Monthly Deposition of $^{137}$Cs in the Period from 1964 through 1971 at Osaka, Japan

MATSUNAMI, T., MIZOHATA, A., FUJITA, A., and MAMURO, T.

Radiation Center of Osaka Prefecture, Department of Health Physics and Instrumentation, Sakai, 704.

(Received, Jan. 11, 1972)

ABSTRACT

Monthly deposition of $^{137}$Cs at Osaka was measured in the period of 7 years from July 1964 through July 1971. Gamma-ray spectra of the samples collected monthly by the basin method were measured with a large volume Ge(Li) detector shielded with 20 cm iron in order to determine their $^{137}$Cs activities. On close examination of the variation of monthly $^{137}$Cs deposition, it is noted that, besides the seasonal variation of so-called "spring maximum", there appeared many peaks, each of which can be assumed to have been caused by the influence of a nuclear explosion. Yearly $^{137}$Cs depositions during the period were also estimated and compared with those measured by another institute.

INTRODUCTION

Monthly deposition of $^{137}$Cs at Osaka was measured in the period of 7 years from July 1964 through July 1971. On close examination of the variation of monthly $^{137}$Cs deposition, it is demonstrated that, besides the seasonal variation of so-called "spring maximum", there appeared many peaks. Attempts were made to associate these peaks with the nuclear explosions carried out during the period.

METHODS

Using two basins of 0.5 m² in collecting area which were set on the roof of our laboratory, monthly deposition was collected and evaporated to dryness. From the residue 6 g was taken and sealed into a plastic container of 4 cm in diameter.

---

松並忠男，溝畑隆，藤田晃，真室哲雄：大阪府立放射線中央研究所
大阪府堺市新家町，〒704
and 1 cm in height, and then subjected to \( \gamma \)-ray spectrometry with a Ge(Li) detector of 47 cm\(^3\) in effective volume shielded with 20 cm iron, measuring time being usually 40 ksec. Photopeak area due to \(^{137}\)Cs 662 keV \( \gamma \)-rays was calculated by an electronic computer.

**RESULT AND DISCUSSION**

The results are shown in Fig. 1. It is generally accepted that the so-called “spring maximum” appears at the time of year from April to June in Japan. This situation is well expressed in Fig. 1, but it is also noticed that many other peaks appeared rather irregularly. The eighteen peaks observed in the 7 years are numbered consecutively in Fig. 1. On comparison of the times of peak appearance with the dates of the nuclear explosions, it was noted that each peak could be attributed either to a nuclear explosion or to a “spring maximum”. Our assumptions are summarized in Table 1. Peaks Nos. 3, 4, 6, 9, 12, 14 and 18 are considered to be attributed to spring maxima. Peak No. 1 of October 1964 is thought to have been caused by the tropospheric debris produced in the first Chinese nuclear explosion which was carried out on land surface on October 16, 1964. Similar explanation could be given to peaks Nos. 2, 5, 7, 11, 13, 15 and 16, each of which appeared shortly after a nuclear explosion. The second Chinese nuclear explosion
Table 1. Dates of peak appearance and nuclear explosions assumed to have caused the peaks

<table>
<thead>
<tr>
<th>Peak No.</th>
<th>Date of peak appearance</th>
<th>Nuclear explosion assumed to have caused the peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>October 1964</td>
<td>October 16, 1964; China-1; surface</td>
</tr>
<tr>
<td>2</td>
<td>January 1965</td>
<td>January 15, 1965; U. S. S. R.; venting underground</td>
</tr>
<tr>
<td>3*</td>
<td>May 1965</td>
<td>May 14, 1965; China-2; surface</td>
</tr>
<tr>
<td>4*</td>
<td>April to May 1966</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>November 1966</td>
<td>October 27, 1966; China-4; surface</td>
</tr>
<tr>
<td>6*</td>
<td>April 1967</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>July 1967</td>
<td>June 17, 1967; China-6; atmosphere, megaton scale</td>
</tr>
<tr>
<td>8</td>
<td>October 1967</td>
<td>June 17, 1967; China-6; atmosphere, megaton scale</td>
</tr>
<tr>
<td>9*</td>
<td>April 1968</td>
<td>December 25, 1967; China-7; atmosphere, 20 kiloton</td>
</tr>
<tr>
<td>10</td>
<td>July 1968</td>
<td>unknown</td>
</tr>
<tr>
<td>11</td>
<td>September to October 1968</td>
<td>July 8 to September 8, 1968; France; southern hemisphere</td>
</tr>
<tr>
<td>12*</td>
<td>May to June 1969</td>
<td>December 27, 1968; China-8; atmosphere, megaton scale</td>
</tr>
<tr>
<td>13</td>
<td>October 1969</td>
<td>September 29, 1969; China-10; atmosphere, megaton scale</td>
</tr>
<tr>
<td>14*</td>
<td>April 1970</td>
<td>September 29, 1969; China-10; atmosphere, megaton scale</td>
</tr>
<tr>
<td>15</td>
<td>June 1970</td>
<td>May 21 and 26, 1970; U. S. A.; venting underground</td>
</tr>
<tr>
<td>16</td>
<td>November 1970</td>
<td>October 14, 1970; China-11; atmosphere, megaton scale</td>
</tr>
<tr>
<td>17</td>
<td>March 1971</td>
<td>October 14, 1970; China-11; atmosphere, megaton scale</td>
</tr>
<tr>
<td>18*</td>
<td>May 1971</td>
<td></td>
</tr>
</tbody>
</table>

