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ENVIRONMENTAL RADIOACTIVITY ISPRA 1966

by

M. de BORTOLI, P. GAGLIONE and A. MALVICINI

1967

Joint Nuclear Research Center
Ispra Establishment - Italy

Protection

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European Atomic Energy Community - EURATOM
Joint Nuclear Research Center - Ispra Establishment (Italy)
Protection
Brussels, August 1967 - 70 Pages - 13 Figures - FB 100

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Data are given on the concentrations of strontium-90, cesium-137 and other radionuclides in fallout, air, soil, waters, herbage, animal bones and foods.

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SUMMARY

In this report are briefly described the measurements of environmental radioactivity performed during 1966 by the site survey group of the Protection Service.

Data are given on the concentrations of strontium-90, cesium-137 and other radionuclides in fallout, air, soil, waters, herbage, animal bones and foods.

KEYWORDS

Chapter A :

ENVIRONMENT, RADIOACTIVITY, MONITORING, FALLOUT, SOILS, PLANTS, BONES, FOOD, CONTAMINATION, RADIOISOTOPES, STRONTIUM 90, CESIUM 137, EUROPE, REACTORS.

Grass, Italy.

Chapter B :

MONITORING, RADIOACTIVITY, FALLOUT, HYDROLOGY, CONTAMINATION, SAMPLING, POTASSIUM 40, RADIOISOTOPES.

Lakes.

Chapter C :

FOOD, MILK, RADIOISOTOPES, CONTAMINATION, MONITORING, STRONTIUM 90, CESIUM 137, FISH, CATTLE, VEGETABLES, BETA DETECTION.

Chapter D :

ENVIRONMENT, CONTAMINATION, RADIOISOTOPES, MONITORING, BETA DETECTION, STRONTIUM 90, STRONTIUM 89, CESIUM 137, EUROPE, REACTORS, FALLOUT, RAIN.

Italy.

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ENVIRONMENTAL RADIOACTIVITY
ISPRA 1966(*)

INTRODUCTION

In this report are summarized the results of the environmental radioactivity measurements performed by the site survey group of the Protection Service. The personnel of this group, which is supervised by Prof. A. Malvicini, chief of the Protection Service, is the following:

responsible for Site Survey and Meteorology Section: P. Gaglione

responsible for the chemical laboratory: M. de Bortoli

radioactivity measurements: O. Malgarini, E. Lovati

chemical laboratory: E. Pecchio, L. Tortora, O. Cadario

air monitoring stations: M. Tramontana

sampling: G. Brughera, L. Pasqualini

secretary: A. Schieppati

The work is carried out in a chemical laboratory and in a radioactivity measurements laboratory, equipped for gamma and alpha spectrometry and low-level beta counting.

The following reports on the same subject have already been published:

CNI	-	43	Misure di radioattività ambientale, Ispra 1958 - 59
CNI	-	95	Misure di radioattività ambientale, Ispra 1960
EUR	-	223i	Misure di radioattività ambientale, Ispra 1961
EUR	-	481i	Misure di radioattività ambientale, Ispra 1962

(*) Manuscript received on May 30, 1967.

EUR	-	2213e	Environmental radioactivity, Ispra 1963
EUR	-	2509e	Environmental radioactivity, Ispra 1964
EUR	-	2965e	Environmental radioactivity, Ispra 1965

The aim of the measurements is mainly the constant knowledge of the radioactivity levels on the site and in the environs of the Euratom Ispra Establishment, in order to identify and evaluate radioactive contaminations, which the Establishment itself should cause.

The results obtained from the surveillance programme indicate that, also for the calendar year 1966, the environmental radiation exposure for the persons living in the neighbourhood of the Establishment was due, almost exclusively, to natural sources and world-wide fallout.

During 1966 the efficiency of the monitoring program has been improved through the following developments:

1) a system for the continuous monitoring and sampling of the liquid effluents dischargedby the Establishment via the Novellino brook ;

2) thermoluminesence dosimeters, placed in the survey stations to provide accurate measurement of the exposition dose ;

3) the stations air filters have been equipped with charcoal cartridges for trapping of radioiodine ;

4) a radiochemical method for the determination of plutonium in soil (1) has been developed and applied.

More extensive explanations on these topics are given in the following paragraphs.

Moreover, two papers have been presented, by the staff of the group, at the 1st international meeting of the International Radiation Protection Association, held in Rome during September 1966. In one (2) of these papers the air concentration values are given of the most important long lived fallout radionuclides measured during five years at Ispra. The method used enabled the determination of ^{238}Pu, despite its very low concentration (10^{-18} Ci/m^3) and this, in turn, has made possible the detection of the arrival to ground level of the debris due to the failure of an isotope powered satellite. The second paper (3) deals with the relationships observed for ^{90}Sr and ^{137}Cs in their pathway from deposition onto herbage up to secretion into milk. These relationships have been derived from the numerous data collected during five years of environmental monitoring.

The equipment of the mobile unit, referred to in the preceding report, has been completed, but the vehicle has been operated only scarcely and irregularly, owing to lack of personnel.

1. AIR RADIOACTIVITY

The state of the 8 survey stations by the end of 1966 was essentially that described in the last annual report, except for thermoluminescence dosimeters and charcoal filters, which during 1966 have been adopted as part of the stations standard equipment.

The dosimeters are of the calcium fluoride type, with glass envelope, which makes them quite suitable for exposition in open air. They exhibit, infact, an excellent resistance to humidity, sunlight and temperature excursions, showing also a very good reproducibility and accuracy for the determination of small doses (1 mR).

The charcoal filter (see photograph in Figure 1), consists of a metal cylindrical container (7.5 cm in diam. and 2.5 cm in lenght), filled with approximately 50 g of activated cocoanut coal; the cartridge is placed immediatly after the paper filter and replaced fortnightly, i.e. after the filtration of 8 - 9 thousand cubic meters of air.

The standard equipment of the stations thus includes:

1) paper filter (replaced daily); 2) activated charcoal cartridge (replaced fortnightly); 3) thermoluminescence dosimeter (replaced monthly); 4) precipitation collector (monthly samples); 5) gamma radiation telemetering unit (NaI (Tl) crystal). Moreover 6 stations are equipped with continuously moving paper filter. Three of these devices have double scintillator detectors for the instantaneous telemetering of the alpha and beta activity of the dust collected on the filter.

Also the type and frequency of the measurements performed on air filters are substantially unchanged. The daily values of the gross beta radioactivity concentration in air for the single stations, published hitherto in these reports, will be reported henceforth in internal reports, together with the results of the other measurements performed within the fence of the Establishment. Consequently, only the mean daily values of the gross beta air concentration are reported here in Tables 1 to 4 and represented in Figures 2 and 3, together with atmospheric precipitation data. Air radioactivity increases, due to the Chinese detonations of May 9 and October 28, 1966 are apparent from these tables, approximately 23 and 13 days later, respectively; on the contrary there is no evidence of the French bursts performed by July, in the Southern Hemisphere.

Air filter samples are submitted to radiochemical determinations of ^{90}Sr, ^{137}Cs, ^{239}Pu(*) and ^{238}Pu. The measurement of this last radionuclide has been included into our program with the aim of detecting and following the arrival to ground level of the SNAP - 9 A debris (4). This was an isotope power source, with a load of 17 KCi of ^{238}Pu, which was launched with a satellite on April 1964 and failed to go into orbit. The system re-entered the atmosphere, apparently over the Indian Ocean, and underwent burnup, causing contamination of the atmosphere. There is, obviously, much interest in following the deposition pattern of this debris and it is with the aim of contributing data useful to the general understanding of the mechanisms involved, that these measurements are performed.

The determination of the ratio between the two plutonium isotopes (239 and 238) and the determination of their absolute concentrations are carried out through the method described in ref. (1), on

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(*) In this report the symbol ^{239}Pu indicates the fallout mixture of the 239 and 240 plutonium isotopes.

separate samples, in order to avoid influence of the activity from ^{236}Pu (the tracer added for determination of the chemical recovery) on that of ^{238}Pu.

In Table 5 are reported the monthly values of the ^{238}Pu / ^{239}Pu ratio together with those of the gross beta, ^{90}Sr, ^{89}Sr, ^{137}Cs and ^{239}Pu air concentration. The same data are represented in Figure 4.

2. RADIOACTIVITY OF ATMOSPHERIC PRECIPITATION AND DEPOSITION

Monthly samples of total (dry and wet) deposition are collected by stainless steel pots at Ispra (total collecting area 4 m^2) and, for reference purposes, in Milano (1 m^2). Gross beta counting and gamma spectrometry measurements, as well as radiochemical determinations of ^{90}Sr and ^{137}Cs are performed on the dry residue obtained after evaporation. Similar deposition samples are collected in the survey stations by column collectors (see photograph in Figure 5). ^{90}Sr and ^{137}Cs analyses are carried out on the cation exchangers and on the filters separately to get information about the fraction in solution of both radionuclides.

Gross beta radioactivity, ^{90}Sr, ^{89}Sr and ^{137}Cs deposited at Ispra and Milano during 1966 are given in Tables 6 and 7, respectively. The deposition values of gross beta radioactivity and ^{90}Sr

from 1958 through 1966 at Ispra are represented in Figures 6 and 7.

Evidence of the influence of the Chinese nuclear detonations on the deposited radioactivity is provided by the gamma spectrometric analyses and by the values of gross beta and ^{89}Sr deposition. The evolution of the ^{89}Sr to ^{90}Sr ratio in air (at Ispra) and in deposited radioactivity (at Ispra and Milano) is represented in Figure 8.

3. RADIOACTIVITY OF WATERS

Five liter water samples are collected monthly in 23 locations including lakes, streams, wells and tapwater. In two sites on lake Maggiore samples are taken also at dephts of 25 and 50 m. All these samples are evaporated and counted for gross beta radioactivity. Flame photometric measurements of potassium, performed on each sample, allow subtraction from the gross radioactivity of the contribution due to the isotope 40 of this element.

In Tables 8 to 10 are reported the geographic coordinates of the sampling sites and the beta radioactivity concentration in the water of lake Maggiore and in other waters, respectively.

Large water samples (500 l) are collected quarterly in the four lakes Maggiore, Monate, Comabbio and Varese and submitted to gamma spectrometry and radiochemical determinations of single nuclides. The data obtained from these analyses are reported in Table 11.

A control of sewer waters is accomplished within the Establishment collecting about thirty 100 ml daily samples, which are evaporated and counted for gross alpha and gross beta radioactivity.

By November 1966 continuous sampling and monitoring of the water of the Novellino brook became effective in the survey station built for this purpose on the water course. This station was already used for the control of air radioactivity.

The brook flows into lake Maggiore and originally drained the territory upon wich is lying the Establishment. It actually receives almost all the liquid effluents discarged from the Establishment itself and,particularly, all the radioactive liquid wastes. The flow of the brook ranges between 0.1 and 0.4 m^3/sec under normal conditions, with maxima of about 1 m^3/ sec, during rare floods.

A continuous gamma monitor (NaI(Tl) crystal) is placed inside the station on a by-pass water flow. The water volume seen by the detector, in an annular geometry, is approximately two liters. This instrument has been included into the stations telemetering network, the gross gamma counting rate being transmitted to the central room, where a continuous record is kept. Alpha and beta monitors are going to be put in place during the current year.

These measurements, performed directly on the running water, are conceived to fulfil alarm requirements; they, consequently, are not suited to an accurate evaluation of the total activity wasted during a selected period of time. Hence a continuous and proportional water collector has been developed in our laboratory. This device (see photograph in Figure 9) consists of a vertical tube connected to the stream, with a number of lateral orifices, at such heights above level zero, as to produce a water flow proportional to the effective flow of the brook. The zero level is defined by the upper end of a broad crested weir wich has been built to have the flow varying according to a simple and well known formula. The water supplied by the bored tube is collected into a pot, which is emptied daily. The sampled fraction of the brook flow is in the order of magnitude of 10^{-5} and the proportionality, already checked experimentally in the laboratory, is being checked at present on the site. The brook flow for different levels is determined through measurements of the velocity distribution by a current meter; a continuous record of the water level provides knowledge of the volume flowed during one day.

A fraction of the daily water samples collected in this way is evaporated and submitted to gross alpha and gross beta measurements. Tri-monthly composite samples will be processed for radiochemical and gamma spectrometric analyses.

4. SOIL RADIOACTIVITY

The surveillance of soil radioactivity is performed through yearly sampling in 14 off-site stations (see map in Figure 13) and in 6 points within the fence of the Establishment. Each sample is made up to ten cores, 10 cm in diam. and 10 cm in depth, covering a total area of 780 cm^2. After mixing and sieving, the samples are submitted to gamma spectrometry and radiochemical determinations of ^{90}Sr, ^{137}Cs and ^{239}Pu. The chemical method for the last radionuclide has been developed in our laboratory and the details of the procedure, including also air filters analysis, may be found elsewhere (1). The main feature of this method consists in the separation of plutonium from the bulk of iron and from anions, through absorption of the former cation on exchange resin, whereas the latter, complexed by EDTA (ethylene diaminotetraacetic acid) passes through the column. The fraction bound with this chelating agent is determined, for the elements present in the soil, by the pH of the solution fed onto the ion exchanger. After further separations and purifications, final plutonium samples for alpha spectrometry are obtained by electrodeposition. Electrodeposition apparatus and cell components are shown in Figure 10.

The results of soil analyses for both fallout contamination and natural radioactivity are reported in Tables 12 and 13. Also during 1966 the vertical profile of the contamination has been studied in two sites, analysing separately the samples collected at different depths. The results of this measurements are reported in Table 14 and represented in Figure 11. The profile is very similar to that observed during 1965.

