health and safety laboratory

FALLOUT PROGRAM
QUARTERLY SUMMARY REPORT

July 1, 1974

UNITED STATES ATOMIC ENERGY COMMISSION
NEW YORK, N. Y. 10014

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QUARTERLY SUMMARY REPORT

(March 1, 1974 through June 1, 1974)

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ABSTRACT

The report presents current data from the HASL Program, the Swedish National Defence Research Institute, the Air Resources Laboratories of NOAA, the Geophysical Fluid Dynamics Laboratory of NOAA and the Radiological and Environmental Research Division of Argonne National Laboratory. The initial section consists of interpretive reports and notes on radioactivity from nuclear tests in air and precipitation in Sweden; strontium^{90} in diet during 1973; surface deposition in the United States; carbon^{14} measurements in the stratosphere during 1971-73; and environmental radiation measurements in the vicinity of a boiling water reactor. Subsequent sections include tabulations of radionuclide levels in fallout, surface air, stratospheric air, milk, diet, and tap water. A bibliography of recent publications related to radionuclide studies, is also presented.

Preceding reports in this series:

Year	HASL Report Nos.
1958	42, 51
1959	65
1960	77, 84, 88, 95
1961	105, 111, 113, 115
1962	117, 122, 127, 131
1963	132, 135, 138, 140
1964	142, 144, 146, 149
1965	155, 158, 161, 164
1966	165, 171, 172, 173
1967	174, 181, 182, 183
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INTRODUCTION

Every three months, the Health and Safety Laboratory issues a report summarizing current information obtained at HASL pertaining to fallout. This report, the latest in the series, contains information that became available during the period from March 1, 1974 to June 1, 1974. The next report is scheduled for publication October 1, 1974. Preceding reports in the series, starting with HASL-42, "Environmental Contamination from Weapons Tests", and continuing with HASL-284 (this report), may be purchased from the Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U. S. Department of Commerce, Springfield, Virginia 22151. A complete listing of these Fallout Program Quarterly Summary Reports is given on the abstract page of this report.

To give a more complete picture of the current fallout situation and to provide a medium for rapid publication of radionuclide and trace element data, these quarterly reports often contain information from other laboratories and programs, some of which are not part of the general AEC program. To assist in developing, as rapidly as possible, provisional interpretations of the data, special interpretive reports and notes prepared by scientists working in the field of fallout are also included from time to time. Many of these scientists are associated in some way with the general AEC program. Information developed outside HASL is identified as such and is gratefully acknowledged by the Laboratory. In this report, data from the Swedish National Defence Research Institute, Air Resources Laboratories of NOAA, Geophysical Fluid Dynamics Laboratory of NOAA, and the Radiological and Environmental Research Division of Argonne National Laboratory, are presented.

A portion of the radiochemical analyses either have been or are being carried out by commercial laboratories under contract to the HASL Environmental Studies Division. The results of these analyses are reported as part of HASL's regular fallout program. The contractor analytical laboratories which provided data are Nuclear Science and Engineering Corp., Pittsburgh, Pa.; Isotopes, Inc., Westwood, N. J.; Radiochemistry, Inc., Louisville, Ky.; LFE Environmental Analysis Labs., Richmond, Calif.; Controls for Radiation, Inc., Cambridge, Mass.; Hazleton-Nuclear Science Corp., Palo Alto, Calif. (now Teledyne Isotopes Palo Alto Labs.); Food, Chemical & Research Labs., Inc., Seattle, Wash.; Custom Nuclear Co., Mountainview, Calif.; Ledoux and Company, Teaneck, N. J.; and U. S. Testing Co., Richland, Washington.

This report is divided into four main parts:

1. Interpretive Reports and Notes
2. HASL Fallout Program Data
3. Data from Sources other than HASL
4. Recent Publications Related to Radionuclide Studies

PART I

INTERPRETIVE REPORTS AND NOTES

Försvarets Forskningsanstalt
Avdelning 4
104 50 Stockholm 80

FOA 4 rapport
C 4570-A1
Mars 1974

RADIOACTIVITY FROM NUCLEAR WEAPONS IN AIR AND PRECIPITATION IN SWEDEN FROM MID-YEAR 1968 TO MID-YEAR 1972

Brita Bernström

Antal blad 32

Summary

The concentrations of various fission products in ground level air and precipitation from mid-year 1968 to mid-year 1972 are reported. Since 1963 the cesium-137 concentration in surface air decreases each year to 1967. After a small increase 1968 the air concentration of cesium-137 remains on the same level to 1971 and decreases 1972 to the lowest level reported since the measurements started.

Short-lived barium-140 was detected in ground level air after the Chinese explosions in December 1968, November 1971, January 1972, and March 1972. After the Chinese tests in September 1969 and October 1970 the concentration of barium-140 was below the detection level.

Sammanfattning

Koncentrationerna för olika fissionsprodukter i markluft och nederbörd rapporteras för tiden 1968-07 t o m 1972-06.

Från 1963 har koncentrationen av cesium-137 i markluft minskat varje år till 1967. Efter en uppgång 1968 har halten av cesium-137 förblivit ungefär densamma till 1971, varefter halten minskade 1972 till den lägsta nivå, som uppmätts sedan mätningarna startade.

Kortlivad barium-140 förekom i markluft efter de kinesiska explosionerna som utfördes 68-12-27, 71-11-18, 72-01-07 och 72-03-18. Däremot låg koncentrationen av barium-140 i markluft efter provsprängningarna i september 1969 och oktober 1970 under den nivå som är mätbar med nuvarande rutin.

Uppdragsnr: AR88

Nyckelord: Cesium, globalnedfall, omgivningsradioaktivitet
Cesium, global fallout, environmental radioactivity

Rapporten utsänd till: UD (U Ericsson), FöD (J Prawitz), Cfs (3 ex), MVC, SMHI, FHS, MHS, SkyddS, AB Atomenergi (3 ex), Fysiska inst Uppsala, Lund, Sthlm univ och CTH, Statens strålskyddsinst (2 ex), Statens inst f folkhälsan, Radiofys inst Lund (2 ex), Radiofys inst Gbg och Umeå, Lantbrukshögskolan (2 ex), Veterinärhögskolan (2 ex), FOA 1, FOA P
FOA 4: 410, 42, 43, 46, 47, 473, 48 (20 ex), 49

CONTENTS

INTRODUCTION

In this report results of measurements of radioactivity in ground level air and precipitation from mid-year 1968 to mid-year 1972 are summarized. Results from previous years are given in reports by Lindblom (1965, 1969) and Bernström (1969).

During this period atmospheric nuclear tests were made in People's Republic of China and by France in the South Pacific (table 1). A number of underground nuclear explosions have been undertaken by USA and USSR and some of these have resulted in atmospheric releases of radioactivity (table 2).

The fresh radioactive debris sampled at the Swedish stations has almost exclusively emanated from Chinese tests. Radioactivity from underground explosions have been unequivocally observed in two cases, one being the Schooner test in Nevada (8 Dec 1968) (Persson 1971) and the other an explosion in USSR, presumably on 23rd March 1971 (Eriksen 1972). Debris from the French tests has not been observed over Sweden, but has been sampled in ground-level air on board a commercial freighter in the Pacific.

SAMPLING PROGRAM

The sampling stations are situated at Kiruna, Lycksele, Östersund, Hagfors Stockholm, Tumba, Gothenburg and Ljungbyhed (cf figure 1 and table 3). The Lycksele station was temporarily closed in 1968 and started again in 1971. The Östersund and Hagfors stations started in 1971.
At Hagfors no precipitation samples are collected.
Radioactive debris in ground level air is sampled by passing air through a glass-fibre filter by means of a centrifugal air pump. The capacity of the first samplers was 2880 m^3 (~ 3600 kg) per day. They have successively been replaced by samplers with a capacity of 11500 m^3 (~ 14400 kg) per day. The filter area is 0.4 × 0.4 m^2. The samplers are run continuously and filters are changed three times a week. At the Tumba station a high-capacity sampler with a filter area of 1 m^2 and a capacity of 72000 m^3 (~ 90000 kg) per day has been in operation since 1971.

Radioactive debris at higher altitudes (normally 8-13 km) is collected by filtering devices carried by aeroplane. The sampling is performed by the Royal Swedish Air Force. The aeroplane is equipped with six filter holders, each containing a filter (glass-fibre or polystyrene) of size 0.3 × 0.6 m^2. The sampling capacity depends on velocity and altitude and is of the order 100 kg per hour. Observations of radioactivity at high altitudes are reported elsewhere (Persson & Sisefsky, 1969, Sisefsky & Persson, 1970, Sisefsky & Persson, 1971, Persson & Sisefsky, 1971).

Radioactivity in precipitation is collected by stainless steel funnels with a diameter of 2 m. The funnels are heated during winter. The water passes through a sampling column, consisting of a cellulose filter, an anion-exchanger and a cation-exchanger. The sampling units are changed once a week. The amount of water passing the sampling column is used as a measure of precipitation during the sampling period. A description of the device is given by Lindblom (1967).

MEASUREMENTS

All surface air samples are checked three days after the end of the sampling period by means of a "gross-gamma" Na(Tl)I-counter. When the count exceeds a pre-set limit, the individual samples are analyzed by gamma-spectroscopy. All samples from the Stockholm station are, however, analyzed by gamma-spectroscopy.

All surface air samples from the same month and station are collected in a Marinelli-type container, and the pooled samples are measured with a 4" × 4" Na(Tl)I-detector. The monthly samples are measured again after six months in order to give a better estimate of the long-lived nuclides.

ANALYSIS

The analysis of the γ-spectra is performed by a computer program that makes a least squares fit of the observed spectrum to a sum of standard spectra from the relevant nuclides (Rydberg, 1968). When necessary this analysis is supplemented by data from Ge(Li)-spectroscopic determinations of e.g. the $^{95}Zr/^{95}Nb$-ratio.

RESULTS

The monthly mean concentrations and the monthly deposition of long-lived fission products are given in table 4. The values are corrected for decay to mid-month. Table 5 gives the quarterly deposition of ^{137}Cs since end of 1961.

Figures 2 and 3 summarize the ground-level air observations of ^{137}Cs since 1957.

The ^{137}Cs-concentration decreased from 1964 to 1967, thereafter it remained on a slightly higher level to 1971. In 1972 the ^{137}Cs-concentration has dropped to the lowest level observed. Fig 4 shows the variation of the ratios of $^{106}Ru/^{137}Cs$, $^{125}Sb/^{137}Cs$ and $^{144}Ce/^{137}Cs$ in ground level air. Fig 5 shows the same ratios obtained in precipitation. The data of the two measurements show a fair agreement.

Figure 6 shows the ratio of $^{95}Zr/^{137}Cs$ in air and precipitation. The figure shows that each China test caused an increase of the ratio. The exponential decay that follows after the increase is more regular after the megaton tests.

Short-lived activities have been observed in surface air in Sweden during some periods. Table 6 gives the measurements at Stockholm and in figures 7-8 the concentration of ^{140}Ba is plotted.

