



Forty Years of Anthropogenic Radionuclides in Surface Seawater. Italian and Japanese Data

Arrigo A. Cigna

Fraz. Tuffo, I-14023 COCCONATO (Asti), Italy

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Abstract – The concentrations of man made radionuclides in surface seawater since early '60s are here reported as measured in Italy and Japan. Most of the data refers to ^{90}Sr and ^{137}Cs , but occasionally the concentrations of ^{89}Sr and ^{134}Cs in some Italian samples are also given. The main sources of man made radionuclides were the global fallout produced by the nuclear weapon tests and the Chernobyl accident. The respective contributions to the contamination of surface seawater around both countries are discussed.

Keywords – Surface seawater, radionuclides, fallout, Chernobyl accident

1. Introduction

The regular measurement of anthropogenic radionuclides in seawater has been started in the '60s and the results were published frequently in the so called “grey” literature.

With reference to the Japanese measurements, the papers are probably not so much available in western institutions. Therefore it was deemed worthwhile to compile all the data in a single paper in order to have an easy access to the scientific community. In addition the average monthly deposition over both countries was calculated.

The early measurements of the radioactivity released by nuclear weapon tests were performed in Italy in 1950 (Santomauro and Cigna 1953), but only in 1960 the measurement of specific radionuclides was performed in surface seawater, as well as in other

environmental samples, by the Health Physics Laboratory of the CNEN Nuclear Research Centre of Ispra (Varese). In the same year also the CAMEN (Centre for Military Application of Nuclear Energy, now CISAM) started a series of measurements in seawater (Argiero *et al.* 1963).

Following this, a national network was operated by the Laboratory for Environmental Radioactivity of the CNEN Nuclear Research Centre of Casaccia (Roma) until the end of the '70s, when this task was carried out by the CNEN Laboratory for the Study of the Marine Environment of Fiascherino (La Spezia) which later became the Marine Environmental Research Centre. Later, in the '80s and '90s some measurements were made by the Laboratories of Piacenza and Cagliari, respectively, of the ARPA Emilia-Romagna and ASL 8 - Cagliari. At present only these laboratories carry on regular measurements of sea water radionuclides in Italy.

In addition to original papers by different authors, the results were published yearly in booklets with data on environmental radioactivity collected in Italy published yearly by CNEN (from 1970 to 1976) ENEA (from 1977 to 1991) and, from 1992 to 1998, by ANPA (Agenzia Nazionale Protezione Ambiente). Some of the older reports are no longer accessible.

Few occasional mistakes, which occurred in the previous publications, were corrected by taking into account the results reported in the original laboratory records, presently in the author's file. The original data was also adopted, when possible, because in the last issues of the reports published by ANPA, instead of the original results obtained by

*Corresponding author. E-mail: arrigocigna@tiscali.it

each laboratory, only maximum, minimum and average values were reported.

After 1998, the national network which included up to 7 stations, reduced itself to a single station (Cesenatico) operated by the Laboratory of Piacenza, and to 5 around the coast of Sardinia operated by the ASL 8 - Cagliari, on account of a general lack of interest of other institutions to continue this survey.

Immediately after the atomic bomb attack on Hiroshima and Nagasaki in August, 1945, a large group of scientists were organised by the Scientific Research Council of Japan under the Ministry of Education. Early in 1947 the Atomic Bomb Casualty Commission was set up and its results were instrumental for the development of radiation protection.

A Special Committee on the Effects of Radioactivity in the Science Council of Japan was established in 1955 to co-ordinate the publication of a large number of papers which resulted to be an invaluable source of knowledge and data at that time (Committee for Compilation of Report on Research in the Effects of Radioactivity 1956). These volumes are an important source of knowledge concerning the distribution of radionuclides in many compartments of the environment.

The first measurements of environmental radioactivity in the marine environment were mainly limited to gross beta. Only in 1964 the National Institute of Radiological Sciences started the publication of data on ^{90}Sr and ^{137}Cs in seawater in the bulletin "Radioactivity Survey data in Japan", as NIRS-RSD reports, until No. 137, October 2002. Starting with No. 138, October 2003, the bulletin is published by the Japan Chemical Analysis Center.

2. Materials and Methods

Italy

During the long period here considered, the sampling point sometimes has been changed. In Table 1 a list of each sampling point with its co-ordinates is reported. (Fig. 1). Each sample of sea water (100 to 250 litres generally) was collected at a few kilometres from the coast in the surface layer.

Japan

Another long series of measurements carried out in seawater is available from Japan and the concentrations of

Table 1. Sampling points along the Italian coast.

| Sea | Station | Latitude North | Long. E Greenwich |
|---------------|-----------------|----------------|-------------------|
| Ligurian Sea | Genova | 44°23' | 8°55' |
| " | La Spezia | 44°01' | 09°46' |
| " | Livorno | 43°33' | 10°17' |
| " | Capraia | 43°02' | 09°52' |
| Tyrrhenian | Alghero | 40°32' | 08°17' |
| " | La Maddalena | 41°12' | 09°26' |
| " | Porto Torres | 40°54' | 08°30' |
| " | Arbatax | 39°56' | 09°46' |
| " | Porstoscuso | 39°14' | 08°17' |
| " | Cagliari | 39°07' | 09°12' |
| " | St. Severa | 42°00' | 11°52' |
| " | Napoli | 40°47' | 14°07' |
| " | Palermo | 38°08' | 13°23' |
| Adriatic | Venezia | 45°20' | 12°24' |
| " | Chioggia | 45°11' | 12°17' |
| " | Cesenatico | 44°14' | 12°28' |
| " | Rimini | 44°03' | 12°34' |
| " | Middle Adriatic | 42°50' | 15°07' |
| " | Pescara | 42°38' | 14°13' |
| " | Barletta | 41°20' | 16°17' |
| " | South Adriatic | 40°13' | 18°40' |
| Ionic | Taranto | 40°25' | 17°05' |
| Mediterranean | Pantelleria | 36°51' | 11°55' |

^{90}Sr and ^{137}Cs in seawater around the coast of Japan are available since 1964. Surface water samples of about 40 litres were collected in different sampling points as listed in Table 2 and Fig. 2 close to the coast, where the effects of terrestrial fresh water from rivers was expected to be negligible. The sampling was carried out when there was no rainfall for the last few days. After 1975, the samples were collected rather regularly mainly in July-August.

3. Results

Italy

Each sample was acidified with HCl to pH = 2 to avoid absorption of radionuclides on the container wall. Radionuclides were separated by different processes, followed by gamma or beta measurements. A known amount of ^{134}Cs was added as yield determinant for ^{137}Cs . Caesium was then separated by co-precipitation upon ammonium molybdo-phosphate. The supernate from caesium co-precipitation was



Fig. 1. The sampling stations of sea water in Italy.

transferred to a clean polyethylene barrel and strontium was precipitated as oxalate following the addition of oxalic acid and NH_4OH to pH 5.5.

When necessary, the results are corrected for radioactive decay to the sampling date. In Table 3 the concentration of the radionuclides in sea water are reported (Malvicini and Vido 1961; Cigna *et al.* 1962; Cigna *et al.* 1964; CNEN 1970-1976; ENEA 1977-1991; ANPA 1992-1998; Delfanti *et al.* 2003; Povinec *et al.* 2003).

Whenever possible the values expressed as Bq/m^3 were calculated after the original data as reported in the laboratory records to correct few mistakes found in the published data. Also some unpublished, but valid, results which are recorded in the author's file, have been included in this list, as, *e.g.*, those kindly transmitted by CAMEN in 1961-62.

A general view of the concentrations measured in the last decades is also given in Fig. 3 and 4.

Japan

Immediately after the collection, the samples were acidified with HCl to pH lower than 3, and successively ^{90}Sr and ^{137}Cs were measured after chemical separation

Table 2. Sampling points along the Japanese coast.

| Sea | Station | Latitude North | Long. E Greenwich |
|---------------|-----------|----------------|-------------------|
| Japan Sea | Niigata | 37°58' | 139°04' |
| Japan Sea | Aomori | 41°16' | 141°11' |
| Japan Sea | Fukui | 35°42'-45' | 135°58'-136°40' |
| Japan Sea | Shimane | 35°33' | 133°01' |
| Japan Sea | Fukuoka | 33°36' | 130°22' |
| Japan Sea | Kyoto | 35°38'-33' | 135°18'-19' |
| Japan Sea | Saga | 33°20' | 129°50' |
| Japan Sea | Nagasaki | 32°43' | 129°51' |
| Japan Sea | Hokkaido | 42°55' | 140°10' |
| Pacific Ocean | Fukushima | 37°50' | 141°04' |
| Pacific Ocean | Chiba | 35°10' | 139°43' |
| Pacific Ocean | Hiroshima | 34°17'-21' | 135°23'-25' |
| Pacific Ocean | Ibaraki | 36°20' | 140°42' |
| Pacific Ocean | Kanagawa | 35°28' | 139°39' |
| Pacific Ocean | Aichi | 34°44'-50' | 136°47'-137°12' |
| Pacific Ocean | Osaka | 34°20'-30' | 135°24'-27' |
| Pacific Ocean | Hyogo | 34°38'-40' | 135°10'-12' |
| Pacific Ocean | Miyagi | 38°19'-24' | 141°03'-31' |
| Pacific Ocean | Moji | 33°57'-59' | 130°58' |
| Pacific Ocean | Kagoshima | 31°51' | 130°33' |
| Pacific Ocean | Shimane | 35°32' | 133°01' |
| Pacific Ocean | Yamaguchi | 34°23' | 131°31' |
| Pacific Ocean | Shizuoka | 34°46' | 138°30' |
| Pacific Ocean | Okinawa | 26°27' | 127°54' |

and purification. The standard deviation of each measurement is between 10 and 20% of the absolute value.

The results from each sampling point were grouped according to their location, either in the Japan Sea or in the Pacific Ocean, and the average values are reported in Table 4. Such averages were also plotted in Fig. 5 and 6.

4. Discussion

Sources of man-made radionuclides

The radioactive fallout produced by the nuclear weapons tests was main source of radionuclides into the environment, and therefore into the seawater. Periods of intensive testing were in 1952-1954, 1957-1958 and 1961-1962. A limited nuclear test ban treaty was signed in August 1963 and subsequently there was much less frequent testing in the atmosphere. In the end of nuclear bomb testing era a series of testing was carried out by the Popular Republic of China and France, but the contribution to the global

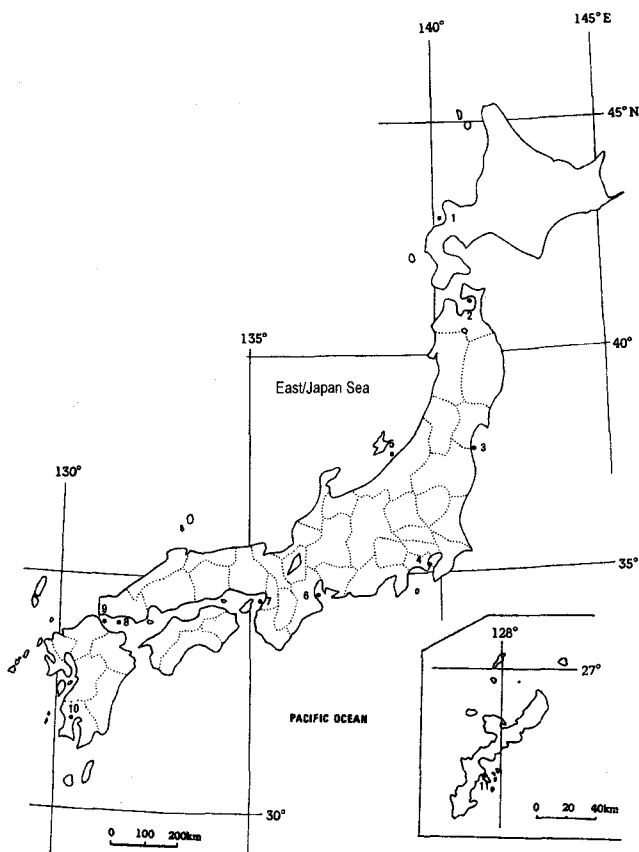


Fig. 2. The sampling stations of sea water in Japan (from NIRS-RSD reports, modified).

inventory of radionuclides released into the environment was much smaller than the previous ones.

Italy

The concentrations of ^{90}Sr and ^{137}Cs in fallout, due to the experimental weapon detonations, collected since 1960 in about ten stations, were measured. The values for the period from 1954 to 1960 were estimated from the data available for New York City (similar to Italy for its geographical situation and amount of precipitation) which were found rather close to Italian average. Further details concerning such an evaluation are available in Giorcelli (1981).

As reported before for the measurements performed on the surface sea water, the concentrations in fallout were published yearly in booklets with data on environmental radioactivity collected in Italy published yearly by CNEN (from 1970 to 1976), ENEA (from 1977 to 1991) and, from 1992 to 1998, by ANPA. In these reports both the sampling stations and the procedures for the measurements are published.

In Table 5 and Fig 7 the average monthly depositions of ^{90}Sr and ^{137}Cs obtained on the basis of all the data available for each time interval are reported.

The Chernobyl accident in April 1986 was another important source with a short peak value in the sea water or higher (fallout) than the levels produced by the weapon tests in selected sites. The radionuclides released by this accident reached the Mediterranean Sea by the direct fallout (mainly tropospheric) over the sea, through the rivers (particularly those flowing into the Northern Mediterranean Basins) and, indirectly, by the discharge of the rivers Dnieper and Danube into the Black Sea and through the Bosphorus Strait.

Average values of ^{137}Cs concentration in the different basin of the Mediterranean are reported in Table 6, which includes also the ^{137}Cs concentration observed in the Black Sea (Aarkrog 1994).

The contribution from the Black Sea is more important than the direct fallout and is responsible of the higher values found in the eastern part of the Mediterranean Sea (Table 3). A regional study in the Aegean Sea (Zodiatis 1994; Egorov *et al.* 1994; Florou *et al.* 1994) provides a detailed description of the advection of the Black Sea water in the North Aegean Sea.

The effect of the rivers discharge into the sea is confirmed also by the values found in the Liguro-Provençal Basin (from Rhône river) and Adriatic Sea (from Po river) which are slightly higher than those found in other parts of the Mediterranean.

A circumstantial report on the radiological exposure of the population of the European Community to radioactivity in the Mediterranean Sea (Cigna *et al.* 1994) confirmed that the largest contribution of anthropogenic radionuclides is due to the fallout from nuclear weapons testing and the Chernobyl accident, while the routine discharges from the nuclear fuel cycle had a minor impact. Other sources, as research centres and hospitals, are negligible.

Japan

The concentration of radionuclides release by the nuclear weapon tests during the '60s was very similar to the concentrations measured in the Italian seas. Since both countries are far from the proving ground, a certain homogenisation of the plume released by each test occurs before the deposition. Such a process is particularly important for the stratospheric fallout.

Table 3. Radionuclides concentration in Italian seawater from 1960 to 2002. The error corresponding to σ is reported for each value. In the second column (Org.) the organisation which performed the measurements is reported: CNI=CNEN, Ispra; CAM=CAMEN, S. Piero a Grado; CNC=CNEN, Casaccia; CNE=CNEN, Fiascherino/ENEA, S.Teresa; ARP=ARPA, Piacenza; ASL8=ASL 8, Cagliari