5. HERBAGE RADIOACTIVITY

Herbage contamination is monitored at six off-site and at five on-site locations (see map in Figure 13). The former, at which also soil samples are collected, are in the neighbourhoods of the following villages: Barza, Brebbia, Ispra, Monvalle, Osmate and Taino.

Two kilograms (fresh weight) samples are collected monthly during the growing season (April to October), clipping randomly several sub-samples in different fields at each site. The samples are dried and submitted to gamma spectrometry; radiochemical determination of ^{90}Sr and ^{137}Cs are performed on ashed aliquots of the samples.

The data obtained from herbage analyses during 1966 are reported in Tables 15 to 17.

The presence of fresh fission products, due to the Chinese bursts, was evident in the herbage samples collected during June and July.

6. ^{90}Sr AND ^{137}Cs IN MILK

One liter milk samples are collected twice a week in the dairies of four villages (Barza, Brebbia, Ispra and Osmate) and in the milk supply stations of Varese and Milano. Gamma spectrometry and radiochemical determinations of ^{90}Sr are performed on the pooled monthly samples. The complete results of the analyses are reported in Tables 18 to 23 and partially (^{90}Sr only) represented in Figure 12.

7. ^{90}Sr AND ^{137}Cs IN FISHES

Three biological species from the lakes Comabbio, Monate and Varese and five from lake Maggiore are sampled and submitted to gamma spectrometry and radiochemical determinations of ^{90}Sr. The number of species has been increased for lake Maggiore, in order to include into the surveillance program two species which, from a recent work (5), appear to be important for fishery. The fish samples are supplied, on a quarterly basis, directly by the fisher men of the lakes. As in the preceding years, also during 1966, some samples were not available, particularly in winter months, owing to fishing difficulties.

The data on radioactivity in fishes are reported in Tables 24 to 27.

During 1966 supplementary information have been gained dealing with the distribution of radioactivity within the fish body. Four samples, two of "Perca fluviatilis" and two of "Coregonus sp. (bondella)", have been analysed with this aim and the results are reported in Tables 28 and 29. A comprehensive work is in preparation, into which all the information and data obtained since 1960 through the monitoring of fish radioactivity will be gathered and discussed (6).

8. OTHER ACTIVITIES

a) ^{90}Sr in calf-bones

Femour samples of about 2 months old, milk fed calves are collected at the neighbour villages and analysed for their ^{90}Sr content.

The values of the ^{90}Sr concentration, expressed as pCi/g ash, are reported in Tables 30 and 31.

b) ^{90}Sr and ^{137}Cs in vegetables

Samples of some of the more eaten vegetable species, available on the market of Milano, are collected monthly and submitted to gamma spectrometry measurements.

Yearly pooled samples are processed for ^{90}Sr and ^{137}Cs determinations. The results are reported in Table 32.

c) Control of liquid effluents

During 1966 forty samples of processed liquid wastes from the decontamination plant were analysed before discharge into the Novellino brook. Each sample is controlled by gross alpha and gross beta counts and gamma spectrometry measurements. Yearly pooled samples and, whenever necessary also particular samples, are submitted to radiochemical determinations of ^{90}Sr, ^{137}Cs, plutonium and, if required, of other nuclides. The uranium concentration is determined by fluorimetry on the samples showing unusually high alpha activity.

The detailed results concerning total and specific activities wasted during 1965 and 1966 are reported in the internal report already mentioned.

Bottom sediments (mainly sand and silt) of the Novellino brook have been sampled and analysed to detect and measure eventual concentration of the radionuclides wasted via the stream. The results obtained by gamma spectrometric analyses are reported in Table 33. They show that no concentration occurs between water and sediments for both ^{137}Cs and ^{60}Co, the level of their contamination in the sediments being very low.

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Table 1

CONCENTRATION OF GROSS BETA RADIOACTIVITY IN AIR AT ISPRA

1966

Day	JANUARY		FEBRUARY		MARCH	
	pCi/m^3	mm rain	pCi/m^3	mm rain	pCi/m^3	mm rain
1	0.06	0.4	0.09		0.15	
2	0.08		0.08		0.14	
3	0.07		0.05		0.10	
4	0.11		0.08		0.12	
5	0.13		0.09		0.08	
6	0.10		0.14		0.08	
7	0.10		0.11		0.10	
8	0.11		0.10		0.12	
9	0.13		0.10		0.12	
10	0.16		0.09	1.0	0.20	
11	0.17	0.2	0.05	20.6	0.17	
12	0.14		0.04	7.4	0.07	
13	0.13		0.02	28.2	0.05	
14	0.14		0.05		0.13	
15	0.14		0.14		0.14	
16	0.17		0.14	0.8	0.10	
17	0.26		0.07	4.4	0.10	
18	0.25		0.05		0.13	
19	0.22		0.06	3.0	0.08	
20	0.25		0.03	14.6	0.08	
21	0.22		0.02	129.0	0.10	
22	0.17	9.2	0.05	18.0	0.14	
23	0.08		0.15	9.2	0.12	
24	0.06		0.15		0.20	
25	0.08		0.13		0.14	
26	0.10	1.4	0.13		0.25	
27	0.07		0.15		0.26	
28	0.07		0.04	29.6	0.23	
29	0.09				0.16	
30	0.10				0.14	
31	0.13				0.19	
Av. value	0.13		0.09		0.14	
Min. value	0.06		0.02		0.05	
Max. value	0.26		0.15		0.26	
Total precipit.		11.2		265.8		

Table 2

CONCENTRATION OF GROSS BETA RADIOACTIVITY

IN AIR AT ISPRA

1966

Day	APRIL		MAY		JUNE	
	pCi/m^3	mm rain	pCi/m^3	mm rain	pCi/m^3	mm rain
1	0.13		0.19		0.15	10.8
2	0.16		0.20		0.52	
3	0.24		0.17		0.68	
4	0.18		0.16		0.56	
5	0.17		0.16		0.56	
6	0.13		0.05	58.6	0.76	
7	0.12	11.0	0.04	19.8	0.61	
8	0.03	3.4	0.06	0.2	0.57	31.8
9	0.02	44.8	0.07	0.2	0.60	2.4
10	0.02	8.6	0.05	0.8	0.50	
11	0.07	18.2	0.06		0.73	
12	0.06	0.6	0.13		0.74	
13	0.03	14.8	0.16		0.76	7.0
14	0.09		0.12		0.80	
15	0.07	11.4	0.14		0.75	0.2
16	0.03	26.4	0.12	5.0	0.72	
17	0.10	0.2	0.14	5.4	0.83	
18	0.09		0.16	1.4	0.44	26.6
19	0.06	0.8	0.11	9.6	0.11	32.2
20	0.01	94.0	0.15	0.2	0.14	7.2
21	0.15	0.8	0.10		0.17	0.2
22	0.14		0.13		0.18	
23	0.18		0.18	12.6	0.27	1.2
24	0.21		0.19	7.0	0.28	
25	0.01	48.6	0.17	25.2	0.24	
26	0.04	16.8	0.22		0.24	
27	0.12		0.07	0.2	0.21	
28	0.10		0.05		0.37	
29	0.06		0.12		0.16	
30	0.11		0.17		0.10	
31			0.12			
Av. value	0.10		0.13		0.47	
Min. value	0.01		0.04		0.10	
Max. value	0.24		0.22		0.83	
Total precipit.		300.4		146.2		119.6

Table 3

CONCENTRATION OF GROSS BETA RADIOACTIVITY

IN AIR AT ISPRA

1966

Day	JULY		AUGUST		SEPTEMBER	
	pCi/m^3	mm rain	pCi/m^3	mm rain	pCi/m^3	mm rain
1	0.12		0.15	0.2	0.03	
2	0.16		0.15		0.04	1.4
3	0.23		0.14		0.05	
4	0.25		0.13		0.07	0.2
5	0.14	18.8	0.15		0.10	0.2
6	0.11	9.2	0.15		0.09	
7	0.09	0.2	0.11	7.2	0.08	0.2
8	0.21		0.07	27.0	0.08	
9	0.17		0.12		0.11	0.2
10	0.14		0.11		0.12	
11	0.16	1.6	0.10	0.2	0.13	0.2
12	0.13	0.2	0.12		0.13	0.2
13	0.18		0.16		0.07	9.6
14	0.18	10.8	0.17		0.07	
15	0.16	1.6	0.07	35.4	0.06	1.0
16	0.20	0.2	0.06	1.2	0.05	15.8
17	0.06	54.4	0.10	3.2	0.04	5.0
18	0.04	32.6	0.14	20.2	0.05	0.6
19	0.07	19.4	0.14		0.06	0.2
20	0.06	1.6	0.14	0.2	0.05	
21	0.07		0.12		0.06	0.2
22	0.10	0.2	0.06	12.2	0.06	
23	0.09		0.10		0.09	0.2
24	0.15		0.08	2.4	0.10	0.2
25	0.18		0.07	1.8	0.09	
26	0.13	9.8	0.07	0.2	0.09	0.2
27	0.10	6.6	0.07	0.2	0.10	0.2
28	0.12	0.6	0.07		0.10	0.2
29	0.12		0.09		0.05	34.4
30	0.14		0.04	38.2	0.02	50.8
31	0.14		0.04	3.6		
Av. value	0.14		0.11		0.07	
Min. value	0.04		0.04		0.02	
Max. value	0.25		0.17		0.13	
Total precipit.		167.8		153.4		121.2

Table 4

CONCENTRATION OF GROSS BETA RADIOACTIVITY

IN AIR AT ISPRA

1966

Day	OCTOBER		NOVEMBER		DECEMBER	
	pCi/m^3	mm rain	pCi/m^3	mm rain	pCi/m^3	mm rain
1	0.02	0.2	0.04	0.2	0.15	
2	0.03	9.6	0.05	5.6	0.03	17.8
3	0.05	1.8	0.02	59.6	0.23	
4	0.05	3.2	0.02	40.0	0.25	
5	0.04	0.2	0.02	53.2	0.12	
6	0.06	0.2	0.02	41.0	0.13	
7	0.07	1.6	0.03	0.2	0.12	
8	0.05	29.8	0.06	0.2	0.11	
9	0.06	2.6	0.08	2.4	0.10	
10	0.07	0.2	0.12	0.2	0.09	
11	0.05	40.0	0.84		0.10	
12	0.02	28.0	0.75		0.11	
13	0.02	0.4	0.35		0.07	
14	0.05	3.0	0.50		0.07	
15	0.03	32.4	0.55		0.08	
16	0.02	32.0	0.56		0.09	
17	0.03		0.12		0.10	
18	0.04	10.0	0.17		0.10	
19	0.02	19.4	0.17		0.10	
20	0.02	5.6	0.18		0.08	
21	0.03		0.16		0.03	
22	0.04	0.4	0.18	4.8	0.04	
23	0.06		0.12	16.6	0.07	
24	0.06	7.4	0.22	1.6	0.07	
25	0.03	8.2	0.26		0.07	
26	0.02	29.0	0.31		0.11	
27	0.03	0.2	0.28		0.13	0.6
28	0.03	36.4	0.17		0.07	14.2
29	0.04	29.2	0.10	7.4	0.05	
30	0.03	1.4	0.11		0.05	
31	0.03	15.4			0.06	
Av. value	0.04		0.22		0.10	
Min. value	0.02		0.02		0.03	
Max. value	0.07		0.84		0.25	
Total precipit.		347.8		233.0		32.6

RADIONUCLIDES IN AIR

1966

Month	Gross beta pCi/m^3	Sr^{90} 10^{-3} pCi/m^3	Sr^{89} 10^{-2} pCi/m^3	Cs^{137} 10^{-2} pCi/m^3	Pu^{239} 10^{-4} pCi/m^3	Pu^{238} 10^{-6} pCi/m^3
January	0.13	5.8	b	0.90	0.88	-
February	0.086	4.1	b	0.62	0.78	2.6
March	0.14	7.8	b	1.4	1.2	-
April	0.10	5.5	b	0.95	0.88	3.1
May	0.13	6.7	b	1.1	1.6	6.1
June	0.47	6.7	2.5	1.1	1.2	5.3
July	0.14	3.6	0.78	0.49	0.66	5.0
August	0.11	2.9	0.34	0.42	0.50	5.0
September	0.075	1.3	0.13	0.20	0.28	3.8
October	0.039	0.62	0.067	0.12	0.16	2.5
November	0.22	0.95	1.4	0.12	0.28	2.0
December	0.10	2.0	0.27	0.32	0.33	3.1

b = Below detection limit.

\- = Measurement not performed.

Table 5

Table 6

RADIONUCLIDES RATIOS (1) IN AIR

1966

Month	Cs^{137} / Sr^{90}	Sr^{89} / Sr^{90}	Pu^{239} / Sr^{90}	Pu^{238} / Pu^{239}
January	1.55		1.52	-
February	1.51		1.90	3.4
March	1.80		1.54	-
April	1.73		1.60	3.5
May	1.64		2.39	3.8
June	1.64	3.7	1.79	4.4
July	1.36	2.2	1.83	7.6
August	1.45	1.2	1.72	10.0
September	1.54	1.0	2.16	13.5
October	1.94	1.1	2.58	15.8
November	1.26	14.7	2.95	7.1
December	1.60	1.4	1.65	9.3

(1) = The ratios are expressed in percent (Pu^{239}/Sr^{90} and Pu^{238}/Pu^{239}) and as absolute values (Cs^{137}/Sr^{90} and Sr^{89}/Sr^{90}).