After the Chinese tests of megaton yield in September 1969 and October 1970 no measurable quantities of ^{140}Ba were observed in surface air or precipitation.

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Table 1. Tests in the atmosphere

Date	Country	Site	Height	Yield	Reference
680707	France	Mururoa	Atm	Middle	Le Monde July 9, 1968
680715	"	"	"	"	"- July 17, 1968
680803	"	"	"	"	"- Aug 6, 1968
680824	"	Fangataufa	500 m	~ 1 Mt	"- Aug 29, 1968
680908	"	Mururoa	600 m	~ 2 Mt	
681227	China	Lop Nor		~ 3 Mt	AEC Release L-294 Dec 27, 1968
690929	"	"-		~ 3 Mt	AEC Release M-229 Sep 29, 1969
700515	France	Mururoa		Low	Le Monde Mai 16, 1970
700522	"	"		"	(A series of 8 explosions)
700530	"	Fangataufa		High?	
700624	"	Mururoa		Low	
700703	"	"		> 1 Mt	
700727	"	"		Low	
700802	"	Fangataufa		"	
700806	"	Mururoa		"	
701014	China	Lop Nor		3 Mt	AEC Release N-184 Oct 14, 1970
710605	France	Mururoa		15 kt?	
710613	"	"		~ 500 kt	
710704	"	"		Low	
710808	"	"		"	
710814	"	"		Intermediate	
711118	China	Lop Nor		20 kt	
720107	"	"		"	
720318	"	"		20-200 kt	
720626	France	Mururoa		Very low	

Table 2. Recorded atmospherie releases from underground tests

Date	Country	Testname	Yield	References
680118	USA	Hupmobile		USAEC Report WASH-1183 (June 1971)
680126	"	Cabriolet	2.5 kt	Rad. Health Data and Reports 9 (1968) 142
681107	USSR			Mamuro T et al., Ann Rep Rad Cent Osaka 9 (1968) 9
681208	USA	Schooner	35 kt	Rad. Health Data and Reports 10 (1969) 45
691029	"	Pod		USAEC Report WASH-1183 (June 1971)
700421	"	Snubber		"
700505	"	Mint Leaf		"
701218	"	Baneberry		"
710323	USSR			Eriksen 1972, Kolb W, Nature 232 (1971) 552

Table 3. Sampling stations

Station	Latitude	Longitude
Kiruna	67°51' N	20°16' E
Lycksele	64°36' N	18°40' E
Östersund	63°11' N	14°39' E
Hagfors	60°02' N	13°42' E
Stockholm	59°20' N	18°3' E
Tumba	59°12' N	17°49' E
Göteborg	57°43' N	11°58' E
Ljungbyhed	56°4' N	13°12' E

Table 4. Activity concentration at Kiruna

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
6807				2.5		39	211	161
08				1.8		30	79	110
09	1.5	5.6	0.8	1.8	10.2	27	52	65
10	0.6	2.7	0.4	0.7	5.1	43	19	27
11	0.5	1.9	0.4	0.6	3.8	11	6	12
12	0.2	2.4	0.4	0.7	4.5	30	14	11
6901	1.2	2.4	0.4	0.9	4.9	7	6	4
02	2.3	3.2	0.6	1.2	6.5	7	15	6
03	3.8	3.8	0.6	1.5	7.2	13	22	1
04	7.5	4.4	0.7	1.6	9.1	22	82	20
05	16.3	7.9	1.2	2.5	16.3	39	116	23
06	28.5	12.3	1.3	2.7	26.1	14	347	47
07	31.8	14.7	1.5	3.0	32.0	51	1026	156
08	37.3	20.4	2.1	4.3	46.5	42	628	101
09	9.5	6.7	0.6	1.5	14.9	35	198	32
10	3.8	3.1	0.4	0.6	7.0	19	81	11
11	2.5	2.6	0.3	0.5	5.2	20	71	11
12	2.7	2.9	0.4	0.7	6.8	18	10	< 1
7001	2.7	2.6	0.4	0.8	14.9	16	11	< 1
02	4.5	3.7	0.5	1.0	16.8	19	29	6
03	7.4	5.?	0.6	1.3	17.7	23	114	16
04	16.8	10.6	1.5	2.6	78.8	26	256	45
05	27.9	17.5	2.6	3.9	149.8	24	457	82
06	36.9	26.3	3.4	5.6	140.1	25	765	188
07	23.8	20.8	2.9	4.7	82.5	87	1019	279
08	16.6	19.0	2.8	4.2	58.2	25	439	148
09	1.6	2.4	0.5	0.6	6.1	57	249	101
10	0.5	0.9	0.2	0.2	8.1	46	83	33
11	1.0	1.2	0.3	0.2	8.9	14	12	≤ 4
12	2.0	3.3	0.6	0.9	22.8	11	16	4

Table 4. Activity concentration at Kiruna (cont)

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Cs	mm	^{95}Zr	^{137}Cs
7101	1.7	2.5	0.4	0.7	5.6	8	42	13
02	4.1	4.1	0.6	1.2	9.5	15	88	11
03	8.6	6.0	0.9	1.6	12.6	7	32	< 1
04	21.4	9.9	1.6	2.4	24.5	42	469	68
05	23.4	12.4	1.8	2.5	28.5	9	152	29
06	45.4	28.2	4.2	5.8	66.9	24	1500	264
07	22.7	17.6	2.5	3.9	41.2	45	467	147
08	10.8	10.5	1.6	2.4	25.8	67	609	184
09	3.0	3.9	0.5	0.9	8.4	15	85	26
10	0.7	1.4	0.2	0.3	3.1	32	27	7
11	0.8	2.1	0.3	0.5	4.1	24	≤ 7	< 1
12	0.5	1.5	0.2	0.4	3.2	29	12	6
7201	2.1	3.2	0.3	0.7	6.0	3	33	< 1
02	1.3	3.2	0.2	0.8	5.8	2	3	< 1
03	0.6	2.3	0.4	0.8	4.9	10	30	≤ 3
04	3.5	1.3	0.2	0.4	3.4	20	280	6
05	8.6	2.7	0.4	1.0	7.2	30	521	21
06	11.9	4.1	0.6	1.1	9.7	39	649	78

Table 4. Activity concentration at Lycksele

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
7101	1.8	2.3	0.4	0.7	5.7		*	*
02	4.0	4.3	0.7	1.2	9.5	22	81	21
03	8.8	5.7	0.8	1.5	12.5	21	94	15
04	28.6	13.0	2.0	3.0	32.0	19	312	54
05	34.4	17.7	2.6	3.7	43.4	14	1135	136
06	42.6	25.7	3.7	5.6	63.7	45	2121	534
07	31.6	23.5	3.3	5.1	55.7	39	710	229
08	15.4	15.1	2.3	3.5	37.0	46	376	199
09	4.2	5.2	0.9	1.3	12.1	28	80	29
10	1.3	2.3	0.3	0.5	4.8	11	53	36
11	1.0	1.9	0.2	0.5	3.9	32	24	7
12	0.5	1.4	0.2	0.4	3.2	25	24	4
7201	1.3	2.6	0.3	0.7	5.8	4	5	< 1
02	1.5	3.0	0.3	0.8	5.8	18	11	< 1
03	0.7	3.0	0.4	1.0	5.8	9	26	< 1
04	2.4	1.2	0.2	0.5	2.8	17	273	≤ 3
05	9.1	2.5	0.4	1.1	7.3	76	713	71
06	13.0	4.6	0.6	1.3	11.2	24	325	39

* No sample

Table 4. Activity concentration at Östersund

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
7102	4.4	4.3	0.6	1.3	9.4	19	44	18
03	9.3	6.2	0.8	1.6	12.8	7	51	8
04	26.5	12.4	1.8	2.8	29.5	14	72	20
05	34.2	17.4	2.2	3.6	41.4	24	701	97
06	42.0	26.2	3.7	5.4	61.9	72	1277	267
07	28.9	22.7	3.4	4.8	53.5	44	796	195
08	18.6	18.0	2.8	4.0	43.1	52	516	152
09	4.4	5.7	0.8	1.4	13.6	26	194	75
10	1.5	2.7	0.3	0.6	5.8	27	24	< 1
11	0.8	2.0	0.3	0.4	4.1	18	42	20
12	0.6	1.8	0.2	0.5	3.6	7	19	9
7201	0.7	3.1	0.4	0.8	6.4	1	3	< 1
02	1.6	4.1	0.4	1.0	7.6	8	19	5
03	0.8	4.0	0.6	1.5	8.0	3	4	< 1
04	4.7	2.0	0.3	0.8	5.3	13	184	3
05	11.4	3.6	0.7	1.3	9.3	30	310	26
06	15.1	5.3	0.7	1.5	12.4	64	442	43

Table 4. Activity concentration at Hagfors

Date	Ground level air: fCi/kg				
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce
7109	3.4	4.3	0.7	1.1	10.1
10	0.8	1.5	0.2	0.3	2.8
11	0.2	0.7	0.1	0.1	1.2
12	0.2	0.7	< 0.03	0.2	1.4
7201	0.7	1.0	< 0.06	0.3	1.6
02	0.6	1.4	0.1	0.4	2.9
03	0.8	3.6	0.5	1.2	7.5
04	5.2	2.3	0.5	0.8	5.5
05	12.3	3.6	0.6	1.2	9.4
06	13.3	4.0	0.6	1.2	10.2

Table 4. Activity concentration at Stockholm (* Tumba)

Date	Ground level air: fCi/kg					Precipitation*: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
6807	8.4	17.7	2.3	4.6	38.5	65	499	441
08	3.3	10.2	1.3	2.7	20.4	41	111	156
09	1.6	5.8	0.7	1.6	11.2	35	85	116
10	0.4	1.9	0.2	0.6	3.7	104	90	142
11	1.0	2.8	0.5	0.9	5.7	30	43	56
12	0.4	1.9	0.3	0.7	4.0	25	26	≤ 2
6901	2.2	3.9	0.7	1.5	8.1	29	122	51
02	3.0	4.1	0.8	1.6	8.3	47	72	55
03	3.8	3.7	0.6	1.5	7.4	11	41	11
04	6.4	3.8	0.6	1.4	7.8	46	367	67
05	19.0	8.4	1.2	2.6	17.1	25	371	77
06	44.7	19.0	2.0	4.2	39.5	14	322	41
07	31.9	14.4	1.5	3.1	32.4	12	226	52
08	44.0	24.7	2.6	5.4	55.7	93	541	124
09	11.4	8.2	0.8	1.7	18.4	56	604	145
10	5.3	4.6	0.6	1.0	11.3	12	93	12
11	2.7	2.5	0.4	0.6	5.7	88	226	76
12	3.0	3.6	0.5	0.8	7.6	17	130	24
7001	2.8	3.3	0.5	0.9	7.8	27	154	38
02	3.3	2.8	0.4	0.8	6.4	5	30	2
03	7.3	4.8	0.6	1.3	10.9	53	34	72
04	9.3	5.3	0.8	1.4	12.6	42	674	118
05	31.5	19.7	2.8	4.4	46.4	5	200	29
06	47.8	34.2	4.6	7.6	81.2	33	1227	253
07	20.6	18.4	2.6	4.1	42.8	42	1433	408
08	15.2	17.4	2.6	3.9	39.8	7	201	48
09	5.6	8.1	1.2	2.0	18.4	55	237	125
10	2.4	4.2	0.6	1.0	9.2	44	80	37
11	1.3	2.2	0.4	0.6	5.0	83	245	112
12	1.5	2.2	0.3	0.7	4.9	17	35	20