| Sampling point | Org. | Date | ^{137}Cs Bq/m ³ | $\pm\sigma$ | ^{134}Cs Bq/m ³ | $\pm\sigma$ | ^{90}Sr Bq/m ³ | $\pm\sigma$ | ^{89}Sr Bq/m ³ | $\pm\sigma$ |
|----------------|------|---------|-------------------------------------|-------------|-------------------------------------|-------------|------------------------------------|-------------|------------------------------------|-------------|
| Genova | CNI | Jul-60 | | | | | 2.4 | 0.4 | | |
| La Spezia | CNI | Sept-60 | | | | | 2.2 | 0.3 | | |
| Rimini | CNI | Oct-60 | | | | | 7.0 | 1.1 | | |
| Pescara | CNI | Nov-60 | 8 | 1.6 | | | 6.3 | 0.9 | | |
| Barletta | CNI | Nov-60 | 7.0 | 1.4 | | | 5.6 | 0.8 | | |
| Venezia | CNI | Nov-60 | 8.9 | 1.8 | | | 7.8 | 1.2 | | |
| Capraia | CNI | Jan-61 | | | | | 19.3 | 7.7 | | |
| La Spezia | CNI | Jun-61 | | | | | 2.2 | 0.3 | | |
| Napoli | CNI | Jun-61 | | | | | 2.6 | 0.4 | | |
| Rimini | CNI | Jun-61 | 6.7 | 1.3 | | | 5.9 | 0.9 | | |
| Pescara | CNI | Jun-61 | 5.2 | 1.0 | | | 3.7 | 0.6 | | |
| Barletta | CNI | Jun-61 | | | | | 3.3 | 0.5 | | |
| Venezia | CNI | Jun-61 | 6.3 | 1.3 | | | 5.2 | 0.8 | | |
| Capraia | CAM | Sept-61 | 11.5 | 5.8 | | | 25.2 | 10.1 | | |
| Genova | CAM | Sept-61 | 10.0 | 5.0 | | | 8.9 | 3.6 | | |
| Napoli | CAM | Oct-61 | 13.0 | 6.5 | | | 14.8 | 5.9 | | |
| Alghero | CAM | Nov-61 | 17.8 | 8.9 | | | 18.5 | 7.4 | | |
| Pantelleria | CAM | Nov-61 | 15.9 | 8.0 | | | 20.0 | 8.0 | | |
| Taranto | CAM | Dec-61 | 11.1 | 5.6 | | | 7.8 | 3.1 | | |
| Ancona | CAM | Jan-62 | 8.1 | 4.1 | | | 28.5 | 11.4 | | |
| Bari | CAM | Jan-62 | 5.9 | 3.0 | | | 21.1 | 8.4 | | |
| Venezia | CAM | Feb-62 | 12.6 | 6.3 | | | 29.6 | 11.8 | | |
| Genova | CAM | Mar-62 | 12.6 | 6.3 | | | 26.3 | 10.5 | | |
| Napoli | CAM | May-62 | 17.0 | 8.5 | | | 11.5 | 4.6 | | |
| Pantelleria | CAM | Jun-62 | 17.8 | 8.9 | | | 24.8 | 9.9 | | |
| Taranto | CAM | Jun-62 | 10.7 | 5.4 | | | 13.0 | 5.2 | | |
| Ancona | CAM | Jul-62 | 10.4 | 5.2 | | | 18.9 | 7.6 | | |
| Barletta | CNI | Jul-62 | | | | | 29.6 | 4.4 | 248 | 50 |
| Rimini | CNI | Jul-62 | | | | | 22.2 | 3.3 | 356 | 71 |
| Venezia | CNI | Jul-62 | | | | | 33.3 | 5.0 | 356 | 71 |
| La Spezia | CNI | ago-62 | | | | | 22.2 | 3.3 | 185 | 37 |
| Napoli | CNI | ago-62 | | | | | | | 207 | 41 |
| S. Severa | CNI | Oct-62 | | | | | 25.9 | 3.9 | 178 | 36 |
| Napoli | CNI | Mar-63 | | | | | 15.6 | 2.3 | 78 | 16 |
| Venezia | CNI | Mar-63 | | | | | 28.1 | 4.2 | 272 | 54 |
| La Spezia | CNI | Mar-63 | | | | | 10.0 | 1.5 | 39 | 8 |
| Rimini | CNI | Mar-63 | | | | | 28.9 | 4.3 | 241 | 48 |
| Pescara | CNI | Mar-63 | | | | | 12.9 | 1.9 | 93 | 19 |
| Barletta | CNI | Mar-63 | | | | | 25.2 | 3.8 | 163 | 33 |
| La Spezia | CNI | Jul-63 | | | | | 24.8 | 3.7 | 139 | 28 |
| Napoli | CNI | Jul-63 | 52.2 | 10.4 | | | 31.1 | 4.7 | 243 | 49 |
| Venezia | CNI | Jul-63 | 47.4 | 9.5 | | | 58.1 | 8.7 | 284 | 57 |
| Rimini | CNI | Jul-63 | 55.2 | 11.0 | | | 72.2 | 10.8 | 277 | 55 |
| Pescara | CNI | Jul-63 | 75.6 | 15.1 | | | 54.3 | 8.1 | 306 | 61 |
| Barletta | CNI | Jul-63 | 53.0 | 10.6 | | | 57.0 | 8.6 | 369 | 74 |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|------|---------|-------------------------------------|-----|-------------------------------------|----|------------------------------------|------|------------------------------------|----|
| La Spezia | CNC | Jan-64 | | | | | 20.7 | 3.1 | < 33 | |
| Napoli | CNC | Jan-64 | | | | | 18.5 | 2.8 | < 33 | |
| Venezia | CNC | Jan-64 | | | | | 34.6 | 5.2 | < 33 | |
| Rimini | CNC | Jan-64 | | | | | 44.8 | 6.7 | < 33 | |
| Pescara | CNC | Jan-64 | | | | | 45.9 | 6.9 | < 33 | |
| Barletta | CNC | Jan-64 | | | | | 45.6 | 6.8 | < 33 | |
| La Spezia | CNC | Jul-64 | | | | | 37.8 | 5.7 | | |
| Napoli | CNC | Jul-64 | | | | | 44.8 | 6.7 | | |
| Venezia | CNC | Jul-64 | | | | | 95.9 | 14.4 | | |
| Rimini | CNC | Jul-64 | | | | | 82.2 | 12.3 | | |
| Pescara | CNC | Jul-64 | | | | | 62.2 | 9.3 | | |
| Barletta | CNC | Jul-64 | | | | | 66.7 | 10.0 | | |
| La Spezia | CNC | Oct-68 | 14.1 | 2.8 | | | 8.5 | 1.3 | | |
| Napoli | CNC | Oct-68 | 12.1 | 2.4 | | | 5.6 | 0.8 | | |
| Taranto | CNC | Oct-68 | 12.0 | 2.4 | | | 10.3 | 1.5 | | |
| Venezia | CNC | ago-68 | 14.6 | 2.9 | | | 16.2 | 2.4 | | |
| Taranto | CNC | Jan-69 | 19.3 | 3.9 | | | 11.6 | 1.7 | | |
| La Spezia | CNC | Feb-69 | 7.6 | 1.5 | | | 4.7 | 0.7 | | |
| Napoli | CNC | Feb-69 | 8.7 | 1.7 | | | 4.1 | 0.6 | | |
| Venezia | CNC | Feb-69 | 13.1 | 2.6 | | | 7.8 | 1.2 | | |
| La Spezia | CNC | Jul-69 | 8.6 | 1.7 | | | 6.9 | 1.0 | | |
| La Spezia | CNC | Jan-70 | 10.1 | 2.0 | | | 6.4 | 1.0 | | |
| Napoli | CNC | Jan-70 | 8.0 | 1.6 | | | 6.3 | 1.0 | | |
| Taranto | CNC | Jan-70 | 11.3 | 2.3 | | | 9.1 | 1.4 | | |
| La Spezia | CNC | Jul-70 | 8.3 | 1.7 | | | 6.1 | 0.9 | | |
| Napoli | CNC | Jul-70 | 8.4 | 1.7 | | | 7.2 | 1.1 | | |
| Taranto | CNC | Jan-71 | 2.9 | 0.6 | | | 7.4 | 1.1 | | |
| La Spezia | CNC | Jul-71 | 3.7 | 0.7 | | | 5.8 | 0.9 | | |
| Venezia | CNC | Jul-71 | 7.1 | 1.4 | | | 11.6 | 1.7 | | |
| Taranto | CNC | Sept-71 | 4.4 | 0.9 | | | 9.5 | 1.4 | | |
| Venezia | CNC | Mar-72 | 5.0 | 1.0 | | | | | | |
| Napoli | CNC | Mar-72 | 2.7 | 0.5 | | | 7.5 | 1.1 | | |
| Venezia | CNC | Sept-72 | 3.2 | 0.6 | | | 12.1 | 1.8 | | |
| La Spezia | CNC | Sept-72 | 2.6 | 0.5 | | | 7.8 | 1.2 | | |
| Napoli | CNC | Sept-72 | 4.3 | 0.9 | | | 9.2 | 1.4 | | |
| Napoli | CNC | Mar-73 | 2.4 | 0.5 | | | 6.8 | 1.0 | | |
| La Maddalena | CNC | Mar-73 | 3.1 | 0.6 | | | 5.0 | 0.8 | | |
| Venezia | CNC | Mar-73 | 1.4 | 0.3 | | | 3.4 | 0.5 | | |
| La Spezia | CNC | Mar-73 | 2.9 | 0.6 | | | 3.7 | 0.6 | | |
| La Maddalena | CNC | Sept-73 | 1.7 | 0.3 | | | 2.8 | 0.4 | | |
| Venezia | CNC | Sept-73 | 2.6 | 0.5 | | | 6.7 | 1.0 | | |
| La Spezia | CNC | Sept-73 | | | | | 4.2 | 0.6 | | |
| La Maddalena | CNC | Mar-74 | 1.0 | 0.2 | | | 10.0 | 1.5 | | |
| Napoli | CNC | Sept-74 | 2.0 | 0.4 | | | 4.4 | 0.7 | | |
| La Maddalena | CNC | Sept-74 | 1.2 | 0.2 | | | 5.1 | 0.8 | | |
| Venezia | CNC | Sept-74 | 2.4 | 0.5 | | | 7.3 | 1.1 | | |
| La Maddalena | CNC | Mar-75 | 1.7 | 0.2 | | | 3.7 | 0.6 | | |
| Venezia | CNC | Mar-75 | 3.6 | 0.4 | | | 6.0 | 0.9 | | |
| La Maddalena | CNC | Sept-75 | 2.4 | 0.2 | | | 2.1 | 0.3 | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|-------|---------|-------------------------------------|-----|-------------------------------------|----|------------------------------------|-----|------------------------------------|----|
| Napoli | CNC | Sept-75 | 1.5 | 0.1 | | | 2.3 | 0.3 | | |
| La Spezia | CNC | Mar-76 | 2.8 | 0.3 | | | | | | |
| La Maddalena | CNC | Mar-76 | 3.9 | 0.4 | | | | | | |
| Napoli | CNC | Mar-76 | 3.4 | 0.3 | | | | | | |
| Venezia | CNC | Mar-76 | 4.4 | 0.4 | | | | | | |
| La Spezia | CNC | Sept-76 | 2.7 | 0.3 | | | 4.8 | 0.7 | | |
| La Maddalena | CNC | Sept-76 | 3.1 | 0.3 | | | 5.2 | 0.8 | | |
| Napoli | CNC | Sept-76 | 4.7 | 0.5 | | | 4.0 | 0.6 | | |
| Venezia | CNC | Sept-76 | 3.8 | 0.4 | | | 7.0 | 1.1 | | |
| Taranto | CNC | Sept-76 | 3.1 | 0.3 | | | 5.8 | 0.9 | | |
| La Spezia | CNC | Mar-77 | 2.2 | 0.2 | | | 2.8 | 0.4 | | |
| Napoli | CNC | Mar-77 | 2.0 | 0.2 | | | 4.1 | 0.6 | | |
| Venezia | CNC | Mar-77 | 2.4 | 0.2 | | | 5.8 | 0.9 | | |
| Taranto | CNC | Mar-77 | 2.8 | 0.3 | | | 4.7 | 0.7 | | |
| La Spezia | CNC | Sept-77 | 2.5 | 0.3 | | | 3.1 | 0.5 | | |
| Napoli | CNC | Sept-77 | 2.4 | 0.2 | | | 4.0 | 0.6 | | |
| Venezia | CNC | Sept-77 | 3.6 | 0.4 | | | 6.8 | 1.0 | | |
| Taranto | CNC | Sept-77 | 4.4 | 0.4 | | | 4.0 | 0.6 | | |
| La Spezia | CNC/E | Mar-78 | 1.9 | 0.2 | | | 3.6 | 0.5 | | |
| Napoli | CNC/E | Mar-78 | 1.9 | 0.2 | | | 3.6 | 0.5 | | |
| Venezia | CNC/E | Mar-78 | 3.0 | 0.3 | | | 5.8 | 0.9 | | |
| Taranto | CNC/E | Mar-78 | 2.1 | 0.2 | | | 3.9 | 0.6 | | |
| La Spezia | CNC/E | Sept-78 | 2.0 | 0.2 | | | 3.1 | 0.5 | | |
| Napoli | CNC/E | Sept-78 | 2.6 | 0.3 | | | 3.9 | 0.6 | | |
| Venezia | CNC/E | Sept-78 | 3.6 | 0.4 | | | 5.2 | 0.8 | | |
| Taranto | CNC/E | Sept-78 | 2.7 | 0.3 | | | 3.9 | 0.6 | | |
| La Spezia | CNE | Mar-79 | 1.9 | 0.2 | | | | | | |
| Napoli | CNE | Mar-79 | 1.9 | 0.2 | | | | | | |
| Venezia | CNE | Mar-79 | 3.1 | 0.3 | | | | | | |
| Taranto | CNE | Mar-79 | 2.8 | 0.3 | | | | | | |
| La Spezia | CNE | Sept-79 | 2.2 | 0.2 | | | | | | |
| Napoli | CNE | Sept-79 | 2.3 | 0.2 | | | | | | |
| Venezia | CNE | Sept-79 | 3.4 | 0.3 | | | | | | |
| Taranto | CNE | Sept-79 | 3.5 | 0.4 | | | | | | |
| La Spezia | CNE | Mar-80 | 2.6 | 0.3 | | | | | | |
| Napoli | CNE | Mar-80 | 1.9 | 0.2 | | | | | | |
| Venezia | CNE | Mar-80 | 3.0 | 0.3 | | | | | | |
| Taranto | CNE | Mar-80 | 2.9 | 0.3 | | | | | | |
| La Spezia | CNE | Sept-80 | 2.8 | 0.3 | | | | | | |
| Napoli | CNE | Sept-80 | 1.9 | 0.2 | | | | | | |
| Venezia | CNE | Sept-80 | 3.3 | 0.3 | | | | | | |
| Taranto | CNE | Sept-80 | 3.3 | 0.3 | | | | | | |
| La Spezia | CNE | Mar-81 | 2.0 | 0.2 | | | | | | |
| Napoli | CNE | Mar-81 | 1.9 | 0.2 | | | | | | |
| Venezia | CNE | Mar-81 | 2.8 | 0.3 | | | | | | |
| Taranto | CNE | Mar-81 | 2.4 | 0.2 | | | | | | |
| Napoli | CNE | Sept-81 | 2.2 | 0.2 | | | | | | |
| Venezia | CNE | Sept-81 | 3.1 | 0.3 | | | | | | |
| Taranto | CNE | Sept-81 | 3.0 | 0.3 | | | | | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|------|---------|-------------------------------------|------|-------------------------------------|-----|------------------------------------|----|------------------------------------|----|
| La Spezia | CNE | Mar-82 | 5.7 | 1.4 | | | | | | |
| Napoli | CNE | Feb-82 | 4.6 | 1.1 | | | | | | |
| Venezia | CNE | Feb-82 | 7.1 | 1.8 | | | | | | |
| Taranto | CNE | Feb-82 | 6.1 | 1.5 | | | | | | |
| La Spezia | CNE | ago-82 | 4.6 | 1.1 | | | | | | |
| Napoli | CNE | Jul-82 | 4.7 | 1.2 | | | | | | |
| Venezia | CNE | Jul-82 | 6.1 | 1.5 | | | | | | |
| Taranto | CNE | Jul-82 | 6.7 | 1.7 | | | | | | |
| La Spezia | CNE | Apr-83 | 4.1 | 1.0 | | | | | | |
| Napoli | CNE | Feb-83 | 4.9 | 1.2 | | | | | | |
| Venezia | CNE | Feb-83 | 4.3 | 1.1 | | | | | | |
| Taranto | CNE | Feb-83 | 4.6 | 1.2 | | | | | | |
| Napoli | CNE | Sept-83 | 5.4 | 1.4 | | | | | | |
| Venezia | CNE | Sept-83 | 4.9 | 1.2 | | | | | | |
| Taranto | CNE | Sept-83 | 7.8 | 2.0 | | | | | | |
| La Spezia | CNE | Mar-84 | 4.0 | 1.0 | | | | | | |
| Napoli | CNE | Mar-84 | 4.1 | 1.0 | | | | | | |
| Venezia | CNE | Mar-84 | 5.3 | 1.3 | | | | | | |
| Taranto | CNE | Mar-84 | 5.0 | 1.2 | | | | | | |
| La Spezia | CNE | Jul-84 | 4.8 | 1.2 | | | | | | |
| Napoli | CNE | Sept-84 | 4.4 | 1.1 | | | | | | |
| Venezia | CNE | Sept-84 | 4.7 | 1.2 | | | | | | |
| Taranto | CNE | Sept-84 | 5.8 | 1.2 | | | | | | |
| Napoli | CNE | Mar-85 | 5.3 | 0.5 | | | | | | |
| Venezia | CNE | Mar-85 | 7.6 | 0.8 | | | | | | |
| Taranto | CNE | Mar-85 | 7.6 | 0.8 | | | | | | |
| La Spezia | CNE | Sept-85 | 4.1 | 0.6 | | | | | | |
| Napoli | CNE | Sept-85 | 5.2 | 0.8 | | | | | | |
| Venezia | CNE | Sept-85 | 7.8 | 0.5 | | | | | | |
| Taranto | CNE | Sept-85 | 6.9 | 0.8 | | | | | | |
| La Maddalena | CNE | Sept-85 | 6.4 | 0.8 | | | | | | |
| La Spezia | CNE | Mar-86 | 6.5 | 1.3 | | | | | | |
| Napoli | CNE | Feb-86 | 6.1 | 1.2 | | | | | | |
| Venezia | CNE | Mar-86 | 6.0 | 1.2 | | | | | | |
| Taranto | CNE | Feb-86 | 6.4 | 1.3 | | | | | | |
| La Spezia | CNE | Jun-86 | 57.9 | 5.8 | 28.5 | 4.3 | | | | |
| Venezia | CNE | Jun-86 | 113.0 | 11.3 | 47.7 | 7.2 | | | | |
| Taranto | CNE | Jun-86 | 60.7 | 6.1 | 25.9 | 3.9 | | | | |
| La Spezia | CNE | Oct-86 | 16.7 | 1.7 | 4.9 | 2.5 | | | | |
| Napoli | CNE | Sept-86 | 33.6 | 3.4 | 10.5 | 5.3 | | | | |
| Napoli | CNE | Oct-86 | 22.2 | 2.2 | 12.8 | 1.9 | | | | |
| Venezia | CNE | Oct-86 | 30.6 | 3.1 | 11.8 | 1.8 | | | | |
| Taranto | CNE | Sept-86 | 48.8 | 4.9 | 18.7 | 2.8 | | | | |
| Taranto | CNE | Oct-86 | 45.0 | 4.5 | 14.1 | 2.1 | | | | |
| Taranto | CNE | Dec-86 | 43.6 | 4.4 | 8.5 | 4.3 | | | | |
| La Maddalena | CNE | Sept-86 | 25.6 | 2.6 | 10.6 | 1.6 | | | | |
| Napoli | CNE | Apr-87 | 7.3 | 0.7 | 4.5 | 2.3 | | | | |
| Venezia | CNE | Feb-87 | 22.7 | 2.3 | 5.4 | 0.8 | | | | |
| Taranto | CNE | Mar-87 | 11.1 | 1.1 | 2.3 | 1.2 | | | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|------|---------|-------------------------------------|-----|-------------------------------------|-----|------------------------------------|----|------------------------------------|----|
| La Spezia | CNE | Jul-87 | 7.4 | 0.7 | 2.6 | 1.3 | | | | |
| Napoli | CNE | Sept-87 | 7.2 | 0.7 | 2.9 | 1.5 | | | | |
| Venezia | CNE | Sept-87 | 15.5 | 1.6 | 3.8 | 1.9 | | | | |
| Taranto | CNE | Sept-87 | 14.2 | 1.4 | 3.9 | 2.0 | | | | |
| La Maddalena | CNE | Sept-87 | 6.9 | 0.7 | 4.2 | 2.1 | | | | |
| La Spezia | CNE | Mar-88 | 6.1 | 0.6 | | | | | | |
| Napoli | CNE | Mar-88 | 5.4 | 0.5 | | | | | | |
| Venezia | CNE | Mar-88 | 11.5 | 1.1 | | | | | | |
| Taranto | CNE | Mar-88 | 8.4 | 0.8 | | | | | | |
| La Maddalena | CNE | Mar-88 | 5.1 | 0.5 | | | | | | |
| La Spezia | CNE | Sept-88 | 5.0 | 0.5 | | | | | | |
| Napoli | CNE | Sept-88 | 4.0 | 0.4 | | | | | | |
| Venezia | CNE | Sept-88 | 8.2 | 0.8 | | | | | | |
| Taranto | CNE | Sept-88 | 7.7 | 0.8 | | | | | | |
| La Maddalena | CNE | Sept-88 | 5.3 | 0.5 | | | | | | |
| La Spezia | CNE | Mar-89 | 4.4 | 0.4 | | | | | | |
| Napoli | CNE | Mar-89 | 5.5 | 0.6 | | | | | | |
| Cesenatico | ARP | Mar-89 | 6.4 | 0.6 | 1.0 | 0.5 | | | | |
| Venezia | CNE | Mar-89 | 6.6 | 0.7 | | | | | | |
| Taranto | CNE | Mar-89 | 4.7 | 0.5 | | | | | | |
| La Maddalena | CNE | Mar-89 | 4.5 | 0.4 | | | | | | |
| La Spezia | CNE | Sept-89 | 5.1 | 0.5 | | | | | | |
| Napoli | CNE | Sept-89 | 5.7 | 0.6 | | | | | | |
| Cesenatico | ARP | Oct-89 | 7.6 | 0.8 | 0.8 | 0.4 | | | | |
| Venezia | CNE | Sept-89 | 5.7 | 0.6 | | | | | | |
| La Maddalena | CNE | Sept-89 | 3.7 | 0.4 | | | | | | |
| La Spezia | CNE | Feb-90 | 4.3 | 0.4 | | | | | | |
| Napoli | CNE | Mar-90 | 4.8 | 0.4 | | | | | | |
| Cesenatico | ARP | Jun-90 | 8.6 | 1.3 | | | | | | |
| Venezia | CNE | Feb-90 | 6.9 | 0.6 | | | | | | |
| Taranto | CNE | Mar-90 | 5.6 | 0.4 | | | | | | |
| La Maddalena | CNE | Mar-90 | 4.4 | 0.7 | | | | | | |
| La Spezia | CNE | Sept-90 | 5.6 | 0.7 | | | | | | |
| Napoli | CNE | Oct-90 | 5.4 | 0.6 | | | | | | |
| Cesenatico | ARP | Dec-90 | 8.9 | 1.3 | 1.1 | 0.6 | | | | |
| Venezia | CNE | Sept-90 | 6.5 | 0.8 | | | | | | |
| Taranto | CNE | Oct-90 | 5.9 | 0.5 | | | | | | |
| La Maddalena | CNE | Sept-90 | 4.2 | 0.5 | | | | | | |
| La Spezia | CNE | Mar-91 | 4.4 | 0.4 | | | | | | |
| Cesenatico | ARP | Mar-91 | 8.1 | 1.2 | | | | | | |
| Venezia | CNE | Mar-91 | 4.6 | 0.4 | | | | | | |
| Taranto | CNE | Mar-91 | 5.1 | 0.5 | | | | | | |
| La Maddalena | CNE | Mar-91 | 4.0 | 0.4 | | | | | | |
| La Spezia | CNE | Sept-91 | 4.8 | 0.4 | | | | | | |
| Napoli | CNE | Oct-91 | 4.1 | 0.4 | | | | | | |
| Cesenatico | ARP | Sept-91 | 5.3 | 0.8 | | | | | | |
| Taranto | CNE | Sept-91 | 4.7 | 0.4 | | | | | | |
| La Maddalena | CNE | Sept-91 | 3.9 | 0.4 | | | | | | |
| La Spezia | CNE | May-92 | 3.3 | 0.3 | | | | | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|------|---------|-------------------------------------|-----|-------------------------------------|----|------------------------------------|-----|------------------------------------|----|
| Napoli | CNE | Mar-92 | 3.7 | 0.4 | | | | | | |
| Venezia | CNE | Mar-92 | 4.0 | 0.4 | | | | | | |
| Taranto | CNE | Mar-92 | 3.0 | 0.3 | | | | | | |
| La Maddalena | CNE | Mar-92 | 3.1 | 0.3 | | | | | | |
| La Spezia | CNE | Jul-92 | 3.2 | 0.3 | | | | | | |
| Napoli | CNE | Sept-92 | 3.1 | 0.3 | | | | | | |
| Cesenatico | ARP | Sept-92 | 1.6 | 0.2 | | | | | | |
| Venezia | CNE | Sept-92 | 4.1 | 0.4 | | | | | | |
| Taranto | CNE | Sept-92 | 3.3 | 0.3 | | | | | | |
| La Maddalena | CNE | Jun-92 | 3.1 | 0.3 | | | | | | |
| La Spezia | CNE | Feb-93 | 4.3 | 0.3 | | | | | | |
| Napoli | CNE | Mar-93 | 3.6 | 0.4 | | | | | | |
| Cesenatico | ARP | Jun-93 | 5.5 | 0.5 | | | 1.0 | 0.1 | | |
| Venezia | CNE | Mar-93 | 3.8 | 0.3 | | | | | | |
| Taranto | CNE | Apr-93 | 4.4 | 0.4 | | | | | | |
| La Maddalena | ASL8 | Mar-93 | 4.7 | 0.4 | | | | | | |
| La Spezia | CNE | Sept-93 | 4.3 | 0.4 | | | | | | |
| Napoli | CNE | Nov-93 | 3.2 | 0.4 | | | | | | |
| Cesenatico | ARP | Sept-93 | 3.6 | 0.3 | | | 3.4 | 0.2 | | |
| Taranto | CNE | Sept-93 | 3.1 | 0.3 | | | | | | |
| La Maddalena | ASL8 | Sept-93 | 4.4 | 0.4 | | | | | | |
| La Spezia | CNE | Mar-94 | 3.2 | 0.3 | | | | | | |
| Napoli | CNE | Mar-94 | 3.2 | 0.3 | | | | | | |
| Cesenatico | ARP | Jun-94 | 3.0 | 0.3 | | | 1.1 | 0.1 | | |
| Venezia | CNE | Mar-94 | 3.5 | 0.4 | | | | | | |
| Taranto | CNE | Mar-94 | 2.8 | 0.3 | | | | | | |
| La Maddalena | ASL8 | Mar-94 | 2.9 | 0.3 | | | | | | |
| La Spezia | CNE | Sept-94 | 2.9 | 0.3 | | | | | | |
| Napoli | CNE | Sept-94 | 3.1 | 0.3 | | | | | | |
| Cesenatico | ARP | Nov-94 | 3.4 | 0.2 | | | 1.7 | 0.4 | | |
| Venezia | CNE | Sept-94 | 3.3 | 0.3 | | | | | | |
| Taranto | CNE | Sept-94 | 3.1 | 0.3 | | | | | | |
| La Maddalena | ASL8 | Sept-94 | 3.4 | 0.3 | | | | | | |
| La Spezia | CNE | Mar-95 | 3.2 | 0.5 | | | | | | |
| Napoli | CNE | Mar-95 | 3.1 | 0.5 | | | | | | |
| Cesenatico | ARP | Jun-95 | 1.0 | 0.1 | | | 1.9 | 0.2 | | |
| Venezia | CNE | Mar-95 | 3.6 | 0.5 | | | | | | |
| La Maddalena | ASL8 | Mar-95 | 2.9 | 0.4 | | | | | | |
| La Spezia | CNE | Sept-95 | 3.6 | 0.5 | | | | | | |
| Cesenatico | ARP | Dec-95 | 3.2 | 0.3 | | | 2.1 | 0.2 | | |
| Venezia | CNE | Sept-95 | 3.3 | 0.5 | | | | | | |
| Taranto | CNE | Sept-95 | 2.8 | 0.4 | | | | | | |
| La Maddalena | ASL8 | Sept-95 | 3.4 | 0.5 | | | | | | |
| La Spezia | CNE | Mar-96 | 3.1 | 0.3 | | | | | | |
| Napoli | CNE | Mar-96 | 3.2 | 0.4 | | | | | | |
| Cesenatico | ARP | Jun-96 | 3.7 | 0.2 | | | 2.1 | 0.2 | | |
| Venezia | CNE | Mar-96 | 4.0 | 0.4 | | | | | | |
| La Maddalena | ASL8 | Mar-96 | 3.4 | 0.5 | | | | | | |
| La Spezia | CNE | Sept-96 | 3.5 | 0.4 | | | | | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ¹³⁷ Cs Bq/m ³ | ±σ | ¹³⁴ Cs Bq/m ³ | ±σ | ⁹⁰ Sr Bq/m ³ | ±σ | ⁸⁹ Sr Bq/m ³ | ±σ |
|----------------|------|---------|-------------------------------------|-----|-------------------------------------|----|------------------------------------|------|------------------------------------|----|
| Cesenatico | ARP | Dec-96 | 1.7 | 0.2 | | | 3.9 | 0.1 | | |
| Venezia | CNE | Sept-96 | 3.8 | 0.4 | | | | | | |
| La Maddalena | ASL8 | Sept-96 | 3.6 | 0.5 | | | | | | |
| La Spezia | CNE | Apr-97 | 2.6 | 0.3 | | | | | | |
| Cesenatico | ARP | Jun-97 | 3.1 | 0.2 | | | 1.2 | 0.1 | | |
| Venezia | CNE | Apr-97 | 4.3 | 0.4 | | | | | | |
| La Maddalena | ASL8 | Apr-97 | 4.0 | 0.8 | | | | | | |
| La Spezia | CNE | ago-97 | 3.9 | 0.4 | | | | | | |
| Cesenatico | ARP | Nov-97 | 3.0 | 0.1 | | | 2.0 | 0.1 | | |
| Venezia | CNE | Sept-97 | 3.0 | 0.3 | | | | | | |
| La Maddalena | ASL8 | Sept-97 | 3.6 | 0.7 | | | | | | |
| Cagliari | ASL8 | Dic-97 | | | | | 1.5 | 0.2 | | |
| Cesenatico | ARP | Jun-98 | 3.2 | 0.2 | | | 1.3 | 0.2 | | |
| Arbatax | ASL8 | Jun-98 | 2.9 | 0.3 | | | 1.0 | 0.1 | | |
| Cagliari | ASL8 | Nov-98 | 3.3 | 0.3 | | | 1.5 | 0.2 | | |
| La Maddalena | ASL8 | Mar-98 | | | | | 1.9 | 0.2 | | |
| La Maddalena | ASL8 | Jun-98 | 2.6 | 0.2 | | | | | | |
| La Maddalena | ASL8 | Nov-98 | 2.9 | 0.2 | | | 0.8 | 0.1 | | |
| Porto Torres | ASL8 | May-98 | | | | | 0.4 | 0.04 | | |
| Portoscuso | ASL8 | Sept-98 | 1.2 | 0.1 | | | 1.4 | 0.1 | | |
| La Spezia | CNE | Sept-98 | 3.0 | 0.2 | | | | | | |
| Cesenatico | ARP | Dec-98 | 2.6 | 0.2 | | | 2.1 | 0.1 | | |
| Venezia | CNE | Sept-98 | 3.4 | 0.1 | | | | | | |
| Southern Adr. | CNE | Dec-98 | 3.3 | 0.2 | | | | | | |
| Arbatax | ASL8 | Feb-99 | 3.0 | 0.2 | | | 4.4 | 0.4 | | |
| Arbatax | ASL8 | Sept-99 | 3.1 | 0.6 | | | 1.3 | 0.1 | | |
| Cagliari | ASL8 | May-99 | 2.9 | 0.6 | | | 1.1 | 0.1 | | |
| La Maddalena | ASL8 | Jul-99 | 2.9 | 0.5 | | | 1.5 | 0.2 | | |
| Porto Torres | ASL8 | Apr-99 | 3.7 | 0.6 | | | 0.8 | 0.1 | | |
| Porto Torres | ASL8 | Sept-99 | 3.3 | 0.5 | | | 1.3 | 0.1 | | |
| Portoscuso | ASL8 | Dec-99 | | | | | 3.1 | 0.1 | | |
| Cesenatico | ARP | Sept-99 | 2.3 | 0.2 | | | 1.4 | 0.1 | | |
| Arbatax | ASL8 | Dec-00 | 3.1 | 0.5 | | | 2.4 | 0.2 | | |
| Cagliari | ASL8 | Feb-00 | 3.9 | 0.7 | | | | | | |
| Cagliari | ASL8 | Oct-00 | 2.9 | 0.5 | | | 3.1 | 0.3 | | |
| La Maddalena | ASL8 | Dec-00 | 2.6 | 0.5 | | | 1.1 | 0.1 | | |
| Porto Torres | ASL8 | May-00 | | | | | 3.4 | 0.3 | | |
| Porto Torres | ASL8 | Dec-00 | 3.8 | 0.7 | | | 2.3 | 0.2 | | |
| Cesenatico | ARP | May-00 | 1.9 | 0.1 | | | 2.6 | 0.1 | | |
| Cesenatico | ARP | Dec-00 | 1.3 | 0.2 | | | 3.2 | 0.1 | | |
| Arbatax | ASL8 | Jun-01 | 2.4 | 0.4 | | | 1.7 | 0.2 | | |
| Arbatax | ASL8 | Nov-01 | 2.1 | 0.4 | | | 2.1 | 0.2 | | |
| Cagliari | ASL8 | May-01 | 3.0 | 0.5 | | | 1.1 | 0.1 | | |
| Cagliari | ASL8 | Dec-01 | 3.3 | 0.6 | | | 1.6 | 0.2 | | |
| La Maddalena | ASL8 | May-01 | 2.6 | 0.4 | | | 1.3 | 0.1 | | |
| La Maddalena | ASL8 | Nov-01 | 2.5 | 0.4 | | | 1.8 | 0.2 | | |
| Porto Torres | ASL8 | May-01 | 2.3 | 0.4 | | | 1.4 | 0.1 | | |
| Porto Torres | ASL8 | Dec-01 | 2.0 | 0.3 | | | 1.2 | 0.1 | | |
| Cesenatico | ARP | Jun-01 | 1.8 | 0.2 | | | | | | |