MONTHLY GROSS BETA RADIOACTIVITY, STRONTIUM-90, STRONTIUM-89 AND CESIUM-137 DEPOSITION

I S P R A

Month	Gross beta K^{40} equivalent		Strontium-90		Sr^{89}	Sr^{89}/Sr^{90}	Cesium-137		mm rain
	mCi/Km^2 *	pCi/l	mCi/Km^2	pCi/l	mCi/Km^2		mCi/Km^2	pCi/l	
January	1.1	98	0.06	5.4	b		0.13	12	11.2
February	4.4	17	0.65	2.4	b		0.92	3.5	265.8
March	1.1	-	0.15	-	b		0.23	-	0.0
April	5.0	17	0.79	2.6	b		1.1	3.7	300.4
May	11	75	0.72	4.9	0.35	0.49	0.95	6.5	146.2
June	19	160	0.81	6.8	3.3	4.1	1.1	9.2	119.6
July	5.9	35	0.47	2.8	1.0	2.1	0.68	4.1	167.8
August	4.2	27	0.49	3.2	0.42	0.86	0.64	4.2	153.4
September	1.3	11	0.12	0.99	0.11	0.92	0.19	1.6	121.2
October	2.4	6.9	0.23	0.66	0.14	0.61	0.33	0.95	347.8
November	2.2	9.5	0.083	0.36	0.40	4.8	0.12	0.52	233.0
December	0.43	13	0.042	1.3	0.051	1.2	0.062	1.9	32.6

b = Below detection limit.

* = Values in this column are extrapolated to last day of collection month.

Table 7

MONTHLY GROSS BETA RADIOACTIVITY, STRONTIUM-90, STRONTIUM-89 AND CESIUM-137 DEPOSITION

M I L A N O

Month	Gross beta K^{40} equivalent		Strontium-90		Sr^{89}	Sr^{89}/Sr^{90}	Cesium-137		mm rain
	mCi/Km^2 *	pCi/l	mCi/Km^2	pCi/l	mCi/Km^2		mCi/Km^2	pCi/l	
January	1.1	100	0.08	7.3	b		0.12	10.9	11
February	4.6	53	0.74	8.6	b		1.0	11.6	86
March	1.3	46	0.19	6.8	b		0.31	11.1	28
April	3.0	18	0.36	2.2	b		0.63	3.8	165
May	2.7	49	0.27	4.9	b		0.35	6.4	55
June	16	216	0.56	7.6	2.8	5.0	0.83	11	74
July	3.8	51	0.29	3.9	0.85	2.9	0.47	6.3	75
August	3.8	51	0.34	4.5	0.37	1.1	0.53	7.1	75
September	1.6	17	0.092	0.99	0.084	0.91	0.17	1.8	93
October	1.9	6.5	0.15	0.51	0.12	0.80	0.28	0.96	293
November	3.4	26	0.097	0.73	0.48	4.9	0.15	1.1	133
December	0.56	12	0.048	1.1	0.064	1.3	0.070	1.6	45

b = Below detection limit.

* = Values in this column are extrapolated to last day of collection month.

Table 8

Table 9

GEOGRAPHIC COORDINATES OF WATER SAMPLING POINTS

		Name of site	Latitude N	Longitude E (Greenwich)	Altitude a. s. l. (m)
		Lakes			
P	1	Maggiore Center of the Lake	45° 54' 26''	8° 34' 31''	193
P	2	Maggiore Zenna	46° 06' 00''	8° 44' 10''	193
P	3	Maggiore Sasso Galletto	45° 55' 40''	8° 37' 53''	193
P	4	Maggiore Laveno	45° 54' 26''	8° 37' 00''	193
P	5	Maggiore Ispra	45° 48' 50''	8° 36' 25''	193
P	6	Maggiore Sesto Calende	45° 43' 22''	8° 37' 36''	193
P	7	Maggiore Acque Nere Mouth	45° 49' 33''	8° 37' 23''	193
P	8	Maggiore Ranco	45° 48' 06''	8° 33' 08''	193
P	9	Maggiore Baveno	45° 54' 30''	8° 30' 30''	193
P	10	Monate	45° 48' 07''	8° 38' 55''	266
P	11	Varese	45° 49' 00''	8° 43' 08''	238
P	12	Comabbio	45° 46' 48''	8° 41' 38''	243
		Rivers			
P	13	Acque Nere I	45° 49' 30''	8° 37' 23''	194
P	14	Acque Nere II	45° 48' 50''	8° 38' 28''	207
P	15	Tresa	45° 59' 40''	8° 44' 00''	200
P	16	Boesio	45° 54' 20''	8° 37' 30''	200
P	17	Toce	45° 55' 58''	8° 29' 39''	433
P	18	Novellino	45° 49' 00''	8° 37' 25''	200
		Drinkable Waters			
P	19	Farm Vicina	45° 48' 35''	8° 37' 13''	213
P	20	Farm Casello	45° 48' 40''	8° 37' 10''	213
P	21	Farm Gabriella	45° 48' 10''	8° 36' 30''	216
P	22	Fontanone	45° 48' 06''	8° 37' 40''	230
P	23	Roccolo	45° 48' 11''	8° 37' 36''	247

BETA RADIOACTIVITY SUBTRACTED POTASSIUM-40 IN THE WATER OF LAKE "MAGGIORE"

pCi/l

1966

	Sampling point		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly average
P1	Center of the lake	(surface)	2.3	2.5	2.2	2.1	1.7	3.4	2.8	2.9	1.4	1.3	1.0	1.4	2.08
P1	Center of the lake	m 25	3.1	2.5	2.6	1.5	1.6	3.4	2.4	1.9	2.1	1.7	1.5	1.8	2.17
P1	Center of the lake	m 50	2.8	2.5	2.2	1.3	1.4	2.6	1.7	1.9	1.5	2.0	1.3	1.9	1.92
P2	Zenna	(surface)	3.1	2.1	2.6	1.5	1.5	-	-	3.1	2.1	2.5	1.9	1.7	2.21
P3	Sasso Galletto	"	3.1	2.5	3.1	1.8	1.8	-	-	4.1	2.3	1.8	1.2	1.9	2.36
P4	Laveno	"	2.5	2.8	2.4	1.4	1.5	-	-	5.4	2.9	2.0	1.3	1.2	2.34
P5	Porto Ispra	"	2.9	2.2	2.5	2.5	1.7	2.8	2.9	3.8	2.5	2.3	1.9	0.9	2.41
P6	Sesto Calende	"	2.7	2.3	1.5	1.4	2.0	-	-	2.3	2.3	2.1	1.7	1.4	1.97
P7	Acque Nere Mouth	"	2.9	17	7.8	7.2	2.8	4.3	1.7	12	2.6	2.0	4.2	2.5	5.58
P8	Ranco	(surface)	3.2	3.0	1.5	1.8	1.9	3.6	3.0	10	2.1	1.8	1.7	1.7	2.94
P8	Ranco	m 25	2.3	1.8	0.6	2.0	2.6	2.6	2.6	9.7	1.7	1.2	1.7	1.1	2.49
P8	Ranco	m 50	2.7	2.6	2.5	2.1	1.6	3.0	1.9	1.3	2.1	2.1	1.3	0.7	1.99
P9	Baveno	(surface)	2.9	3.0	2.7	1.8	1.9	-	-	3.5	1.9	1.8	1.3	0.9	2.17
	Average value		2.81	3.60	2.63	2.18	1.85	3.21	2.38	5.66	2.12	1.89	1.69	1.47	

Table 10

Table 11

BETA RADIOACTIVITY SUBTRACTED POTASSIUM-40 IN LAKES, STREAMS AND WELLS

NEAR TO THE ISPRA ESTABLISHMENT pCi/l

1966

Sampling point		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly average
	Lakes													
P10	Monate	10	11	10	11	8.4	12	11	11	9.0	7.5	8.2	8.5	9.80
P11	Varese	8.9	7.4	7.2	6.2	7.1	6.5	6.6	6.8	5.1	5.0	4.1	3.9	6.23
P12	Comabbio	12	12	13	10	11	16	13	11	9.1	8.1	8.3	8.0	11.0
	Rivers													
P13	Acque Nere I	4.2	3.9	3.9	5.0	3.8	4.7	4.3	4.3	3.0	4.6	4.6	4.5	4.23
P14	Acque Nere II	3.9	13	4.4	8.8	4.5	5.7	4.1	4.7	3.4	4.4	3.9	3.0	5.32
P15	Tresa	3.3	2.9	3.3	1.8	2.3	-	-	5.2	3.9	2.9	2.1	1.9	2.96
P16	Boesio	0.5	1.0	0.8	1.4	0.6	-	-	4.2	0.5	1.6	0.7	0.5	1.18
P17	Toce	1.6	2.2	0.5	2.0	1.5	-	-	2.3	1.5	6.6	2.4	1.0	2.16
P18	Novellino	5.8	6.7	40	12	5.4	4.1	3.3	5.1	1.7	3.1	3.6	4.1	7.01
	Drinkable Waters													
P19	Farm Vicina	0.5	0.5	0.5	2.0	4.4	0.5	0.5	3.5	0.5	0.5	0.5	0.5	1.20
P20	Farm Casello	0.5	0.7	1.2	0.5	1.1	0.5	0.5	1.7	0.5	0.5	0.5	0.5	0.73
P21	Farm Gabriella	0.7	0.5	0.5	0.5	0.5	4.6	0.5	0.7	0.5	0.5	0.5	0.5	0.88
P22	Fontanone	2.5	1.9	1.9	0.5	0.5	1.5	1.7	1.1	0.5	0.8	0.7	0.6	1.18
P23	Roccolo	3.7	2.4	3.2	1.3	1.6	3.0	1.9	2.4	0.7	1.5	1.0	1.3	2.00

RADIONUCLIDES IN LAKES

1966

Table 12

Name of the lake	Sampling date	Sr^{90} pCi/l	Ca mg/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K mg/l	Cs^{137} pCi/g K
"Maggiore"	17 - 3	0.74	17.5	42	0.35	2.0	175
""	22 - 6	0.86	18.5	47	0.37	1.9	195
""	14 - 9	0.82	19.5	42	0.36	2.1	172
""	6 - 12	0.85	20.0	43	0.23	2.3	100
"Monate"	16 - 3	4.6	8.5	541	0.78	0.9	870
""	14 - 6	4.7	10.0	470	1.0	1.5	667
""	12 - 9	4.6	9.5	485	0.83	1.3	638
""	5 - 12	4.4	9.9	444	0.66	1.4	472
"Comabbio"	15 - 3	6.3	26.0	242	0.96	1.7	560
""	15 - 6	5.6	25.0	224	0.87	2.0	435
""	10 - 9	6.2	21.0	296	0.88	2.5	352
""	6 - 12	4.4	25.0	176	0.59	2.2	258
"Varese"	17 - 3	4.0	32.0	125	0.74	2.3	320
""	21 - 6	3.1	28.0	111	0.74	2.4	308
""	13 - 9	2.3	25.5	90	0.63	2.7	233
""	5 - 12	2.4	40.0	60	0.36	2.8	129

Table 13

STRONTIUM-90 AND CESIUM-137 IN SOIL

FEBRUARY 1966

Sampling site	Lat. (N)	Long. (E)	Alt. (m)	Strontium-90		Cesium-137		Plutonium-239	
				pCi/g(*)	mCi/Km^2	pCi/g (*)	mCi/Km^2	pCi/Kg(*)	mCi/Km^2
Angera	45°46'35"	8°35'48"	210	1.2	114	1.5	143	23	2.19
Barza	45°47'45"	8°36'53"	213	1.3	96	2.0	147	25	1.84
Brebbia	45°49'30"	8°38'40"	223	0.67	71	1.0	106	-	-
Golasecca (**)	45°42'30"	8°39'26"	243	1.2	97	2.0	161	25	2.01
Ispra	45°49'05"	8°37'20"	205	0.99	72	1.8	131	-	-
Malgesso	45°49'40"	8°40'38"	295	0.84	82	1.4	137	-	-
Monvalle	45°51'30"	8°37'20"	209	1.1	81	1.4	104	-	-
Osmate	45°47'15"	8°39'10"	330	1.1	77	2.0	140	-	-
Pallanza	45°55'40"	8°32'58"	202	1.4	98	2.0	140	-	-
Paruzzaro	45°45'00"	8°31'43"	305	0.76	58	1.5	115	-	-
Solcio	45°49'00"	8°33'03"	209	1.2	91	1.9	144	30	2.27
Taino	45°45'30"	8°37'30"	272	1.5	100	2.2	147	-	-
Travedona	45°48'20"	8°41'28"	260	0.87	78	1.3	116	-	-
Varano Borghi	45°46'30"	8°41'50"	270	1.2	87	1.7	123	32	2.31

(*) = These data have been rounded off to two digits, whereas the mCi/Km^2 values are given as obtained by multiplication.
(**) = Site previously indicated as "Diga Miorina".
\- = Determination not performed.

Table 14

NATURAL RADIOACTIVITY AND STABLE ELEMENTS IN SOILS

FEBRUARY 1966

Sampling site	Th^{232} p.p.m.	Ra^{226} 10^{-12} g/g	K (1) mg/g	Ca (1) mg/g
Angera	8.9	0.66	17.6	5.0
Barza	9.8	0.63	16.2	5.0
Brebbia	10.3	0.67	18.7	4.2
Golasecca	12.9	0.86	19.4	4.4
Ispra	11.0	0.73	18.8	4.0
Malgesso	9.4	0.60	18.9	6.3
Monvalle	11.5	0.96	19.3	5.5
Osmate	12.5	0.84	17.9	3.5
Pallanza	10.4	0.69	14.2	6.6
Parruzzaro	14.3	0.92	24.0	2.9
Solcio	12.9	0.85	21.4	2.8
Taino	14.1	0.99	19.2	5.5
Travedona	12.0	0.78	23.7	4.8
Varano Borghi	10.9	0.74	16.1	4.5

(1) = These values represent the total concentration and not an exchangeable fraction.

