along the coast of Japan Sea than that on the Pacific. This means that the source of the activity lay in the north from Japan.

2. The radioactivity in rain water in spring, 1955

Since 5th of March, 1955, the radioactivities which might be attributed to Nevada experiments were detected several times both in rain water and in the air at Tokyo, Osaka, Yonago and other stations. They were presumably due to the experiments performed on 18th and 22nd of February, 1st, 7th, 13th and 29th of March, 1955. In these cases, dusts would have been transferred by the westerly winds in the upper air.

The highest activity in rain water was of the order of $3\sim 4 \times 10^{-9}$ curie/l. E. TAJIMA at St. Paul's University, Tokyo confirmed the radioactivity in the air near the ground by means of the filtration method. The maximum value of about 2×10^{-11} curie/m³ observed on 12th April was probably attributable to the experiment on 29th of March. J. NEMOTO at Central Meteorological Observatory found a good correlation between the sites of the centre of anticyclones moving from the north with a mean speed of about 20 m/sec and the variation of activity in the air observed at Tokyo by E. TAJIMA. According to NEMOTO the activity of the air at Tokyo increases when the centre of high is located in the area over the Japan Sea or off the northeastern coast on the Pacific side of Japan.

It is interesting to note that comparatively dense, radioactive dusts consisting mainly of soil materials containing fragments of quartz, calcite, albite, clay minerals etc. fell on several places in the spring of this year, among which those that fell on 13th April at Asahikawa, Hokkaido Island were the strongest (2600 cpm/g as the value on 22nd Apr.). It is supposed that the activity might also be attributed to the experiment on 29th of March. The radiochemical analysis of the dust is now being carried on in our laboratory.

3. Discussions

The maximum activity of artificial radioactivity in rain water measured in Japan in 1954 was 1~0.5 $\mu\text{c/l}$ detected at Kyoto on 16th May [1]. The second was 0.3 $\mu\text{c/l}$ found at Yamagata on 22nd of September.

In April 1953, the radioactive rain-out was observed in the east Massachusetts, USA, two days after the detonation at Nevada, of which the maximum activity was $1.9 \mu\text{C}/\text{l}$ as 3-day activity [2]. G. JAFFE, W. WITTMANN and C.C. BATES [3] detected the radioactivity of about $6200 \text{ cpm}/\text{l}$ as the value 78 hours after the explosion in hailstones which attacked the District of Columbia Area on May 26, 1953, only 29 hours after the explosion at Nevada [4].

On the other hand, assuming that the last Bikini experiment in 1954 was done on 5th May, the 3-day activity in rain water precipitated in Kyoto area would have been $5\sim 2.5 \mu\text{C}/\text{l}$, which was much stronger than the values observed in USA mentioned above. According to P.E. DAMON and, P.K. KURODA [5] the artificial radioactivity in rain water observed at Arkansas, USA, in the period from June to July, 1953, was of the order of only $10^{-9}\sim 10^{-11} \text{ curie}/\text{l}$. Even in the maximum intensity of the latter it was considerably weaker than those generally observed in Japan since May in 1954. It is rather amazing that the activity in rain water observed in Japan caused by the Bikini-tests in 1954 was stronger than those observed in USA in 1953 due to her continental weapon tests, despite the course of air flow in the former was much longer than that in the latter.

In the case of the second maximum of $0.3 \mu\text{C}/\text{l}$ at Yamagata in September 1954, the date and the site of explosion were unknown, but, supposing that the date was 14th September, the 3-day value would have been about $1.2 \mu\text{C}/\text{l}$ which was by no means of weaker activity.

These facts seem to indicate that the radioactivity of rain-out would not decrease rapidly beyond a certain distance, for instance, 1500 km or more from the explosion site. This is in agreement with the observed relation of activity in fall-out to distance from the zero site [6]. However, the topographic effect on the activity was clearly seen in Japan. Owing to the central mountain range along the Main Island of Japan, the activity was always much weaker on the opposite side of the mountain range.

In the case of May rainfall, the abrupt rise in radioactivity was observed on 14th of the month only at Kagoshima, a southernmost city of Japan, though rain fell over a large area in Japan on that day. Likewise, the activity coming from the north was found at first only at Niigata and Hirosaki on 18th~19th of September. Similar facts were observed in the end of October when the third maximum began. In these cases, the activity in rain water spread out after a few days over a larger area, and in the same time the maximum activities in rain water were measured at many places. Such a situation has also been observed in the USA [2]. Generally, the rain-out arrives at places in a limited area far from the explosion site, on occasions, more rapidly than falling dust from the air. It is not unusual, therefore, that activities in rain water that fell in the eastern part of the USA, about 4000 km apart from the Nevada experiment site, were detected only about two days after detonation [2]. It has been found further that a remarkably non-uniform distribution of radioactivity may occur [2] even in a limited area, which is mainly due to its non-uniformity in the air. On the other hand, falling dusts spread over the whole area of the USA in about 4~5 days after the detonation in rather complicated forms of distribution [7]. These facts mean that the airborne dusts which are thrown up into the upper atmosphere are transferred first by the rapid flow such as of a jet stream without any

appreciable horizontal diffusion (probably less than 10°) and when they meet by chance rainy clouds the radioactive rain-out may fall on a comparatively limited area by the washing effect of cloud or rain drops. Then, afterward, falling dusts which are settling from higher levels of the air being carried by the turbulent flow in the lower atmosphere fall on a larger area.

It is interesting to note that, as mentioned above, the radioactive materials presumably originated from Nevada experiments carried out in the spring, 1955, were also detected at many places in Japan. In this case, radioactive dusts arrived at Japan in about 10~20 days after detonation.

M. ABRIBAT *et al* [8] and H. GARRIGUE [9] observed also the artificial radioactivity in rain water precipitated on the region of Paris and other places. According to them, the radioactive rain-out due to Bikini-tests in June to July in 1946 and Nevada experiments in the fall of 1951 reached Paris respectively in about 20 days and 8~15 days after detonation. In these experiences including those in the USA and in Japan, the dusts might have been transferred by speedy, westerly winds in the upper atmosphere except in the case of radioactive rain-out observed in Japan in May, 1954 [10]. As a result of a rough estimation of the flow rate of dust particles it was found to be of the order of 1000~2000 km/day on an average. The maximum speed ever known was 3000 km/day in the case of hail storms in Troy area, N.Y., USA, in April, 1954 [4].

It has become obvious that the effect of radioactive fall-out due to atomic explosions is on a global scale. In the cases of the radioactivity observed in Japan last autumn, the site and the date of explosion were unknown, but, considering from the flow rate, the estimated date of explosion, results of radiochemical analysis and meteorological conditions, it would be not inappropriate to suppose that the radioactivity might have come from somewhere in USSR even if it was situated far from Japan.

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