Table 4. Activity concentration at Stockholm (* Tumba) (cont)

Date	Ground level air: fCi/kg					Precipitation*: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
7101	2.4	3.2	0.5	0.8	7.1	25	127	45
02	4.9	4.5	0.8	1.2	10.1	19	220	38
03	9.6	5.6	0.6	1.6	12.4	19	376	62
04	22.2	10.3	1.6	2.4	25.4	4	918	99
05	53.5	27.3	3.8	5.8	66.4	10	322	43
06	39.5	24.1	3.1	5.0	56.6	31	1275	263
07	36.5	27.9	4.1	5.8	66.2	64	614	168
08	16.6	16.0	2.4	3.5	38.6	57	771	272
09	3.9	5.1	0.8	1.2	11.7	23	96	44
10	1.8	3.1	0.4	0.7	6.5	30	27	20
11	1.1	2.6	0.3	0.6	5.3	41	42	30
12	0.7	2.2	0.3	0.6	4.3	20	33	8
7201	2.9	5.0	0.5	1.2	9.8	4	26	6
02	1.4	3.4	0.3	0.7	5.7	15	52	22
03	0.9	4.3	0.4	1.3	8.3	3	31	< 1
04	5.2	2.3	0.5	0.8	5.5	13	512	21
05	13.6	4.2	0.7	1.7	11.7	36	656	57
06	17.8	5.9	0.7	1.7	13.8	29	254	33

Table 4. Activity concentration at Gothenburg

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
6807				2.5		84	296	315
08				2.3		49	96	127
09				1.4		37	55	77
10				0.2		132	124	130
11				0.6		82	54	48
12				0.5			*	*
6901				0.4		48	150	96
02				0.9		26	34	15
03				1.5			*	*
04				0.9		15	814	130
05				2.5		28	1269	156
06				5.2		29	630	141
07				3.3		43	671	121
08	18.5	10.3	1.0	2.3	23.1	57	449	133
09	11.8	8.2	1.0	1.8	19.2	59	198	33
10	5.5	4.2	0.6	1.0	10.0	19	110	14
11	2.0	2.2	0.3	0.5	7.3	59	120	50
12	2.3	2.7	0.4	0.6	10.0	29	59	13
7001	2.2	2.8	0.3	0.7	13.4	34	86	14
02	2.5	2.5	0.4	0.7	11.0	38	25	27
03	5.4	3.5	0.4	0.9	12.5	54	137	25
04	10.9	6.2	0.9	1.5	52.4	58	663	119
05	26.4	15.5	2.2	3.5	103.5	25	700	179
06	36.5	25.5	3.6	5.7	135.4	108	1331	405
07	10.7	9.5	1.2	2.1	36.9	79	1162	386
08	*	*	*	*	*	[illegible]	[illegible]	128
09	5.2	7.2	1.2	1.8	20.4	80	537	256
10	2.6	4.3	0.7	1.0	41.9	70	100	50
11	2.2	3.3	0.6	0.9	20.9	86	133	74
12	1.8	2.4	0.4	0.7	15.7	38	90	33

* No sample

Table 4. Activity concentration at Gothenburg (cont)

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
7101	3.1	4.0	0.7	1.2	8.6	51	146	66
02	5.2	4.0	0.6	1.1	9.2	38	310	63
03	12.7	7.2	0.9	2.0	16.9	57	659	77
04	38.4	17.0	2.6	3.9	42.7	42	678	84
05	42.0	20.8	3.2	4.4	51.2	22	573	148
06	44.4	27.4	4.2	6.0	66.7	81	1022	242
07	35.8	27.3	4.1	5.8	66.2	64	726	163
08	12.4	11.8	1.8	2.8	27.4	142	585	290
09	2.5	3.2	0.5	0.8	7.6	79	152	86
10	1.2	2.1	0.3	0.6	4.5	63	22	≤ 3
11	0.9	1.9	0.2	0.5	3.9	87	101	80
12	0.4	1.3	0.1	0.4	2.4	44	23	24
7201	2.1	2.5	0.3	0.5	4.5	22	29	12
02	0.9	2.4	0.1	0.6	4.2	28	79	14
03	0.4	2.0	0.2	0.7	4.3	29	11	10
04	1.9	1.3	0.1	0.5	2.9	83	709	44
05	6.7	2.3	0.4	0.9	6.0	112	814	67
06	7.4	1.1	0.3	0.7	5.6	97	632	100

Table 4. Activity concentration at Ljungbyhed

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
6807						81	255	499
08	4.2	12.5	1.7	3.4	24.8	38	92	145
09	2.6	9.5	1.4	2.5	17.8	30	37	73
10	1.5	3.9	0.5	1.0	6.8	72	68	110
11	0.6	2.1	0.3	0.6	4.0	43	55	60
12	0.8	2.6	0.3	0.9	5.5	24	15	20
6901	1.4	2.2	0.4	0.8	4.7	43	96	66
02	2.7	3.1	0.5	1.2	6.4	34	50	47
03	7.2	6.7	1.1	2.6	13.3	11	44	15
04	8.4	3.8	0.7	1.7	9.7	34	332	56
05	20.9	8.3	1.0	2.4	18.2	53	990	230
06	54.9	22.2	2.4	5.1	47.7	36	1254	186
07	44.3	20.2	2.1	4.2	45.5	8	353	66
08	47.5	26.7	2.6	5.8	60.3	36	266	60
09	18.6	13.1	1.3	2.8	30.1	46	328	89
10	4.4	3.5	0.5	0.8	8.8	17	84	20
11	3.2	2.9	0.4	0.7	7.1	74	176	84
12	3.4	4.0	0.5	0.9	9.3	24	89	24
7001	2.8	3.3	0.5	0.8	17.8	11	59	21
02	3.7	3.2	0.5	1.0	16.2	28	53	17
03	8.4	5.6	0.7	1.5	19.1	54	439	105
04	14.3	7.9	1.2	1.9	69.3	52	423	87
05	39.6	23.6	3.5	5.6	169.2	75	914	294
06	56.6	40.0	5.6	9.0	209.7	6	234	50
07	22.4	19.4	2.8	4.3	77.2	73	1383	469
08	11.5	13.4	2.0	3.0	50.9	23	389	163
09	7.1	10.6	1.6	2.5	28.9	65	299	145
10	2.7	4.0	0.6	1.0	39.6	53	106	60
11	2.6	3.2	0.5	0.9	25.1	91	143	104
12	1.1	1.6	0.3	0.4	9.6	50	108	50

Table 4. Activity concentration at Ljungbyhed (cont)

Date	Ground level air: fCi/kg					Precipitation: pCi/m^2		
	^{95}Zr	^{106}Ru	^{125}Sb	^{137}Cs	^{144}Ce	mm	^{95}Zr	^{137}Cs
7101	0.2	2.9	0.5	0.8	6.3	47	138	60
02	0.5	3.0	0.5	0.9	7.1	24	307	79
03	1.4	6.5	0.9	1.6	15.4	37	863	112
04	26.3	12.0	1.8	2.5	28.5	29	596	86
05	43.0	22.2	3.0	4.6	53.2	27	997	216
06	42.3	26.2	3.8	5.7	33.4	62	1339	385
07	32.8	25.1	3.8	5.1	61.6	64	831	242
08	16.6	16.5	2.5	3.7	38.5	69	639	230
09	5.0	6.3	1.0	1.6	15.1	29	220	89
10	2.3	4.1	0.5	1.1	9.0	42	79	57
11	1.1	2.4	0.4	0.8	5.8	91	76	74
12	0.9	2.3	0.3	0.6	5.6	33	22	16
7201	2.5	3.8	0.4	0.8	7.6	6	27	5
02	1.2	2.9	0.3	0.7	5.5	19	52	8
03	0.8	3.6	0.5	1.2	7.7	31	18	15
04	7.8	2.9	0.4	1.0	8.0	56	828	70
05	13.1	4.5	0.8	1.5	10.8	35	436	55
06	12.4	4.1	0.5	1.2	11.1	53	530	90

Table 5. Quarterly deposition of ^{137}Cs in mCi/km^2

		Kiruna	Lycksele	Tumba	Gothenburg	Ljungbyhed
1961	4	0.21	0.26	1.06	0.87	-
1962	1	0.14	0.39	1.54	1.40	-
	2	2.06	2.45	4.09	3.51	4.54
	3	2.38	3.88	4.91	4.02	4.02
	4	0.26	0.39	0.92	1.16	1.10
1963	1	0.21	0.24	0.83	1.04	0.92
	2	1.75	4.39	8.19	6.50	7.43
	3	9.88	7.50	9.95	17.65	12.68
	4	1.07	1.22	1.64	5.67	3.42
1964	1	0.39	0.59	0.52	2.02	0.80
	2	3.76	4.95	4.89	9.09	5.11
	3	6.94	3.29	5.10	5.87	4.74
	4	0.60	0.60	1.30	2.19	1.04
1965	1	0.66	0.54	0.72	0.94	0.67
	2	1.47	1.32	2.09	2.63	2.35
	3	1.70	1.54	2.26	2.02	2.62
	4	0.01	0.16	0.50	0.47	0.66
1966	1	-	0.17	0.60	1.22	0.53
	2	0.84	0.46	1.13	0.89	1.10
	3	0.74	0.93	0.47	0.50	0.90
	4	0.08	0.16	0.34	0.27	0.30
1967	1	0.07	0.14	0.23	0.31	0.49
	2	0.14	0.37	0.40	0.26	0.56
	3	0.31	0.20	0.39	0.39	0.31
	4	0.04	0.06	0.11	0.14	0.17
1968	1	0.01	0.04	0.08	0.10	0.23
	2	0.73		0.29	0.53	0.54
	3	0.34		0.71	0.51	0.72
	4	0.05		0.20	-	0.19
1969	1	0.01		0.12	-	0.13
	2	0.09		0.18	0.43	0.47
	3	0.29		0.32	0.29	0.22
	4	0.02		0.11	0.08	0.13
1970	1	0.02		0.11	0.07	0.14
	2	0.32		0.40	0.70	0.43
	3	0.53		0.58	0.77	0.78
	4	0.04		0.17	0.16	0.21

Table 5. Quarterly deposition of ^{137}Cs in mCi/km^2 (cont.)