VERTICAL PROFILE OF FALLOUT CONTAMINATION IN SOIL

MAY 1966

SITE	Strontium-90		Cesium-137		Plutonium-239	
	pCi/g	% of total	pCi/g	% of total	pCi/Kg	% of total
ISPRA						
depth cm						
0 - 5	1.18	61	2.1	66	34	58
5 - 10	0.47	24	0.74	23	12	21
10 - 15	0.17	9	0.26	8	8	14
15 - 20	0.12	6	0.08	3	4	7
OSMATE						
depth cm						
0 - 5	1.08	54	2.1	49	27	58
5 - 10	0.55	28	1.4	33	11	24
10 - 15	0.23	12	0.57	13	5.3	11
15 - 20	0.13	6	0.21	5	3.1	7

Table 15

STRONTIUM-90 AND CESIUM-137 IN HERBAGE (1)

1966

Sampling site	Sampling date		R (2)	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
Barza	April	27	5.6	3.8	8.2	465	2.2	19.8	111
Brebbia	"	"	6.4	1.2	7.6	158	0.43	33.7	13
Ispra	"	"	6.5	1.5	6.0	250	0.45	38.1	12
Monvalle	"	"	6.1	1.6	8.2	195	0.69	23.0	30
Osmate	"	"	5.7	2.6	5.0	520	0.74	29.0	26
Taino	"	"	5.3	1.5	4.3	349	1.8	16.3	110
Barza	May	23	5.3	2.5	9.2	272	2.4	18.8	128
Brebbia	"	"	4.6	3.5	9.8	357	0.94	20.0	47
Ispra	"	"	4.8	7.2	12.3	585	2.1	8.5	247
Monvalle	"	"	6.9	1.7	10.4	163	0.46	27.2	17
Osmate	"	"	7.4	1.6	8.9	180	0.56	37.2	15
Taino	"	"	6.5	2.5	10.8	231	1.4	14.8	95

(1) = Values are given per weight unity of dry matter.

(2) = Weight ratio of the fresh matter at the collection to the dry matter.

Table 17

STRONTIUM-90 AND CESIUM-137 IN HERBAGE [1]

1966

Sampling site	Sampling date		R [2]	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
Barza	June	23	6.7	4.5	10.0	450	3.4	18.0	189
Brebbia	"	"	5.4	2.2	11.6	190	1.2	17.2	70
Ispra	"	"	6.7	4.4	10.4	423	1.7	33.3	51
Monvalle	"	"	4.9	1.6	12.0	133	1.2	17.2	70
Osmate	"	"	5.5	2.7	12.0	225	1.1	18.8	59
Taino	"	"	6.3	2.4	8.8	273	1.7	20.0	85
Barza	July	21	4.5	2.9	9.2	315	2.9	12.8	226
Brebbia	"	"	5.9	5.5	16.0	344	1.8	15.6	115
Ispra	"	"	6.2	9.6	16.4	585	2.3	16.0	144
Monvalle	"	"	6.9	1.9	11.2	170	0.78	14.0	56
Osmate	"	"	5.3	7.9	14.8	535	1.2	13.2	91
Taino	"	"	5.4	2.9	12.4	234	0.97	15.6	62

(1) = Values are given per weight unity of dry matter.

(2) = Weight ratio of the fresh matter at the collection to the dry matter.

STRONTIUM-90 AND CESIUM-137 IN HERBAGE (1)

1966

Sampling site	Sampling date	R (2)	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
Barza	August 11	6.0	3.0	11.6	258	0.84	18.0	47
Brebbia	" "	6.1	3.7	14.8	250	0.92	23.3	39
Ispra	" "	6.5	2.1	10.4	202	0.63	29.2	22
Monvalle	" "	6.3	3.6	12.4	290	0.86	15.7	55
Osmate	" "	6.7	2.9	13.2	220	0.54	24.8	22
Taino	" "	6.5	2.1	10.4	202	1.1	18.6	59
Barza	September 7	5.3	4.3	10.4	413	3.1	16.0	194
Brebbia	" "	5.9	3.1	11.2	277	0.98	24.1	41
Ispra	" "	6.7	5.3	10.8	491	2.2	12.8	172
Monvalle	" "	5.3	2.0	12.0	167	2.1	13.4	157
Osmate	" "	9.1	2.6	17.6	148	0.54	37.8	14
Taino	" "	6.4	2.5	15.2	164	0.97	20.0	49
Barza	October 18	6.9	2.9	9.6	302	1.1	25.2	44
Brebbia	" "	6.3	5.4	11.6	465	0.90	29.6	30
Ispra	" "	7.4	2.3	11.6	198	0.91	34.5	26
Monvalle	" "	6.8	3.2	16.0	200	1.2	22.2	54
Osmate	" "	7.7	3.2	12.0	268	1.5	17.1	88
Taino	" "	5.8	2.9	12.4	234	1.8	15.2	118

(1) = Values are given per weight unity of dry matter.

(2) = Weight ratio of the fresh matter at the collection to the dry matter.

Table 18

STRONTIUM-90 AND CESIUM-137 IN MILK

B A R Z A

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	42	1.30	32	91	1.75	52
February	60	1.18	51	180	1.67	110
March	81	1.10	74	390	1.71	230
April	60	1.10	55	180	1.92	94
May	59	1.12	53	57	1.72	33
June	57	1.05	54	52	1.76	30
July	59	1.10	54	42	1.72	24
August	68	1.12	61	49	1.62	30
September	56	1.17	48	71	1.69	42
October	60	1.15	52	73	1.60	46
November	47	1.27	37	64	1.72	37
December	46	1.14	40	81	1.75	46

Table 19

Table 20

STRONTIUM-90 AND CESIUM-137 IN MILK

B R E B B I A

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	70	1.27	55	310	1.65	190
February	56	1.21	46	230	1.65	140
March	52	1.15	45	210	1.60	130
April	54	1.12	48	210	1.54	136
May	50	1.15	43	110	1.63	68
June	45	1.12	40	91	1.53	60
July	50	1.15	43	130	1.56	83
August	47	1.20	39	110	1.52	72
September	44	1.25	35	120	1.50	80
October	57	1.20	48	117	1.51	78
November	38	1.30	29	93	1.52	61
December	48	1.32	36	154	1.58	97

STRONTIUM-90 AND CESIUM-137 IN MILK

ISPRA

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	42	1.27	33	220	1.67	130
February	43	1.16	37	210	1.52	140
March	60	1.15	52	240	1.63	150
April	56	1.10	51	220	1.58	139
May	43	1.10	39	110	1.51	73
June	35	1.05	33	130	1.49	87
July	32	1.07	30	140	1.65	85
August	36	1.12	32	160	1.66	96
September	32	1.10	29	98	1.60	61
October	38	1.25	30	115	1.55	74
November	39	1.32	30	130	1.50	87
December	49	1.32	37	146	1.51	97

Table 21

STRONTIUM-90 AND CESIUM-137 IN MILK

MILANO

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	15	1.16	13	49	1.60	31
February	17	1.12	15	51	1.63	31
March	15	1.26	12	44	1.51	29
April	14	1.03	14	32	1.56	21
May	14	1.10	13	34	1.54	22
June	14	1.02	14	31	1.55	20
July	12	1.02	12	27	1.54	18
August	10	1.05	10	21	1.50	14
September	13	1.10	12	23	1.54	15
October	11	1.20	9	38	1.55	25
November	11	1.25	9	24	1.47	16
December	11	1.10	10	26	1.53	17

Table 22

STRONTIUM-90 AND CESIUM-137 IN MILK

OSMATE

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	45	1.30	35	180	1.65	110
February	46	1.21	38	160	1.63	98
March	55	1.20	46	160	1.65	97
April	44	0.90	49	130	1.51	86
May	54	1.15	47	91	1.45	63
June	57	0.97	59	100	1.47	68
July	36	0.82	44	84	1.41	60
August	40	1.05	38	97	1.50	65
September	39	1.00	39	78	1.45	54
October	34	1.20	28	66	1.31	50
November	35	1.30	27	74	1.55	48
December	30	1.25	24	106	1.57	67

Table 23

STRONTIUM-90 AND CESIUM-137 IN MILK

V A R E S E

1966

Month	Sr^{90} pCi/l	Ca g/l	Sr^{90} pCi/g Ca	Cs^{137} pCi/l	K g/l	Cs^{137} pCi/g K
January	41	1.21	34	150	1.65	91
February	38	1.18	32	140	1.60	88
March	39	1.20	33	180	1.69	110
April	42	1.15	37	150	1.58	95
May	40	1.17	34	100	1.50	67
June	34	1.15	30	83	1.58	53
July	33	0.85	39	79	1.51	52
August	39	1.15	34	76	1.55	49
September	33	1.12	29	63	1.48	43
October	26	1.20	22	70	1.48	47
November	29	1.27	23	76	1.57	48
December	34	1.15	30	77	1.61	48

Table 24

STRONTIUM-90 AND CESIUM-137 IN LAKE FISHES

LAKE "COMABBIO"

1966

Biological species	Sampling date	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
	March						
Perca fluviatilis	29	1.0	14.1	71	1.9	3.09	615
Scardinius erith.	9	1.2	15.0	80	0.93	2.85	326
Eupomotis gibbosus	29	0.93	14.5	64	0.63	3.10	203
	June						
Perca fluviatilis	14	0.84	13.0	65	1.1	3.24	340
Scardinius erith.	13	1.4	16.5	85	0.76	3.04	250
Eupomotis gibbosus	14	0.78	12.4	63	0.51	3.20	159
	September						
Perca fluviatilis	9	0.85	9.2	93	1.4	2.82	496
Scardinius erith.	15	1.6	13.0	123	0.69	2.78	248
Eupomotis gibbosus	9	0.65	11.5	57	0.82	2.94	279
	December						
Perca fluviatilis	-	-	-	-	-	-	-
Scardinius erith.	5	1.1	12.5	88	0.78	2.85	274
Eupomctis gibbosus	-	-	-	-	-	-	-

- = Sample not available.

Table 25

STRONTIUM-90 AND CESIUM-137 IN LAKE FISHES

LAKE "MAGGIORE"

1966

Table 26

Biological species	Sampling date	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
	March						
Perca fluviatilis	3	0.16	10.8	15	1.3	2.90	448
Scardinius erith.	3	0.25	13.4	20	0.98	2.93	335
Eupomotis gibbosus	-	-	-	-	-	-	-
Coregonus sp.("bondella")	28	0.085	6.6	13	0.70	3.14	223
Alburnus alborella	10	0.11	6.5	17	0.87	2.76	315
	June						
Perca fluviatilis	13	0.18	12.0	15	1.2	3.03	396
Scardinius erith.	13	0.26	12.5	21	0.55	2.93	188
Eupomotis gibbosus	13	0.14	11.7	12	0.42	3.18	132
Coregonus sp.("bondella")	-	-	-	-	-	-	-
Alburnus alborella	17	0.12	6.7	18	0.63	3.03	208
	September						
Perca fluviatilis	7	0.13	10.0	13	0.83	3.43	242
Scardinius erith.	7	0.22	9.4	23	0.38	3.06	124
Eupomotis gibbosus	7	0.12	11.5	10	0.29	2.81	103
Coregonus sp.("bondella")	7	0.062	4.8	13	0.55	3.05	180
Alburnus alborella	7	0.074	5.5	14	0.46	2.22	207
	December						
Perca fluviatilis	5	0.14	15.3	9	0.72	3.10	232
Scardinius erith.	12	0.27	18.8	14	0.32	2.69	119
Eupomotis gibbosus	-	-	-	-	-	-	-
Coregonus sp.("bondella")	-	-	-	-	-	-	-
Alburnus alborella	12	0.097	8.2	12	0.54	2.56	211

- = Sample not available.

STRONTIUM-90 AND CESIUM-137 IN LAKE FISHES

LAKE "MONATE"

1966

Biological species	Sampling date	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
	March						
Perca fluviatilis	29	1.5	12.8	117	7.6	3.14	2 420
Scardinius erith.	21	3.0	14.9	201	2.1	3.22	652
Eupomotis gibbosus	-	-	-	-	-	-	-
	June						
Perca fluviatilis	16	1.6	14.1	113	8.0	3.64	2 200
Scardinius erith.	14	2.7	14.7	184	2.0	3.62	553
Eupomotis gibbosus	14	1.7	13.1	130	3.9	3.12	1 250
	September						
Perca fluviatilis	15	1.3	15.0	87	6.0	3.25	1 850
Scardinius erith.	15	2.3	19.5	118	1.3	2.72	478
Eupomotis gibbosus	9	1.3	10.8	120	5.2	2.81	1 850
	December						
Perca fluviatilis	-	-	-	-	-	-	-
Scardinius erith.	12	1.5	17.8	84	0.98	2.66	368
Eupomotis gibbosus	-	-	-	-	-	-	-

\- = Sample not available.

Table 27

Table 28

STRONTIUM-90 AND CESIUM-137 IN LAKE FISHES

LAKE "VARESE"

1966

Biological species	Sampling date	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
	March						
Perca fluviatilis	9	0.46	12.5	37	0.73	3.18	230
Scardinius erith.	9	0.96	16.1	60	0.81	2.82	287
Eupomotis gibbosus	31	0.39	13.0	30	0.27	2.63	103
	June						
Perca fluviatilis	13	0.40	12.5	32	0.63	3.15	200
Scardinius erith.	13	0.93	14.3	65	0.68	3.07	222
Eupomotis gibbosus	16	0.28	10.1	28	0.24	3.22	75
	September						
Perca fluviatilis	-	-	-	-	-	-	-
Scardinius erith.	6	0.69	13.5	51	0.51	2.66	192
Eupomotis gibbosus	6	0.23	8.3	28	0.12	2.76	43
	December						
Perca fluviatilis	12	0.31	16.4	19	0.50	3.03	165
Scardinius erith.	5	1.0	21.2	47	0.55	2.75	200
Eupomotis gibbosus	-	-	-	-	-	-	-

- = Sample not available.

