Office Memorandum • UNITED STATES GOVERNMENT

TO : Those Listed Below

DATE: February 9, 1955

FROM : Merril Eisenbud, Manager
New York Operations

410805

SUBJECT: TRANSLATIONS OF JAPANESE ARTICLES

SYMBOL: M:ME

Attached are the following articles which have been translated from the Japanese either in whole or in summary as indicated:

1. "Rain from South and Snow From North" by Dr. Yasuo Miyake

2. (Summary) "Effect of the Hydrogen Bomb Explosion On The Rice and Vegetables" by Dr. Tomoji Egawa.

3. "Ash of Bikini and Its Effects On Human Body" by Dr. H. Kakehi.

4. (Summary) "Why Fishing Boats Were Contaminated By Radiation" by Dr. Eizo Tajima.

At the present time arrangements have been made to translate "Studies On Influence of Radioactivity From the Point of Fisheries Science" (Preliminary Report IV) published under the direction of Profs. Mori, Matsue, Suehiro and Miyama. Copies will be distributed if available.

Addressees:
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RAIN FROM SOUTH AND SNOW FROM NORTH*

by

Yasuo Miyake

As a result of the explosion of the hydrogen bomb at Bikini, many places in Japan had rain contaminated with artificial radioactivities since May 14. It continued until September and material like drink water, vegetable, tea and milk had been contaminated to the fear of people. Though the rain in Japan was expected not to carry the radioactivity any more beyond the middle of September because of the change in the distribution of atmospheric pressure, districts of Tohoku and Hokuriku began to have the radioactive rain this time made in Russia. Thus Japan is now exposed to the ash of death from the both sides.

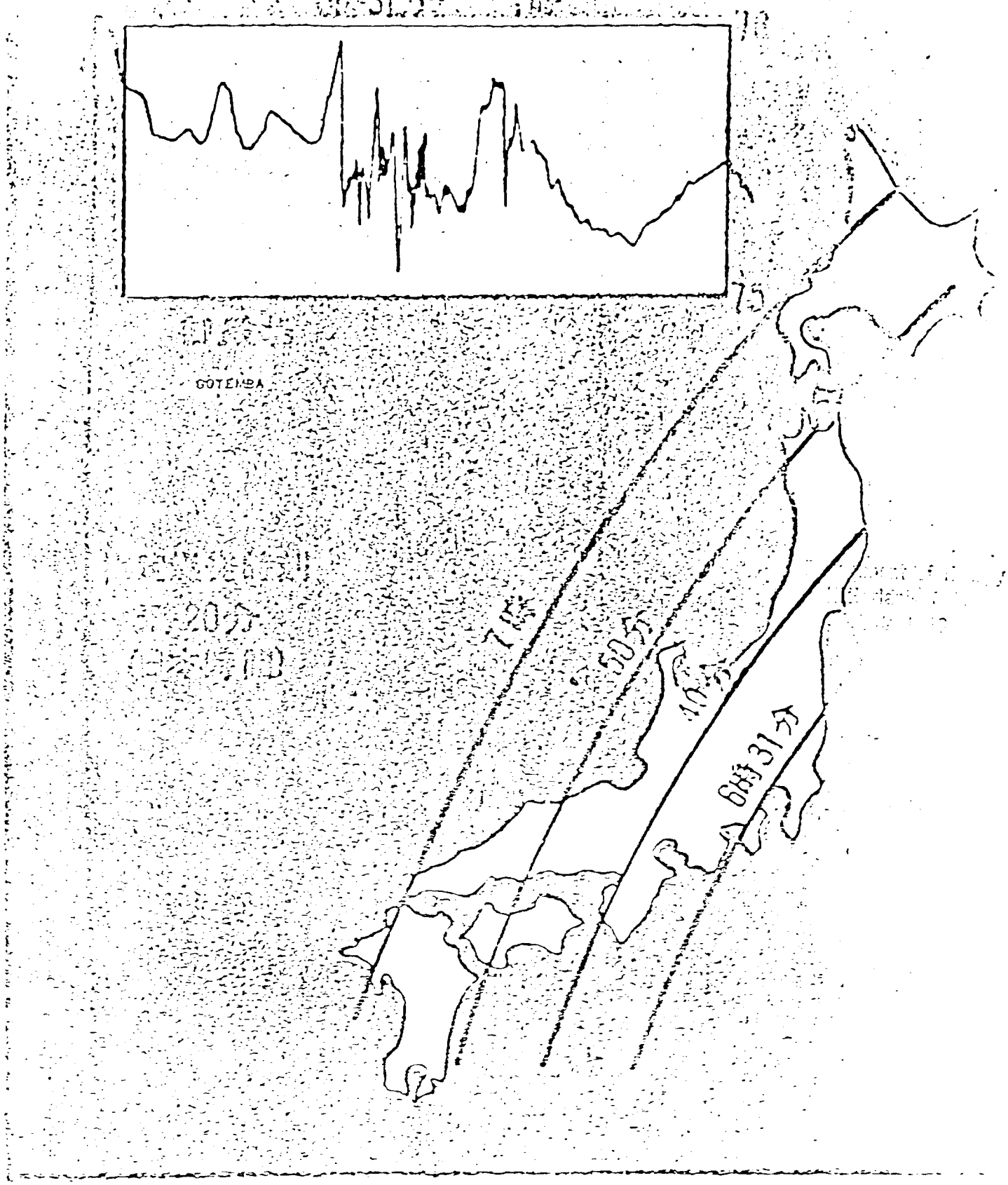
In the above, we have classified the radioactive rains simply into that coming from Bikini and from Russia. We shall explain in the following on what scientific basis this judgment is made.

Detection of Atomic Explosion:

It is one of the secrets of a country how it detects the atomic explosion occurred in other countries. But one may be able to point out various possible ways of detection as follows: (1.) Anomalous oscillation of atmospheric pressure (2) Anomalous vibration of the surface of the ocean (tidal wave in small scale) (3) Wave of earthquake (4) Radicactivity in the atmosphere (5) Radioactive rain (6) Anomaly of the atmospheric electricity. Some of these phenomena have in fact been observed in Japan as a consequence of the experiments in the Bikini area since last March.

One of them is the anomalous oscillation of atmospheric pressure. Mr. R. Yamamoto of the Department of Meteorology of Kyoto University noticed that the sensitive barometer at Shio-no-misaki recorded an anomalous oscillation several times since March 1 and interpreted it as a phenomenon due to the experiment of the hydrogen bomb. Afterwards, the records of barometers from various districts of Japan were put together, from which the curves of Fig. 1 were obtained showing the variation of the intial times from place to place when the anomalous oscillation of atmosphere occurred. From these curves, it is found that the velocity of the anamalous pressure wave is 285 m/sec. on the average, which is somewhat slower than the velocity of sound. Calculating from this value, the dates of the experiments are estimated to be:

*Printed in KAGAKU ASAHI, December 1954. (Translated by Toichiro Kimoshita)



第1図　ビキニ水爆実験による津波　5月5日 (MAY 5)

FIG. 1 PRESSURE WAVE DUE TO H BOMB EXPERIMENT AT BIKINI

March 1	3:45 A.M.
March 27	3:30 A.M.
April 26	3:04 A.M.
May 5	3:03 A.M.

by the Japanese Standard Time. (The accuracy is ± 5 min.)

The next evidence is the anomalous vibration of the surface of sea. The tidal indicator of the observation points on the Pacific coast detected the tidal waves caused by the explosion of hydrogen bomb. This wave arrived at the Japanese coast about one hour and a half later than the anomalous atmospheric oscillation. (See Fig. 2).

Radioactivity in the Atmosphere -- Thirdly, the radioactivity is observed in the air as well as in the rainwater. Mr. T. Shiokawa of Shizuoka University have been measuring the radioactivity of the ash which is obtained by burning a vaseline-coated paper (30cmx30cm) exposed to the air on the roof. He observed a radioactivity of 750 cpm from a paper which was exposed outdoors from May 13 to May 16. Meanwhile, at Kagoshima, Mr. M. Kamata of Kagoshima University observed a radioactivity of 4000 cpm/l in the rain of May 14. Then Mr. T. Shidei of Kyoto University observed on May 16 a striking amount of radioactivity (86,000 cpm/l) in the rain. Thereafter the rain began to show strong radioactive contamination at many places on the Pacific coast.

Judging from the data obtained by the barometers and the tidal indicators, the explosion on May 5 is the one closest to the middle of May when the radioactive rain began to fall over Japan. This is just the beginning of "tsuyu" (rainy season) of this year. If one studies the motion of the air mass at this time, one will find that the air mass around Bikini goes round the rim of the zone of high atmospheric pressure in the north Pacific, arrives at southern Japan through Philippines and Formosa, and forms the "tsuyu" front line to pour the rain there. Since it takes about a week for the air mass to travel from Bikini to Japan, it will be around May 13 or 14 that the radioactive substances produced by the May 5 explosion arrives at Japan. (Fig. 3). The measurement of the halflife at that time also indicates that the explosion took place about 7 or 8 days ago.

Furthermore, it was clearly shown that the radioactivity in the rain, since May, had been stronger on the Pacific coast than on the Japan Sea side by an order of magnitude.