		Kiruna	Lycksele	Östersund	Tumba	Gothenburg	Ljungbyhed
1971	1	0.02			0.14	0.21	0.25
	2	0.36	0.72		0.40	0.47	0.69
	3	0.36	0.46	0.42	0.48	0.54	0.56
	4	0.01	0.05	0.03	0.06	0.10	0.15
1972	1	< 0.01	< 0.01	< 0.01	0.03	0.04	0.03
	2	0.10	0.11	0.07	0.11	0.21	0.21

Table 6. Short-lived fission product activity in air at Stockholm

Sampling date	Ground level air: fCi/kg		
	$^{95}Zr+^{95}Nb$	^{140}Ba	^{141}Ce
690113-15	4.7	3.9	4.6
15-17	4.8	4.8	5.7
17-20	3.0	1.5	2.1
20-22	5.6	2.3	4.9
22-24	6.7	2.9	4.4
24-27	6.6	2.9	5.6
27-29	2.3	1.4	2.2
29-31	3.0	1.4	2.5
31-0203	3.6	0.8	3.2
690203-05	2.3	0.6	1.2
05-07	1.8	< 0.4	0.8
07-12	4.3	0.8	2.9
12-14	4.7	0.7	2.5
14-17	5.1	0.7	2.7
17-19	9.0	1.7	6.7
19-24	5.6	1.3	3.8
24-28	13.5	1.3	8.7
28-0303	8.4	0.5	4.3
690303-07	8.8	< 0.6	4.8
711203-06	3.2	1.3	1.7
06-08	2.2	1.6	2.0
08-10	1.6	2.4	1.6
10-13	1.5	1.0	1.6
13-15	2.0	0.3	< 0.5
15-17	2.3	< 0.2	< 0.6
17-20	3.0	< 0.2	0.7
720119-21	4.2	8.1	7.8
21-24	1.5	1.6	1.5
24-26	17.6	17.8	20.8
26-28	14.1	10.9	15.9
28-31	11.9	12.7	15.6
31-0202	9.6	13.6	15.2

Table 6. Short-lived fission product activity in air at Stockholm (cont.)

Sampling date	Ground level air: fCi/kg		
	$^{95}Zr+^{95}Nb$	^{140}Ba	^{141}Ce
720202-04	12.8	15.0	17.8
04-07	18.1	19.9	26.3
07-09	4.0	3.4	5.8
09-11	3.9	2.4	3.8
11-14	0.8	0.7	0.4
14-16	1.8	1.2	< 1.2
16-18	3.2	1.2	1.8
18-21	3.4	1.3	2.7
720331-0405	0.9	< 0.1	0.9
720405-07	1.2	< 0.5	< 0.7
07-10	0.4	< 0.2	< 0.3
10-12	2.8	0.8	2.0
12-14	3.0	< 0.5	2.4
14-17	23.2	3.8	12.4
17-19	9.3	1.8	4.5
19-21	34.0	2.1	9.7
21-24	8.6	1.4	4.1
24-26	13.8	1.8	7.8
26-28	10.8	1.2	4.8
28-0503	42.4	5.7	18.9
720503-05	36.8	4.4	16.8
05-08	15.8	2.2	8.3
08-10	26.6	2.7	9.5
10-15	32.3	2.1	12.5
15-17	42.9	2.7	15.5
17-19	26.4	1.9	10.9
19-24	23.4	2.4	11.5
24-26	28.6	1.3	11.1
26-29	17.4	1.1	6.2
29-31	24.5	1.2	8.1
31-0602	11.2	0.9	5.3
720602-05	32.7	1.2	12.0
05-07	66.6	3.1	23.5
07-09	65.8	2.3	24.2
09-12	42.3	< 0.7	15.2
12-14	33.6	1.9	15.3
14-16	25.5	< 1.1	8.8
16-19	58.4	1.5	22.1
19-21	29.2	< 1.2	13.4

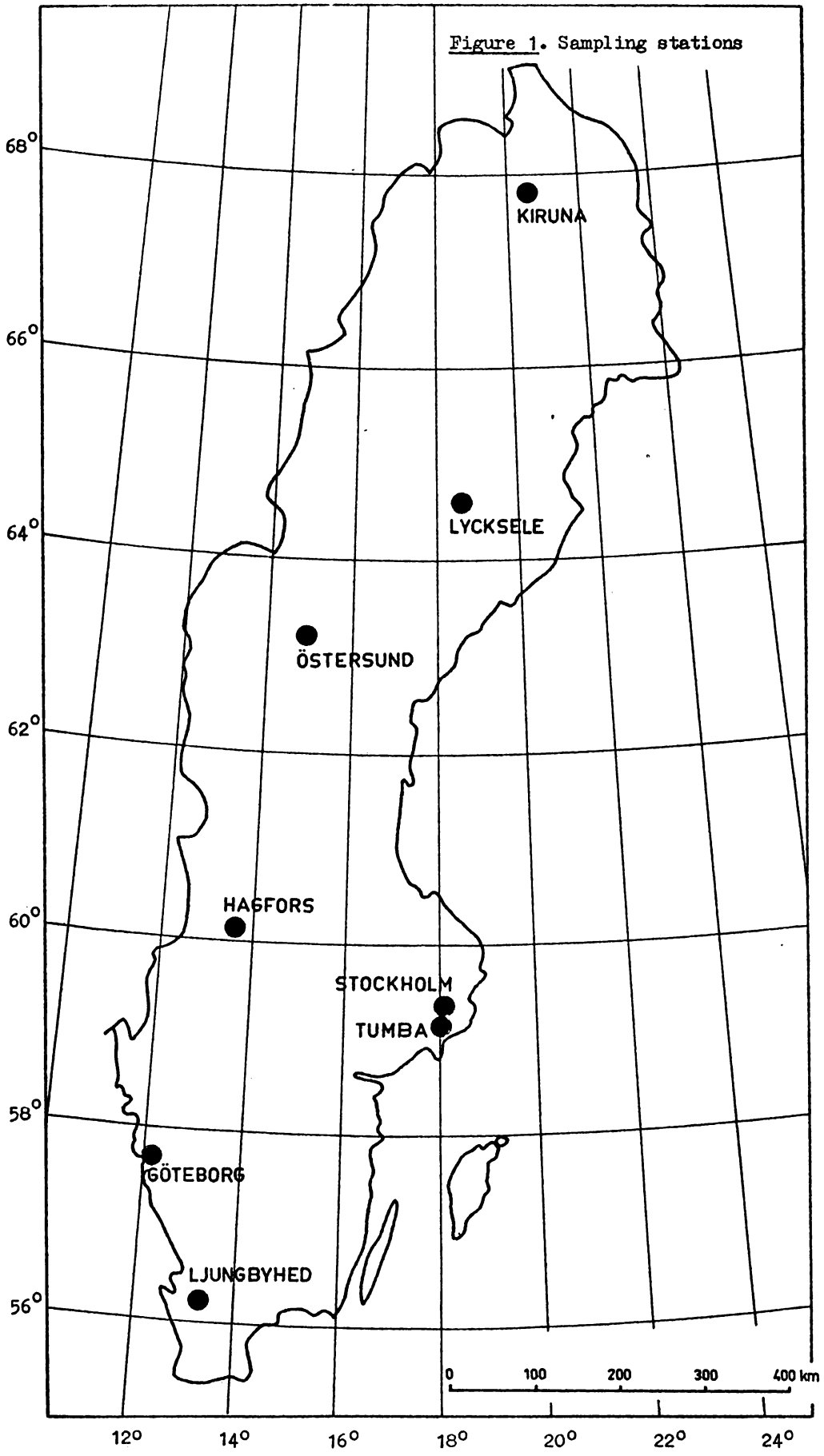


Figure 1. Sampling stations
68°
66°
64°
62°
60°
58°
56°
KIRUNA
LYCKSELE
ÖSTERSUND
HAGFORS
STOCKHOLM
TUMBA
GÖTEBORG
LJUNGBYHED
0 100 200 300 400 km
12°
14°
16°
18°
20°
22°
24°