(Table 3. Continued)

| Sampling point | Org. | Date | ^{137}Cs Bq/m ³ | $\pm\sigma$ | ^{134}Cs Bq/m ³ | $\pm\sigma$ | ^{90}Sr Bq/m ³ | $\pm\sigma$ | ^{89}Sr Bq/m ³ | $\pm\sigma$ |
|----------------|------|--------|-------------------------------------|-------------|-------------------------------------|-------------|------------------------------------|-------------|------------------------------------|-------------|
| Cesenatico | ARP | Dec-01 | 2.1 | 0.3 | | | | | | |
| Arbatax | ASL8 | May-02 | 3.0 | 0.6 | | | 0.5 | 0.1 | | |
| Arbatax | ASL8 | Dec-02 | 2.9 | 0.3 | | | 1.2 | 0.1 | | |
| Cagliari | ASL8 | May-02 | 3.1 | 0.6 | | | 1.2 | 0.1 | | |
| Cagliari | ASL8 | Oct-02 | 2.9 | 0.5 | | | 0.8 | 0.1 | | |
| La Maddalena | ASL8 | May-02 | 2.5 | 0.4 | | | 1.3 | 0.1 | | |
| La Maddalena | ASL8 | Nov-02 | 2.9 | 0.6 | | | 1.2 | 0.1 | | |
| Porto Torres | ASL8 | May-02 | 2.4 | 0.4 | | | 1.1 | 0.1 | | |
| Porto Torres | ASL8 | Nov-02 | 2.3 | 0.4 | | | 0.8 | 0.1 | | |
| Cesenatico | ARP | Jul-02 | 1.7 | 0.2 | | | | | | |
| Cesenatico | ARP | Dec-02 | 1.8 | 0.3 | | | | | | |
| Arbatax | ASL8 | May-03 | 9.7 | 1.8 | | | | | | |
| Arbatax | ASL8 | Nov-03 | 3.0 | 0.1 | | | | | | |
| Cagliari | ASL8 | May-03 | 2.6 | 1.2 | | | | | | |
| Cagliari | ASL8 | Dec-03 | 1.2 | 0.2 | | | | | | |
| La Maddalena | ASL8 | Jun-03 | 3.2 | 0.6 | | | | | | |
| La Maddalena | ASL8 | Nov-03 | 3.0 | 0.8 | | | | | | |
| Porto Torres | ASL8 | Jun-03 | 2.7 | 0.4 | | | | | | |
| Porto Torres | ASL8 | Nov-03 | 3.8 | 0.1 | | | | | | |

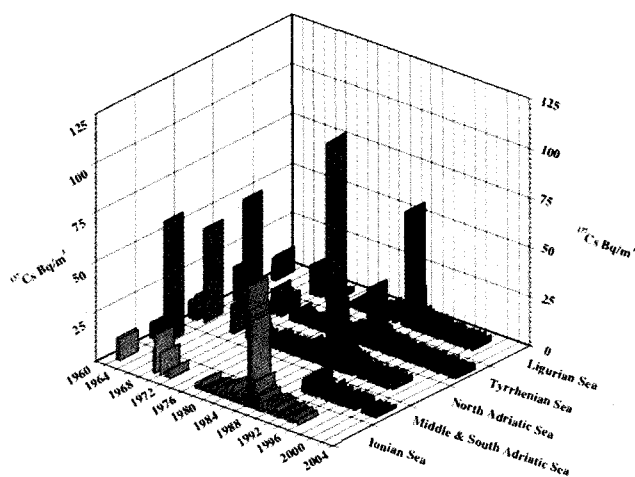


Fig. 3. Surface seawater concentration of ^{137}Cs along the Italian coast.

On the contrary, the contribution from the Chernobyl accident, which spread out above all as tropospheric fallout, was negligible in Japan and no increase was detected in the Japanese seawater in agreement with Baskaran *et al.* (1991) who also found a negligible contribution in the Alaskan Arctic.

The concentrations of ^{90}Sr and ^{137}Cs in fallout, due to the experimental weapon detonations, collected since 1960 in some stations (whose number ranged from about ten to

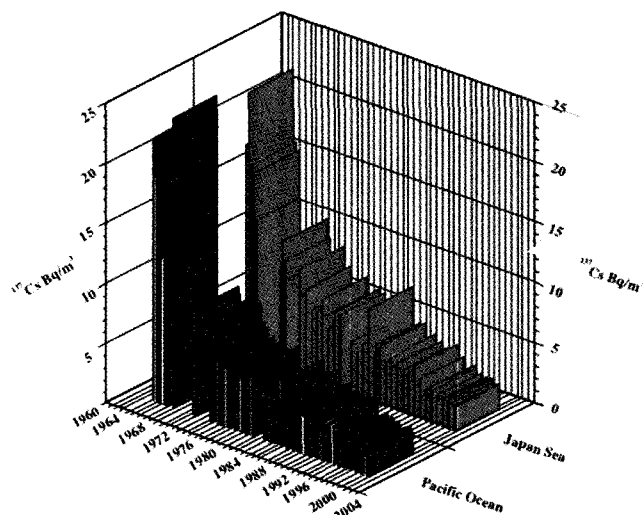


Fig. 4. Surface seawater concentration of ^{137}Cs along the Japanese coast.

forty), were measured. The results were reported in the bulletin "Radioactivity Survey data in Japan" (NIRS 1967 to 2002; JCAC 138). In these reports both the sampling stations and the procedures for the measurements are published.