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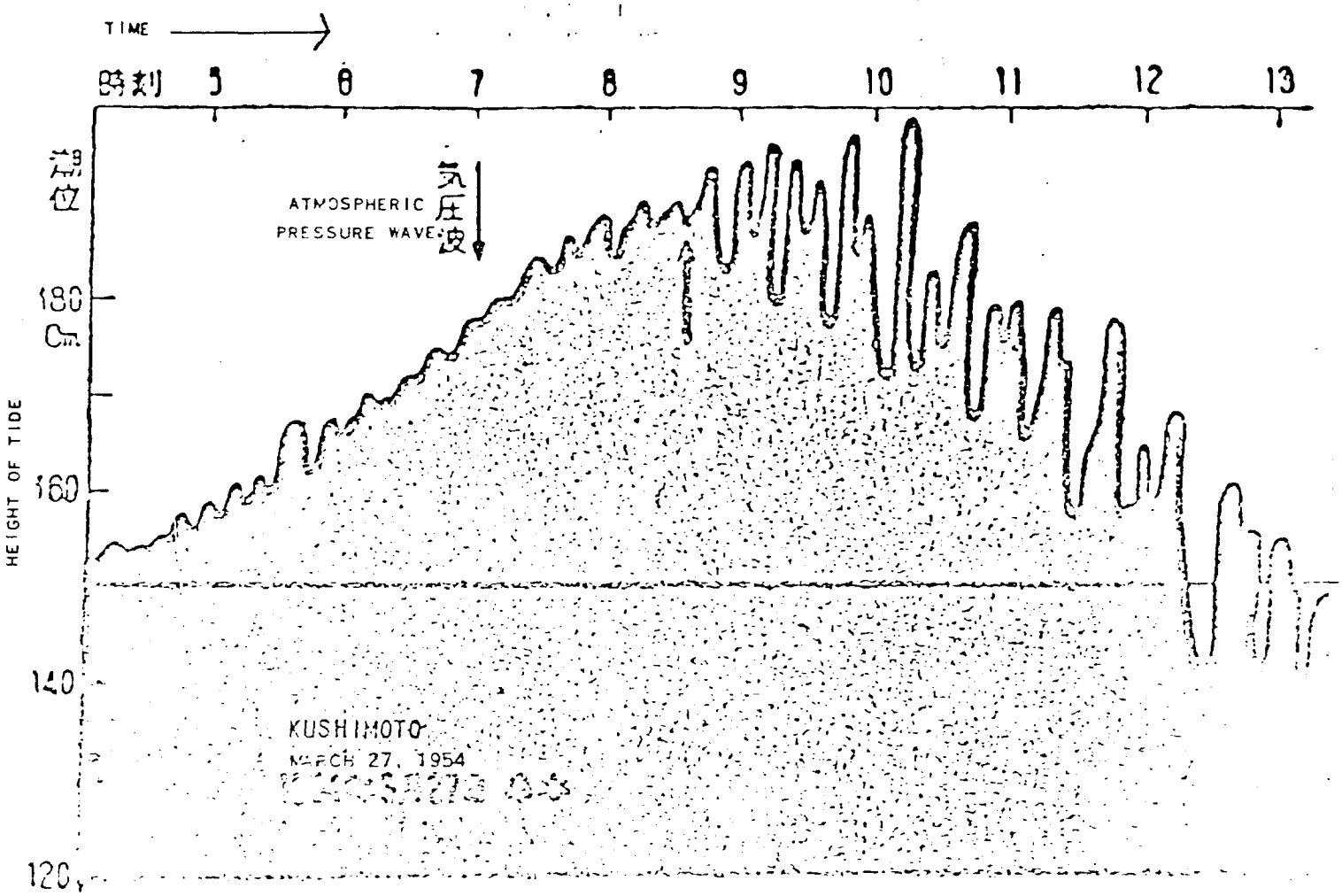
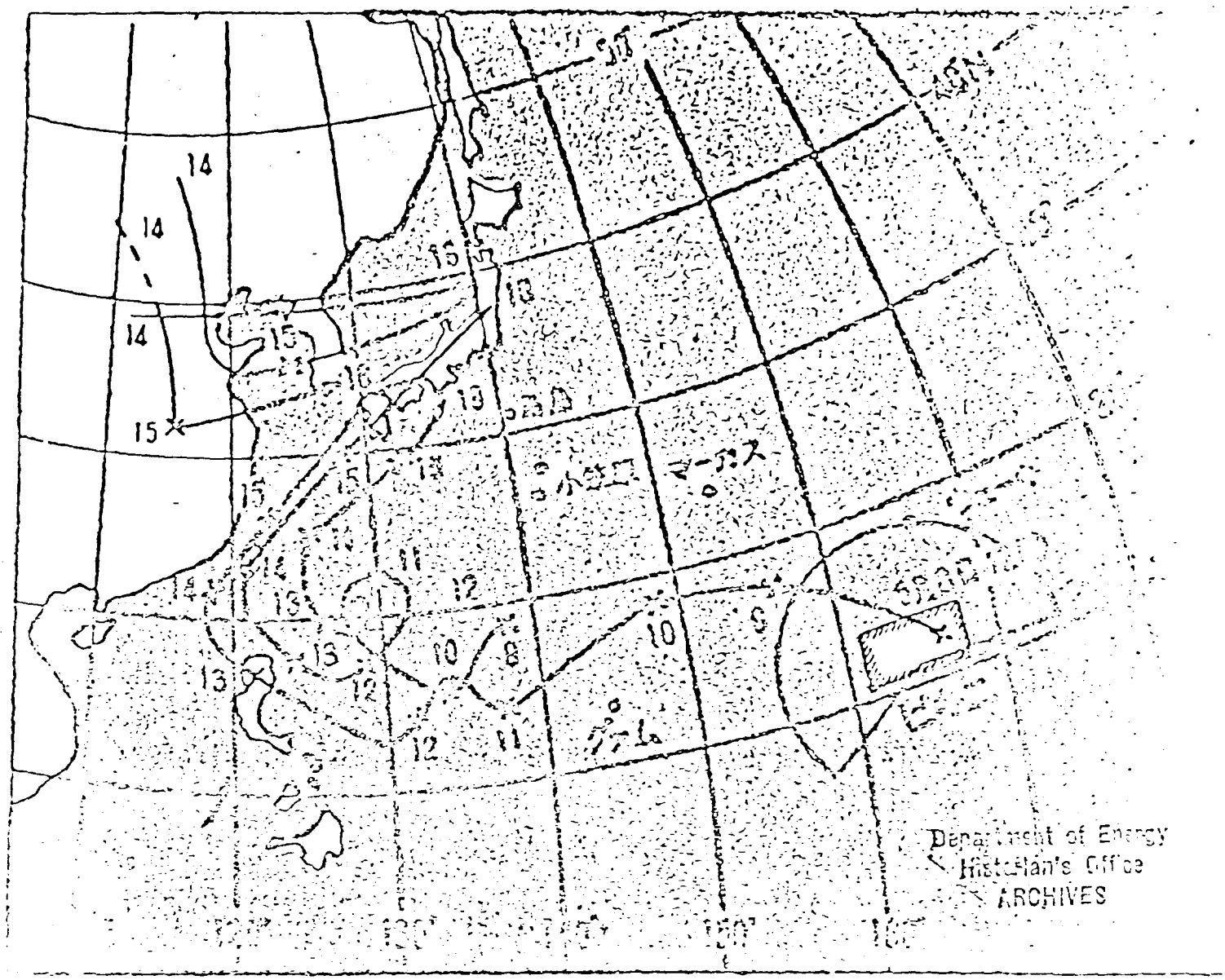


第２図　ビキニ水爆実験によって起きた海面の異常振動

FIG. 2　　ANOMALOUS OSCILLATION OF SEA SURFACE DUE TO H BOMB AT BIKINI



第3図　今年5月8～16日　高度10,000フィートの流跡図

FIG. 3　MAY 8 - MAY 16, 1954　STREAM LINE AT ALTITUDE 10,000 FEET

By chemical analysis of the radioactive rain, the existence of the following elements are detected: Ba^{140}, Sr^{89}, Zr^{95}, Nb^{95}, Y^{91}, La^{140}, I^{131}, I^{132}, I^{133}, $Te^{129}(m)$, and U^{237}. According to Mr. Yokoyama of Tokyo University considerable amount of the trans-uranium element N_p^{239} (half-life 2.3 days) seems to exist in the rain. On the basis of these observations, it may be concluded that the radioactive rain of middle May results mainly from the Bikini experiment of May 5. The half-life of the radioactivity observed in the rain had become longer and longer afterwards. In mid-September rain of several hundred cpm/l had been observed in Tokyo, the half-life of which being about 60 days.

Members of Miyake laboratory of the Meteorological Institute collected the radioactive substances in the air using an airplane in cooperation with the Asahi-shinbun. They found an artificial radioactivity of $0.8 \sim 2.0 \times 10^{-12}$ curie/m^3 on the average in the atmosphere 1000 m to 3000 m above sea level. Furthermore, people of Ishii laboratory of the Meteorological Institute tried to detect the artificial radioactivity in the high atmosphere making use of a radio-sonde. They observed radioactive deposits of 70 cpm on a rubber balloon (800 g in weight) which went up to 19 km above sea level. Most of the radioactivity was found on the upper half of the balloon.