Fig 2. ^{137}Cs in ground level air at Stockholm

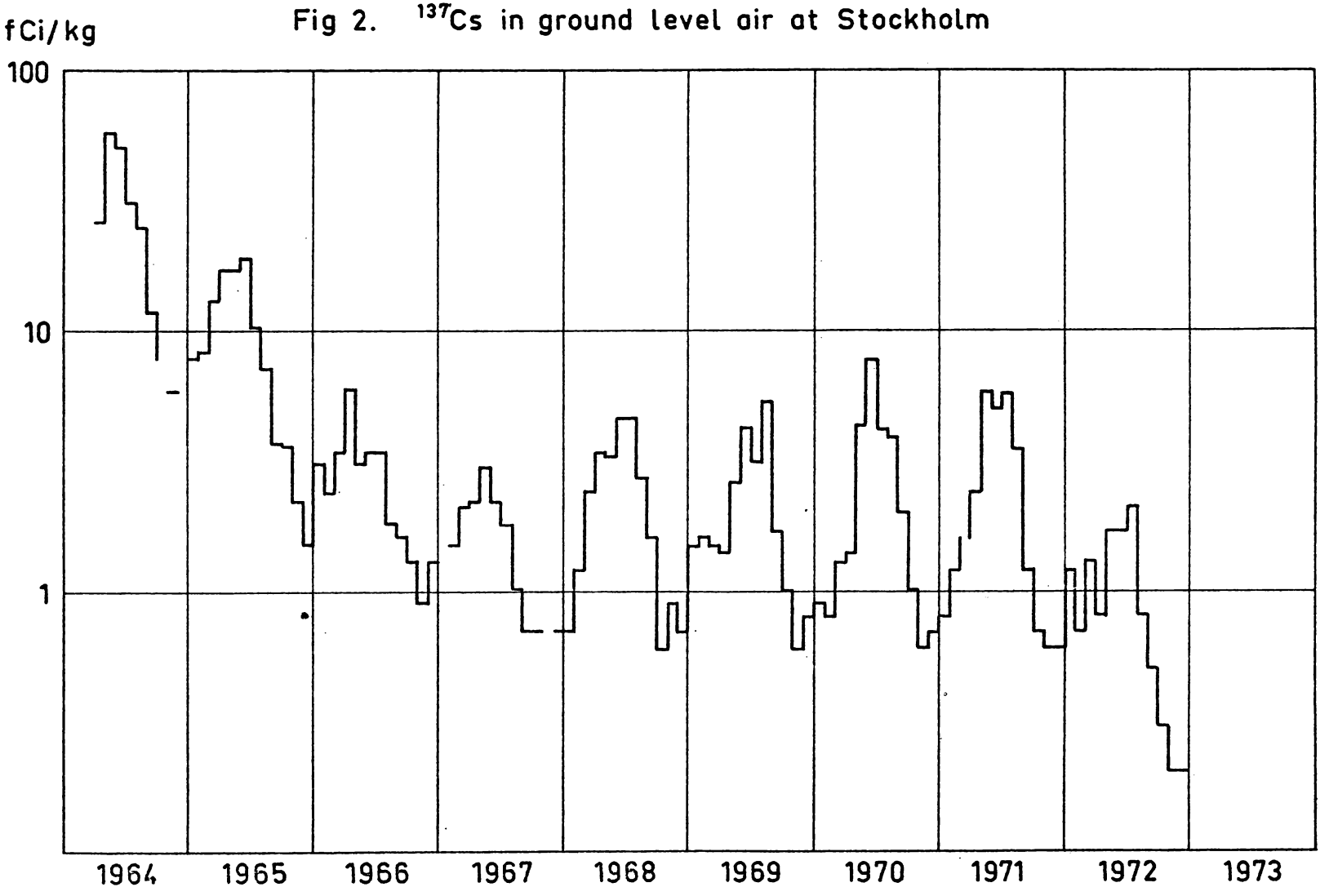


Fig 3. ^{137}Cs in ground level air at Stockholm

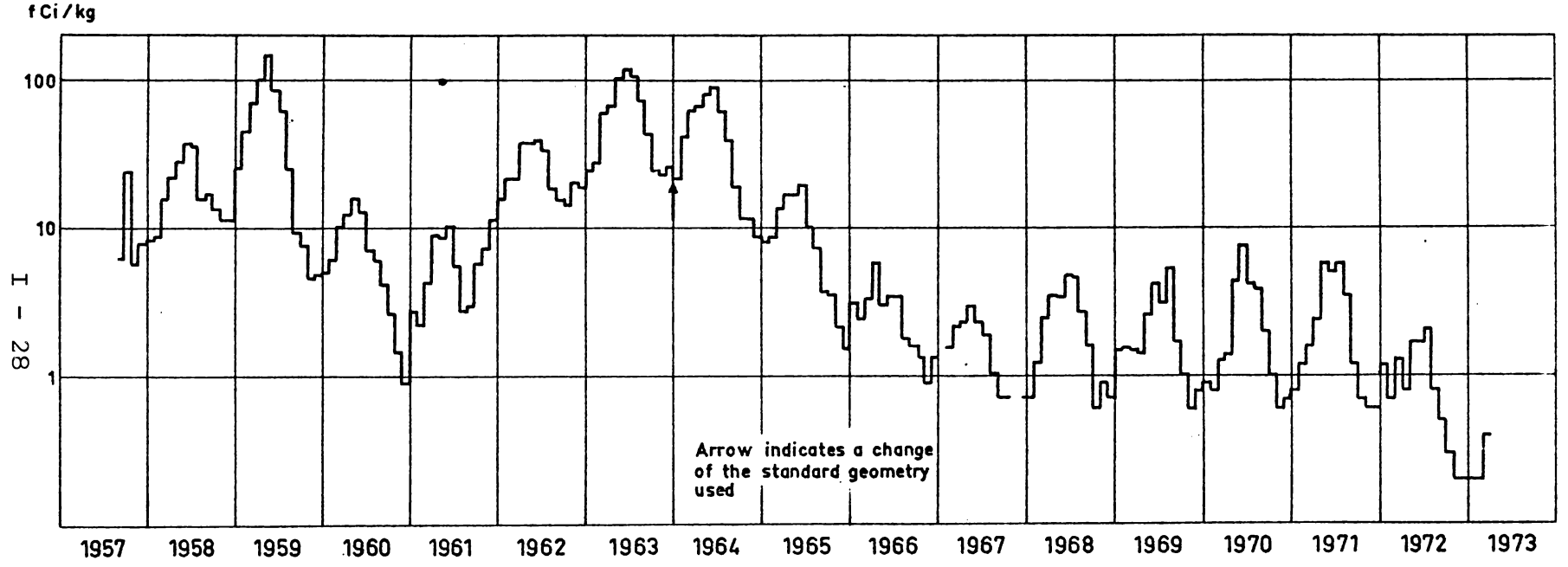


Fig 4. Fission product ratios in ground level air at Stockholm

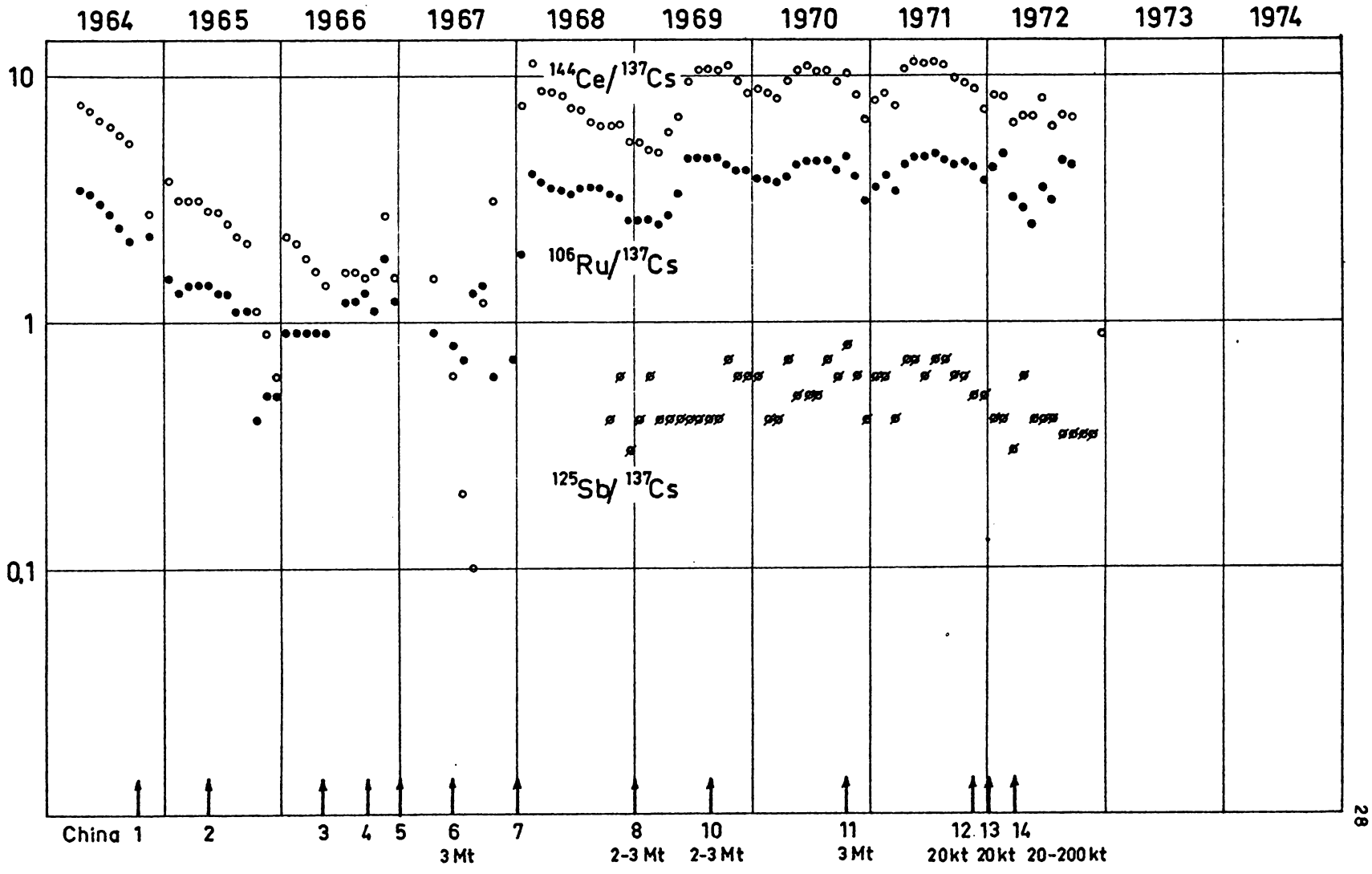


Fig 5. Fission product ratios in preciptation at Tumba

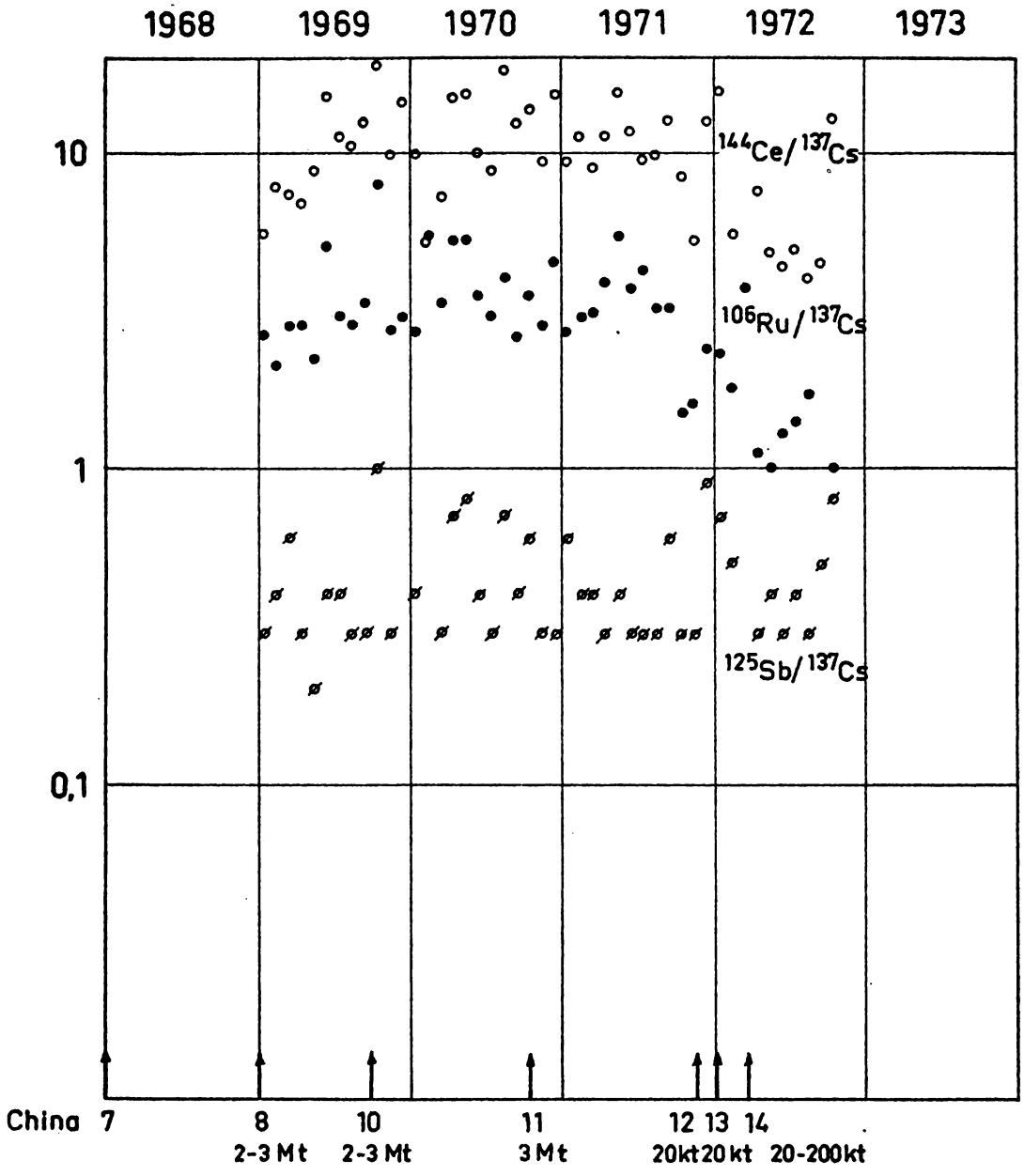


Fig 6. $^{95}Zr/^{137}Cs$ in ground level air (Stockholm, o) and precipitation (Tumba, ×)