In Table 7 and Fig. 8 the average monthly depositions of ^{90}Sr and ^{137}Cs are reported. The peak contribution of the Chernobyl accident to the fallout in Japan is lower by a factor of about 70 in comparison to Italy.

Table 4. Radionuclides concentration in Japanese seawater from 1963 to 2001.

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ ±σ | Sr ⁹⁰ Bq/m ³ ±σ | Sampling point | Date | Cs ¹³⁷ Bq/m ³ ±σ | Sr ⁹⁰ Bq/m ³ ±σ |
|----------------|---------|--|---------------------------------------|----------------|---------|--|---------------------------------------|
| Chiba | Jul-63 | | 22.2 | Aichi | May-71 | 6.3 | 8.5 |
| Chiba | Nov-63 | | 16.7 | Fukui | May-71 | 9.3 | 6.3 |
| Chiba | Jun-64 | 21.8 | 19.1 | Osaka | May-71 | 4.8 | 11.1 |
| Chiba | Aug-64 | | 10.4 | Hyogo | May-71 | 8.9 | 7.8 |
| Chiba | Sept-64 | | 21.1 | Shimane | May-71 | 7.0 | 5.9 |
| Chiba | Oct-64 | 18.5 | 7.4 | Niigata | Jun-71 | 8.5 | 10.0 |
| Chiba | Nov-64 | | 10.4 | Fukui | Jun-71 | 8.1 | 5.9 |
| Chiba | Dec-64 | | 19.2 | Fukuoka | Jun-71 | 8.9 | 6.7 |
| Fukushima | May-65 | 16.7 | 14.8 | Aomori | Aug-71 | 8.9 | 8.5 |
| Fukushima | Jun-65 | 21.8 | 17.9 | Niigata | Aug-71 | 10.4 | 8.1 |
| Fukushima | Aug-65 | 19.6 | 16.8 | Ibaraki | Aug-71 | 8.9 | 7.8 |
| Fukushima | Nov-65 | 13.0 | 11.2 | Kanagawa | Aug-71 | 7.4 | 7.0 |
| Niigata | Apr-65 | 17.8 | 26.3 | Aichi | Aug-71 | 9.3 | 5.9 |
| Niigata | Aug-65 | | 23.1 | Fukui | Aug-71 | 9.6 | 8.1 |
| Niigata | Oct-65 | 22.2 | 10.5 | Kyoto | Aug-71 | 8.9 | 8.5 |
| Chiba | Feb-65 | 21.1 | 12.8 | Shimane | Aug-71 | 9.6 | 7.4 |
| Chiba | Mar-65 | 8.5 | 12.2 | Saga | Aug-71 | 10.0 | 7.8 |
| Chiba | May-65 | 13.0 | 8.9 | Nagasaki | Aug-71 | 9.3 | 6.7 |
| Chiba | Jun-65 | 14.4 | 10.4 | Miyagi | Aug-71 | 10.7 | 8.1 |
| Chiba | Aug-65 | | 17.0 | Osaka | Sept-71 | 8.1 | 8.5 |
| Chiba | Nov-65 | 10.2 | 10.9 | Hyogo | Sept-71 | 8.1 | 7.4 |
| Hiroshima | May-65 | 16.8 | 22.2 | Hiroshima | Sept-71 | 9.6 | 7.0 |
| Hiroshima | Aug-65 | 12.5 | 21.2 | Fukuoka | Sept-71 | 10.7 | 9.3 |
| Hiroshima | Oct-65 | 22.4 | 10.6 | Aomori | Nov-71 | 8.5 | 6.7 |
| Fukushima | Mar-66 | 10.1 | 11.8 | Niigata | Nov-71 | 9.3 | 9.6 |
| Fukushima | Jun-66 | 15.2 | 10.6 | Ibaraki | Nov-71 | 6.7 | 5.9 |
| Fukushima | Aug-66 | 11.1 | 10.4 | Fukui | Nov-71 | 9.3 | 7.4 |
| Fukushima | Nov-66 | 13.3 | | Aichi | Nov-71 | 8.9 | 6.7 |
| Fukushima | Dec-66 | 8.5 | 4.8 | Osaka | Nov-71 | 8.5 | 8.5 |
| Niigata | Mar-66 | 16.3 | 5.3 | Hyogo | Nov-71 | 7.4 | 6.3 |
| Niigata | May-66 | 16.3 | 13.0 | Shimane | Nov-71 | 7.8 | 4.8 |
| Niigata | Aug-66 | 13.7 | | Fukuoka | Nov-71 | 7.8 | 6.3 |
| Chiba | Feb-66 | 12.1 | 11.1 | Kanagawa | Dec-71 | 8.5 | 6.3 |
| Fukui | May-66 | 12.8 | 19.4 | Aomori | Jan-72 | 9.3 | 7.0 |
| Fukui | Aug-66 | 17.4 | 16.8 | Aomori | Feb-72 | 8.9 | 6.7 |
| Fukui | Dec-66 | 11.7 | 26.1 | Miyagi | Feb-72 | 7.8 | 6.7 |
| Hiroshima | Jan-66 | 13.3 | 13.0 | Ibaraki | Feb-72 | 8.1 | 5.2 |
| Hiroshima | Aug-66 | 16.8 | 7.6 | Kanagawa | Feb-72 | 6.7 | 6.7 |
| Hiroshima | Dec-66 | 14.9 | 12.7 | Aichi | Feb-72 | 7.8 | 6.7 |
| Niigata | Mar-67 | | 7.8 | Kyoto | Feb-72 | 7.4 | 8.1 |
| Fukushima | Nov-67 | 24.1 | | Osaka | Feb-72 | 5.2 | 9.6 |
| Hiwayama | Mar-67 | | 5.2 | Hyogo | Feb-72 | 7.4 | 7.0 |
| Niigata | Mar-67 | | 5.2 | Hiroshima | Feb-72 | 7.4 | 5.9 |
| Aomori | May-71 | 9.3 | 7.4 | Saga | Feb-72 | 6.7 | 7.0 |
| Ibaraki | May-71 | 8.1 | 6.7 | Nagasaki | Feb-72 | 7.0 | 6.3 |
| Kanagawa | May-71 | 8.1 | 6.3 | Niigata | Feb-72 | 9.6 | 9.3 |
| | | | | Miyagi | Feb-72 | 7.0 | 5.9 |
| | | | | Fukui | Feb-72 | 7.4 | 6.3 |
| | | | | Shimane | Feb-72 | 7.4 | 8.1 |

(Table 4. Continued)

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ | Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ |
|----------------|---------|-------------------------------------|-----|------------------------------------|-----|----------------|---------|-------------------------------------|-----|------------------------------------|-----|
| Fukuoka | Feb-72 | 8.9 | | 6.7 | | Kanagawa | Sept-77 | 5.6 | 0.4 | 4.8 | 0.7 |
| Fukushima | May-74 | 7.0 | 0.4 | 3.7 | 0.4 | Niigata | Jul-77 | 5.2 | 0.4 | 4.8 | 0.6 |
| Miyagi | Jun-74 | 11.5 | 0.7 | 8.5 | 0.4 | Aichi | Jul-77 | 5.2 | 0.4 | 6.7 | 0.8 |
| Yamagata | Jun-74 | 5.2 | 0.4 | 5.2 | 0.4 | Osaka | Aug-77 | 4.4 | 0.4 | 6.7 | 0.7 |
| Hyogo | Jun-74 | 5.9 | 0.7 | 5.6 | 0.4 | Yamaguchi | Aug-77 | 5.6 | 0.4 | 4.1 | 0.6 |
| Nagasaki | Jun-74 | 5.6 | 0.4 | 5.6 | 0.4 | Fukuoka | Jul-77 | 4.8 | 0.4 | 4.8 | 0.6 |
| Aomori | Jul-74 | 13.0 | 0.7 | 8.1 | 0.4 | Kagoshima | Aug-77 | 7.0 | 0.4 | 3.7 | 0.7 |
| Akita | Jul-74 | 5.6 | 0.4 | 5.9 | 1.1 | Okinawa | Oct-77 | 4.8 | 0.4 | 4.8 | 0.7 |
| Ibaraki | Jul-74 | 5.9 | 0.4 | 6.3 | 0.4 | Niigata | Jul-78 | 7.0 | 0.5 | 5.2 | 0.6 |
| Niigata | Jul-74 | 5.9 | 0.4 | 5.2 | 0.4 | Fukuoka | Jul-78 | 5.6 | 0.5 | 5.2 | 0.6 |
| Ishikawa | Jul-74 | 7.8 | 0.7 | 5.6 | 0.4 | Aichi | Jul-78 | 4.1 | 0.4 | 5.9 | 0.4 |
| Aichi | Jul-74 | 3.7 | 0.4 | 9.3 | 0.4 | Hokkaido | Aug-78 | 5.9 | 0.5 | 5.2 | 0.4 |
| Hiroshiu | Jul-74 | 5.9 | 0.4 | 5.6 | 0.4 | Aomori | Aug-78 | 5.2 | 0.5 | 4.8 | 0.4 |
| Kagoshima | Jul-74 | 5.6 | 0.4 | 4.1 | 0.4 | Fukushima | Aug-78 | 4.8 | 0.5 | 4.8 | 0.4 |
| Hokkaido | Aug-74 | 6.3 | 0.4 | 6.3 | 0.7 | Kanagawa | Aug-78 | 5.6 | 0.5 | 4.1 | 0.5 |
| Kanagawa | Aug-74 | 5.6 | 0.4 | 5.2 | 0.4 | Osaka | Aug-78 | 4.8 | 0.4 | 7.8 | 0.5 |
| Fukui | Aug-74 | 7.0 | 0.4 | 9.6 | 0.4 | Yamaguchi | Aug-78 | 5.9 | 0.5 | 4.8 | 0.5 |
| Kyoto | Aug-74 | 5.6 | 0.4 | 5.6 | 0.4 | Kagoshima | Aug-78 | 5.9 | 0.5 | 4.1 | 0.4 |
| Shimane | Aug-74 | 7.4 | 0.4 | 5.2 | 0.4 | Okinawa | Aug-78 | 5.2 | 0.5 | 4.1 | 0.5 |
| Fukuoka | Aug-74 | 4.4 | 0.4 | 5.6 | 0.4 | Niigata | Jul-79 | | | 5.2 | 0.5 |
| Saga | Aug-74 | 7.0 | 0.4 | 6.3 | 0.4 | Aichi | Jul-79 | 4.1 | 0.5 | 5.6 | 0.5 |
| Osaka | Sept-74 | 4.8 | 0.4 | 7.4 | 0.4 | Yamaguchi | Jul-79 | 5.6 | 0.5 | 4.8 | 0.6 |
| Yamaguchi | Sept-74 | 6.7 | 0.4 | 6.3 | 0.4 | Fukuoka | Jul-79 | 4.4 | 0.5 | 4.8 | 0.5 |
| Shizuoka | Sept-74 | 5.2 | 0.4 | 4.8 | 0.4 | Hokkaido | Jul-79 | 4.8 | 0.5 | 5.2 | 0.6 |
| Hokkaido | Jul-75 | 7.0 | 0.6 | 4.8 | 0.4 | Hokkaido | Aug-79 | 4.8 | 0.5 | 5.2 | 0.6 |
| Kanagawa | Jul-75 | 5.6 | 0.5 | 5.2 | 0.3 | Aomori | Aug-79 | 4.8 | 0.4 | 5.2 | 0.6 |
| Niigata | Jul-75 | 6.3 | 0.5 | 4.8 | 0.3 | Fukushima | Aug-79 | 5.2 | 0.4 | 4.1 | 0.4 |
| Aichi | Jul-75 | 1.9 | 0.4 | 4.8 | 0.3 | Kanagawa | Aug-79 | 6.3 | 0.5 | 4.4 | 0.6 |
| Osaka | Jul-75 | 4.1 | 0.4 | 7.8 | 0.4 | Kagoshima | Aug-79 | 5.9 | 0.5 | 4.8 | 0.6 |
| Fukuoka | Jul-75 | 5.6 | 0.5 | 5.2 | 0.3 | Osaka | Sept-79 | 4.4 | 0.4 | 5.9 | 0.6 |
| Aomori | Aug-75 | 7.4 | 0.6 | 5.6 | 0.3 | Okinawa | Nov-79 | 4.8 | 0.5 | 3.7 | 0.5 |
| Fukushima | Aug-75 | 8.1 | 0.6 | 5.9 | 0.3 | Niigata | Jun-80 | 5.6 | 0.5 | 4.8 | 0.4 |
| Okinawa | Sept-75 | 5.6 | 0.4 | 4.8 | 0.4 | Okinawa | Jun-80 | 5.2 | 0.4 | 4.4 | 0.4 |
| Yamaguchi | Oct-75 | 6.7 | 0.5 | 4.8 | 0.3 | Aichi | Jul-80 | 2.2 | 0.4 | 4.4 | 0.4 |
| Kagoshima | Feb-76 | 6.7 | 0.5 | 4.4 | 0.3 | Osaka | Jul-80 | 2.6 | 0.4 | 7.0 | 0.5 |
| Yamaguchi | Jul-76 | 6.3 | 0.5 | 6.3 | 0.7 | Fukuoka | Jul-80 | 5.6 | 0.4 | 4.4 | 0.4 |
| Fukuoka | Jul-76 | 6.3 | 0.5 | 6.3 | 1.1 | Hokkaido | Aug-80 | 5.6 | 0.5 | 4.4 | 0.5 |
| Aomori | Aug-76 | 6.3 | 0.4 | 5.9 | 0.4 | Aomori | Aug-80 | 7.0 | 0.5 | 4.4 | 0.5 |
| Hokkaido | Aug-76 | 5.6 | 0.5 | 4.4 | 0.6 | Kanagawa | Aug-80 | 5.9 | 0.5 | 4.1 | 0.4 |
| Kanagawa | Aug-76 | 5.6 | 0.4 | 3.7 | 0.5 | Yamaguchi | Aug-80 | 3.7 | 0.5 | 5.2 | 0.5 |
| Aichi | Aug-76 | 4.8 | 0.4 | 3.3 | 1.8 | Fukushima | Sept-80 | 3.3 | 0.4 | 5.2 | 0.4 |
| Osaka | Aug-76 | 4.1 | 0.4 | 8.1 | 0.6 | Kagoshima | Sept-80 | 4.8 | 0.4 | 4.8 | 0.4 |
| Kagoshima | Aug-76 | 5.6 | 0.4 | 5.6 | 0.6 | Hokkaido | Jul-81 | 5.6 | 0.5 | 4.4 | 0.4 |
| Okinawa | Aug-76 | 5.6 | 0.4 | 4.1 | 0.5 | Niigata | Jul-81 | 5.2 | 0.4 | 5.2 | 0.4 |
| Niigata | Sept-76 | 5.2 | 0.4 | 5.2 | 0.6 | Aichi | Jul-81 | 3.7 | 0.4 | 4.4 | 0.4 |
| Fukushima | Feb-77 | 4.8 | 0.4 | 4.1 | 0.5 | Fukuoka | Jul-81 | 5.9 | 0.4 | 3.3 | 0.4 |
| Hokkaido | Jul-77 | 5.9 | 0.4 | 5.6 | 0.6 | Aomori | Aug-81 | 6.3 | 0.4 | 4.4 | 0.4 |
| Aomori | Aug-77 | 5.9 | 0.4 | 5.9 | 0.6 | Fukushima | Aug-81 | 4.8 | 0.4 | 4.1 | 0.4 |
| Fukushima | Sept-77 | 5.6 | 0.4 | 5.9 | 0.7 | Kanagawa | Aug-81 | 5.6 | 0.4 | 3.7 | 0.4 |

(Table 4. Continued)