Russian Experiment of Atomic Bomb

It was anticipated on the basis of various information that Russian experiment of atomic bomb would be held about the end of August. Thus careful observation of barometer has been continued and the half-life of radioactivity has been measured at each rainfall. No definite result has been obtained until September 16 when Tass announced that the experiment was over. There was hardly any moment of relief, however, before the rain which fell in the districts of Tohoku and Hokuriku in the early morning of September 19 was found to carry strong artificial radioactivity. On September 22, a record-breaking amount 124,000 cpm/l of radioactivity was observed in the rain at Yamagata. Just about this time the Typhoon No. 14 left Japan off Kashima-nada in the early morning of September 19 and, in turn, the dry and cold air streamed into Japan from Manchuria area. The radioactivity was found only in the rain of Tohoku districts which was supplied by the cold front line formed by that cold air. On the other hand, there was almost no radioactivity in the rain which belonged to the warm front line on the Pacific coast. It is thus clear that the source of this radioactivity is not in Bikini but lies in some place to the north of Japan. (See Figs. 4 and 5).

The source of the cold air which came upon Tohoku around Sept. 19 can be traced back along the stream line, which passes through Manchuria and the vicinity of the Baykal lake, to the central or northeastern part of Siberia. It might thus be supposed that the experiment was done somewhere in northeastern Siberia or Arctic coast.

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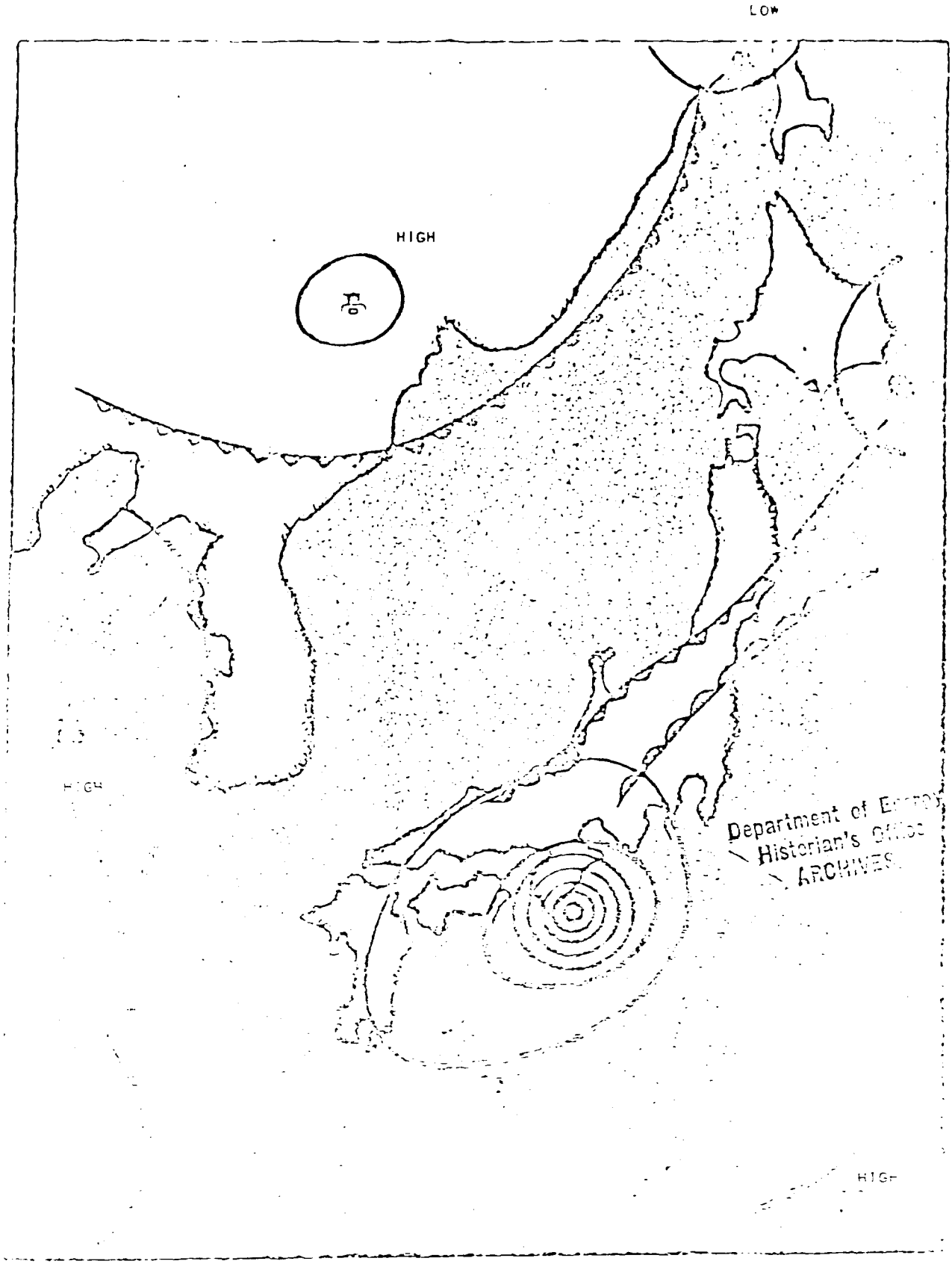
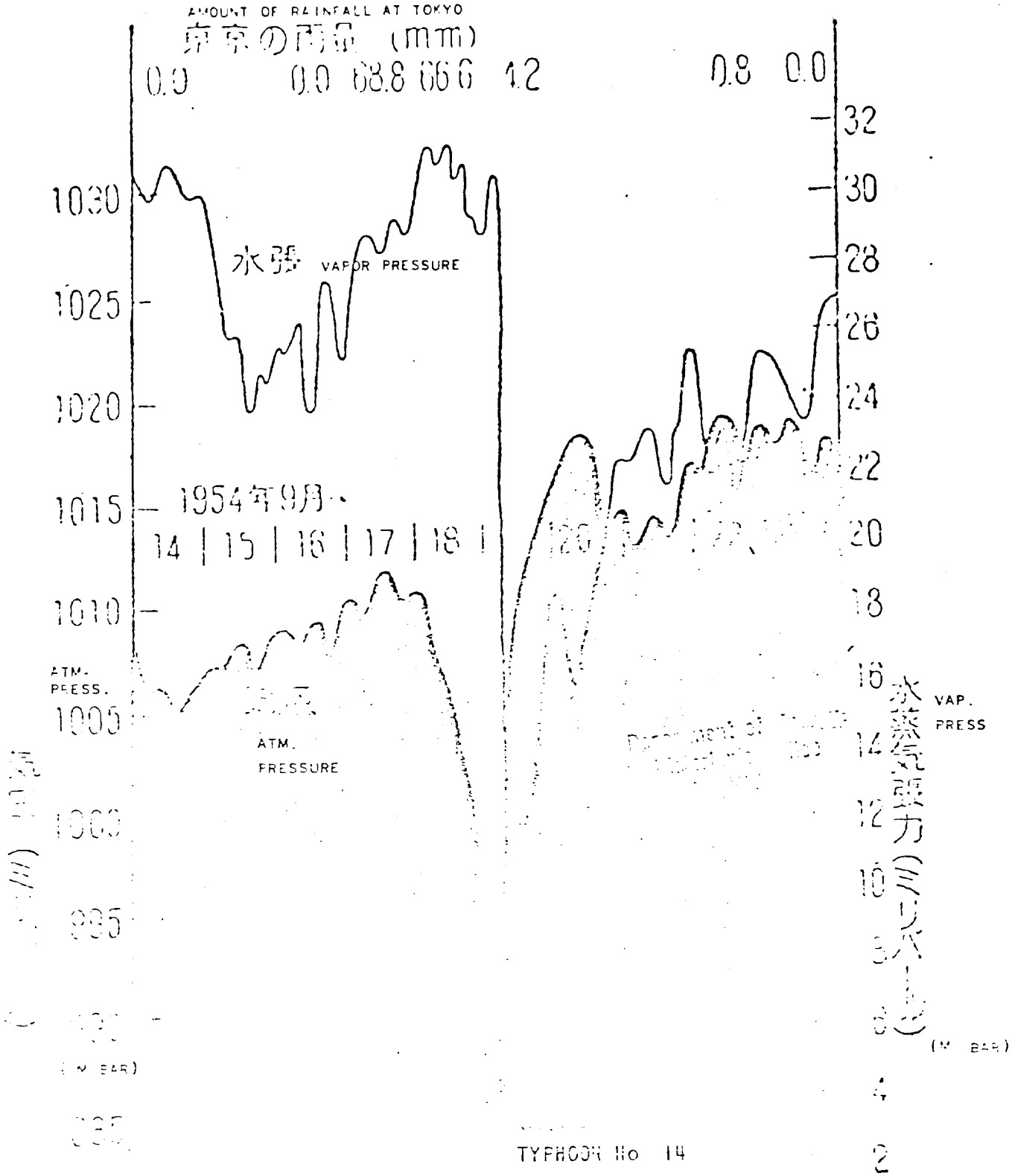


第4図　今年9月18日の天気図

FIG. 4　　WEATHER MAP　　SEPTEMBER 18, 1954



第5図　9月19日前後の気圧　水蒸気張力　降水量

FIG 5　ATM. PRESSURE, VAP. PRESSURE, AMT. OF RAIN FALL AROUND SEPT. 19 1954

In this case, the anomalous oscillation of the atmospheric pressure was not observed. This might indicate that it is rather an experiment of a large atomic bomb rather than the real hydrogen bomb. The half-life of the radioactivity observed after September 19 is short, being of the order of 7 to 10 days. Of course, this simply means that the explosion occurred very recently and not that the Russian bomb is made of radioactive substance of shorter half-lives. By the way, as is seen in Fig. 6, the air mass to the north of Japan receded northwards around September 25 and the air flowed to Japan from the south. It is interesting to notice that the amount of radioactivity carried by the rain decreased quite appreciably during this period.