Table 29

DISTRIBUTION OF RADIOACTIVITY AND STABLE ELEMENTS WITHIN THE FISH BODY

LAKE MAGGIORE - JUNE 1966

	% fresh weight	Sr^{90} pCi/g	Ca mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
PERCA FLUVIATILIS (About 30 individuals, 2300 Kg)							
Skin	10.0	0.46	37.4	12.3	0.60	2.22	270
Head	24.9	0.18	17.6	10.2	0.59	2.50	240
Bones	13.7	0.22	16.9	13.0	0.74	2.85	260
Muscle	43.5	0.0043	0.30	14.4	1.3	4.05	320
Intestine	7.9	0.043	2.80	15.4	0.70	2.24	310
COREGONUS Sp. (bondella) (About 20 individuals, 2510 Kg)							
Skin & Muscle	57.8	0.0089	0.65	13.7	0.46	3.80	120
Head	10.4	0.16	10.9	14.7	0.24	3.06	78
Bones	16.7	0.13	11.3	11.5	0.23	2.19	110
Intestine	15.1	0.066	4.89	13.5	0.24	2.36	100

DISTRIBUTION OF RADIOACTIVITY AND STABLE ELEMENTS WITHIN THE FISH BODY

LAKE MAGGIORE - DECEMBER 1966

	% fresh weight	Sr^{90} pCi/g	Ca mg/g	Sr mg/g	Sr^{90} pCi/g Ca	Cs^{137} pCi/g	K mg/g	Cs^{137} pCi/g K
PERCA FLUVIATILIS (About 30 individuals, 2810 Kg)								
Skin	6.7	0.40	48.5	0.193	8	0.60	5.13	117
Head	29.9	-	16.9	0.067	-	0.42	2.16	195
Bones	9.6	0.24	25.6	0.122	9	0.71	4.47	159
Muscle	47.4	0.0040	0.47	0.0031	9	0.34	3.33	102
Intestine	6.4	0.03	3.14	0.0036	10	0.12	4.54	26.4
COREGONUS Sp. (bondella) (About 20 individuals, 1840 Kg)								
Skin & Muscle	59.9	0.039	4.20	0.0187	9	0.70	3.09	227
Head	15.5	0.14	12.4	0.0751	11	0.21	3.34	63.0
Bones	13.6	0.21	19.8	0.120	11	0.27	4.80	56.3
Intestine	11.0	0.02	2.48	0.0064	8	0.23	1.97	117

- = Measurement not performed.

Table 30

Table 31

STRONTIUM-90 IN CALF BONES

1966

Sampling site	Sampling date	Sr^{90} pCi/g ash	Sr^{90} (1) pCi/g Ca
	January		
Angera	19	18	49
Brebbia	19	18	49
Monvalle	19	23	62
Osmate	19	23	62
	February		
Angera	15	15	41
Barza	15	23	62
Ispra	15	17	46
Travedona	15	16	43
	March		
Ispra	14	20	54
Malgesso	14	29	78
Osmate	14	29	78
Travedona	14	19	51
	April		
Angera	10	12	32
Brebbia	10	20	54
Malgesso	10	22	60
Monvalle	10	12	32
	May		
Brebbia	16	11	30
Ispra	16	17	46
Osmate	16	10	27
Travedona	16	7.1	19
	June		
Cadrezzate	20	24	65
Comabbio	20	7.0	19
Monvalle	20	5.1	14
Travedona	20	5.1	14

(1) - Calcium concentration in bone ash has been assumed constant as 37.0%.

Table 32

STRONTIUM-90 IN CALF BONES

1966

Sampling site	Sampling date	Sr^{90} pCi/g ash	Sr^{90} (1) pCi/g Ca
	July		
Cadrezzate	25	5.4	15
Capronno	25	8.1	22
Osmate	25	21	57
Travedona	25	17	46
	August		
Angera	16	7.8	21
Capronno	16	4.7	13
Osmate	16	8.3	22
Travedona	16	16	43
	September		
Capronno	11	19	51
Monvalle	11	29	78
Osmate	11	23	62
Taino	11	7.4	20
	October		
Cadrezzate	10	29	78
Monvalle	10	4.7	13
Taino	10	9.6	26
Travedona	10	9.6	26
	November		
Angera	13	10	27
Brebbia	13	28	76
Ispra	13	5.7	15
Monvalle	13	8.0	22
	December		
Angera	14	8.1	22
Barza	14	23	62
Osmate	14	21	57
Travedona	14	5.7	15

(1) = Calcium concentration in bone ash has been assumed constant as 37.0%.

Table 33

STRONTIUM-90 AND CESIUM-137 IN VEGETABLES (1)

1966

Species	Sr^{90} pCi/Kg	Ca g/Kg	Sr^{90} pCi/g Ca	Cs^{137} pCi/g Ca	K g/Kg	Cs^{137} pCi/g K
Spinach - ("Spinacia Oleracea")	48	1.26	38	28	5.89	5
Chard - ("Beta Vulgaris")	45	0.69	65	22	3.94	6
Turnip Tops - ("Brassica Oleracea Botrytis" D.C.)	32	1.62	20	13	3.35	4
Lettuce - ("Lactuca Sativa")	19	0.41	46	7.3	2.59	3
Chicory ("Cichorium Intybus")	39	0.55	71	14	2.87	5
"Catalogna" Chicory - ("Cichorium Intybus", var. Catalogna)	17	0.71	24	11	3.42	3

(1) - Concentration values are referred to fresh matter and are obtained from pooled samples made up for each species, with about 20 samples collected during the year.

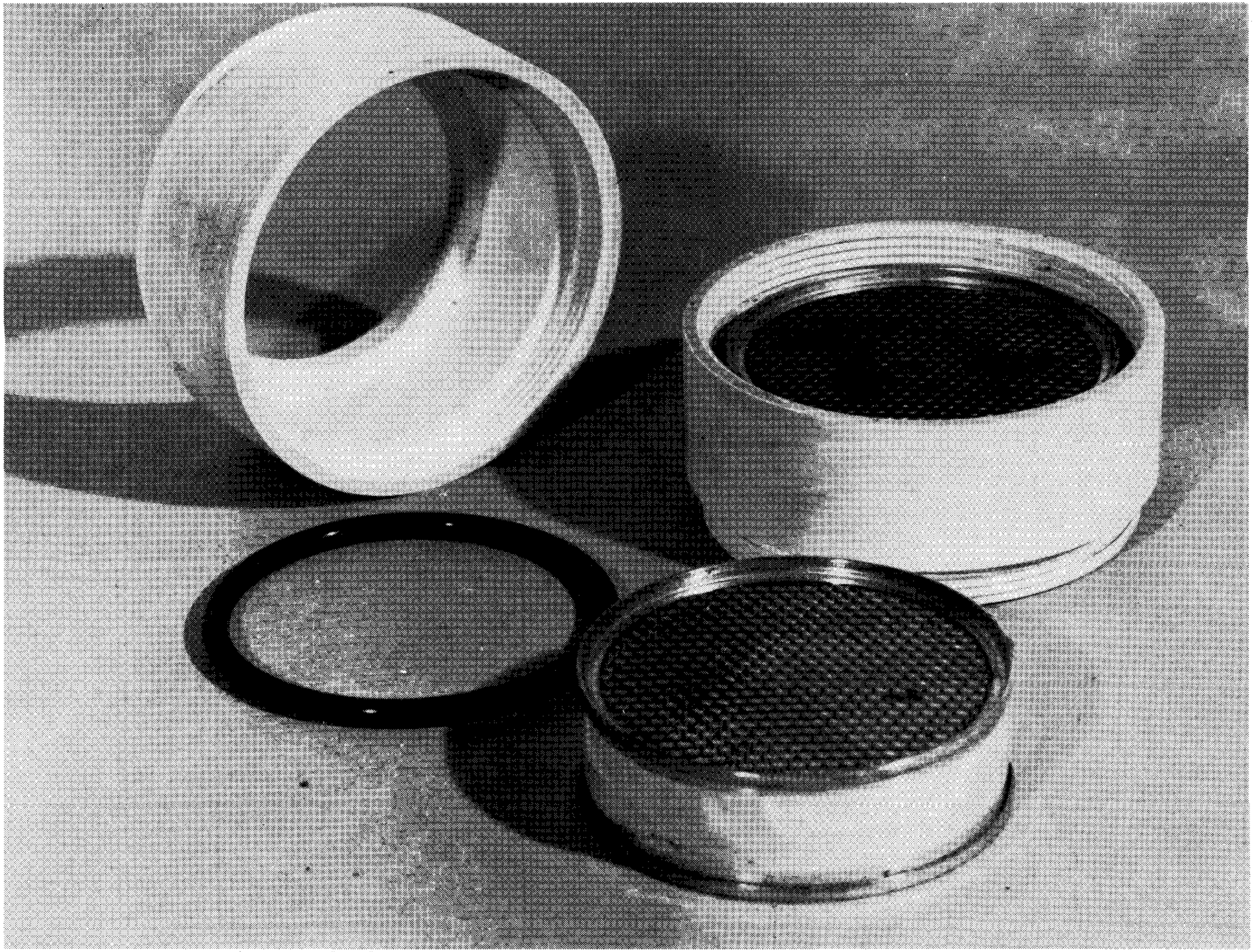

Figure 1 Charcoal cartridge with plastic adaptor for paper filter holder.

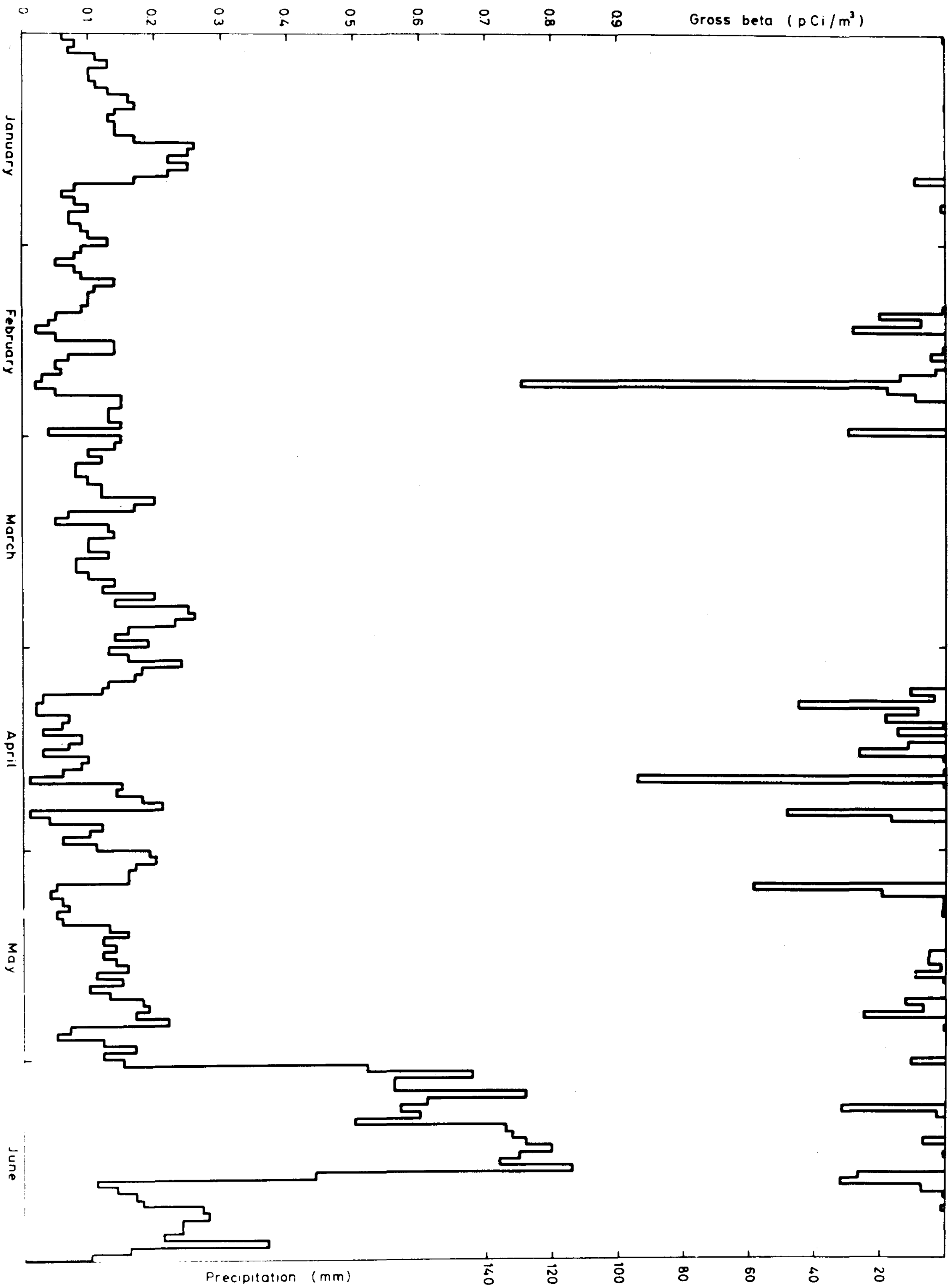

Figure 2 Daily average concentration of gross beta radioactivity in air (January - June 1966).