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ | Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ |
|----------------|---------|-------------------------------------|-----|------------------------------------|-----|----------------|---------|-------------------------------------|-----|------------------------------------|-----|
| Osaka | Aug-81 | 3.3 | 0.4 | 5.9 | 0.4 | Aichi | Jul-87 | 2.2 | 0.3 | 3.0 | 0.3 |
| Kagoshima | Sept-81 | 5.2 | 0.4 | 4.1 | 0.4 | Fukuoka | Jul-87 | 3.7 | 0.4 | 3.0 | 0.3 |
| Yamaguchi | Nov-81 | 5.2 | 0.4 | 4.1 | 0.4 | Kagoshima | Jul-87 | 3.0 | 0.4 | 3.0 | 0.3 |
| Okinawa | Jan-82 | 5.6 | 0.5 | 3.7 | 0.4 | Fukushima | Aug-87 | 4.1 | 0.4 | 3.0 | 0.3 |
| Niigata | Jul-83 | 3.3 | 0.4 | 4.1 | 0.4 | Kanagawa | Aug-87 | 3.3 | 0.4 | 3.0 | 0.3 |
| Aichi | Jul-83 | 1.9 | 0.4 | 2.6 | 0.3 | Osaka | Aug-87 | 1.9 | 0.3 | 3.0 | 0.4 |
| Fukuoka | Jul-83 | 4.1 | 0.4 | 3.3 | 0.4 | Yamaguchi | Aug-87 | 3.7 | 0.4 | 2.6 | 0.3 |
| Kagoshima | Jul-83 | 4.4 | 0.4 | 3.0 | 0.4 | Okinawa | Aug-87 | 3.3 | 0.4 | 2.6 | 0.3 |
| Hokkaido | Aug-83 | 4.8 | 0.5 | 4.1 | 0.4 | Hokkaido | Nov-87 | 4.8 | 0.4 | 3.0 | 0.3 |
| Aomori | Aug-83 | 4.1 | 0.4 | 3.0 | 0.4 | Aomori | Dec-87 | 4.1 | 0.3 | 3.0 | 0.3 |
| Fukushima | Aug-83 | 3.3 | 0.4 | 3.3 | 0.4 | Hokkaido | Jul-88 | 4.9 | 0.4 | 2.5 | 0.3 |
| Kanagawa | Aug-83 | 4.1 | 0.4 | 3.3 | 0.4 | Niigata | Jul-88 | 4.1 | 0.4 | 3.2 | 0.3 |
| Osaka | Sept-83 | 1.9 | 0.4 | 4.4 | 0.4 | Fukuoka | Jul-88 | 3.8 | 0.3 | 1.7 | 0.3 |
| Yamaguchi | Sept-83 | 5.2 | 0.4 | 3.3 | 0.4 | Kagoshima | Jul-88 | 3.9 | 0.4 | 2.9 | 0.3 |
| Okinawa | Sept-83 | 5.2 | 0.4 | 3.3 | 0.4 | Aomori | Aug-88 | 4.9 | 0.4 | 2.4 | 0.3 |
| Kanagawa | Jul-84 | 3.7 | 0.4 | 3.0 | 0.4 | Fukushima | Aug-88 | 4.0 | 0.4 | 2.9 | 0.4 |
| Niigata | Jul-84 | 3.7 | 0.4 | 4.1 | 0.4 | Kanagawa | Aug-88 | 4.4 | 0.4 | 3.0 | 0.4 |
| Aichi | Jul-84 | 3.0 | 0.4 | 3.7 | 0.4 | Aichi | Aug-88 | 2.6 | 0.4 | 2.6 | 0.4 |
| Fukuoka | Jul-84 | 4.4 | 0.4 | 3.7 | 0.4 | Osaka | Aug-88 | 2.5 | 0.4 | 4.1 | 0.4 |
| Kagoshima | Jul-84 | 3.3 | 0.4 | 3.0 | 0.4 | Yamaguchi | Aug-88 | 4.2 | 0.4 | 2.3 | 0.4 |
| Hokkaido | Aug-84 | 5.2 | 0.4 | 3.3 | 0.4 | Okinawa | Sept-88 | 4.8 | 0.4 | 2.4 | 0.3 |
| Aomori | Aug-84 | 4.1 | 0.4 | 25.9 | 0.4 | Hokkaido | Jul-89 | 3.2 | 0.4 | 2.4 | 0.3 |
| Fukushima | Aug-84 | 4.4 | 0.4 | 3.3 | 0.4 | Niigata | Jul-89 | 3.6 | 0.4 | 2.9 | 0.4 |
| Yamaguchi | Aug-84 | 5.2 | 0.4 | 3.3 | 0.4 | Fukuoka | Jul-89 | 4.0 | 0.4 | 2.7 | 0.3 |
| Okinawa | Aug-84 | 3.3 | 0.4 | 3.0 | 0.3 | Kagoshima | Jul-89 | 2.7 | 0.4 | 2.2 | 0.3 |
| Osaka | Sept-84 | 3.0 | 0.4 | 4.1 | 0.4 | Aomori | Aug-89 | 3.7 | 0.4 | 3.0 | 0.4 |
| Niigata | Jul-85 | 4.4 | 0.4 | 4.4 | 0.4 | Fukushima | Aug-89 | 3.5 | 0.4 | 2.6 | 0.3 |
| Aichi | Jul-85 | 3.3 | 0.4 | 3.0 | 0.4 | Aichi | Aug-89 | 2.1 | 0.3 | 2.5 | 0.3 |
| Fukuoka | Jul-85 | 4.1 | 0.4 | 3.0 | 0.4 | Osaka | Aug-89 | 2.3 | 0.4 | 3.1 | 0.3 |
| Kagoshima | Jul-85 | 4.4 | 0.4 | 2.6 | 0.3 | Yamaguchi | Aug-89 | 3.4 | 0.4 | 2.4 | 0.3 |
| Hokkaido | Aug-85 | 3.7 | 0.4 | 3.3 | 0.4 | Kanagawa | Sept-89 | 3.0 | 0.3 | 2.5 | 0.4 |
| Aomori | Aug-85 | 4.1 | 0.4 | 3.3 | 0.4 | Okinawa | Oct-89 | 3.6 | 0.3 | 2.5 | 0.3 |
| Fukushima | Aug-85 | 5.2 | 0.4 | 3.0 | 0.4 | Aichi | Jul-90 | 2.8 | 0.3 | 2.4 | 0.4 |
| Kanagawa | Aug-85 | 4.1 | 0.4 | 3.0 | 0.4 | Niigata | Jul-90 | 3.7 | 0.3 | 2.5 | 0.3 |
| Osaka | Aug-85 | 3.0 | 0.4 | 4.1 | 0.4 | Fukuoka | Jul-90 | 3.2 | 0.3 | 2.4 | 0.3 |
| Yamaguchi | Aug-85 | 4.1 | 0.4 | 3.3 | 0.4 | Kagoshima | Jul-90 | 4.0 | 0.4 | 2.8 | 0.4 |
| Okinawa | Sept-85 | 3.0 | 0.4 | 3.3 | 0.4 | Aomori | Aug-90 | 3.4 | 0.3 | 2.7 | 0.4 |
| Niigata | Jul-86 | 7.0 | 0.5 | 3.7 | 0.4 | Fukushima | Aug-90 | 3.1 | 0.3 | 2.5 | 0.4 |
| Fukuoka | Jul-86 | 4.8 | 0.4 | 3.0 | 0.4 | Kanagawa | Aug-90 | 3.7 | 0.3 | 2.4 | 0.3 |
| Hokkaido | Aug-86 | 7.8 | 0.5 | 3.7 | 0.3 | Osaka | Aug-90 | 2.2 | 0.3 | 3.7 | 0.4 |
| Aomori | Aug-86 | 7.4 | 0.5 | 3.7 | 0.4 | Yamaguchi | Aug-90 | 3.8 | 0.3 | 2.4 | 0.4 |
| Fukushima | Aug-86 | 6.3 | 0.5 | 3.0 | 0.3 | Okinawa | Oct-90 | 4.0 | 0.4 | 2.4 | 0.4 |
| Kanagawa | Aug-86 | 5.9 | 0.4 | 3.3 | 0.3 | Hokkaido | Jul-90 | 5.0 | 0.4 | 2.9 | 0.3 |
| Aichi | Aug-86 | 5.9 | 0.4 | 3.0 | 0.4 | Chiba | Jan-91 | 3.4 | 0.4 | 1.9 | 0.3 |
| Osaka | Aug-86 | 3.3 | 0.4 | 3.7 | 0.4 | Hokkaido | Jul-91 | 3.8 | 0.4 | 2.6 | 0.2 |
| Yamaguchi | Aug-86 | 5.6 | 0.4 | 3.3 | 0.4 | Niigata | Jul-91 | 3.5 | 0.3 | 2.3 | 0.2 |
| Kagoshima | Aug-86 | 4.4 | 0.4 | 3.7 | 0.4 | Aichi | Jul-91 | 1.2 | 0.2 | 2.2 | 0.2 |
| Okinawa | Nov-86 | 4.1 | 0.4 | 3.0 | 0.4 | Yamaguchi | Jul-91 | 3.5 | 0.4 | 2.6 | 0.2 |
| Niigata | Jul-87 | 4.1 | 0.4 | 2.6 | 0.3 | Fukuoka | Jul-91 | 3.4 | 0.3 | 2.7 | 0.2 |

(Table 4. Continued)

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ | Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ |
|----------------|---------|-------------------------------------|-----|------------------------------------|-----|----------------|---------|-------------------------------------|-----|------------------------------------|-----|
| Aomori | Aug-91 | 3.9 | 0.4 | 2.1 | 0.2 | Niigata | Jul-95 | 3.1 | 0.4 | 2.0 | 0.2 |
| Fukushima | Aug-91 | 3.0 | 0.3 | 2.2 | 0.2 | Aichi | Jul-95 | 2.4 | 0.3 | 2.0 | 0.2 |
| Chiba | Aug-91 | 2.9 | 0.5 | 2.8 | 0.4 | Osaka | Jul-95 | 1.2 | 0.3 | 2.4 | 0.2 |
| Kanagawa | Aug-91 | 3.6 | 0.3 | 2.3 | 0.2 | Yamaguchi | Jul-95 | 2.7 | 0.4 | 1.8 | 0.2 |
| Kagoshima | Aug-91 | 3.5 | 0.4 | 2.1 | 0.2 | Fukuoka | Jul-95 | 3.8 | 0.4 | 2.1 | 0.2 |
| Hokkaido | Jul-92 | 2.9 | 0.4 | 3.0 | 0.4 | Kagoshima | Jul-95 | 3.2 | 0.4 | 1.9 | 0.2 |
| Ibaraki | Jul-92 | 3.4 | 0.4 | 2.4 | 0.3 | Aomori | Aug-95 | 3.3 | 0.4 | 1.6 | 0.2 |
| Niigata | Jul-92 | 4.1 | 0.4 | 2.4 | 0.2 | Chiba | Aug-95 | 2.4 | 0.3 | 1.4 | 0.2 |
| Aichi | Jul-92 | 2.1 | 0.3 | 2.4 | 0.3 | Kanagawa | Aug-95 | 2.9 | 0.4 | 2.1 | 0.2 |
| Yamaguchi | Jul-92 | 4.0 | 0.4 | 2.3 | 0.2 | Fukushima | Sept-95 | 3.2 | 0.4 | 2.2 | 0.2 |
| Fukuoka | Jul-92 | 2.8 | 0.4 | 2.5 | 0.3 | Okinawa | Oct-95 | 2.7 | 0.4 | 1.9 | 0.2 |
| Aomori | Aug-92 | 3.6 | 0.4 | 2.4 | 0.3 | Hokkaido | Jul-96 | 2.7 | 0.3 | 2.0 | 0.3 |
| Fukushima | Aug-92 | 2.7 | 0.4 | 2.3 | 0.4 | Aomori | Jul-96 | 2.8 | 0.3 | 1.8 | 0.3 |
| Chiba | Aug-92 | 3.8 | 0.4 | 2.3 | 0.2 | Fukushima | Jul-96 | 2.0 | 0.3 | 1.6 | 0.3 |
| Kanagawa | Aug-92 | 3.8 | 0.5 | 2.3 | 0.4 | Ibaraki | Jul-96 | 2.8 | 0.3 | 2.0 | 0.3 |
| Osaka | Aug-92 | 3.4 | 0.4 | 2.3 | 0.2 | Niigata | Jul-96 | 1.6 | 0.2 | 1.8 | 0.3 |
| Okinawa | Aug-92 | 3.9 | 0.4 | 2.2 | 0.2 | Aichi | Jul-96 | 2.2 | 0.3 | 1.9 | 0.3 |
| Kagoshima | Dec-92 | 3.5 | 0.4 | 2.3 | 0.2 | Osaka | Jul-96 | 2.1 | 0.3 | 1.9 | 0.3 |
| Aomori | May-93 | 3.5 | 0.5 | 1.9 | 0.3 | Yamaguchi | Jul-96 | 2.3 | 0.3 | 2.0 | 0.3 |
| Hokkaido | Jul-93 | 3.7 | 0.4 | 1.6 | 0.2 | Fukuoka | Jul-96 | 2.5 | 0.3 | 2.2 | 0.3 |
| Ibaraki | Jul-93 | 2.8 | 0.3 | 2.0 | 0.2 | Aomori | Aug-96 | 2.6 | 0.3 | 2.5 | 0.2 |
| Niigata | Jul-93 | 2.8 | 0.4 | 1.8 | 0.2 | Chiba | Aug-96 | 1.6 | 0.3 | 2.4 | 0.2 |
| Fukuoka | Jul-93 | 2.6 | 0.4 | 1.9 | 0.2 | Kanagawa | Aug-96 | 2.9 | 0.3 | 1.6 | 0.3 |
| Kagoshima | Jul-93 | 1.9 | 0.3 | 1.8 | 0.2 | Kagoshima | Aug-96 | 1.7 | 0.3 | 1.7 | 0.3 |
| Aomori | Aug-93 | 2.8 | 0.3 | 2.6 | 0.2 | Okinawa | Sept-96 | 2.3 | 0.3 | 2.1 | 0.3 |
| Fukushima | Aug-93 | 2.4 | 0.3 | 2.1 | 0.2 | Hokkaido | Jul-97 | 2.5 | 0.3 | 1.8 | 0.3 |
| Chiba | Aug-93 | 2.5 | 0.3 | 2.2 | 0.2 | Aomori | Jul-97 | 3.4 | 0.4 | 1.7 | 0.3 |
| Kanagawa | Aug-93 | 2.9 | 0.3 | 2.1 | 0.2 | Fukushima | Jul-97 | 2.2 | 0.3 | 1.4 | 0.3 |
| Aichi | Aug-93 | 2.3 | 0.3 | 2.2 | 0.2 | Ibaraki | Jul-97 | 1.9 | 0.3 | 1.5 | 0.3 |
| Osaka | Aug-93 | 1.7 | 0.3 | 2.3 | 0.2 | Niigata | Jul-97 | 2.7 | 0.3 | 1.9 | 0.3 |
| Yamaguchi | Sept-93 | 2.8 | 0.4 | 2.0 | 0.2 | Osaka | Jul-97 | 1.6 | 0.3 | 1.9 | 0.3 |
| Okinawa | Sept-93 | 3.2 | 0.4 | 2.1 | 0.2 | Aomori | Aug-97 | 2.7 | 0.3 | 1.8 | 0.3 |
| Hokkaido | Jul-94 | 3.7 | 0.4 | 2.4 | 0.2 | Chiba | Aug-97 | 2.2 | 0.3 | 1.7 | 0.3 |
| Aomori | Jul-94 | 2.8 | 0.3 | 1.7 | 0.2 | Kanagawa | Aug-97 | 2.1 | 0.3 | 1.7 | 0.3 |
| Ibaraki | Jul-94 | 2.9 | 0.3 | 2.0 | 0.2 | Aichi | Aug-97 | 2.5 | 0.3 | 2.1 | 0.3 |
| Niigata | Jul-94 | 4.4 | 0.4 | 1.8 | 0.2 | Yamaguchi | Aug-97 | 2.7 | 0.3 | 1.6 | 0.3 |
| Aichi | Jul-94 | 3.8 | 0.4 | 2.3 | 0.2 | Fukuoka | Aug-97 | 2.4 | 0.3 | 2.0 | 0.3 |
| Fukuoka | Jul-94 | 4.1 | 0.4 | 2.1 | 0.2 | Kagoshima | Sept-97 | 2.2 | 0.3 | 2.0 | 0.3 |
| Aomori | Aug-94 | 4.2 | 0.4 | 2.7 | 0.2 | Okinawa | Sept-97 | 3.0 | 0.4 | 2.1 | 0.3 |
| Fukushima | Aug-94 | 2.8 | 0.3 | 2.1 | 0.2 | Hokkaido | Jul-98 | 2.5 | 0.2 | 1.9 | 0.2 |
| Chiba | Aug-94 | 4.0 | 0.4 | 2.0 | 0.2 | Aomori | Jul-98 | 2.3 | 0.2 | 1.4 | 0.1 |
| Kanagawa | Aug-94 | 3.4 | 0.3 | 2.2 | 0.2 | Fukushima | Jul-98 | 1.8 | 0.2 | 1.8 | 0.2 |
| Osaka | Aug-94 | 3.4 | 0.3 | 2.7 | 0.2 | Niigata | Jul-98 | 2.5 | 0.2 | 1.4 | 0.1 |
| Yamaguchi | Aug-94 | 2.7 | 0.3 | 1.9 | 0.2 | Ibaraki | Jul-98 | 2.2 | 0.2 | 1.5 | 0.1 |
| Kagoshima | Aug-94 | 3.2 | 0.3 | 2.2 | 0.2 | Chiba | Jul-98 | 2.1 | 0.2 | 1.8 | 0.2 |
| Okinawa | Oct-94 | 3.3 | 0.4 | 2.3 | 0.2 | Kanagawa | Jul-98 | 2.5 | 0.3 | 1.9 | 0.2 |
| Hokkaido | Jul-95 | 3.4 | 0.4 | 2.0 | 0.2 | Aichi | Jul-98 | 2.3 | 0.2 | 1.7 | 0.2 |
| Aomori | Jul-95 | 3.0 | 0.4 | 1.9 | 0.2 | Osaka | Jul-98 | 1.4 | 0.2 | 1.8 | 0.1 |
| Ibaraki | Jul-95 | 1.8 | 0.3 | 2.2 | 0.2 | Aomori | Aug-98 | 1.9 | 0.2 | 1.7 | 0.2 |

(Table 4. Continued)

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ |
|----------------|---------|-------------------------------------|------|------------------------------------|------|
| Fukuoka | Aug-98 | 2.5 | 0.2 | 1.6 | 0.2 |
| Yamaguchi | Sept-98 | 2.4 | 0.2 | 1.7 | 0.2 |
| Kagoshima | Sept-98 | 2.1 | 0.2 | 1.6 | 0.2 |
| Okinawa | Oct-98 | 1.9 | 0.2 | 1.2 | 0.2 |
| Hokkaido | Jul-99 | 2.2 | 0.3 | 1.5 | 0.2 |
| Aomori | Jul-99 | 2.4 | 0.3 | 1.8 | 0.2 |
| Fukushima | Jul-99 | 2.3 | 0.3 | 1.6 | 0.2 |
| Ibaraki | Jul-99 | 1.5 | 0.24 | 1.7 | 0.23 |
| Chiba | Jul-99 | 1.7 | 0.3 | 2.0 | 0.2 |
| Niigata | Jul-99 | 2.2 | 0.3 | 1.7 | 0.2 |
| Aichi | Jul-99 | 1.9 | 0.3 | 2.0 | 0.2 |
| Osaka | Jul-99 | 1.7 | 0.3 | 1.7 | 0.2 |
| Aomori | Sept-99 | 2.2 | 0.3 | 1.5 | 0.2 |
| Kanagawa | Sept-99 | 2.5 | 0.3 | 2.0 | 0.2 |
| Yamaguchi | Sept-99 | 2.4 | 0.3 | 1.8 | 0.2 |
| Fukuoka | Sept-99 | 2.3 | 0.3 | 2.0 | 0.3 |
| Kagoshima | Oct-99 | 2.0 | 0.3 | 1.8 | 0.2 |
| Okinawa | Oct-99 | 2.2 | 0.3 | 2.1 | 0.2 |
| Hokkaido | Jun-00 | 2.3 | 0.3 | 1.9 | 0.3 |
| Aomori | Jul-00 | 2.1 | 0.3 | 1.6 | 0.3 |
| Fukushima | Jul-00 | 2.1 | 0.3 | 1.6 | 0.3 |
| Ibaraki | Jul-00 | 1.1 | 0.3 | 0.8 | 0.2 |
| Niigata | Jul-00 | 2.4 | 0.3 | 1.9 | 0.3 |
| Aichi | Jul-00 | 1.9 | 0.3 | 1.7 | 0.3 |
| Aomori | Aug-00 | 2.0 | 0.3 | 2.0 | 0.3 |
| Chiba | Aug-00 | 1.8 | 0.3 | 2.1 | 0.3 |
| Kanagawa | Aug-00 | 2.3 | 0.3 | 1.4 | 0.3 |
| Osaka | Aug-00 | 1.4 | 0.3 | 2.2 | 0.3 |
| Yamaguchi | Aug-00 | 2.2 | 0.3 | 1.0 | 0.3 |
| Fukuoka | Aug-00 | 2.1 | 0.3 | 1.3 | 0.3 |
| Kagoshima | Sept-00 | 0.8 | 0.2 | 1.4 | 0.3 |
| Okinawa | Sept-00 | 2.2 | 0.3 | 1.7 | 0.3 |
| Hokkaido | Jun-01 | 2.0 | 0.3 | 1.7 | 0.3 |
| Fukushima | Jul-01 | 1.8 | 0.3 | 1.3 | 0.3 |
| Ibaraki | Jul-01 | 1.9 | 0.3 | 1.5 | 0.3 |
| Chiba | Jul-01 | 1.8 | 0.3 | 1.7 | 0.3 |
| Niigata | Jul-01 | 1.7 | 0.3 | 1.7 | 0.3 |
| Aichi | Jul-01 | 1.9 | 0.3 | 1.7 | 0.3 |
| Osaka | Jul-01 | 0.8 | 0.3 | 1.6 | 0.3 |
| Aomori | Aug-01 | 2.0 | 0.3 | 2.1 | 0.3 |
| Kanagawa | Aug-01 | 2.3 | 0.3 | 1.3 | 0.3 |

| Sampling point | Date | Cs ¹³⁷ Bq/m ³ | ±σ | Sr ⁹⁰ Bq/m ³ | ±σ |
|----------------|---------|-------------------------------------|-----|------------------------------------|-----|
| Yamaguchi | Aug-01 | 2.1 | 0.3 | 1.4 | 0.3 |
| Fukuoka | Aug-01 | 2.5 | 0.3 | 1.5 | 0.3 |
| Kagoshima | Sept-01 | 1.3 | 0.3 | 1.3 | 0.3 |
| Okinawa | Nov-01 | 1.9 | 0.3 | 1.3 | 0.3 |