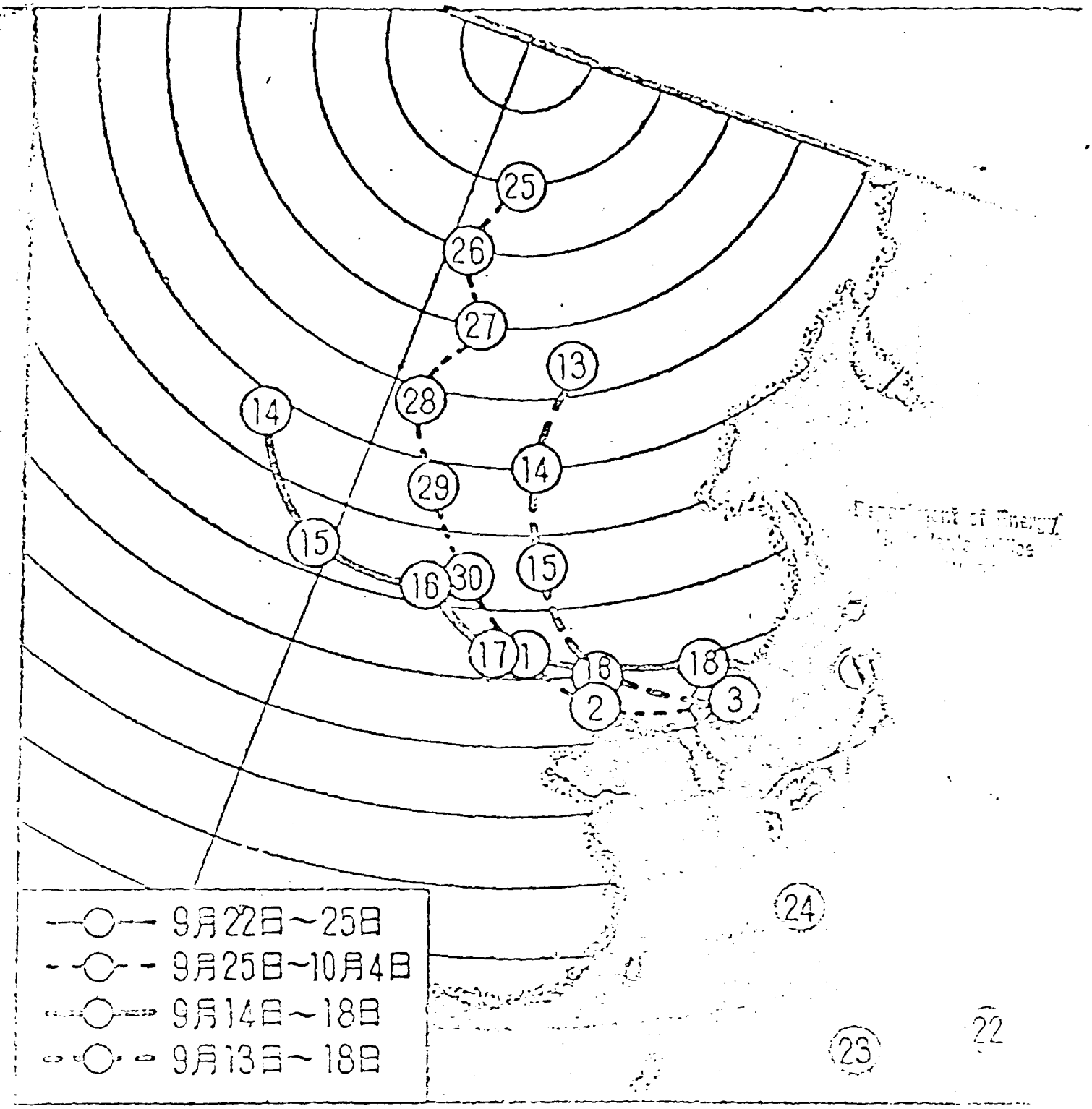
The result of chemical analysis shows that this rain involves the artificial radioactivity consisting of nearly the same elements as that made in Bikini. As mentioned before, this case is contrasted to the Bikini case in the sense that the radioactivity appeared only in the Tohoku district and the Japan sea coast and not on the Pacific coast. On the basis of the above information, it was concluded that the radioactive rain reported after September 19 was produced in Russia.

Dangerous Radioactive Snow

It may be a troublesome problem if the Russian-made radioactive rain turns into snow and falls on the Tohoku and Hokuriku districts which are the places suffering annually from heavy snowfall. It is not known how long the Russian radioactivity will remain to stain the rain or snow, but in view of the Bikini case, it may be expected that the radioactive rain of several hundred cpm/l will be observed for a considerable period.

It is well known in the case of natural radioactivity that the snow is a better collector of radioactive substances in the atmosphere than the rain. This is due to the fact that the snowflake goes down slower in the air than the raindrop. Thus, when the contamination of the air is of the same order, the snow will become more radioactive than the rain.

Usually 60 to 70% of the rain water escapes directly into the river. On the other hand the snow will stay on the ground for a long time and have a larger probability to sink into the soil. Though it is very unlikely, people in the snowy districts might happen to be exposed to the radioactivity over a long period, if the snow falls with strong radioactivity. There is also a possibility that the water of rivers become radioactive when the snow melts and contaminates the water for drink as well as the water in shallow bays along the coasts resulting in a damage to the sea products. The most dangerous of all is, however, the case where the snow itself is used for drinking and cooking which is likely to occur in the mountain districts. The only practical method available in such cases will be to



第6図　9月から10月にかけての高度1,000フィートの流[illegible]

FIG 6　STREAM LINE AT 1,000 FEET BETWEEN SEPTEMBER AND OCTOBER, 1954

use some effective filter which makes use of, for instance, the diatomaceous earth.

For the present, there may probably be no danger of the radioactive snow. However, it will never be too early to begin the study of the measures to meet the possible radioactive snows which might be produced by future atomic explosions.

SUMMARY OF "EFFECT OF THE HYDROGEN BOMB EXPLOSION ON THE RICE AND VEGETABLES"*

by

Tomoji Egawa

A. Vegetables

1. The artificial radioactivity of vegetables was measured after Sept. 10. Some of the vegetables show considerable amount of trace of artificial radioactivity. At the end of June, the half-life of the radioactivity was estimated to be of the order of 30 days. (no measurement of half-life was done since then.) It is remarkable that some vegetables still show high counting rate in spite of the time interval of 4 months since the last explosion.

2. In general, it is the stem and leaf that give high counts. Therefore, attention should be paid to those vegetables whose leaves are used as food.

3. There is hardly any radioactivity in the fruits or seeds which ripened in recent time.

4. It is difficult to determine whether these radioactive substances are simply external or absorbed in the body.

B. Wheat and Barley

1. Of the wheat and barley harvested in 1952 and 1953, no artificial radioactivity was observed except for 2 cases (10 in all).

2. The reason for contamination of these 2 cases is unknown and is being restudied.

3. The result of study on wheat and barley harvested in 1954 is as follows:

	cases	Highest Count	Lowest Count	Average
grain	16	14	3	6
stem and leaf	13	33	9	23
bran	8	38	18	28

where the unit is ct/min/10 gr.

*Printed in KAGAKU ASAHI, December 1954. (Summarized & translated by Toichiro Kinoshita)

4. The contamination of grains of wheat and barley may have some significance since these are main foods of the Japanese. For instance, if one eats 300 gr. of wheat every day which is contaminated by 14 ct/min/10gr. the radioactivity amounts to 420 counts which may not be an insignificant figure in view of the controversial safety limit of radiation hazard.

C. Rice

1. Rice of 1952 seems to be free from artificial radioactivity (one example only. Grain, chaff, and bran are investigated).

2. Rice of 1953 has no artificial radioactivity. (2 examples).

3. Three samples tested at Hokuriku agricultural experimental station shows clearly the contamination of artificial radioactivity in the bran and chaff but no radioactivity in polished rice grain.

4. Two samples at Niigata agricultural experimental station have hardly any artificial radioactivity in the bran, and no trace at all in the polished rice grain.

ASH OF BIKINI AND ITS EFFECTS ON HUMAN BODY

by

H. Kakehi

1. Introduction (omitted).

2. Physical Properties of the Ashes:

According to the report of the fishermen of Fukuryu Maru, the ash began to come down about 3 hours after the hydrogen bomb explosion. It continued to fall about 5 hours at varying rates and covered the boat like the light snow that footprints were left on the deck as they walked around.

The ash consists of light and white grains of various size less than 1 mm in diameter. Microscopic examination shows that they are amorphous and porous. It might be the fragment of the coralline substance. (Fig. 1) Its radioactivity was surprisingly strong and even a few grains of ash showed ten-thousands counts per minute on March 16. The thickness of the absorber to reduce the intensity of radiation to a half (or the inverse of the absorption coefficient) is 47mg/cm^{2}Al=0.2mmAl for the β - ray and 5.5mmPb for the γ - ray (March 17). The radioautograph of the β-ray from the ash is shown in Fig. 2. The half-life was about 8 days at first, but it is in these days (about April 5) of the order of 18 days. Extrapolating the damping curve of radioactivity observed after March 17, the intensity of the β- ray on the next day of the explosion (March 2) is estimated to be about 50 times larger than that of March 17. Similar result may be obtained for the γ- ray too.