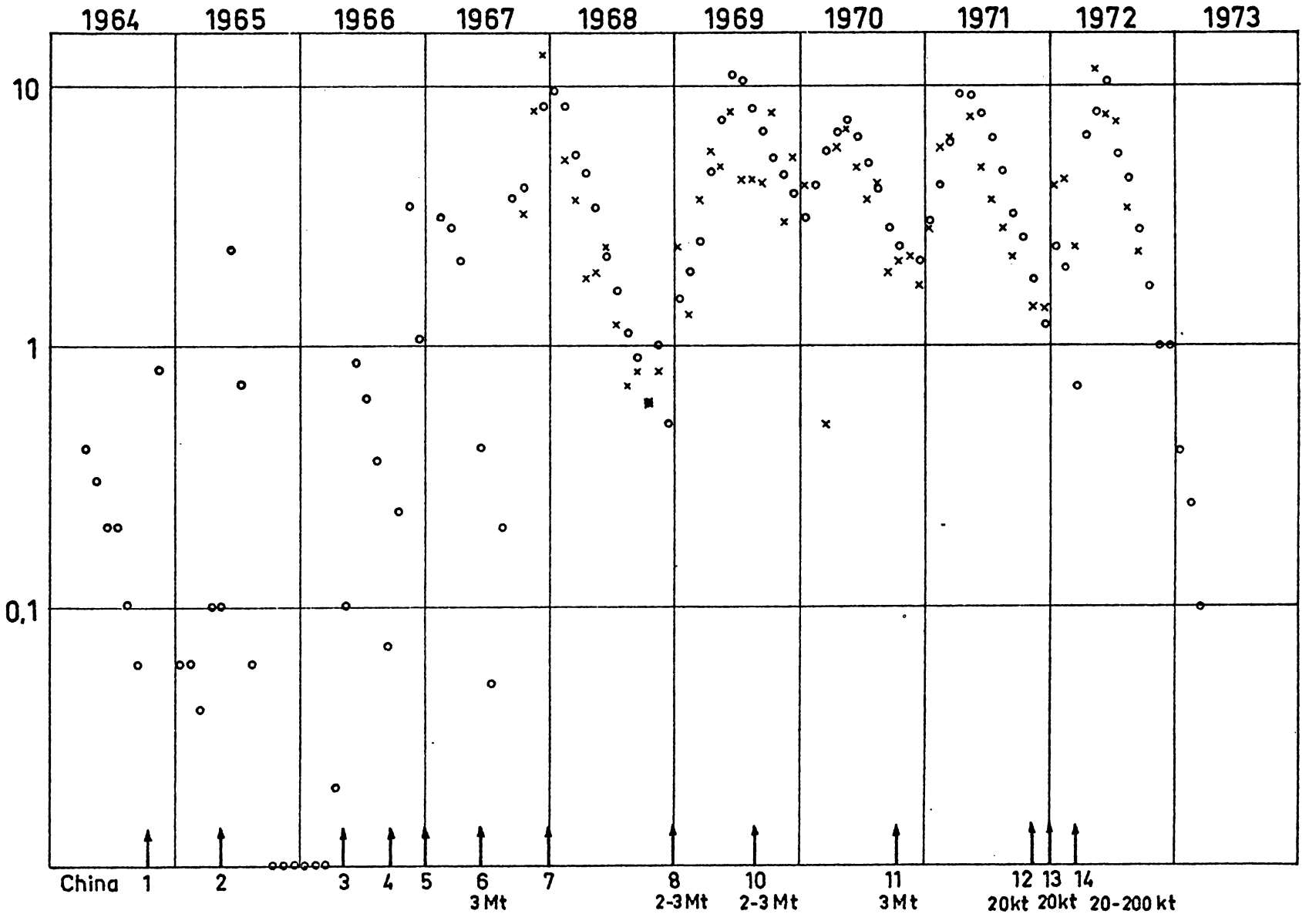


Fig 7. ^{140}Ba-concentration in fCi/kg in surface air at Stockholm

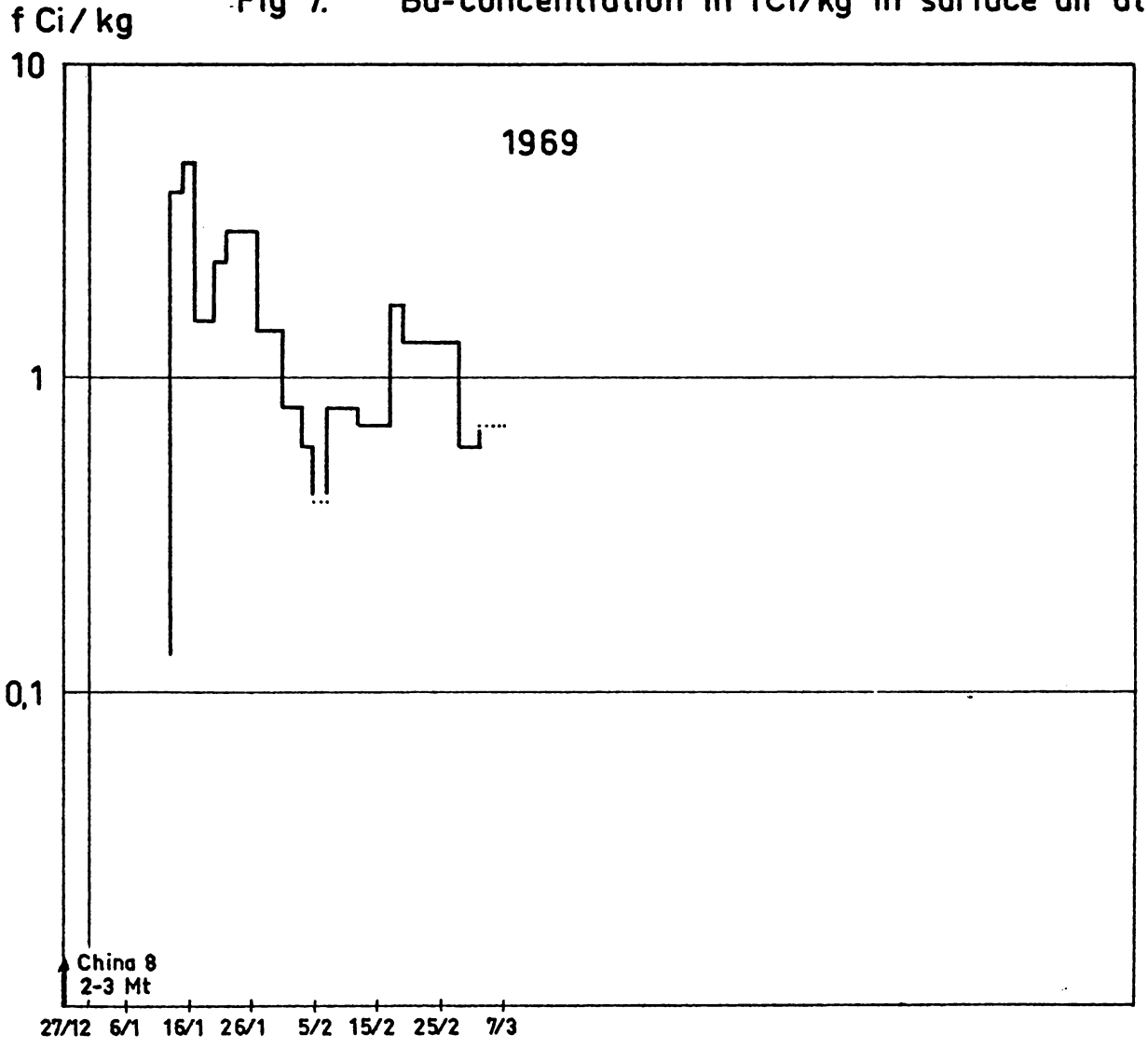
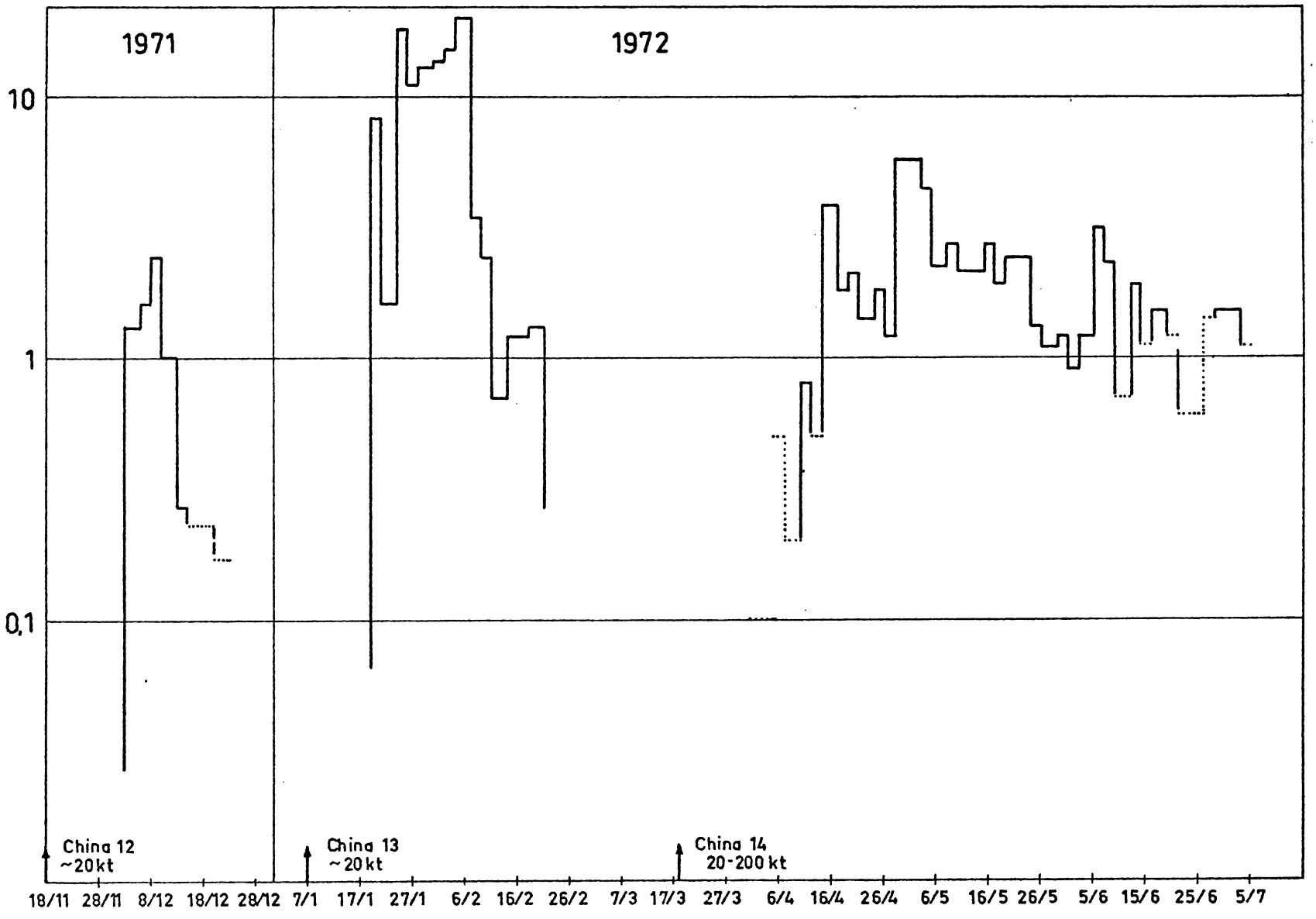


Fig 8. ^{140}Ba-concentration in fCi/kg in surface air at Stockholm



STRONTIUM-90 IN THE DIET

RESULTS THROUGH 1973

by B. G. Bennett (HASL)

ABSTRACT

Estimates of Sr-90 intake via the total diet in New York City and San Francisco have been made since 1960 from quarterly food samplings and average consumption statistics. The dietary intakes of Sr-90 have decreased from the maximum levels attained during 1963-64, but the declines have become more gradual in recent years due to the continuing small amounts of Sr-90 deposition and the little-changing cumulative deposit of Sr-90 in soil. The annual intake in 1973 averaged 9.7 pCi/day in New York and 3.2 pCi/day in San Francisco, slight decreases from the previous year. Further gradual reductions in Sr-90 intake are anticipated during 1974.