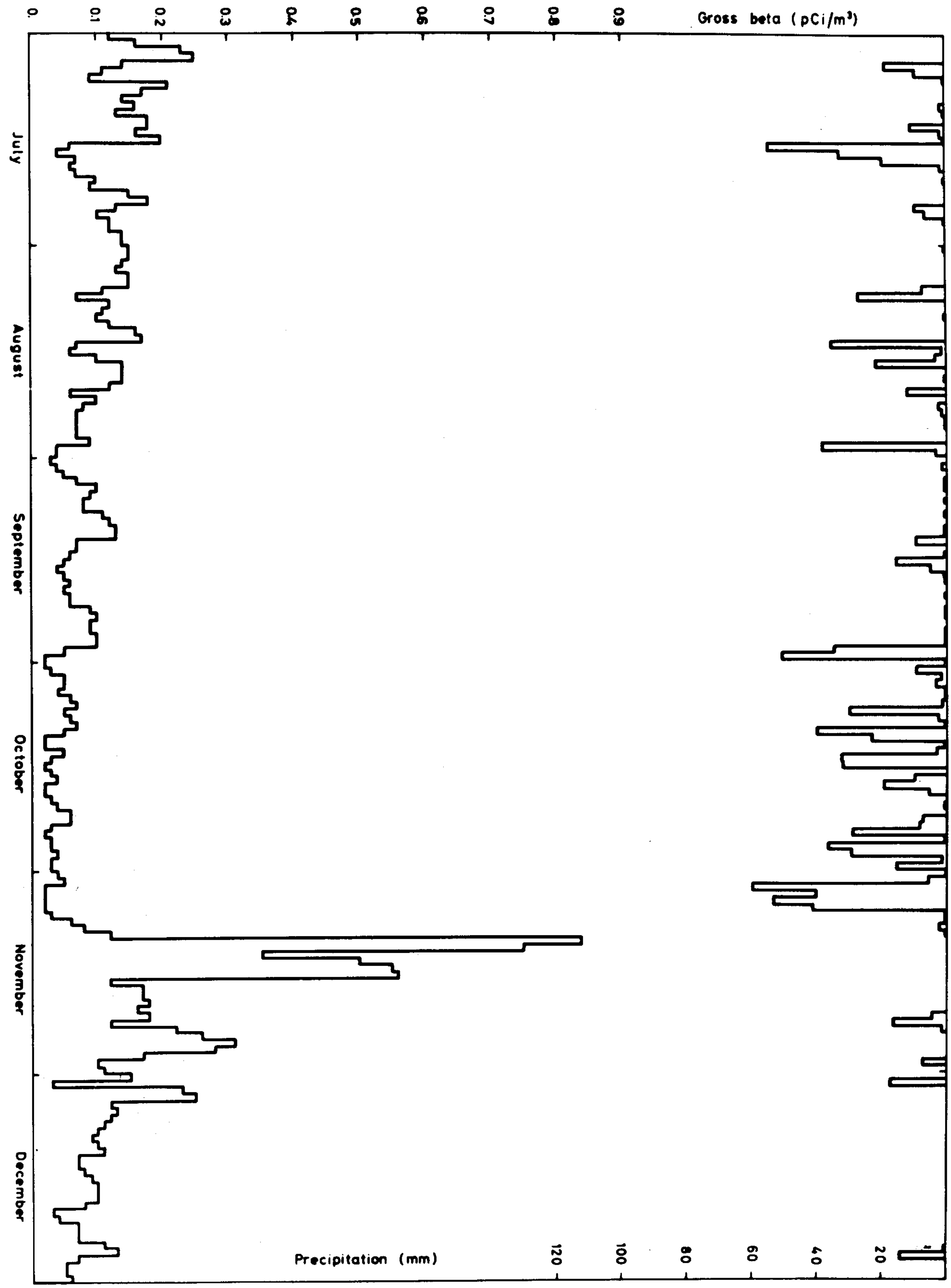

Figure 3 Daily average concentration of gross beta radioactivity in air (July - December 1966).

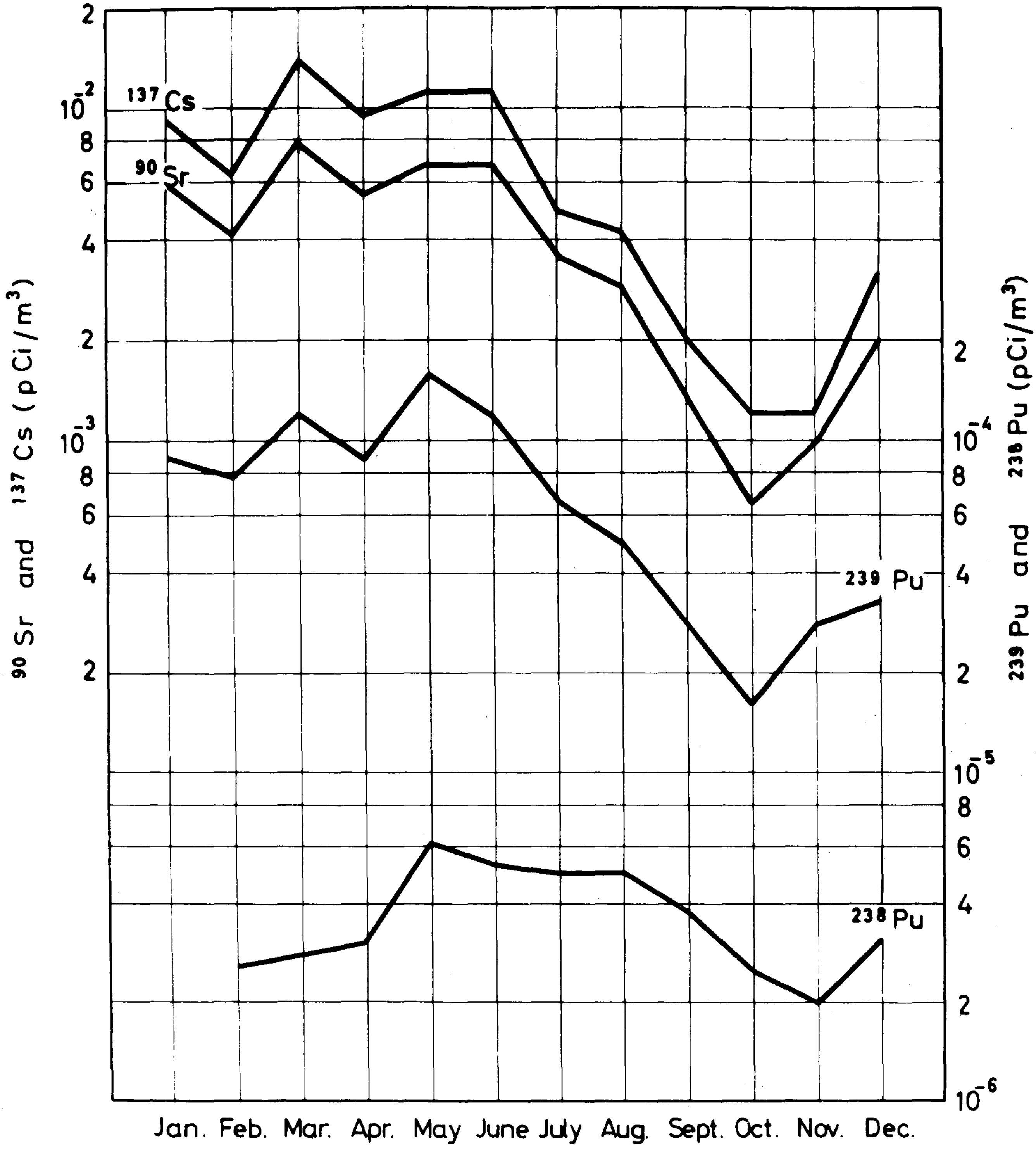

Figure 4 Strontium-90, cesium-137, plutonium-239 and plutonium-238 monthly air concentrations.

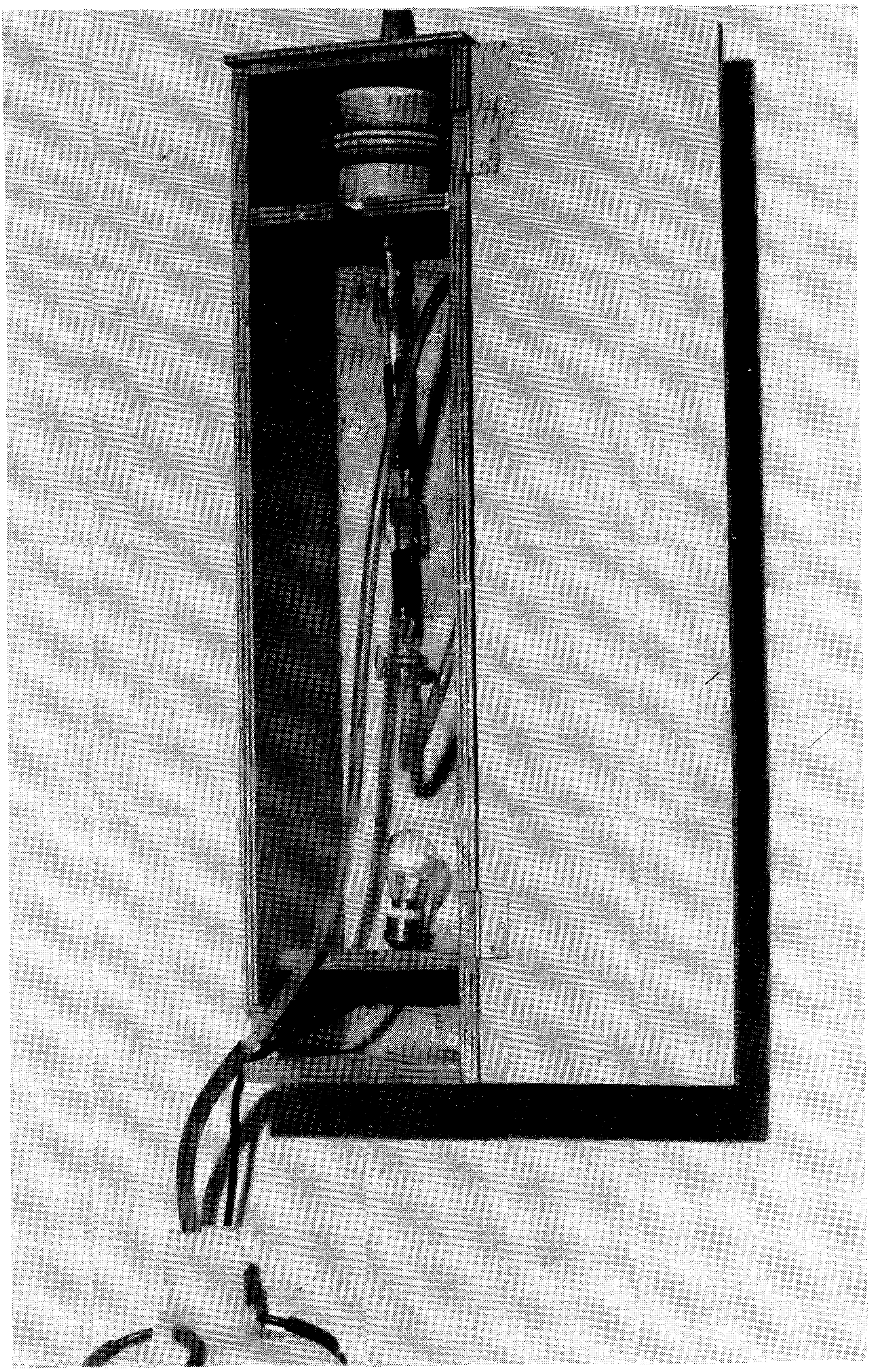

Figure 5 Ion - exchange column of deposition collector, with filter and heating bulb in wood housing.

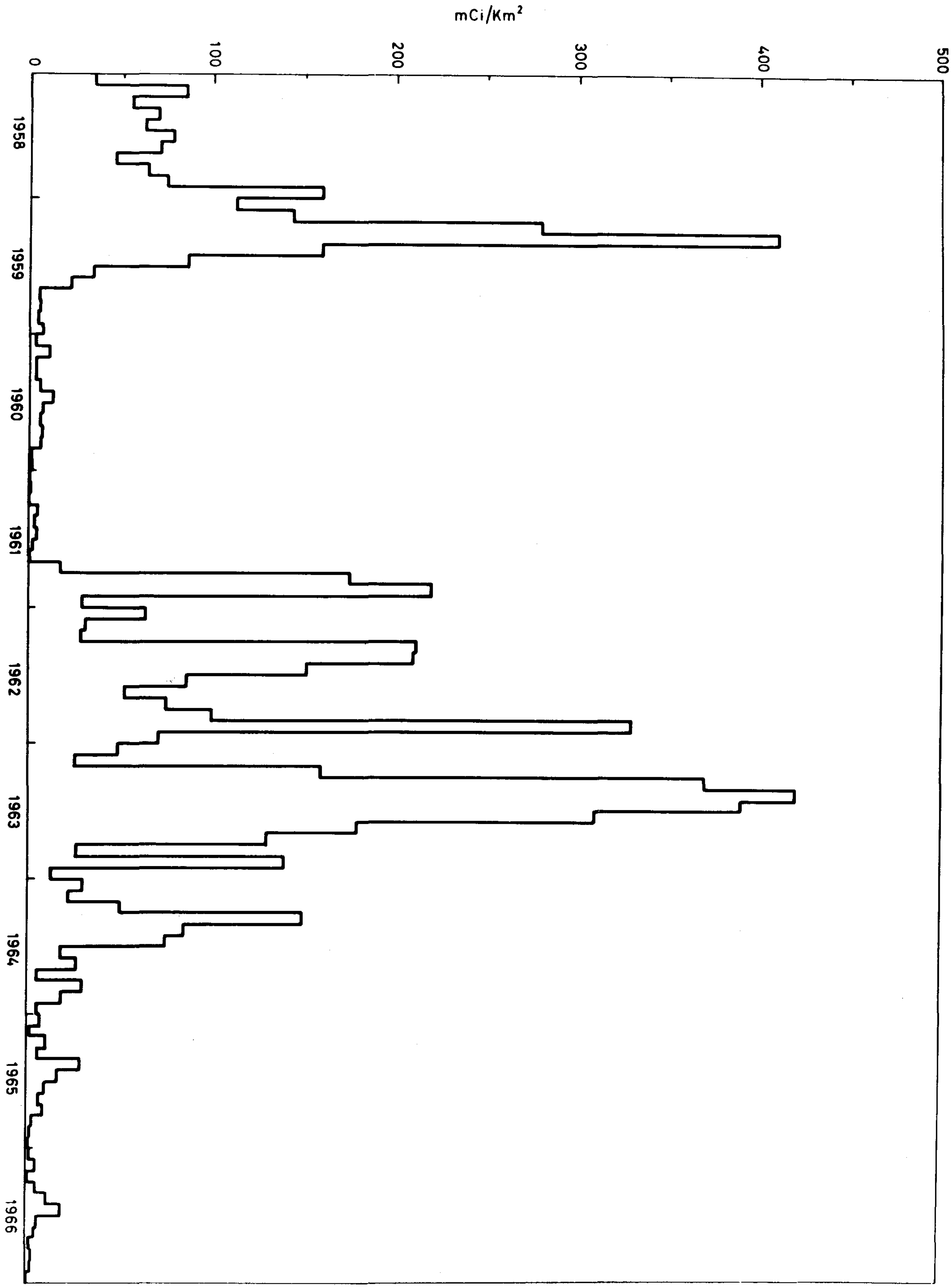

Figure 6 Gross beta radioactivity monthly deposition from 1958 through 1966.