The chemical analysis of the ash has been performed at Kimura laboratory (Department of Chemistry, Tokyo University). The result published so far is shown in Table 1. There are several definitions of the half-life according to the purpose as is shown below. The half-life given in Table 1 is the physical half-life defined as the period of time during which the amount of a particular radioactive isotope is reduced to half its initial value. The biological half-life is the time during which the amount of elements deposited in some part of the body decreases to half as a result of assimilation, dissimilation, alteration, excretion, etc. The effective half-life is the time during which the radioactivity of the deposited radioisotope is reduced to half as a result of combination of the two effects mentioned above. This is the quantity which must be taken account of in discussing the injury produced by the radioactive elements deposited in the human body.

*Printed in Journal of Japan Physicians Society, Vol. 31, No. 9 (May 1, 1954)
(Translated by Toichiro Kinoshita)

In Table 2 the physical, biological, and effective half-lives of the main elements which are supposed to deposit in the human body are given together with the organs in which they tend to deposit.

As is evident from this, these elements have a tendency to deposit in the bone, thyroid, kidney and liver. There may be some rare earths which have not been detected yet. If they exist, they will also deposit in these organs.

In the animal experiments, the Bikini ash was given to the animals with the food and also by the hypodermic injection and then their autoradiograph was taken. The result is the same as that of Table 2. Especially, the deposit is found to be the largest in the bone. This is very important in connection with the problem of prognosis of the patients.

The result up to March 26 of quantitative analysis making use of the radioactivity of these elements is shown in Table 3. (Kimura Lab.) To our slight relief in this unfortunate accident, more than 50% of the radioactivity is found in the rare earths while the amount of Sr^{90} is only of the order of 0.02%. The radioactive elements are absorbed in various ways through the digestive organ, respiratory organ, skin, etc. The rate of absorption of course depends on the elements and the chemical compounds which they form.

3. Clinical Problems:

Injury of patients of the Bikini accident has been caused by the radiation of the fallout in contrast to the atomic bomb injury at Hiroshima and Nagasaki. In the former, the injury is caused either by the irradiation of β- and γ - rays of fission products located outside or on the surface of the body or by the irradiation of special organs such as the bone, thyroid, kidney, and liver in which the fission products are deposited by means of absorption through the respiratory organ, digestive organ, skin, etc. In the latter, the main cause of the (radiation) injury is the exposure to the initial nuclear radiation though there may be some effects of the induced radiation from inside and outside of the body. Thus the characteristic danger of the Bikini ash lies in the fact that the fission products deposit in such organs as the bone, thyroid, kidney, and liver; irradiate them, and moreover, are difficult to take out of these organs.

To understand better the effect of radiation on the living body, we shall first see what reaction will happen when the energy of the β - or γ - ray is absorbed by a cell, which is a unit of the life. In general the living body contains a lot of water which will be ionized by the radiation yielding the free radicals like $H^{\cdot}$ and $OH^{\cdot}$ or the harmful molecules like H_2O_2. If this happens, the function of cell is damaged and such a biological change follows as the destruction of

chromosome, the change of permeability of the cell membrane, the suppression of cell-division, the decrease of leucocyte, the induction of the boil, death, etc.

One of the most important facts about the biological effect of radiation is known as the law of Tribondeau-Bergony which asserts that the cell is most sensitive to the radiation when it is young and has the tendency of cell-division. For instance, in the human body, blood-producing organs (bone, spleen, lymphatic, etc.) and genital cells are most likely to be injured by radiation.

The injury of radiation from outside of the body may be classified into two categories. One is caused by the β - ray of fission products adhered to the skin. In this case, the skin turns to black, gives rise to bleb or fester, and the hair may be lost from the head. In fact, hands and faces of two patients who entered the Tokyo University Hospital on March 15 were black and had festers at some places. It was found by a Geiger counter that the radioactivity was strong at the head, ears, neck, armpits, abdomen, sole, parts of hands or feet between the fingers or toes. The result of measurement by the miliroentgenometer (distance 5 cm) is given in Table 4. The radioautograph of the hair is shown in Fig. 3.

The other is caused by the γ - rays of radioactive substances adhered to the deck, cabin, fishing implements, clothes, etc. Since the γ- ray has a large penetrating power, it will irradiate the whole body and cause the change of blood (decrease of leucocyte), recurrent anemia, depilation, injury to the genital cells, hereditary change, etc.

As is well-known, we are incessantly exposed to the cosmic-ray from the sky and the radiation of natural radioactive substances like radium and radon from the earth. Nevertheless, we are not injured by these radiations, not to a visible extent at least. This is due to the fact that even the exposure on successive days has no damage if the amount of irradiation is less than a certain limit. The maximum amount which the human body can tolerate is called the permissible dose. The international society of radiology determined that the permissible dose is 300 miliroentgen per week. People living on a boat are exposed to the radiation at any time so that the permissible dose is 1.8 mr per hour. The intensity of radiation on the Fukuryu Maru measured at Yaizu on March 17 was 10 ~ 100 mr per hour which was 5 ~ 50 times the permissible dose.

In Table 5, it is shown how the intensity of radiation changes from place to place in the boat and how it changes with time. It is seen that on the average the intensity decreased to about 20 ~ 30 % of the value of March 17 during the period of a month. If one estimates the intensity of radiation on March 2 from the damping curve, it is about 50 times larger than that of March 17. Several hours after the ash began to come down many fishermen felt sick and some vomited. This is the so-called

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radiation crapulence. The estimated dose of radiation the fishermen received during the following two weeks is about 200 r. It is therefore not amazing that the bone and other organs suffered considerable injuries.

Next, we shall discuss the most important problem, namely, the deposit of the radioactivity in the body.

The outline of this problem was given already when we referred to the chemical analysis of the ash. We shall therefore begin here with the survey of the animal experiments. The radioactive deposits in various organs of mice are measured 12 hours and 48 hours after they were fed with the Bikini ash (fission products)(Tables 6 and 7 respectively). It is thus found that, though most part passes by the digestive organs, some part is absorbed and deposits selectively in the bone, thyroid, kidney, and liver (Table 8). When the fission product is given to the mice by hypodermic injection, it is found to deposit in the bone, thyroid, kidney, and liver in the same way as above and excreted through the digestive organs and with the urine (Table 9).

As to the patients, the radioactivity of the urine (15 cc) collected in a _____ tube at the early dates was measured and the number of counts was found to be several times the background counting. The same result is obtained for the concentrated urine. These are the evidences for the deposit of the radioactivity in the patient's body.

The radioactivity was also measured by a scintillation counter placed near the thyroid. In one case, the count was 8 times that of the background on March 26 (see Fig. 4) and 2 times on April 13. From the half-life and the absorption curve of the γ-ray, it is presumed that I^{131} deposited in the thyroid. Similar conclusion is arrived at for other patients, too.

On the basis of the fundamental observation described above, we shall discuss the clinical symptoms.

It is convenient to cite the following statement published on April 14 by the clinical subcommittee of the Council for the Investigation of the Atomic Bomb Sickness of the Department of Public Welfare in the names of Yoshio _____, the Director of Tokyo University Hospital, and Shigenobu Kuriyama, the Vice Director of the First State Hospital of Tokyo:

"On March 28, five of the patients of Bikini accident entered the Tokyo University Hospital (seven in all because two patients had been there already) and 16 patients entered the First State Hospital of Tokyo. Though the degree of injury varied from person to person, all of them were found to be the patients of the acute radiation sickness due to the radioactive ashes.

"The radioactivity inside and outside of the body was considerably high at the time of their entrance to the hospitals. But it decreased later on by an appropriate treatment. The content of

radioactivity in the patient's urine has also been reduced very much by now.

"The symptoms may be described separately for the external injuries to the body surface and the injuries to the organs, especially the blood producing organs.

"All patients suffered on the head and the upper half of the body such external injuries as the depilation, deposit of pigment, inflammation of the skin, ulcer, eruption with abcess and scab, and blister. They are recovering from these injuries by the treatment in the hospitals. But some of them are still suffering from the depilation in wide area.

"The injury to blood-producing organs was observed as the decrease of blood count of leucocyte, granulocyte and red blood corpuscles as well as the decrease of the number of cells in the marrow. It was getting worse since they were hospitalized. Especially, the blood count of leucocyte fluctuated around 1000 per cubic milimeter and the number of marrow cells has been of the order of 10,000 per cubic milimeter in several cases. It was thus hematologically diagnosed to be the general acute sickness of the marrow.

"In these cases, in spite of the ample blood transfusion and the use of pills for blood-production, the blood count of the leucocyte and granulocyte did not increase and even the hemorrhagic tendency appeared. Furthermore, their temperature had been as high as 39°C though very effective pills of antibiotic _____ had been given, which has made us fear of an unfavorable prognosis. Such a dangerous condition continued until recently and we had to refrain from publishing the facts in order to avoid undesirable effects on the treatment of the patients. Fortunately, however, the fever began to leave the patients very recently and moreover the blood count of leucocyte in some of the serious cases began to increase. We are working hard to cure the patients completely. It would be our duty and also the hope of all people to save the lives of all patients of this unfortunate accident."