Quarterly samplings of representative food items in New York City and San Francisco have been conducted by the Health and Safety Laboratory since 1960. Results of Sr-90 analyses and estimates of average consumption of these food items yield estimates of the total dietary intakes of Sr-90 for residents of these cities.[1] This information has been used to study the transfer mechanisms of Sr-90 fallout through the food chain to man and to relate to observed variations in Sr-90 body burdens.

Results for the fourth quarter of 1973 and a figure illustrating the quarterly results for the entire sampling period are presented on pages II-4 to II-6 of this report. The average Sr-90 concentration in each diet item and estimates of Sr-90 and Ca intakes for the entire year 1973 are listed in Table 1. It is noted that the calcium intake is estimated to be 370 g per year. Thus, Sr-90 intakes expressed as pCi/day or pCi/g Ca are almost equivalent.

Results for 1973

In New York City the annual Sr-90 intake during 1973 was estimated to be 3550 pCi, an average of 9.7 pCi/day. This is a decrease of 9% from the Sr-90 intake in the previous year. These changes reflect the continuing declines in Sr-90 deposition and decay of the accumulated deposit. In New York the annual Sr-90 deposition was .42 mCi/km^2 in 1973 compared to .75 mCi/km^2 in 1972 and 1.41 mCi/km^2 in 1971. The contributions to Sr-90 intake decreased for most food items, however, variations which appear as slight increases were noted for fresh fruit, canned vegetables, dry beans, rice, meat, poultry and fish. In terms of food categories, Sr-90 intake in 1973 via dairy products declined 21% from the previous year, grain products 18% and vegetables 3%, while increasing were fruit, 8%, and meat, fish, eggs, 27%. For

Table 1

Strontium-90 in the Diet During 1973

Diet Category	kg/yr	gCa/yr	% of yearly intake of Ca	New York City			San Francisco		
				pCi Sr-90/kg	pCi Sr-90/yr	% of yearly intake of Sr-90	pCi Sr-90/kg	pCi Sr-90/yr	% of yearly intake of Sr-90
Dairy Products	200	216.0		5.5	1090		1.2	246	
			58			31			21
Fresh Vegetables	48	18.7		13.1	627		2.7	129	
Canned Vegetables	22	4.4		8.7	192		4.3	95	
Root Vegetables	10	3.8		7.1	71		3.1	31	
Potatoes	38	3.8		5.5	209		2.7	104	
Dry Beans	3	2.1		16.7	50		14.7	44	
			9			32			35
Fresh Fruit	59	9.4		11.0	649		2.3	137	
Canned Fruit	11	0.6		1.2	13		1.1	12	
Fruit Juices	28	2.5		3.0	85		1.5	43	
			3			21			16
Bakery Products	44	53.7		4.2	185		2.6	113	
Flour	34	6.5		5.5	186		2.8	96	
Whole Grain Products	11	10.3		8.5	93		5.6	62	
Macaroni	3	0.6		3.8	11		2.8	8	
Rice	3	1.1		1.7	5		1.4	4	
			20			14			24
Meat	79	12.6		0.6	46		0.2	19	
Poultry	20	6.0		0.7	14		0.4	8	
Eggs	15	8.7		1.5	22		0.8	13	
Fresh Fish	8	7.6		0.7	5		0.3	3	
Shellfish	1	1.6		1.2	1		0.6	1	
			10			2			4
Yearly Intake		370.0 g			3554 pCi			1168 pCi	
Daily Intake					9.6 pCi/gCa			3.2 pCi/gCa	
					9.7 pCi/day			3.2 pCi/day	

the first time in New York a food category other than dairy products contributed the greatest fraction of the total Sr-90 intake. Vegetables accounted for 32% while milk and other dairy products contributed 31% of the total Sr-90 intake in New York during 1973. The contribution from fruit increased slightly to 21%. Grain products contributed 14%, and the combined category of meat, fish, and eggs 2%.

In San Francisco the Sr-90 intake during 1973 was estimated to be 1170 pCi, an average of 3.2 pCi/day, compared to 3.6 pCi/day in 1972. Decreases occurred in contributions from grain products, meat, poultry, eggs, milk, fresh and root vegetables, fresh fruit, and fruit juices, while contributions from potatoes, canned vegetables and fish increased slightly. The relative contributions to the total Sr-90 intake in San Francisco during 1972 were dairy products 21%, grain products 24%, vegetables 35%, fruit 16%, and meat, fish, and eggs 4%.

Table 2 shows how the Sr-90 intake varied during each quarter in 1973 in New York and San Francisco. The numbers in parentheses are the results for 1972.

Table 2

Sr-90 Intake in 1973 (pCi/day)

Quarter	New York	San Francisco
1	10.9 (12.0)	3.7 (4.4)
2	9.5 (11.4)	3.0 (3.5)
3	8.0 (9.8)	2.8 (2.7)
4	10.5 (9.6)	3.3 (4.0)
Yearly Avg.	9.7 (10.7)	3.2 (3.6)

Sr-90 intake declined throughout the year in all but the last quarter in New York and San Francisco.

Sr-90 Intake, 1960-1973

The estimates of annual intakes since 1960 of Sr-90 in the total diet and the major food categories in New York and San francisco are illustrated in Figure 1. The total diet Sr-90 levels in New York have been consistently higher than in San Francisco because of less fallout deposition in the San Francisco food-producing region. The declines in Sr-90 intake in 1960-61 followed the nuclear testing moratorium in 1959-60. Maximum levels of Sr-90 in the diet were recorded in 1963-64 following the period of most active nuclear testing from September 1961 until late 1962, following which the Test Ban

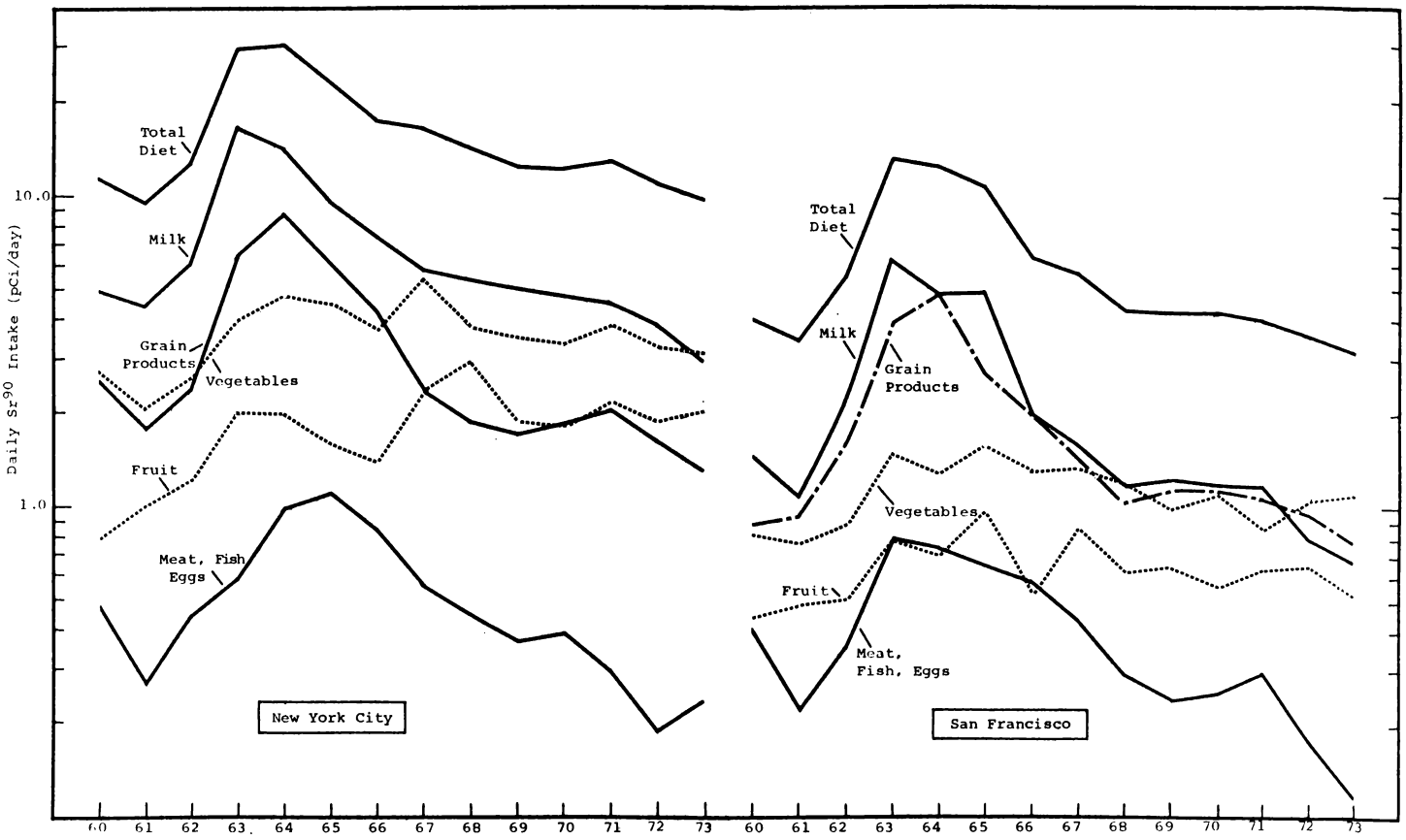


Figure 1. Strontium-90 intake in New York City and San Francisco.