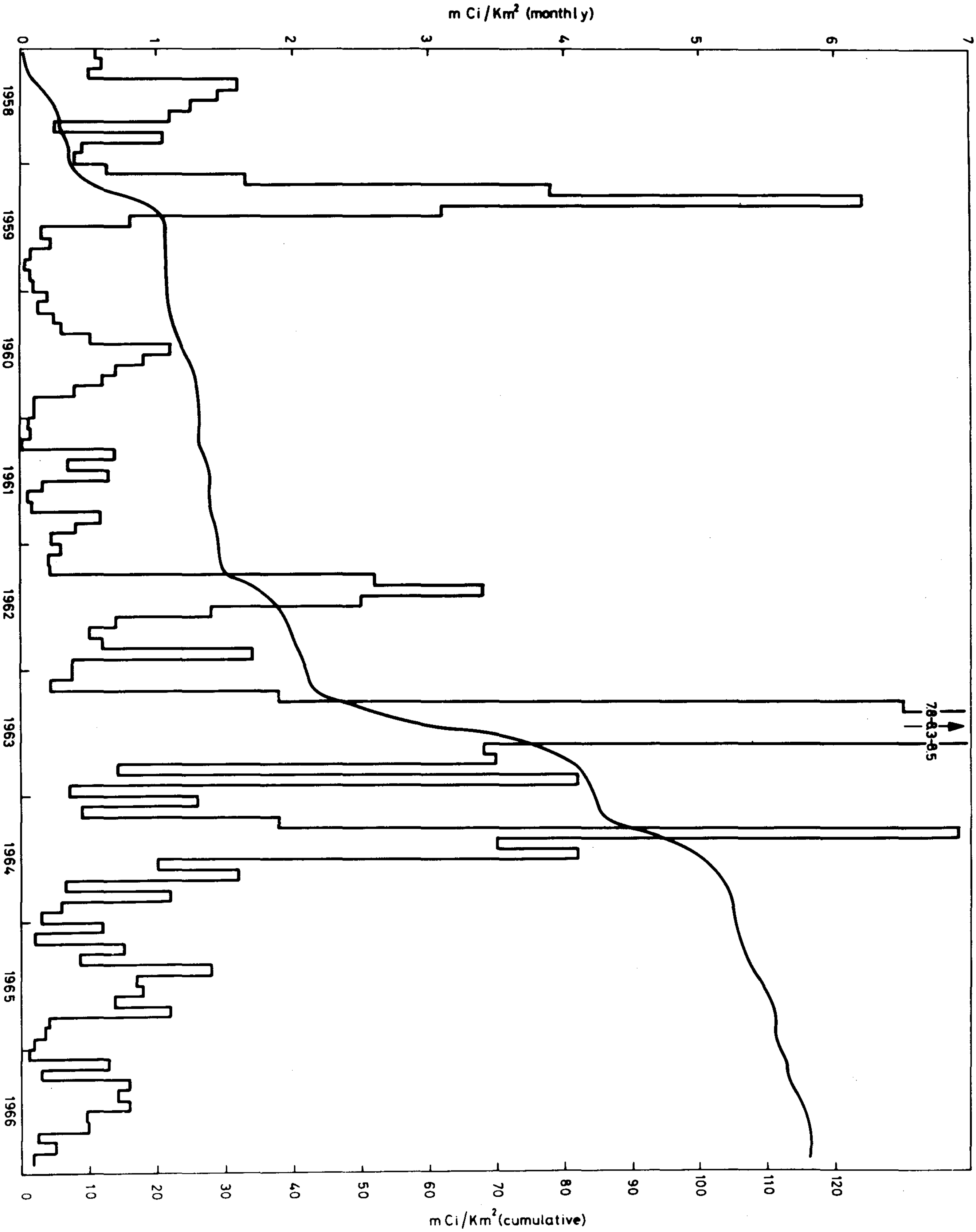

Figure 7 Strontium-90 monthly deposition and cumulative deposit from 1958 through 1966.

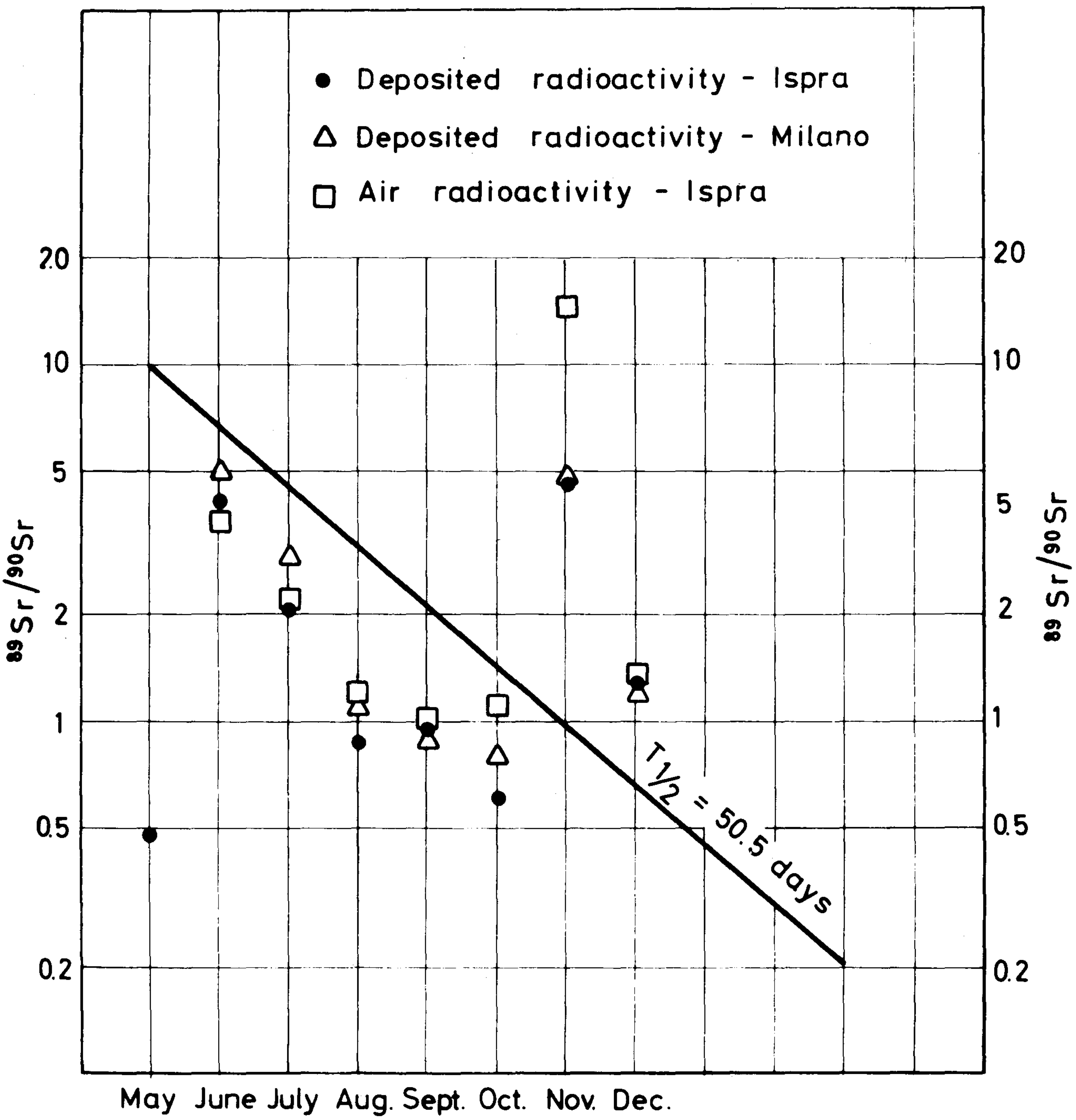

Figure 8 Strontium-89 / strontium-90 ratio in air at Ispra and in deposited radioactivity at Ispra and Milano.

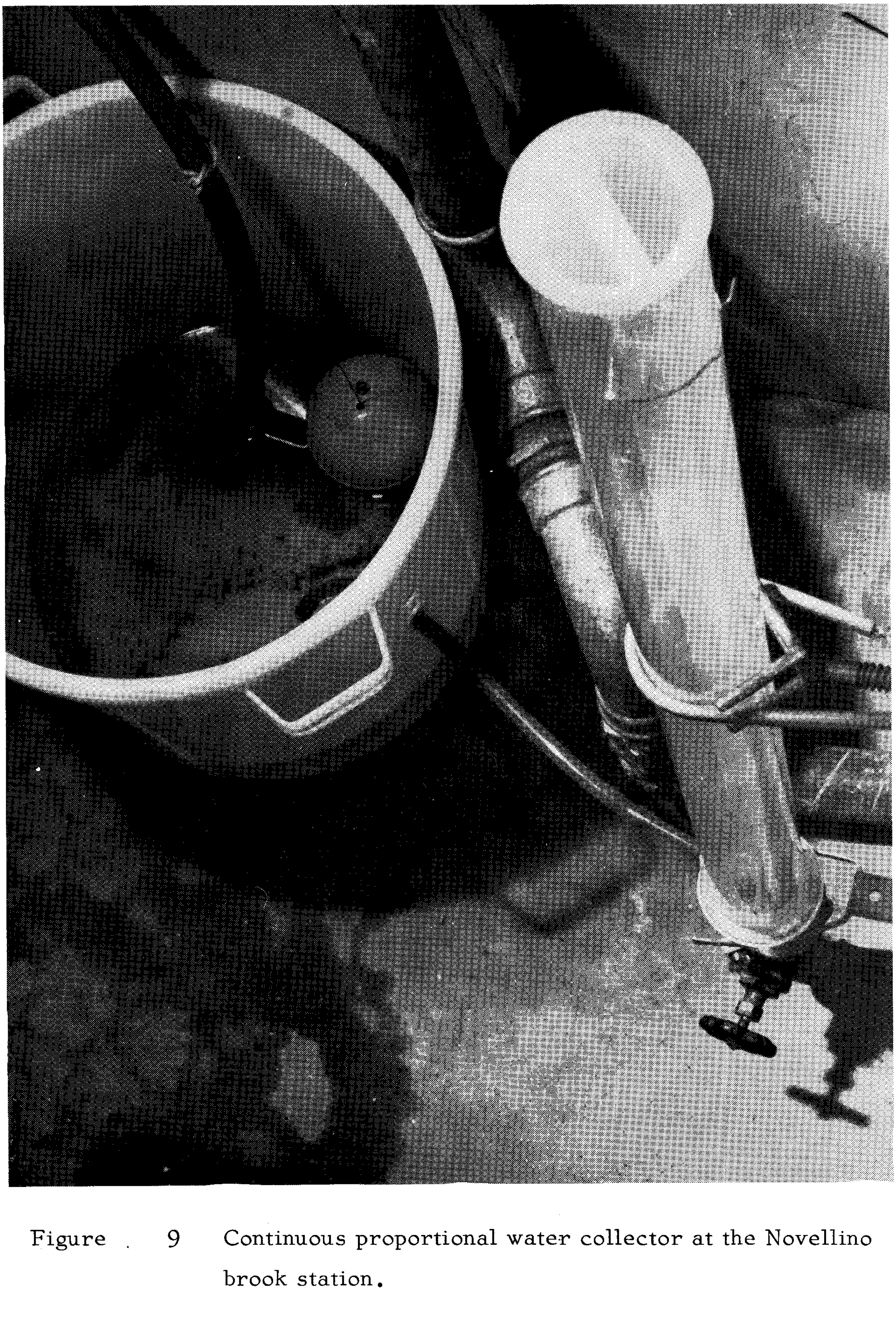

Figure . 9 Continuous proportional water collector at the Novellino brook station.