Summarizing the clinical symptoms, it may be said that the skin burn by the β - ray has almost been cured. There is now hardly any detectable radioactivity remaining on the skin surface. The most serious problem is the injury to the marrow. Two causes may be responsible for this. One is the radiation (especially the γ-ray) from outside, and the other is that of the radioactive elements deposited in the body. The clinical symptoms observed up to now may be mainly caused by the former although some part might have been played by the latter too. This may be evident in view of the fact that the estimated radiation to which the fishermen were exposed during the two weeks stay on the boat amounts to 200 r. The intensity of radiation

from the elements deposited in the body (especially in the bone) is small compared to the external radiation. But it may give a considerable amount of injury during the long period since it will continuously irradiate the important organ, namely the marrow. It is therefore necessary to observe carefully the clinical development in the future. For this purpose, it is important to measure and analyze the quantity of radioactivity in the urine. The study is now being proceeded from this viewpoint. In order to discharge the fission products deposited in the bones, EDTA(Ethylene diamine tetra acetic acid) can be used which however is not very efficient. It is reported that in an animal experiment about 20% of the substances were discharged when EDTA-Na and EDTA-Ca were applied alternatively in an early stage of deposit. In our case, too, it may be possible, using EDTA, to discharge the fission products several times faster than otherwise. Since EDTA-Na, being poisonous, cannot be used to the human body, we are now trying to use EDTA-Ca.

4. About the Hygienics of the Environment and the Food:

(i) The Boat as the Living Place — As is discussed in the section of the physical properties of the ashes, the half-life of the fission products on the Fukuryu Maru was changing from time to time. It was about 8 days at March 17 and 20 days at April 22. By this time, the intensity also decreased to about 20% of that of March 17. On April 22, the intensity of radiation in the boat ranged from 2 mr/hr to 20 mr/hr. It may not be very long before the intensity becomes less than the permissible dose 1.8 mr/hr. As is seen from Table 5, the measured intensity for γ - ray alone and the total intensity of both β - and γ - rays are not very different. This may be understood as the result of the distance between the measuring instruments and the β - ray sources, the absorption of considerable amount of β - rays by the wooden parts of the boat into which the radioactive substance soaked, and the penetration of extra γ - rays from remote sources through the ceilings and the walls.

The radiation has an effect on the human body through the ionization so that the amount of injury should be measured by the miliroentgenmeter. It is not appropriate to use the GM -counter. The conversion of results from one to the other is not simple either.

There are many boats besides the Fukuryu Maru on which the ash fell when they were making voage several hundred miles off Bikini. The count of radioactivity on these boats varies from hundreds to ten-thousands by the GM-counter. But the intensity is at most 3 mr/hr when measured at a distance of 5 cm by the miliroentgenmeter. Since the intensity at 50 cm is only one-hundredth of the amount at 5 cm, it may have hardly any effect on the human body. The amount of radioactivity on these boats is therefore very small and trivial compared to the case of the Fukuryu Maru. However, if the radioactivity is present at all, it may have a chance of getting into the body through the mouth, skin or lung. Of course, it is better not to be exposed to the radiation, however a bit it is. It is

therefore necessary to wash and remove the radioactivity from the boat, clothes and the human body. For reference, the radioautographs of the letters written by the oil which was on the deck of the Kōei Maru and the gloves of the crew are shown in Figure 5.

ii. About the Tuna.

Since different people have different interests in this subject, it involves many intricate problems. I will simply refer to the medical aspect of this problem. The question is then how much of the radioactive ash can be eaten together with the tuna without violating the safety of the human body. This is again not a simple problem. First of all, the ash itself consists of various elements and they are absorbed in the human body at various rates. Even the same element will be absorbed differently according to the form of compounds they constitute. Furthermore, they deposit in various organs such as the bone, kidney, liver and thyroid.

Different elements have different half-lives both physical and biological. To simplify the argument, we shall assume for the moment that the ash consists of only the most dangerous element Sr^{90}. In the usual form of compounds, about 60% of Sr^{90} is absorbed by the body through digestive organs and about 40% deposits in the bones. Its physical half-life is about 20 years, while the biological and effective half-lives are 3.9×10^3 days (about 10 years) and 2.7×10^3 days (about 7.4 years), respectively. It is therefore very difficult to discharge once it deposits in the bones. The permissible dose of deposit in the body is 1 microcurie. Since 40% of the absorbed strontium deposits in the bones, it is dangerous to eat more than 2.5 microcuries. It is not unambiguous how much count the radioactivity of 2.5 microcuries will give to the G.M. counter at 10 cm, since it depends on the geometry, measuring instrument, the thickness of the mica window of the G.M. counter, etc. But, roughly speaking, it may be about 5000 ct/min. Since the safety limit adopted today is 100 ct/min at the distance 10 cm, it may be concluded that it is not dangerous at all to eat the tuna though the above calculation is based on several assumptions.

What measure should be taken when the radioactive substance entered the body or one is exposed to the external radiation to such an extent that certain injury is expected? The first thing to do is to have the blood-counting several times. If any anomaly is found, one has to be checked carefully. Next, the radioactivity in the urine should be measured. We shall not discuss it in details here.

iii. Radioactive rain, etc.

Fall of ash, rain and snow with the radioactivity have been observed at several places in Japan. The detail is not available yet. But it may not be dangerous to the human body and others as far as the intensity of natural and artificial radioactivities remains to be of the present order of magnitude.

5. Conclusion. (omitted)

WHY FISHING BOATS WERE CONTAMINATED BY RADIATION (SUMMARY)*

BY

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1. Foreward:

The major problem on the fisheries operations in the South Sea area is where and how fish and fishing boats were contaminated by radiation.

2. How Radiation Examinations Were Conducted:

Examinations through the G-M guage disclose that decks and other washable parts of a boat are weakly irradiated, while lamps and other unwashable parts are strongly irradiated.

The G-M guage can detect only the "beta" and "gamma" rays. The total volume of rays detected by the guage is averagely composed of 20 per cent of the "beta" ray and 80 per cent of the "gamma" ray.

Certain directional relationships were often observable of fishing boats on the degrees of radiation of their stern, bow, larboard and starboard sides. It is discovered that the directions coincided with those of the seasonal winds which were blowing the boats.

The No. 8 Junko Maru engaged in fisheries operations between 10 and 12 degrees of north latitude and between 173 and 170 degrees of west longitude in the period between April 15 and May 4. It can be inferred that the hydrogen bomb test which affected the boat was carried out in the period between the evening of May 4 and May 8.

3. Degrees of Radiation:

If the irradiated boats are classified into those irradiated in the area west of a spot where a hydrogen bomb test was conducted (hereafter called those of "west area radiation") and those in the area east of the spot (hereafter called those of "east area radiation"), of the "west area radiation" category, those of which more than 1,000 counts per minute were detected will constitute 75 per cent, while such high counts were very rarely found of the "east area radiation" category. The average counts of the "west area radiation" category are registered at 123, while that of the "east area radiation" category at 1,800.

4. East and West Area Radiation Categories:

Of the "east area radiation" category, according to Diagram 2-a, the number of counts show sudden rises on the dates when tests were carried out

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and sharp drops on other dates. Another striking characteristic of the category is that the average degree of radiation is very high.

If a hydrogen bomb test is carried out, the radioactive ashes caused by the test will be blown up high above the sky. According to Mr. Ariyoshi of the Central Meteorological Observatory, chances are high that the area east of Kwajalein Island would be showered with more ashes of this sort than in the area west of the island.

The surveys conducted by him on March 1, April 6, April 26, and May 5 show that the area east of the Bikini Atoll was showered with more radioactive ashes than the area west of the atoll. This tallies with the results of our surveys.

Judging, however, from the weather conditions of March 26, we can surmise that the ashes would have fallen over the distant area east of the Bikini Atoll. We can give no adequate explanation to this. Since the hydrogen bomb tests were suspended in mid-May, the degrees of radiation of the boats visiting the area have gradually decreased.

5. Relationships between Fishing Areas and Radiation:

There are found a close relationship between the radiation of fishing boats and the fishing areas. Only one irradiated fishing boat was discovered in the area north of the 15th degree of north latitude.