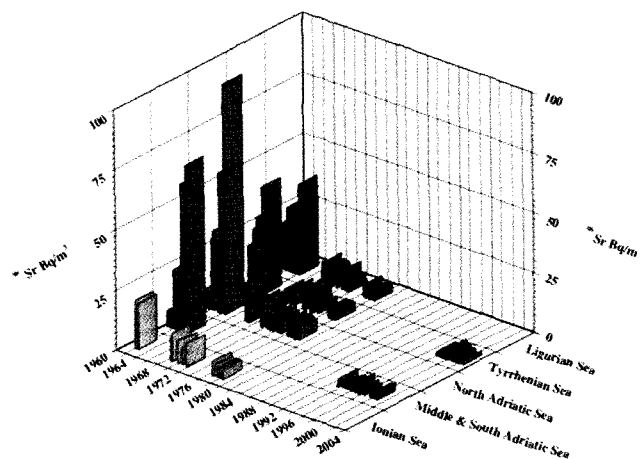


Fig. 5. Surface seawater concentration of ⁹⁰Sr along the Italian coast.

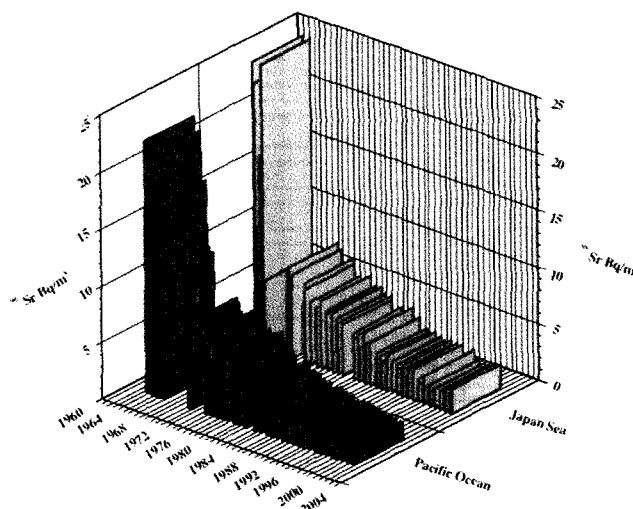


Fig. 6. Surface seawater concentration of ⁹⁰Sr s along the Japanese coast.

Table 5. Average monthly fallout deposition in Italy ($\sigma = \pm 10\%$)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|------|-------|------------------------------------|-------------------------------------|
| 1954 | Jan | | | 1958 | Jan | 17 | 26 |
| | Feb | 30 | 47 | | Feb | 16 | 24 |
| | Mar | 6.7 | 10 | | Mar | 11 | 18 |
| | Apr | 4.4 | 6.7 | | Apr | 20 | 30 |
| | May | 6.3 | 9.6 | | May | 34 | 53 |
| | Jun | 5.9 | 9.3 | | Jun | 23 | 35 |
| | Jul | 1.9 | 2.6 | | Jul | 20 | 31 |
| | Aug | 2.2 | 3.7 | | Aug | 7.8 | 12 |
| | Sep | 19 | 29 | | Sep | 8.5 | 13 |
| | Oct | 2.6 | 4.1 | | Oct | 14 | 21 |
| | Nov | 8.5 | 13 | | Nov | 13 | 19 |
| | Dec | 4.4 | 6.7 | | Dec | 23 | 35 |
| 1955 | Jan | 3.0 | 4.4 | 1959 | Jan | 15 | 23 |
| | Feb | 11 | 18 | | Feb | 22 | 34 |
| | Mar | 31 | 48 | | Mar | 65 | 101 |
| | Apr | 16 | 24 | | Apr | 81 | 124 |
| | May | 11 | 18 | | May | 17 | 26 |
| | Jun | 11 | 18 | | Jun | 57 | 88 |
| | Jul | 3.3 | 5.2 | | Jul | 6.3 | 10 |
| | Aug | 8.5 | 13 | | Aug | 8.5 | 13 |
| | Sep | 5.6 | 8.5 | | Sep | 1.9 | 2.6 |
| | Oct | 4.8 | 7.4 | | Oct | 4.8 | 7.4 |
| | Nov | 5.2 | 8.1 | | Nov | 4.1 | 6.3 |
| | Dec | 7.0 | 11 | | Dec | 6.7 | 8.5 |
| 1956 | Jan | 35 | 5.6 | 1960 | Jan | 4.8 | 7.4 |
| | Feb | 16 | 25 | | Feb | 6.7 | 10 |
| | Mar | 21 | 32 | | Mar | 7.0 | 11 |
| | Apr | 10 | 16 | | Apr | 7.0 | 11 |
| | May | 13 | 20 | | May | 7.0 | 11 |
| | Jun | 10 | 16 | | Jun | 22 | 34 |
| | Jul | 5.9 | 9.3 | | Jul | 16 | 25 |
| | Aug | 12 | 18 | | Aug | 10 | 16 |
| | Sep | 4.1 | 6.3 | | Sep | 9.6 | 15 |
| | Oct | 4.1 | 6.3 | | Oct | 8.5 | 13 |
| | Nov | 11 | 18 | | Nov | 4.1 | 6.3 |
| | Dec | 7.0 | 11 | | Dec | 4.1 | 6.3 |
| 1957 | Jan | 3.3 | 5.2 | 1961 | Jan | 3.0 | 4.4 |
| | Feb | 6.7 | 10 | | Feb | 1.5 | 2.2 |
| | Mar | 13 | 20 | | Mar | 0.37 | 0.74 |
| | Apr | 62 | 95 | | Apr | 14 | 22 |
| | May | 12 | 18 | | May | 7 | 11 |
| | Jun | 11 | 17 | | Jun | 10 | 16 |
| | Jul | 11 | 17 | | Jul | 3.3 | 5.2 |
| | Aug | 6.3 | 9.6 | | Aug | 1.5 | 2.2 |
| | Sep | 5.2 | 8.1 | | Sep | 1.9 | 3.0 |
| | Oct | 5.2 | 8.1 | | Oct | 11 | 18 |
| | Nov | 5.2 | 8.1 | | Nov | 21 | 33 |
| | Dec | 7.8 | 12 | | Dec | 13 | 20 |

(Table 5. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|------|-------|------------------------------------|-------------------------------------|
| 1962 | Jan | 27 | 45 | 1966 | Jan | 6.3 | 9.6 |
| | Feb | 32 | 50 | | Feb | 13 | 20 |
| | Mar | 37 | 60 | | Mar | 7.4 | 12 |
| | Apr | 50 | 80 | | Apr | 14 | 21 |
| | May | 49 | 88 | | May | 12 | 17 |
| | Jun | 46 | 71 | | Jun | 14 | 22 |
| | Jul | 19 | 32 | | Jul | 11 | 17 |
| | Aug | 8.9 | 17 | | Aug | 10 | 14 |
| | Sep | 15 | 26 | | Sep | 4.1 | 6.3 |
| | Oct | 24 | 40 | | Oct | 4.1 | 6.3 |
| | Nov | 57 | 97 | | Nov | 5.9 | 9.3 |
| | Dec | 32 | 52 | | Dec | 4.1 | 5.6 |
| 1963 | Jan | 34 | 57 | 1967 | Jan | 3.7 | 5.9 |
| | Feb | 41 | 68 | | Feb | 4.1 | 5.9 |
| | Mar | 42 | 70 | | Mar | 4.8 | 7.8 |
| | Apr | 100 | 154 | | Apr | 5.2 | 8.1 |
| | May | 141 | 195 | | May | 6.3 | 8.9 |
| | Jun | 106 | 182 | | Jun | 3.7 | 5.9 |
| | Jul | 126 | 231 | | Jul | 3.0 | 4.8 |
| | Aug | 92 | 153 | | Aug | 3.0 | 4.8 |
| | Sep | 46 | 75 | | Sep | 2.2 | 3.3 |
| | Oct | 21 | 34 | | Oct | 1.1 | 1.9 |
| | Nov | 69 | 99 | | Nov | 1.5 | 2.6 |
| | Dec | 22 | 55 | | Dec | 2.2 | 3.3 |
| 1964 | Jan | 24 | 39 | 1968 | Jan | 1.5 | 2.2 |
| | Feb | 24 | 53 | | Feb | 4.1 | 5.9 |
| | Mar | 59 | 40 | | Mar | 3.7 | 5.6 |
| | Apr | 72 | 115 | | Apr | 8.9 | 10 |
| | May | 63 | 102 | | May | 11 | 17 |
| | Jun | 80 | 121 | | Jun | 8.9 | 14 |
| | Jul | 53 | 85 | | Jul | 5.9 | 8.9 |
| | Aug | 37 | 59 | | Aug | 8.5 | 13 |
| | Sep | 8.9 | 14 | | Sep | 4.1 | 7.0 |
| | Oct | 33 | 58 | | Oct | 3.0 | 4.1 |
| | Nov | 13 | 24 | | Nov | 3.0 | 4.8 |
| | Dec | 14 | 23 | | Dec | 1.9 | 2.6 |
| 1965 | Jan | 23 | 32 | 1969 | Jan | 3.3 | 4.8 |
| | Feb | 13 | 20 | | Feb | 3.3 | 5.2 |
| | Mar | 22 | 31 | | Mar | 3.0 | 1.1 |
| | Apr | 20 | 30 | | Apr | 3.0 | 4.8 |
| | May | 27 | 43 | | May | 4.8 | 6.7 |
| | Jun | 23 | 36 | | Jun | 4.8 | 7.8 |
| | Jul | 14 | 22 | | Jul | 4.1 | 6.7 |
| | Aug | 17 | 27 | | Aug | 5.9 | 8.5 |
| | Sep | 16 | 26 | | Sep | 3.3 | 5.2 |
| | Oct | 3.7 | 5.9 | | Oct | 1.1 | 1.5 |
| | Nov | 11 | 18 | | Nov | 2.6 | 4.1 |
| | Dec | 5.6 | 8.5 | | Dec | 1.9 | 2.6 |

(Table 5. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|------|-------|------------------------------------|-------------------------------------|
| 1970 | Jan | 2.6 | 4.1 | 1974 | Jan | 0.74 | 1.1 |
| | Feb | 2.2 | 3.3 | | Feb | 2.2 | 3.3 |
| | Mar | 4.4 | 6.3 | | Mar | 2.2 | 4.8 |
| | Apr | 3.7 | 5.6 | | Apr | 3.0 | 7.0 |
| | May | 7.4 | 11 | | May | 3.0 | 4.8 |
| | Jun | 8.9 | 13 | | Jun | 3.3 | 5.6 |
| | Jul | 5.2 | 8.1 | | Jul | 1.5 | 2.6 |
| | Aug | 6.7 | 11 | | Aug | 1.1 | 2.2 |
| | Sep | 3.7 | 5.9 | | Sep | 0.74 | 1.9 |
| | Oct | 4.4 | 6.7 | | Oct | 1.1 | 1.9 |
| | Nov | 2.6 | 4.1 | | Nov | 0.74 | 1.5 |
| | Dec | 2.6 | 3.3 | | Dec | 0.74 | 1.1 |
| 1971 | Jan | 2.2 | 3.0 | 1975 | Jan | 1.1 | 2.2 |
| | Feb | 1.1 | 1.9 | | Feb | 1.1 | 1.5 |
| | Mar | 3.7 | 5.2 | | Mar | 4.4 | 7.8 |
| | Apr | 7.8 | 11 | | Apr | 3.0 | 5.2 |
| | May | 12 | 17 | | May | 3.0 | 4.8 |
| | Jun | 11 | 16 | | Jun | 2.6 | 4.4 |
| | Jul | 3.7 | 5.9 | | Jul | 1.1 | 1.5 |
| | Aug | 3.3 | 5.9 | | Aug | 1.5 | 2.6 |
| | Sep | 3.0 | 4.1 | | Sep | 0.74 | 1.1 |
| | Oct | 1.1 | 1.9 | | Oct | 0.37 | 0.74 |
| | Nov | 2.2 | 3.3 | | Nov | 0.37 | 0.37 |
| | Dec | 0.74 | 1.1 | | Dec | 0.37 | 0.37 |
| 1972 | Jan | 2.6 | 3.7 | 1976 | Jan | 0.37 | 0.74 |
| | Feb | 2.6 | 3.3 | | Feb | 0.74 | 1.1 |
| | Mar | 1.5 | 2.6 | | Mar | 0.37 | 0.74 |
| | Apr | 2.6 | 4.1 | | Apr | 0.74 | 1.5 |
| | May | 3.7 | 5.6 | | May | 0.74 | 1.1 |
| | Jun | 2.2 | 3.3 | | Jun | 0.37 | 0.74 |
| | Jul | 3.0 | 4.4 | | Jul | 0.37 | 0.74 |
| | Aug | 1.5 | 3.0 | | Aug | 0.37 | 0.74 |
| | Sep | 1.5 | 2.2 | | Sep | 0.37 | 0.74 |
| | Oct | 0.74 | 1.1 | | Oct | 2.2 | 2.6 |
| | Nov | 0.37 | 0.74 | | Nov | 1.5 | 1.9 |
| | Dec | 0.74 | 0.74 | | Dec | 0.37 | 0.74 |
| 1973 | Jan | 2.6 | 1.1 | 1977 | Jan | 0.37 | 0.74 |
| | Feb | 2.6 | 0.74 | | Feb | 0.37 | 0.74 |
| | Mar | 1.5 | 0.74 | | Mar | 1.1 | 1.9 |
| | Apr | 2.6 | 1.9 | | Apr | 4.4 | 2.2 |
| | May | 3.7 | 1.9 | | May | 4.4 | 7.4 |
| | Jun | 2.2 | 2.6 | | Jun | 3.0 | 4.4 |
| | Jul | 3.0 | 2.2 | | Jul | 6.7 | 13 |
| | Aug | 1.5 | 0.74 | | Aug | 7.4 | 13 |
| | Sep | 1.5 | 1.1 | | Sep | 2.2 | 3.3 |
| | Oct | 0.74 | 0.74 | | Oct | 3.7 | 5.6 |
| | Nov | 0.37 | 0.37 | | Nov | 1.1 | 1.9 |
| | Dec | 0.74 | 1.5 | | Dec | 1.1 | 1.9 |

(Table 5. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|------|-------|------------------------------------|-------------------------------------|
| 1978 | Jan | 3.7 | 6.3 | 1982 | Jan | 0.19 | 0.21 |
| | Feb | 3.7 | 5.6 | | Feb | 0.19 | 0.35 |
| | Mar | 4.1 | 6.3 | | Mar | 0.22 | 0.85 |
| | Apr | 7.4 | 16 | | Apr | 0.19 | 0.48 |
| | May | 7.4 | 13 | | May | 0.26 | 0.49 |
| | Jun | 6.3 | 11 | | Jun | 0.26 | 0.42 |
| | Jul | 2.6 | 11 | | Jul | 0.26 | 0.73 |
| | Aug | 1.9 | 3.0 | | Aug | 0.41 | 0.51 |
| | Sep | 0.74 | 1.5 | | Sep | 0.30 | 0.35 |
| | Oct | 0.74 | 1.5 | | Oct | 0.19 | 0.27 |
| | Nov | 0.37 | 0.37 | | Nov | 0.19 | 0.36 |
| | Dec | 1.1 | 1.5 | | Dec | 0.19 | 0.21 |
| 1979 | Jan | 1.5 | 1.7 | 1983 | Jan | 0.36 | 0.18 |
| | Feb | 1.1 | 2.0 | | Feb | 0.38 | 0.22 |
| | Mar | 2.6 | 3.5 | | Mar | 0.19 | 0.33 |
| | Apr | 2.1 | 2.5 | | Apr | 0.19 | 0.49 |
| | May | 0.50 | 0.85 | | May | 0.30 | 0.47 |
| | Jun | 1.4 | 1.9 | | Jun | 0.19 | 0.25 |
| | Jul | 0.93 | 1.1 | | Jul | 0.19 | 0.17 |
| | Aug | 0.93 | 1.5 | | Aug | 0.19 | 0.24 |
| | Sep | 0.35 | 0.44 | | Sep | 0.19 | 0.18 |
| | Oct | 0.76 | 1.0 | | Oct | 0.19 | 0.18 |
| | Nov | 0.28 | 0.27 | | Nov | 0.19 | 0.19 |
| | Dec | 0.48 | 0.84 | | Dec | 0.19 | 0.19 |
| 1980 | Jan | 0.41 | 0.53 | 1984 | Jan | 0.12 | 0.18 |
| | Feb | 0.24 | 0.29 | | Feb | 0.12 | 0.22 |
| | Mar | 0.44 | 0.79 | | Mar | 0.12 | 0.22 |
| | Apr | 0.35 | 0.73 | | Apr | 0.58 | 0.22 |
| | May | 0.91 | 1.1 | | May | 0.53 | 0.46 |
| | Jun | 0.80 | 0.96 | | Jun | 0.40 | 0.29 |
| | Jul | 0.31 | 0.55 | | Jul | 0.23 | 0.12 |
| | Aug | 0.43 | 0.46 | | Aug | 0.41 | 0.19 |
| | Sep | 0.15 | 0.26 | | Sep | 0.44 | 0.23 |
| | Oct | 0.30 | 0.53 | | Oct | 0.76 | 0.22 |
| | Nov | 0.43 | 0.41 | | Nov | 0.33 | 0.15 |
| | Dec | 0.37 | 0.47 | | Dec | 0.23 | 0.12 |
| 1981 | Jan | 0.46 | 0.34 | 1985 | Jan | 0.20 | 0.15 |
| | Feb | 1.3 | 1.0 | | Feb | 0.20 | 0.16 |
| | Mar | 3.0 | 4.3 | | Mar | 0.20 | 0.21 |
| | Apr | 2.8 | 4.2 | | Apr | 0.20 | 0.21 |
| | May | 3.2 | 4.7 | | May | 0.20 | 0.22 |
| | Jun | 1.6 | 2.9 | | Jun | 0.20 | 0.16 |
| | Jul | 1.4 | 3.5 | | Jul | 0.20 | 0.16 |
| | Aug | 0.39 | 0.78 | | Aug | 0.20 | 0.18 |
| | Sep | 0.74 | 1.2 | | Sep | 0.20 | 0.13 |
| | Oct | 0.48 | 0.71 | | Oct | 0.20 | 0.12 |
| | Nov | 0.19 | 0.23 | | Nov | 0.20 | 0.20 |
| | Dec | 0.41 | 0.72 | | Dec | 0.20 | 0.22 |