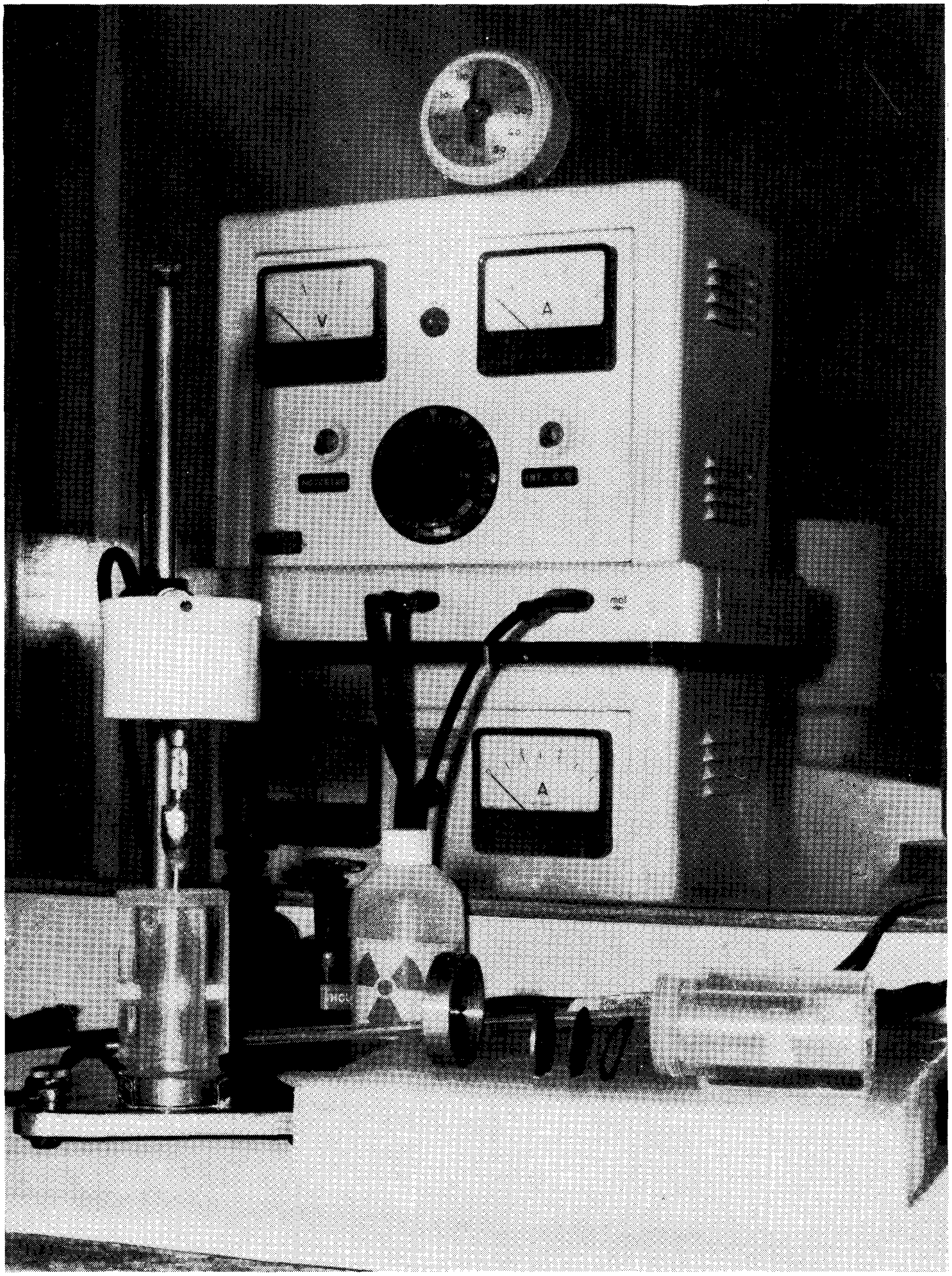

Figure 10 Electrodeposition apparatus, with details of cell, used for plutonium analyses.

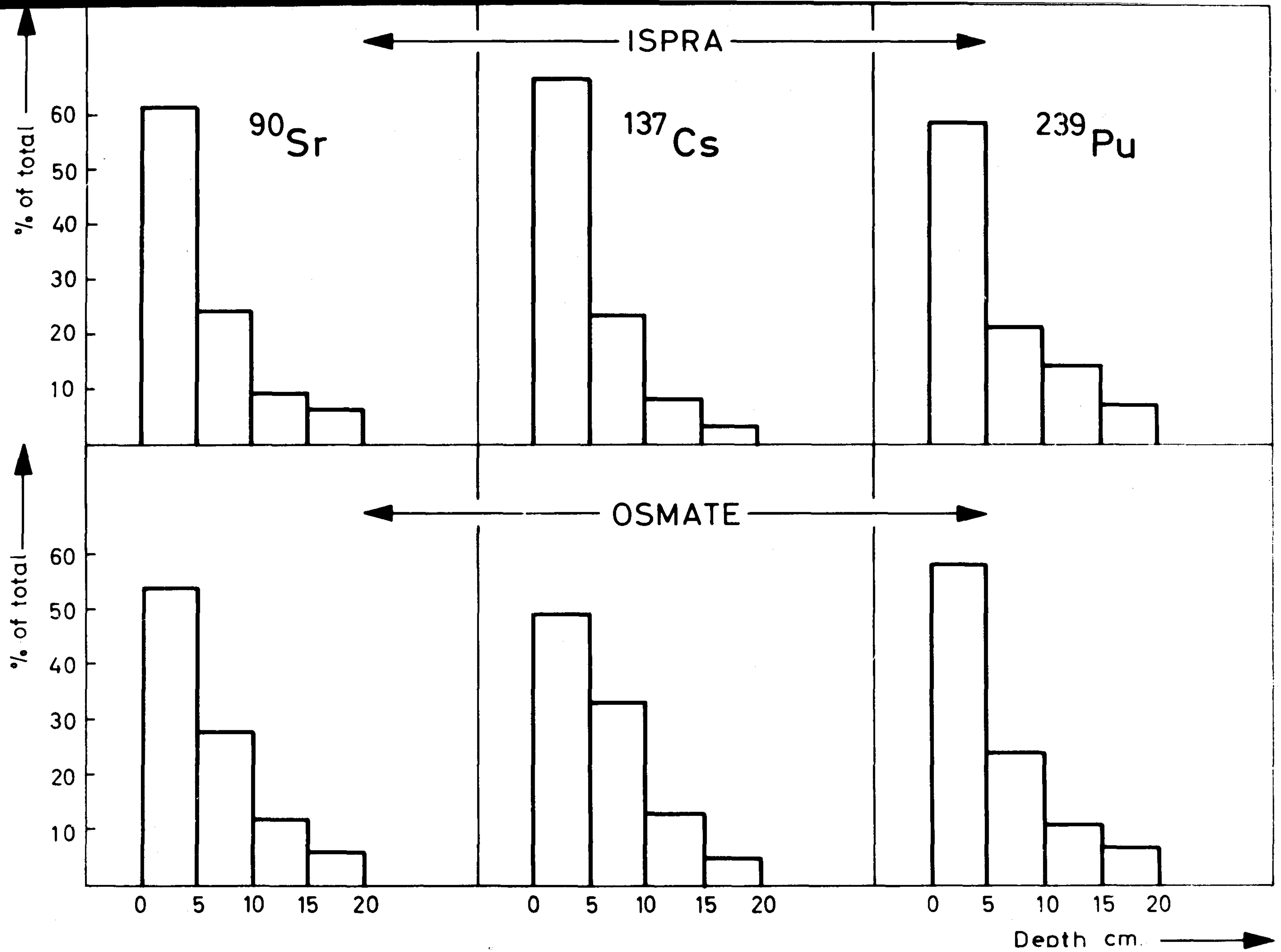

Figure 11 Vertical profile of fallout contamination in soil.

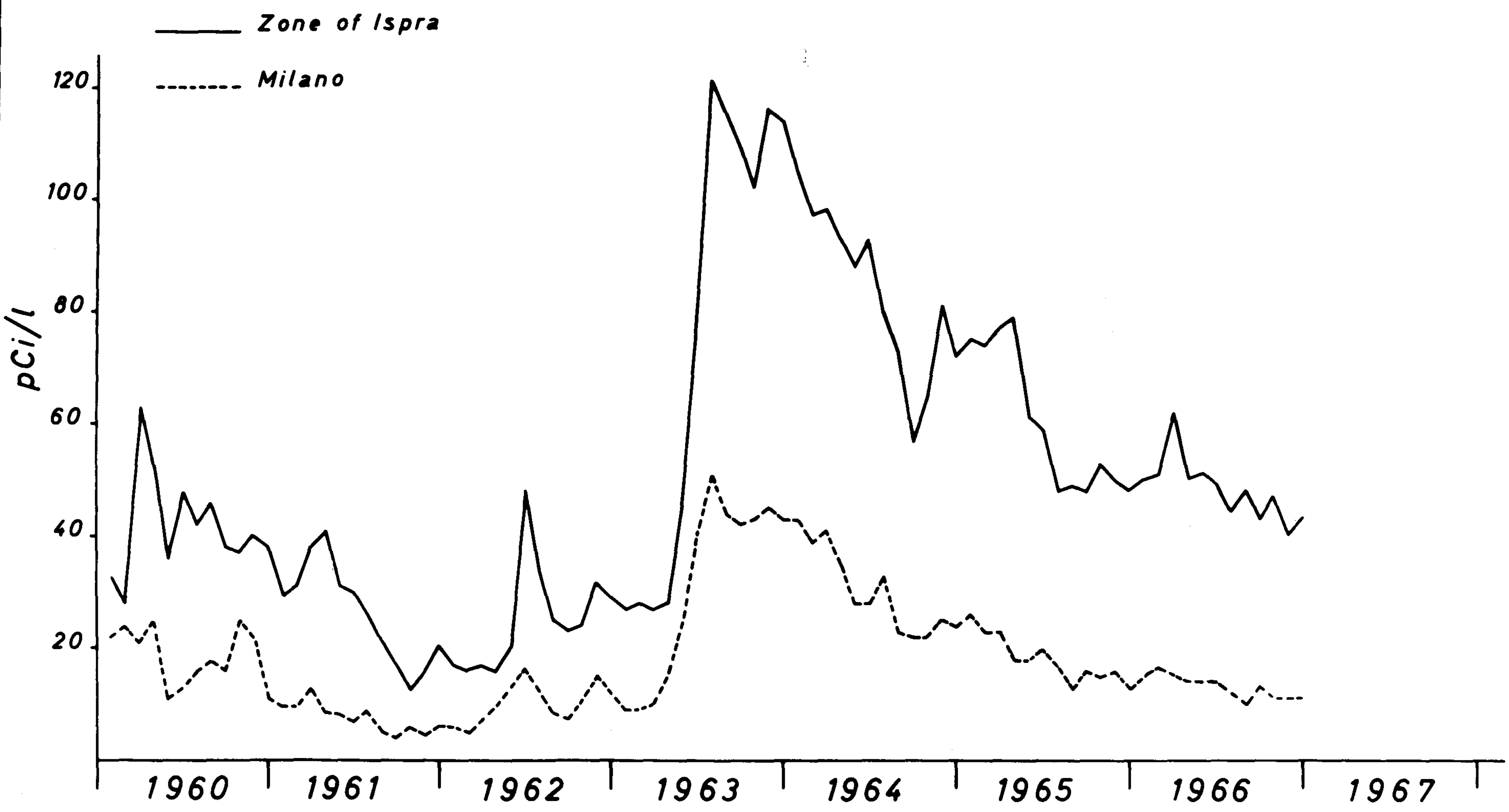

Figure 12 Monthly strontium-90 concentrations in the milk of Ispra and Milano.

● Soil sampling stati

▲ Herbage sampling sta

■ Milk sampling statio

J. N. R. C.

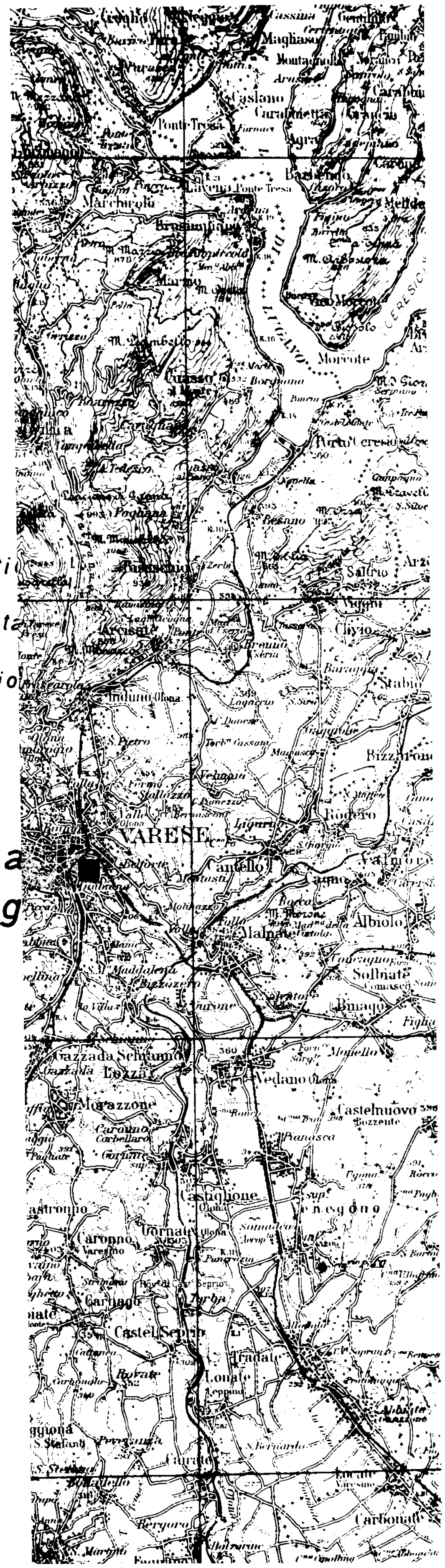

FIG. 13 - Geographica
surrounding

To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

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