6. Relationships between "West Area Radiation" and Fishing Dates:

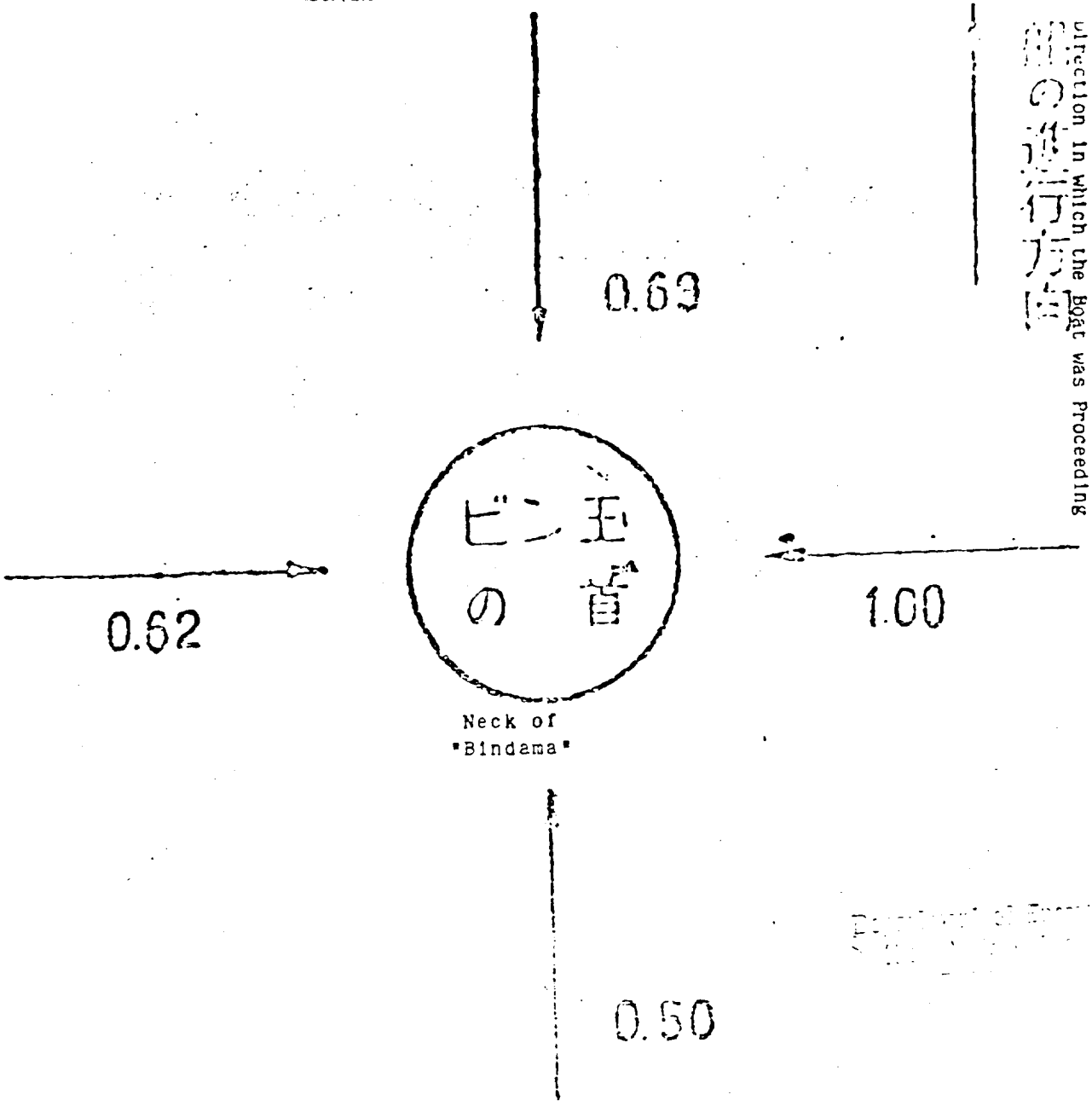
A narrow strip of waters south of the 15th degree of north latitude, extending from east to west, is contaminated with radiation. Any boat which passes there will be found radioactive. The southern end of the irradiated strip of waters will not extend beyond the equator.

7. Case for "West Area Radiation":

The "west area radiation" may have been caused by the radiation of sea water there. In other words the north equator current flows in the sea area between 15 and 5 degrees of north latitude. The area where the hydrogen bomb tests were conducted is in the current. Therefore the irradiated zone moves from east to west.

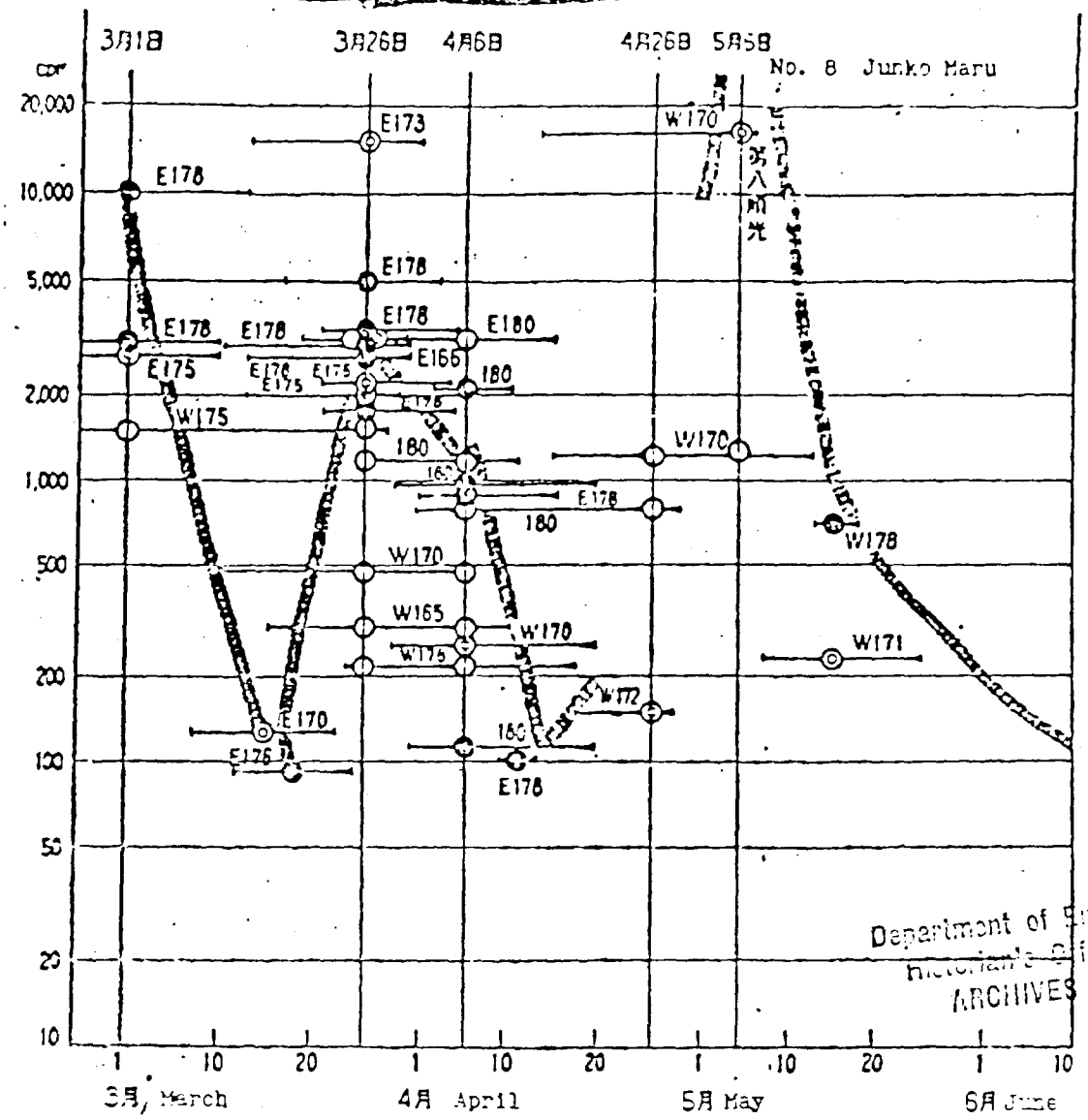
8. Conclusion:

The air over the east of the spot where the tests were conducted is discovered to have been irradiated over the permissible degree. It is also discovered that a fishing boat in the area west of the spot was contaminated by radiation because of the irradiated sea water there.



第1圖　ビンヨの首の放射能の強さ（數字は放射能の強さの比）

Diagram 1 Showing Degree of Radiation of "Bindama, (a kind of fishing tool)"



第2図a　危険区域東方 N10°±3° 以内において漁撈した期間と船の汚染との関係．◎印は漁撈地が E178°±2° で，爆発日と唯1回だけ漁撈期間が交るもの，または全然交らないもの．◎印は漁撈地が E178°±2° 以外で，漁撈期間が爆発日と2回以上交らないもの．○印は漁撈期間が爆発日と2回以上交るもの．波線は◎印を連ねたもの．