(Table 5. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|------|-------|------------------------------------|-------------------------------------|
| 1986 | Jan | 0.20 | 0.08 | 1990 | Jan | 0.05 | 0.55 |
| | Feb | 0.20 | 0.10 | | Feb | 0.04 | 3.1 |
| | Mar | 0.20 | 0.17 | | Mar | 0.04 | 1.7 |
| | Apr | 0.20 | 370 | | Apr | 0.03 | 1.5 |
| | May | 0.20 | 6872 | | May | 0.04 | 1.2 |
| | Jun | 0.20 | 299 | | Jun | 0.04 | 1.8 |
| | Jul | 0.20 | 110 | | Jul | 0.03 | 2.4 |
| | Aug | 0.20 | 57 | | Aug | 0.03 | 1.2 |
| | Sep | 0.20 | 39 | | Sep | 0.03 | 0.78 |
| | Oct | 0.20 | 13 | | Oct | 0.04 | 1.0 |
| | Nov | 0.20 | 17 | | Nov | 0.02 | 0.62 |
| | Dec | 0.20 | 8.6 | | Dec | 0.04 | 2.1 |
| 1987 | Jan | 0.20 | 30 | 1991 | Jan | 0.18 | 1.4 |
| | Feb | 0.20 | 38 | | Feb | 0.19 | 1.8 |
| | Mar | 0.20 | 14 | | Mar | 0.18 | 1.2 |
| | Apr | 0.20 | 21 | | Apr | 0.14 | 1.1 |
| | May | 0.20 | 21 | | May | 0.14 | 0.82 |
| | Jun | 0.20 | 14 | | Jun | 0.13 | 0.77 |
| | Jul | 0.20 | 12 | | Jul | 0.11 | 1.7 |
| | Aug | 0.20 | 9.8 | | Aug | 0.12 | 1.3 |
| | Sep | 0.20 | 7.9 | | Sep | 0.12 | 1.8 |
| | Oct | 0.20 | 11 | | Oct | 0.09 | 0.33 |
| | Nov | 0.20 | 8.7 | | Nov | 0.13 | 0.36 |
| | Dec | 0.20 | 3.9 | | Dec | 0.09 | 0.71 |
| 1988 | Jan | 0.47 | 13 | 1992 | Jan | 0.13 | 0.56 |
| | Feb | 0.70 | 8.1 | | Feb | 0.05 | 0.87 |
| | Mar | 1.0 | 4.6 | | Mar | 0.06 | 0.55 |
| | Apr | 0.20 | 5.1 | | Apr | 0.06 | 0.78 |
| | May | 0.22 | 6.1 | | May | 0.09 | 0.79 |
| | Jun | 0.78 | 3.2 | | Jun | 0.07 | 0.59 |
| | Jul | 0.89 | 4.2 | | Jul | 0.11 | 0.54 |
| | Aug | 0.22 | 3.4 | | Aug | 0.14 | 0.88 |
| | Sep | 0.20 | 1.8 | | Sep | 0.11 | 0.74 |
| | Oct | 0.19 | 2.5 | | Oct | 0.07 | 0.47 |
| | Nov | 0.67 | 1.5 | | Nov | 0.08 | 0.25 |
| | Dec | 1.31 | 2.0 | | Dec | 0.06 | 0.40 |
| 1989 | Jan | 0.41 | 2.7 | 1993 | Jan | 0.15 | 0.36 |
| | Feb | 1.36 | 2.2 | | Feb | 0.17 | 0.37 |
| | Mar | 0.37 | 1.7 | | Mar | 0.15 | 0.42 |
| | Apr | 0.31 | 3.0 | | Apr | 0.15 | 0.51 |
| | May | 0.38 | 2.4 | | May | 0.15 | 0.48 |
| | Jun | 0.26 | 2.1 | | Jun | 0.15 | 0.46 |
| | Jul | 0.22 | 2.6 | | Jul | 0.20 | 0.89 |
| | Aug | 0.22 | 2.0 | | Aug | 0.18 | 0.47 |
| | Sep | 0.22 | 0.89 | | Sep | 0.17 | 0.69 |
| | Oct | 0.23 | 0.56 | | Oct | 0.16 | 0.55 |
| | Nov | 0.23 | 1.1 | | Nov | 0.16 | 0.46 |
| | Dec | 0.23 | 0.96 | | Dec | 0.14 | 0.69 |

(Table 5. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|
| 1994 | Jan | 0.12 | 0.67 |
| | Feb | 0.08 | 0.35 |
| | Mar | 0.08 | 0.42 |
| | Apr | 0.20 | 0.49 |
| | May | 0.07 | 0.47 |
| | Jun | 0.07 | 0.33 |
| | Jul | 0.14 | 0.52 |
| | Aug | 0.15 | 0.44 |
| | Sep | 0.14 | 0.49 |
| | Oct | 0.06 | 0.38 |
| | Nov | 0.07 | 0.21 |
| | Dec | 0.07 | 0.30 |
| 1995 | Jan | 0.05 | 0.55 |
| | Feb | 0.04 | 0.32 |
| | Mar | 0.04 | 0.62 |
| | Apr | 0.14 | 0.45 |
| | May | 0.14 | 0.46 |
| | Jun | 0.14 | 0.35 |
| | Jul | 0.20 | 0.53 |
| | Aug | 0.22 | 0.33 |
| | Sep | 0.15 | 0.31 |
| | Oct | 0.13 | 0.36 |
| | Nov | 0.13 | 0.42 |
| | Dec | 0.13 | 0.51 |
| 1996 | Jan | 0.03 | 0.19 |
| | Feb | 0.03 | 0.21 |
| | Mar | 0.03 | 0.29 |
| | Apr | 0.03 | 0.18 |
| | May | 0.02 | 0.45 |
| | Jun | 0.06 | 0.51 |
| | Jul | 0.04 | 0.28 |
| | Aug | 0.03 | 0.36 |
| | Sep | 0.03 | 0.39 |
| | Oct | 0.06 | 0.43 |
| | Nov | 0.04 | 0.50 |
| | Dec | 0.03 | 0.32 |
| 1997 | Jan | 0.01 | 0.42 |
| | Feb | 0.01 | 0.36 |
| | Mar | 0.01 | 0.56 |
| | Apr | 0.11 | 0.45 |
| | May | 0.11 | 0.45 |
| | Jun | 0.11 | 0.44 |
| | Jul | 0.01 | 0.24 |
| | Aug | 0.01 | 0.27 |
| | Sep | 0.01 | 0.18 |
| | Oct | 0.01 | 0.33 |
| | Nov | 0.01 | 0.26 |
| | Dec | 0.01 | 0.24 |

| Year | Month | ⁹⁰ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|-------------------------------------|
| 1998 | Jan | 0.01 | 0.55 |
| | Feb | 0.01 | 0.17 |
| | Mar | 0.01 | 0.34 |
| | Apr | 0.02 | 0.23 |
| | May | 0.02 | 0.34 |
| | Jun | 0.02 | 0.46 |
| | Jul | 0.00 | 0.77 |
| | Aug | 0.00 | 0.33 |
| | Sep | 0.00 | 0.34 |
| | Oct | 0.01 | 0.34 |
| | Nov | 0.01 | 0.19 |
| | Dec | 0.01 | 0.12 |

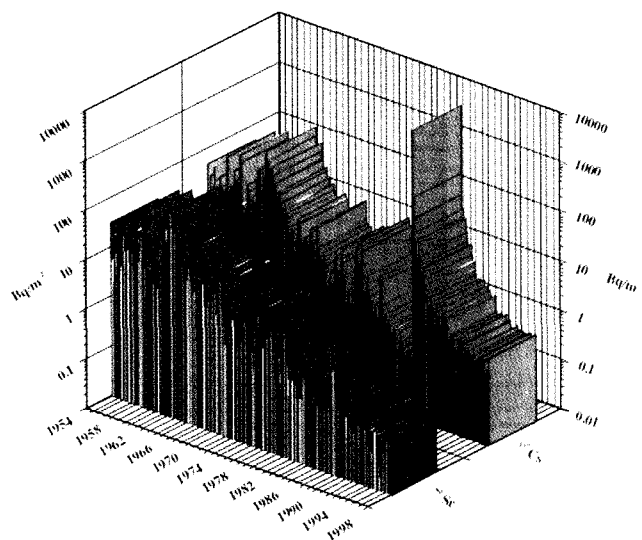


Fig. 7. Average monthly fallout deposition in Italy.

Table 6. Average concentration of ¹³⁷Cs from 1990 data unless otherwise indicated (Aarkrog, 1994).

| Sea Basin | ¹³⁷ Cs concentration Bq/m ³ |
|------------------------|---|
| Alboran Sea (1991) | 3.9 |
| Liguro-Provençal Basin | 6.5±2.3 |
| Algerian Basin | 4.3±1.0 |
| Tyrrhenian Sea | 4.7±0.2 |
| Adriatic Sea | 5.6±1.5 |
| Ionian Sea | 2.9±0.1 |
| Libyan Sea (1993) | 3.8 |
| Levantine Basin (1993) | 7±3 |
| Cyprus Sea (1993) | 9±3 |
| Egean Sea (1993) | 9±4 |
| Black Sea | 52±1 |

Table 7. Average monthly fallout deposition in Japan ($\sigma=\pm 10\%$).

| Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|------------------------------------|-------------------------------------|------|-------|------------------------------------|------------------------------------|-------------------------------------|
| 1961 | Jan | 1.1 | | 3.3 | 1965 | Jan | 27 | | 45 |
| | Feb | 1.5 | | 3.3 | | Feb | 28 | | 36 |
| | Mar | 6.3 | | 7.4 | | Mar | 30 | | 49 |
| | Apr | 7.4 | | 14 | | Apr | 23 | | 38 |
| | May | 4.8 | | 8.5 | | May | 28 | | 47 |
| | Jun | 11 | | 21 | | Jun | 21 | | 34 |
| | Jul | 1.9 | | 4.1 | | Jul | 15 | | 21 |
| | Aug | 0.74 | | 3.0 | | Aug | 5.6 | | 7.8 |
| | Sep | 1.9 | | 11 | | Sep | 8.5 | | 11 |
| | Oct | 22 | | 119 | | Oct | 5.2 | | 7.8 |
| | Nov | 9.3 | | 51 | | Nov | 6.3 | | 12 |
| | Dec | 8.5 | | 26 | | Dec | 11 | | 16 |
| 1962 | Jan | 7.0 | | 33 | 1966 | Jan | 11 | | 17 |
| | Feb | 8.1 | | 29 | | Feb | 12 | | 18 |
| | Mar | 21 | | 70 | | Mar | 16 | | 23 |
| | Apr | 40 | | 117 | | Apr | 10 | | 16 |
| | May | 60 | | 147 | | May | 14 | | 19 |
| | Jun | 45 | | 155 | | Jun | 11 | | 14 |
| | Jul | 30 | | 59 | | Jul | 4.4 | | 5.2 |
| | Aug | 11 | | 26 | | Aug | 1.9 | | 3.3 |
| | Sep | 3.7 | | 11 | | Sep | 2.6 | | 3.0 |
| | Oct | 21 | | 64 | | Oct | 2.6 | | 4.8 |
| | Nov | 37 | | 75 | | Nov | 3.7 | | 4.4 |
| | Dec | 15 | | 26 | | Dec | 4.1 | | 5.6 |
| 1963 | Jan | 4.1 | | 7.0 | 1967 | Jan | 3.7 | | 11 |
| | Feb | 23 | | 26 | | Feb | 4.8 | | 7.4 |
| | Mar | 95 | | 179 | | Mar | 4.6 | | 14 |
| | Apr | 43 | | 127 | | Apr | 5.9 | | 9.6 |
| | May | 153 | 989 | 171 | | May | 3.3 | | 4.1 |
| | Jun | 155 | 656 | 156 | | Jun | 4.1 | | 5.6 |
| | Jul | 68 | 221 | 80 | | Jul | 3.0 | | 3.7 |
| | Aug | 40 | 103 | 58 | | Aug | 1.1 | | 1.5 |
| | Sep | 44 | 64 | 57 | | Sep | 1.1 | | 1.5 |
| | Oct | 32 | 36 | 47 | | Oct | 1.5 | | 2.2 |
| | Nov | 30 | 24 | 48 | | Nov | 1.5 | | 1.9 |
| | Dec | 38 | 34 | 57 | | Dec | 1.5 | | 2.2 |
| 1964 | Jan | 45 | 34 | 60 | 1968 | Jan | 3.0 | | 3.7 |
| | Feb | 38 | 17 | 73 | | Feb | 3.7 | | 4.8 |
| | Mar | 67 | 21 | 93 | | Mar | 4.8 | | 6.7 |
| | Apr | 63 | | 94 | | Apr | 5.9 | | 7.7 |
| | May | 51 | | 69 | | May | 5.6 | | 7.4 |
| | Jun | 59 | | 82 | | Jun | 7.1 | | 8.9 |
| | Jul | 28 | | 37 | | Jul | 4.2 | | 5.8 |
| | Aug | 10 | | 14 | | Aug | 3.3 | | 4.4 |
| | Sep | 15 | | 18 | | Sep | 3.1 | | 4.2 |
| | Oct | 16 | | 33 | | Oct | 2.2 | | 3.2 |
| | Nov | 25 | | 27 | | Nov | 2.3 | | 3.6 |
| | Dec | 20 | | 27 | | Dec | 3.1 | | 3.9 |

(Table 7. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|------------------------------------|-------------------------------------|------|-------|------------------------------------|------------------------------------|-------------------------------------|
| 1969 | Jan | 2.8 | | 4.3 | 1975 | Jan | 1.6 | | 2.5 |
| | Feb | 2.6 | | 3.7 | | Feb | 2.4 | | 3.7 |
| | Mar | 3.4 | | 4.9 | | Mar | 2.2 | | 3.6 |
| | Apr | 4.4 | | 6.3 | | Apr | 2.4 | | 4.0 |
| | May | 4.9 | | 7.1 | | May | 2.3 | | 3.8 |
| | Jun | 5.4 | | 11 | | Jun | 1.5 | | 2.6 |
| | Jul | 4.1 | | 6.4 | | Jul | 0.61 | | 1.1 |
| | Aug | 2.7 | | 3.9 | | Aug | 0.37 | | 0.61 |
| | Sep | 2.0 | | 3.1 | | Sep | 0.34 | | 0.49 |
| | Oct | 2.2 | | 3.1 | | Oct | 0.40 | | 0.66 |
| | Nov | 2.0 | | 3.0 | | Nov | 0.41 | | 0.63 |
| | Dec | 2.4 | | 3.7 | | Dec | 0.57 | | 0.85 |
| 1970 | Jan | 2.4 | | 3.6 | 1976 | Jan | 0.53 | | 0.99 |
| | Feb | 2.4 | | 3.7 | | Feb | 0.69 | | 1.2 |
| | Mar | 3.2 | | 4.7 | | Mar | 0.56 | | 0.99 |
| | Apr | 5.5 | | 4.7 | | Apr | 0.72 | | 1.4 |
| | May | 6.2 | | 8.3 | | May | 0.49 | | 0.96 |
| | Jun | 8.4 | | 9.9 | | Jun | 0.54 | | 1.01 |
| | Jul | 5.0 | | 15 | | Jul | 0.33 | | 0.55 |
| | Aug | 2.9 | | 8.5 | | Aug | 0.23 | | 0.38 |
| | Sep | 2.7 | | 4.6 | | Sep | 0.29 | | 0.44 |
| | Oct | 1.6 | | 2.9 | | Oct | 0.72 | | 1.4 |
| | Nov | 2.1 | | 3.1 | | Nov | 0.53 | | 0.97 |
| | Dec | 2.1 | | 3.3 | | Dec | 0.47 | | 0.73 |
| 1971 | Jan | 1.9 | | 3.8 | 1977 | Jan | 0.30 | | 0.35 |
| | Feb | 2.2 | | 3.4 | | Feb | 0.59 | | 0.55 |
| | Mar | 4.7 | | 4.1 | | Mar | 1.2 | | 1.6 |
| | Apr | 8.5 | | 7 | | Apr | 2.2 | | 3.3 |
| | May | 6.8 | | 13 | | May | 1.6 | | 2.3 |
| | Jun | 8.7 | | 10 | | Jun | 2.2 | | 3.6 |
| | Jul | 6.0 | | 17 | | Jul | 1.5 | | 2.3 |
| | Aug | 1.8 | | 8.8 | | Aug | 1.9 | | 2.9 |
| | Sep | 1.9 | | 3.0 | | Sep | 1.3 | | 2.1 |
| | Oct | 1.5 | | 2.4 | | Oct | 0.94 | | 1.4 |
| | Nov | 1.2 | | 2.4 | | Nov | 1.9 | | 3.4 |
| | Dec | 2.4 | | 2.2 | | Dec | 2.7 | | 3.8 |
| 1972 | Jan | 2.2 | | 3.8 | 1978 | Jan | 2.7 | | 4.0 |
| | Feb | 2.4 | | 3.8 | | Feb | 2.8 | | 4.4 |
| | Mar | 3.0 | | 4.0 | | Mar | 3.6 | | 5.6 |
| | Apr | Not measured until April 1974 | | | | Apr | 4.3 | | 7.2 |
| 1974 | Apr | 4.6 | | 7.1 | May | 3.0 | | 4.6 | |
| | May | 2.9 | | 4.9 | Jun | 2.9 | | 4.3 | |
| | Jun | 4.1 | | 6.3 | Jul | 0.66 | | 1.0 | |
| | Jul | 2.5 | | 3.8 | Aug | 0.67 | | 1.0 | |
| | Aug | 0.9 | | 2.5 | Sep | 0.77 | | 1.2 | |
| | Sep | 1.2 | | 1.9 | Oct | 0.71 | | 0.92 | |
| | Oct | 0.92 | | 1.5 | Nov | 0.53 | | 0.88 | |
| | Nov | 0.92 | | 1.4 | Dec | 0.72 | | 1.1 | |
| | Dec | 1.3 | | 1.8 | | | | | |