* The peaks possibly attributed to spring maximum.

of May 14, 1965 possibly contributed in part to peak No. 3 of May 1965 that coincides with spring maximum. Peak No. 8 was possibly caused by the rather sudden appearance in precipitation of the stratospheric debris produced in the sixth Chinese nuclear explosion of June 17, 1967 of megaton scale which was believed to have been carried out in the upper atmosphere. Our recent study$^{1-2}$, in which the variation of the isotopic activity ratios of $^{141}$Ce to $^{144}$Ce and $^{103}$Ru to $^{106}$Ru in rainwater was observed, showed that the nuclear debris injected into the stratosphere seems to appear rather suddenly in precipitation 120 to 150 days after the explosion. Quite similar explanation could be given to peak No. 17. The sudden appearances in precipitation of the stratospheric debris produced in the seventh (December 25, 1967), the eighth (December 27, 1968) and the tenth (September 29, 1969) Chinese nuclear explosions must have contributed in part to peaks Nos. 9, 12 and 14, respectively, each of which is regarded to have been caused primarily by spring maximum. Peak No. 10 is the only peak that we failed to associate with any explosion. It seems unreasonable to consider that this peak is attributed to the stratospheric debris produced in the sixth Chinese nuclear explosion which was carried out 13 months before. It might be possible that this peak was caused by an explosion unknown to us. Somewhat high depositions of $^{137}$Cs in May to June 1966 and in January 1967 were likely to be caused by the third Chinese ex-
plosion of May 9, 1966 and by the
fifth Chinese explosion of Decem-
ber 28, 1966, respectively.

At first, we thought that the
monthly deposition of a long-lived
nuclide $^{137}$Cs would not reflect sen-
sibly the recent nuclear explosions
because its deposition is strongly
dependent on the monthly precip-
itation. However, the present re-
results show that the monthly $^{137}$Cs
deposition is appreciably influenced
by recent nuclear explosions. It
may be possible in favorable cases
to discriminate the $^{137}$Cs deposition
of tropospheric origin from that
of stratospheric origin.

Yearly $^{137}$Cs depositions estimated from the present study are summarized in
Table 2. They are in parallel with those measured by Japan Analytical Chemistry
Research Institute\(^3\), where the ordinary method of chemical separation and beta
counting was used instead of the present $\gamma$-ray spectrometric method.

### Table 2. Yearly depositions of $^{137}$Cs in Osaka

<table>
<thead>
<tr>
<th>Period</th>
<th>Deposition of $^{137}$Cs (mCi/km$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sakai city*</td>
</tr>
<tr>
<td>From July to December, 1964</td>
<td>1.8</td>
</tr>
<tr>
<td>1965</td>
<td>5.4</td>
</tr>
<tr>
<td>1966</td>
<td>2.3</td>
</tr>
<tr>
<td>1967</td>
<td>1.1</td>
</tr>
<tr>
<td>1968</td>
<td>1.5</td>
</tr>
<tr>
<td>1969</td>
<td>1.7</td>
</tr>
<tr>
<td>1970</td>
<td>1.3</td>
</tr>
<tr>
<td>From January to July, 1971</td>
<td>1.3</td>
</tr>
</tbody>
</table>

* Measured by us.
** Measured by Japan Analytical Chemistry Research Institute.

REFERENCES

2. Mamuro, T., Matsunami T. and Mizohata A. (1971) Observation of Radioruthenium and