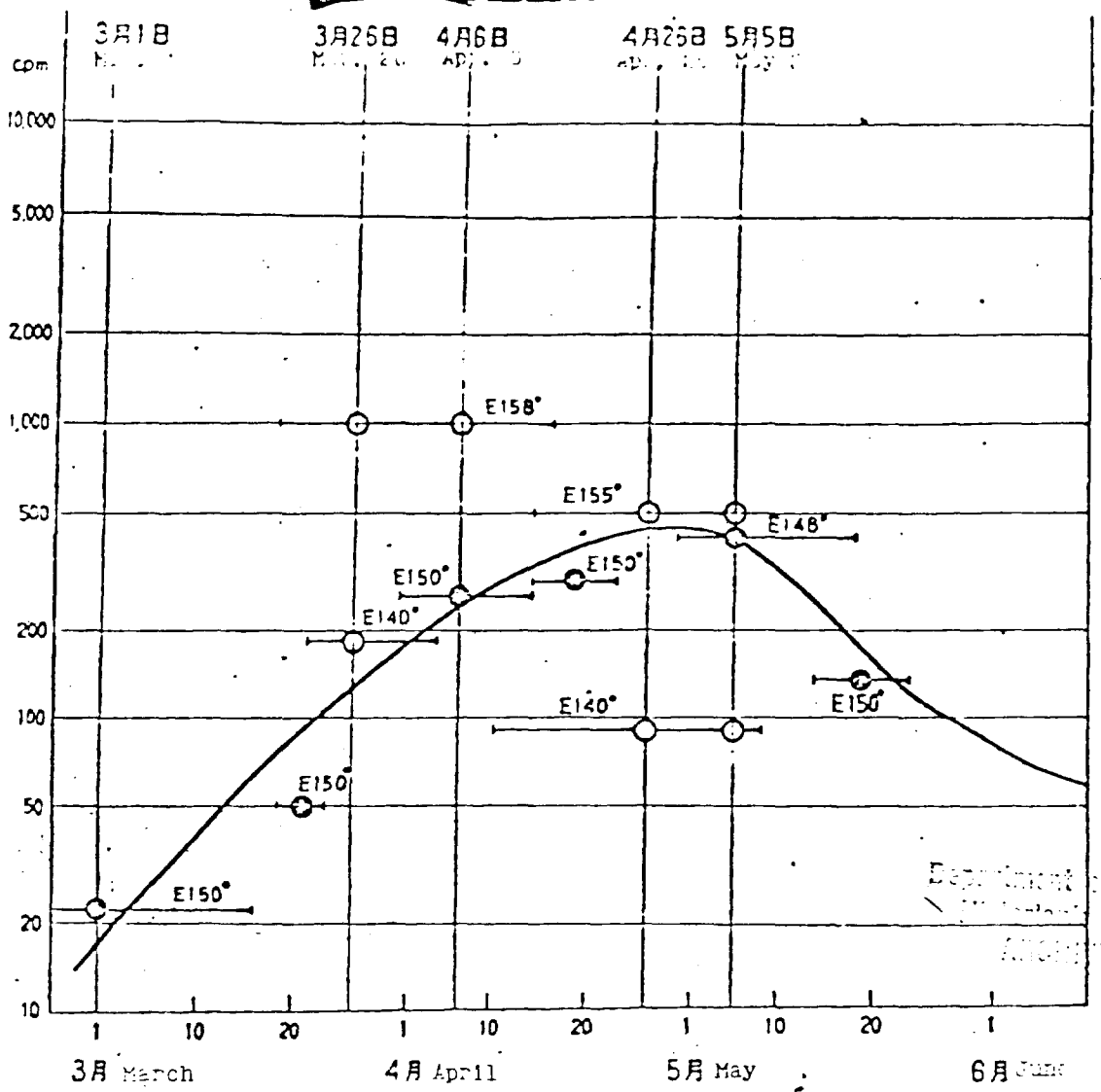
Diagram 2-a Showing Relationships between Fishing Periods and Degrees of Radiation of Boats within the Area between 13 and 3 degrees of North Latitude

Remarks: ◎ Boats which engaged in fishing operations in the area between 178 and 2 degrees of east longitude and during whose fishing operations only one or no hydrogen bomb test was conducted.

◎ Boats which engaged in fishing operations outside the area between 178 and 2 degrees of east longitude and during whose fishing operations less than two hydrogen bomb tests were conducted.

○ Boats during whose fishing operations more than two hydrogen bomb tests were conducted.

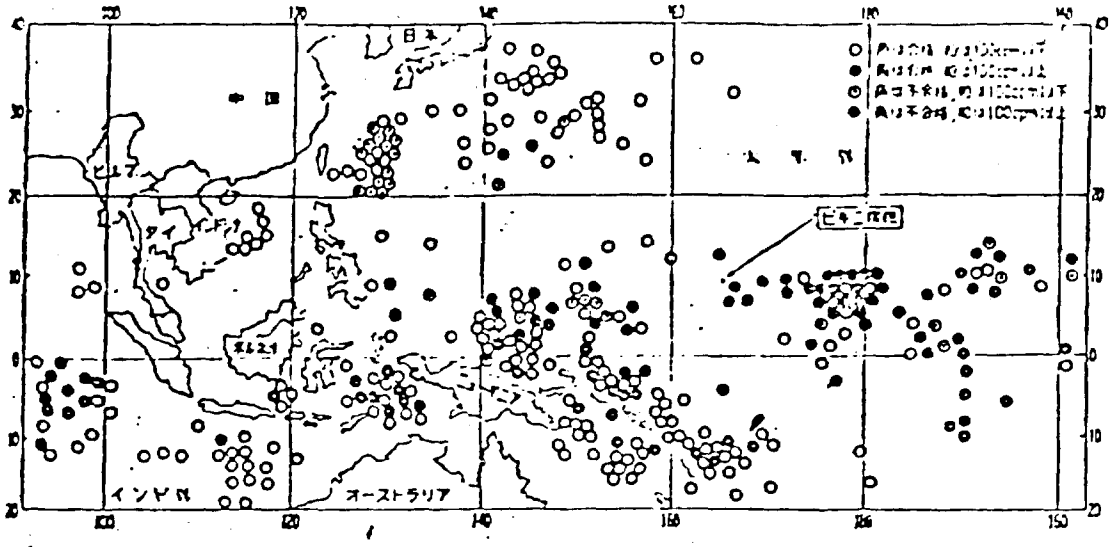
/ Line connecting the ( ) dots.



第2図 b　危険区域西方 N10°±3° 以内において漁撈した期間と船の汚染度との関係（曲線 E150° についてとったもの）

Diagram 2-b Showing Relationships between Fishing Periods and Degrees of Radiation of Boats which engaged in Fishing Operations in the Area between 10 and 3 Degrees of North Latitude.

(The curve shows the relationships at the 150th Degree of Eas. Longitude.)



第3図 漁獲区域と汚染との関係

・強度は 10cpm 以上であった船の通過点を示す。

第3図を見てすぐ気の付くことは次の3つの点である。第1は水爆實驗海域東方において、N10°の線に沿って◎印が顕著的に多い、すなわちこの方面においては漁獲物も船体もともに汚染される割合が非常に大きいことを示す、すなわちこの汚染はさきに述べた東方汚染である。第2は水爆實驗海域南方において N10°の線に沿って汚染された魚族物が見出されている、すなわち汚染されたマグロがとれるのは、水爆實驗海域の東南を問わずほぼ N10°の線に沿って流れる北赤道海流のなかである。この海流の一部が E160° 乃至 140° の近くで北上して、いわゆる黒潮となってフィリッピン東方を日本の方に流れて来るが、その黒潮のなかにも汚染マグロが見出されている、すなわち汚染魚は北赤道海流にのって次く移動するものようである。(これに関しては主題を外れるのでこれ以上この報告では触れないこととしよう。)

次に特筆と最も関係の深い船の汚染は、ほぼ N10° の線より北には唯1隻の例外を除いて存在しない、すなわち事の主旨というと、○印と◎印は N10° より北にはな

Diagram 3 Showing Relationships between Fishing Areas and Degrees of Radiation of Boats.

(○) Boats whose catches passed examinations; less than 100 counts per minute (cpms) were detected of the hulls.

(◎) Boats whose catches passed examinations: more than 100 cpms were detected of the hulls.

(⊙) Boats whose catches failed to pass examinations, less than 100 cpms were detected of the hulls.

(●) Boats whose catches failed to pass examinations; more than 100 cpms were detected of the hulls.

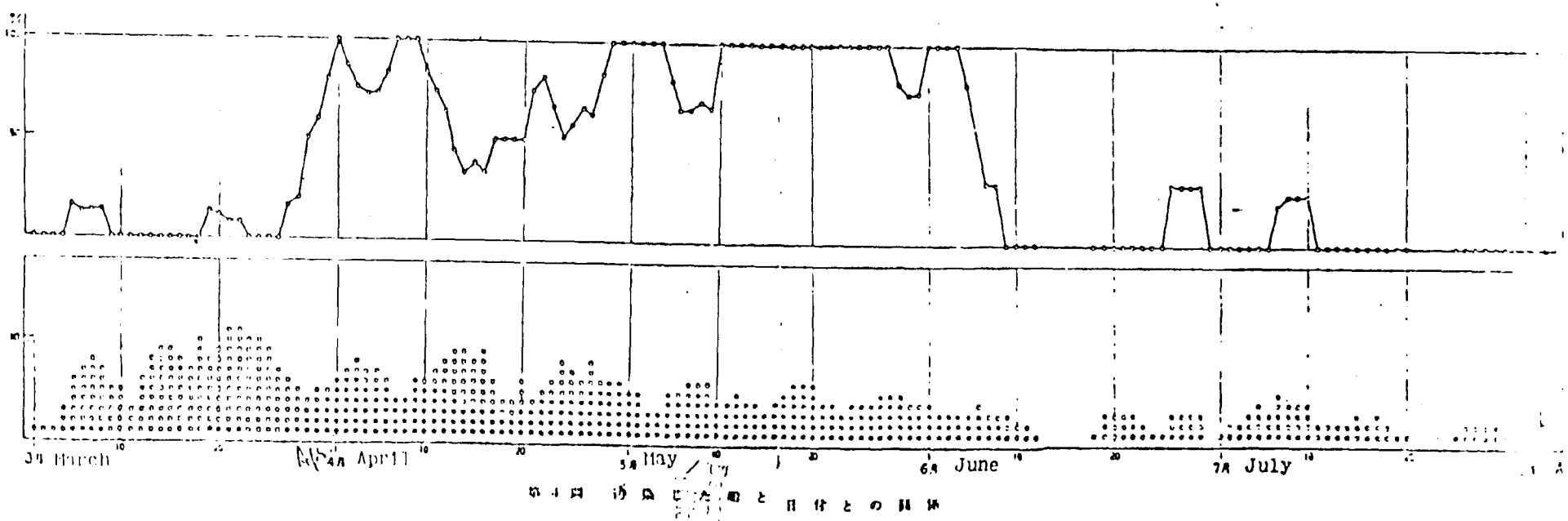


Diagram 4 Showing Relationships Irradiated Boats and Fishing Dates