(Table 7. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|------------------------------------|-------------------------------------|------|-------|------------------------------------|------------------------------------|-------------------------------------|
| 1979 | Jan | 0.81 | | 1.3 | 1983 | Jan | 0.14 | | 0.15 |
| | Feb | 1.3 | | 2.1 | | Feb | 0.14 | | 0.18 |
| | Mar | 1.3 | | 2.1 | | Mar | 0.16 | | 0.21 |
| | Apr | 1.7 | | 2.6 | | Apr | 0.20 | | 0.27 |
| | May | 1.4 | | 2.2 | | May | 0.16 | | 0.18 |
| | Jun | 0.89 | | 1.4 | | Jun | 0.17 | | 0.20 |
| | Jul | 0.58 | | 0.92 | | Jul | 0.14 | | 0.14 |
| | Aug | 0.27 | | 0.40 | | Aug | 0.12 | | 0.07 |
| | Sep | 0.26 | | 0.39 | | Sep | 0.12 | | 0.06 |
| | Oct | 0.28 | | 0.40 | | Oct | 0.10 | | 0.07 |
| | Nov | 0.29 | | 0.45 | | Nov | 0.13 | | 0.11 |
| | Dec | 0.26 | | 0.36 | | Dec | 0.10 | | 0.10 |
| 1980 | Jan | 0.38 | | 0.63 | 1984 | Jan | 0.10 | | 0.10 |
| | Feb | 0.34 | | 0.53 | | Feb | 0.10 | | 0.12 |
| | Mar | 0.48 | | 0.75 | | Mar | 0.12 | | 0.18 |
| | Apr | 0.62 | | 1.01 | | Apr | 0.13 | | 0.11 |
| | May | 0.61 | | 1.02 | | May | 0.12 | | 0.11 |
| | Jun | 0.56 | | 0.79 | | Jun | 0.12 | | 0.08 |
| | Jul | 0.52 | | 0.83 | | Jul | 0.13 | | 0.04 |
| | Aug | 0.19 | | 0.28 | | Aug | 0.16 | | 0.04 |
| | Sep | 0.16 | | 0.24 | | Sep | 0.10 | | 0.04 |
| | Oct | 0.19 | | 0.27 | | Oct | 0.09 | | 0.04 |
| | Nov | 0.24 | | 0.31 | | Nov | 0.07 | | 0.04 |
| | Dec | 0.46 | | 0.74 | | Dec | 0.08 | | 0.08 |
| 1981 | Jan | 0.50 | | 0.79 | 1985 | Jan | 0.08 | | 0.06 |
| | Feb | 0.85 | | 1.3 | | Feb | 0.11 | | 0.09 |
| | Mar | 1.6 | | 2.6 | | Mar | 0.13 | | 0.11 |
| | Apr | 2.9 | | 4.6 | | Apr | 0.11 | | 0.11 |
| | May | 3.1 | | 4.5 | | May | 0.11 | | 0.05 |
| | Jun | 2.1 | | 3.5 | | Jun | 0.09 | | 0.06 |
| | Jul | 0.77 | | 1.4 | | Jul | 0.08 | | 0.03 |
| | Aug | 0.51 | | 0.73 | | Aug | 0.11 | | 0.04 |
| | Sep | 0.32 | | 0.40 | | Sep | 0.09 | | 0.03 |
| | Oct | 0.34 | | 0.44 | | Oct | 0.09 | | 0.05 |
| | Nov | 0.30 | | 0.44 | | Nov | 0.08 | | 0.04 |
| | Dec | 0.25 | | 0.38 | | Dec | 0.07 | | 0.06 |
| 1982 | Jan | 0.28 | | 0.44 | 1986 | Jan | 0.05 | | 0.04 |
| | Feb | 0.31 | | 0.40 | | Feb | 0.08 | | 0.05 |
| | Mar | 0.40 | | 0.60 | | Mar | 0.10 | | 0.08 |
| | Apr | 0.50 | | 0.73 | | Apr | 0.10 | | 0.16 |
| | May | 0.29 | | 0.38 | | May | 1.2 | | 109 |
| | Jun | 0.31 | | 0.39 | | Jun | 0.24 | | 16 |
| | Jul | 0.24 | | 0.31 | | Jul | 0.07 | | 1 |
| | Aug | 0.15 | | 0.17 | | Aug | 0.08 | | 0.55 |
| | Sep | 0.16 | | 0.14 | | Sep | 0.06 | | 0.27 |
| | Oct | 0.12 | | 0.11 | | Oct | 0.06 | | 0.22 |
| | Nov | 0.11 | | 0.13 | | Nov | 0.08 | | 0.19 |
| | Dec | 0.14 | | 0.15 | | Dec | 0.07 | | 0.21 |

(Table 7. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|------------------------------------|-------------------------------------|------|-------|------------------------------------|------------------------------------|-------------------------------------|
| 1987 | Jan | 0.09 | | 0.30 | 1991 | Jan | 0.02 | | 0.03 |
| | Feb | 0.09 | | 0.32 | | Feb | 0.03 | | 0.06 |
| | Mar | 0.07 | | 0.23 | | Mar | 0.04 | | 0.05 |
| | Apr | 0.08 | | 0.23 | | Apr | 0.02 | | 0.04 |
| | May | 0.08 | | 0.18 | | May | 0.02 | | 0.04 |
| | Jun | 0.06 | | 0.18 | | Jun | 0.02 | | 0.04 |
| | Jul | 0.07 | | 0.14 | | Jul | 0.02 | | 0.03 |
| | Aug | 0.05 | | 0.11 | | Aug | 0.02 | | 0.02 |
| | Sep | 0.06 | | 0.09 | | Sep | 0.02 | | 0.03 |
| | Oct | 0.09 | | 0.08 | | Oct | 0.09 | | 0.01 |
| | Nov | 0.09 | | 0.08 | | Nov | 0.02 | | 0.02 |
| | Dec | 0.07 | | 0.11 | | Dec | 0.02 | | 0.03 |
| 1988 | Jan | 0.04 | | 0.13 | 1992 | Jan | 0.01 | | 0.03 |
| | Feb | 0.04 | | 0.10 | | Feb | 0.02 | | 0.03 |
| | Mar | 0.06 | | 0.15 | | Mar | 0.02 | | 0.06 |
| | Apr | 0.07 | | 0.23 | | Apr | 0.04 | | 0.08 |
| | May | 0.06 | | 0.12 | | May | 0.03 | | 0.04 |
| | Jun | 0.03 | | 0.06 | | Jun | 0.02 | | 0.02 |
| | Jul | 0.04 | | 0.04 | | Jul | 0.02 | | 0.02 |
| | Aug | 0.04 | | 0.04 | | Aug | 0.02 | | 0.03 |
| | Sep | 0.03 | | 0.04 | | Sep | 0.03 | | 0.02 |
| | Oct | 0.04 | | 0.05 | | Oct | 0.01 | | 0.02 |
| | Nov | 0.04 | | 0.10 | | Nov | 0.02 | | 0.02 |
| | Dec | 0.03 | | 0.11 | | Dec | 0.02 | | 0.02 |
| 1989 | Jan | 0.03 | | 0.07 | 1993 | Jan | 0.02 | | 0.03 |
| | Feb | 0.03 | | 0.07 | | Feb | 0.02 | | 0.03 |
| | Mar | 0.03 | | 0.11 | | Mar | 0.02 | | 0.05 |
| | Apr | 0.04 | | 0.11 | | Apr | 0.04 | | 0.09 |
| | May | 0.03 | | 0.08 | | May | 0.02 | | 0.04 |
| | Jun | 0.03 | | 0.04 | | Jun | 0.03 | | 0.02 |
| | Jul | 0.03 | | 0.04 | | Jul | 0.02 | | 0.01 |
| | Aug | 0.05 | | 0.04 | | Aug | 0.02 | | 0.01 |
| | Sep | 0.03 | | 0.04 | | Sep | 0.01 | | 0.01 |
| | Oct | 0.03 | | 0.02 | | Oct | 0.01 | | 0.01 |
| | Nov | 0.03 | | 0.02 | | Nov | 0.01 | | 0.01 |
| | Dec | 0.03 | | 0.04 | | Dec | 0.02 | | 0.02 |
| 1990 | Jan | 0.03 | | 0.06 | 1994 | Jan | 0.02 | | 0.02 |
| | Feb | 0.02 | | 0.03 | | Feb | 0.02 | | 0.04 |
| | Mar | 0.04 | | 0.08 | | Mar | 0.03 | | 0.04 |
| | Apr | 0.03 | | 0.11 | | Apr | 0.04 | | 0.07 |
| | May | 0.02 | | 0.05 | | May | 0.03 | | 0.05 |
| | Jun | 0.06 | | 0.03 | | Jun | 0.02 | | 0.02 |
| | Jul | 0.03 | | 0.03 | | Jul | 0.02 | | 0.01 |
| | Aug | 0.03 | | 0.05 | | Aug | 0.03 | | 0.02 |
| | Sep | 0.03 | | 0.05 | | Sep | 0.02 | | 0.02 |
| | Oct | 0.02 | | 0.03 | | Oct | 0.01 | | 0.01 |
| | Nov | 0.02 | | 0.04 | | Nov | 0.02 | | 0.01 |
| | Dec | 0.03 | | 0.04 | | Dec | 0.02 | | 0.02 |

(Table 7. Continued)

| Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² | Year | Month | ⁹⁰ Sr Bq/m ² | ⁸⁹ Sr Bq/m ² | ¹³⁷ Cs Bq/m ² |
|------|-------|------------------------------------|------------------------------------|-------------------------------------|------|-------|------------------------------------|------------------------------------|-------------------------------------|
| 1995 | Jan | 0.01 | | 0.02 | 1999 | Jan | 0.01 | | 0.02 |
| | Feb | 0.02 | | 0.02 | | Feb | 0.02 | | 0.03 |
| | Mar | 0.04 | | 0.04 | | Mar | 0.03 | | 0.04 |
| | Apr | 0.04 | | 0.03 | | Apr | 0.02 | | 0.04 |
| | May | 0.03 | | 0.04 | | May | 0.02 | | 0.03 |
| | Jun | 0.02 | | 0.02 | | Jun | 0.02 | | 0.01 |
| | Jul | 0.02 | | 0.01 | | Jul | 0.02 | | 0.01 |
| | Aug | 0.02 | | 0.01 | | Aug | 0.01 | | 0.02 |
| | Sep | 0.02 | | 0.02 | | Sep | 0.01 | | 0.01 |
| | Oct | 0.02 | | 0.02 | | Oct | 0.02 | | 0.02 |
| | Nov | 0.02 | | 0.01 | | Nov | 0.01 | | 0.01 |
| | Dec | 0.02 | | 0.02 | | Dec | 0.01 | | 0.01 |
| 1996 | Jan | 0.02 | | 0.03 | 2000 | Jan | 0.01 | | 0.01 |
| | Feb | 0.02 | | 0.03 | | Feb | 0.02 | | 0.02 |
| | Mar | 0.02 | | 0.04 | | Mar | 0.04 | | 0.08 |
| | Apr | 0.03 | | 0.05 | | Apr | 0.04 | | 0.09 |
| | May | 0.03 | | 0.03 | | May | 0.02 | | 0.04 |
| | Jun | 0.03 | | 0.02 | | Jun | 0.02 | | 0.02 |
| | Jul | 0.03 | | 0.01 | | Jul | 0.02 | | 0.01 |
| | Aug | 0.03 | | 0.02 | | Aug | 0.01 | | 0.00 |
| | Sep | 0.02 | | 0.01 | | Sep | 0.02 | | 0.01 |
| | Oct | 0.01 | | 0.01 | | Oct | 0.02 | | 0.01 |
| | Nov | 0.02 | | 0.01 | | Nov | 0.02 | | 0.01 |
| | Dec | 0.02 | | 0.02 | | Dec | 0.03 | | 0.04 |
| 1997 | Jan | 0.02 | | 0.02 | 2001 | Jan | 0.03 | | 0.03 |
| | Feb | 0.02 | | 0.03 | | Feb | 0.02 | | 0.03 |
| | Mar | 0.02 | | 0.03 | | Mar | 0.04 | | 0.09 |
| | Apr | 0.03 | | 0.03 | | Apr | 0.03 | | 0.04 |
| | May | 0.03 | | 0.03 | | May | 0.02 | | 0.04 |
| | Jun | 0.02 | | 0.01 | | Jun | 0.01 | | 0.01 |
| | Jul | 0.02 | | 0.01 | | Jul | 0.02 | | 0.01 |
| | Aug | 0.01 | | 0.01 | | Aug | 0.02 | | 0.01 |
| | Sep | 0.02 | | 0.01 | | Sep | 0.02 | | 0.01 |
| | Oct | 0.02 | | 0.01 | | Oct | 0.02 | | 0.00 |
| | Nov | 0.02 | | 0.01 | | Nov | 0.02 | | 0.01 |
| | Dec | 0.02 | | 0.02 | | Dec | 0.02 | | 0.02 |
| 1998 | Jan | 0.02 | | 0.02 | 2002 | Jan | 0.01 | | 0.02 |
| | Feb | 0.02 | | 0.02 | | Feb | 0.02 | | 0.02 |
| | Mar | 0.03 | | 0.03 | | Mar | 0.04 | | 0.16 |
| | Apr | 0.02 | | 0.03 | | | | | |
| | May | 0.02 | | 0.02 | | | | | |
| | Jun | 0.03 | | 0.01 | | | | | |
| | Jul | 0.02 | | 0.01 | | | | | |
| | Aug | 0.02 | | 0.01 | | | | | |
| | Sep | 0.02 | | 0.01 | | | | | |
| | Oct | 0.02 | | 0.01 | | | | | |
| | Nov | 0.02 | | 0.01 | | | | | |
| | Dec | 0.02 | | 0.02 | | | | | |

5. Conclusion

The difference between the concentrations of anthropogenic radionuclides the two countries here considered is mainly due to their position with reference to the source of the radioactive fallout and the general pattern of the tropospheric and stratospheric circulations.

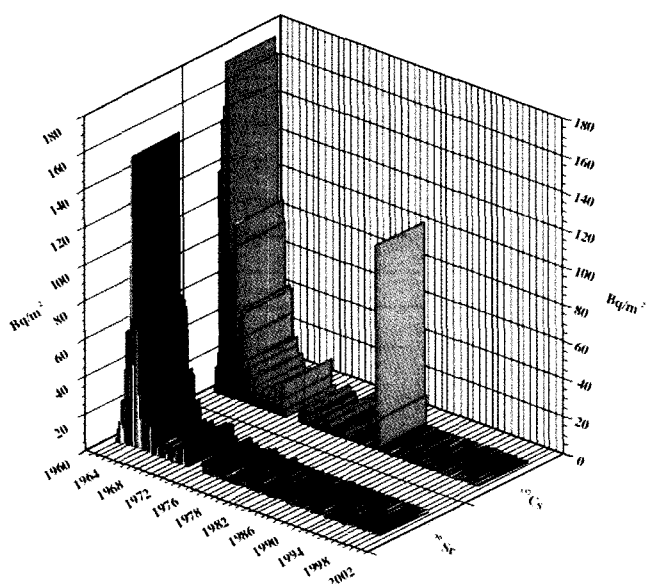


Fig. 8. Average monthly fallout deposition in Japan.

To evaluate the mean residence half-time, $T_{1/2}$, of the radioactive fallout in Italy and Japan, the ^{90}Sr was considered since this radionuclide was practically absent in the Chernobyl fallout. The deposition was normalised for the period of time (1961-1998) when data were available for both countries. The exponential best fit resulted to be:

$$\text{Italy: } (^{90}\text{Sr concentration}) \\ = 4\text{E}+155e^{-0.1799t} \text{ corresponding to a } T_{1/2} = 0.8 \text{ years}$$

$$\text{Japan: } (^{90}\text{Sr concentration}) \\ = 3\text{E}+183e^{-0.2125t} \text{ corresponding to a } T_{1/2} = 0.6 \text{ years}$$

where t is time expressed in years starting from January 1st, 1960.

Similar mean residence half-times were observed in the past (Cigna *et al.* 1987) ranging between 0.5 to 0.9 years. At that time it was uncertain if the spread of these values might be due to some dynamical process present in the stratosphere or to a short term perturbation only.

The values obtained now, which are calculated for a longer time interval of 37 years, support the hypothesis of the dynamical process in the stratosphere. In fact the different conditions of the upper atmosphere circulation in Italy and Japan can explain the difference noticed in the respective mean residence half-times.

The ^{137}Cs peak in the fallout due to the Chernobyl accident is about one order of magnitude lower in Japan

than in Italy on account of the longer pathway from the release point.

The distribution of radionuclides in the Japanese seas is more homogeneous in comparison to the seas around Italy where the morphological differences of the basins and the contribution from important rivers play a relevant role.

Presently the monitoring network of environmental radioactivity in Japan is composed by some tens of stations distributed all over the country and therefore a good level of surveillance is assured. On the contrary in Italy there is only the hope that the measurement of radionuclides in seawater, as well as in other environmental samples, will be resumed within a general framework aiming to consider radiation protection as a tool which remains very useful, independently of the existence of nuclear activities in the country

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