Treaty was signed. The rapid declines in Sr-90 intake following the peak values in 1963-64 became more gradual after 1966-67 as uptake from the little changing cumulative deposit of Sr-90 in soil became the dominant factor contributing to Sr-90 levels in food. The resumption of atmospheric testing by the French and Chinese in 1966, resulting in a relatively constant low fallout rate of Sr-90, has also been a factor in maintaining the dietary intakes of Sr-90 at about constant levels since 1968. The

decreased deposition during 1972 and 1973 is reflected by the slightly lower dietary intakes of Sr-90.

The relative importance of the major food categories to the total Sr-90 intake can be seen in Figure 1. Milk, including other dairy products, has been the most important contributor to Sr-90 intake. Grain products are the second greatest contributors during periods of heavy deposition, but vegetables and, to a lesser extent, fruit become more important in later years. Meat, fish, and eggs are minor contributors.

The variations in the relative contributions of the major food categories to the total Sr-90 intake are listed in Table 3. The contribution from dairy products to the total intake in New York has declined to 31%, it previously being around 40% and even more during periods of heavier deposition. Grain products contribute from 30% in periods of heavy deposition to 15% in later years. For vegetables the range is similar to grain products, but the greatest relative contribution occurred in more recent years, due in part to more rapid declines in the other food categories. In San Francisco, the milk contribution has dropped to 21% of the total yearly Sr-90 intake, increased contribution having occurred during periods of heavier deposition. Grain products have usually accounted for 20 to 30% with a maximum

Table 3

Contributions of Major Food Categories to Average Daily Sr^{90} Intake

	% Contribution					Daily Intake pCi Sr^{90}/day
	Dairy Products	Grain Products	Vegetables	Fruit	Meat Fish, Eggs	
New York City						
1960	43	22	24	7	4	11.3
61	47	19	22	11	3	9.6
62	48	19	20	10	4	12.7
1963	56	22	13	7	2	29.6
64	46	28	16	7	3	30.3
65	42	27	20	7	5	22.9
1966	42	24	21	8	5	17.5
67	35	14	33	14	3	16.4
68	37	13	26	20	3	14.3
1969	40	14	28	15	3	12.4
70	39	15	27	15	3	12.1
71	35	16	30	17	2	12.8
1972	35	15	30	18	2	10.7
73	31	14	32	21	2	9.7
San Francisco						
1960	36	22	21	11	10	4.0
61	31	27	22	14	6	3.5
62	40	29	16	9	6	5.5
1963	47	30	11	6	6	13.3
64	39	39	10	6	6	12.5
65	46	25	15	9	6	10.8
1966	31	31	20	8	9	6.4
67	28	26	23	15	8	5.7
68	27	24	28	15	7	4.3
1969	29	27	23	15	6	4.2
70	28	27	26	13	6	4.2
71	29	27	21	16	7	4.0
1972	22	27	29	18	5	3.6
73	21	24	35	16	4	3.2

contribution of 39% in 1964, one year after the peak milk contribution. Vegetables have increased their contribution from 10% in 1964 to 35% during 1973. The contributions from fruit in both New York and San Francisco have behaved similarly to vegetables but by a factor of 2 less. Meat, fish and eggs have accounted for 5% or less of the total intake in New York and slightly higher relative amounts in San Francisco.

Prediction Methods

A useful model for correlating Sr-90 deposition with Sr-90 levels in milk and a procedure for using milk concentrations to predict total diet Sr-90 intake were discussed in the report HASL-246.[2] The deposition-milk model is given by the following formula

$$M_n = p_1 F_n + p_2 F_{n-1} + p_3 \sum_{m=1} F_{n-m} e^{-m\lambda}$$

M_n (pCi/g Ca) is the average Sr-90/Ca ratio in milk in the year n, and F_n (mCi/km^2) is the Sr-90 fallout deposition during the year n. The proportionality constant p_1 includes the rate and deposit effects of the current year's deposition; p_2 is the lag factor for the previous year's deposition; and $p_3 e^{-m\lambda}$ is the deposit factor with exponential removal due to reduced uptake availability of the deposition in each of the preceding years. The results of least squares fits to the average yearly Sr-90 concentrations in milk in New York through 1970, 1971, and 1972 were reported previously.[2-4] No parameter changes were required by the addition of the 1971 and 1972 data. Inclusion of the 1973 fallout and milk data (Figure 2), results in yet the identical parameter values, which are $p_1 = .69$ $p_2 = .21$ $p_3 = .20$

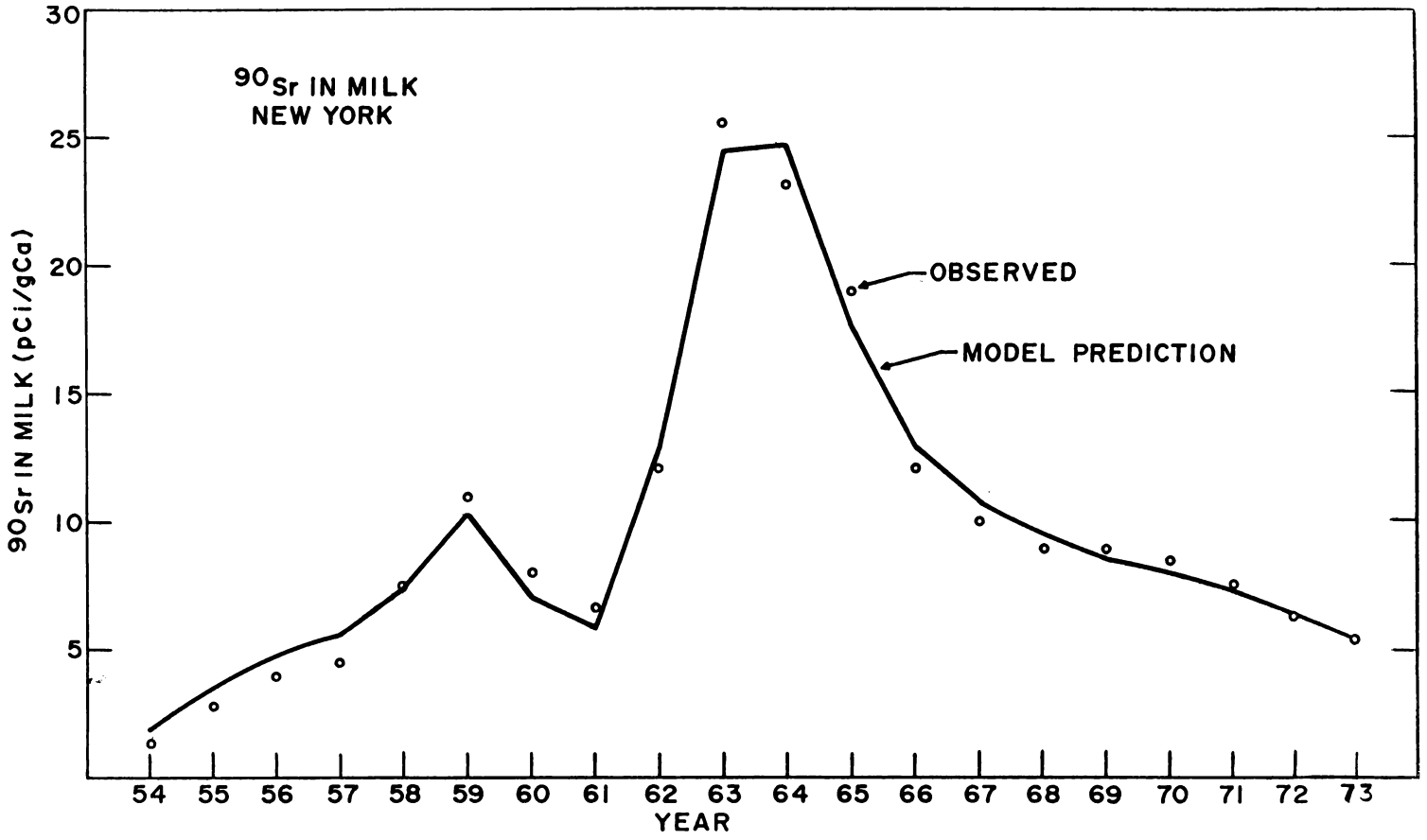


Figure 2. Average annual Sr-90 concentration in milk in New York City.

λ = .14. Such stability of the parameter values with fits to additional data reflects the appropriateness of the model formulation. The mean residence time of Sr-90 in soil inferred from the exponential removal term is 7.1 years after the initial deposition year. This corresponds to 11% per year removal of Sr-90 in addition to the 2.4% radioactive decay. A similar deposition-milk model has been used previously by Bartlett, Russell and Jenkins.[5] Their results for the U. K. are in general agreement with the results reported here.

Table 4

Sr^{90} Deposition and Contamination of Milk in New York

Year	Deposition (mCi/km^2)	Sr-90/Ca Ratio in Milk (pCi/g Ca) Observed	Sr-90/Ca Ratio in Milk (pCi/g Ca) Calculated	Percentage of Sr^{90} in milk attributable to uptake from soil
1954	2.76	1.4	1.9	0
55	3.57	2.8	3.5	13
56	4.43	3.9	4.8	21
57	4.44	4.5	5.6	29
58	6.16	7.6	7.4	30
59	8.68	11.0	10.3	29
60	1.58	8.0	7.0	58
61	2.43	6.7	5.9	66
62	12.33	12.1	12.8	29
63	23.79	25.6	24.4	22
64	15.85	23.2	24.7	36
65	5.53	19.1	17.6	59
66	2.43	12.1	12.9	78
67	1.64	10.0	10.8	85
68	1.32	9.0	9.5	87
69	1.43	9.0	8.7	85
70	1.48	8.4	8.0	84
71	1.41	7.6	7.4	83
72	0.75	6.2	6.3	87
73	0.42	5.4	5.4	92

Table 4 shows the measured annual Sr-90 deposition and the Sr-90/Ca ratio in milk in New York and the milk Sr-90/Ca ratio calculated by the above model using the given proportionality factors. Also shown is the percentage of the Sr-90/Ca ratio attributable to uptake of Sr-90 from soil. Since 1965, contamination of milk has been primarily due to uptake of Sr-90 from the cumulative deposit in soil. In 1973 this source accounted for 92% of the Sr-90 contamination of milk.

The procedure for estimating total diet Sr-90 intake from milk levels during periods of low fallout deposition is given by the following formula.[2]

$$D_i = M_i + 1.4\ M_{i-1}$$

Where D_i is the quarterly Sr-90 intake in total diet (pCi), M_i is the measured Sr-90 intake in milk during the quarter i and 1.4 M_{i-1} is the estimated intake of Sr-90 in foods other than milk based on the milk levels during the preceding quarter. The formula gives 7.9 pCi per day in total diet in New York during 1973, somewhat lower than the measured ratio.

The application of this formula to estimate total diet Sr-90 intake from milk data and comparison with the measured total diet intake are shown in Figure 3. The proportionality factor was modified slightly in the few quarters when Sr-90 deposition was greater than 3 mCi/km^2 per quarter (see ref. 2). The annual total diet Sr-90 intakes estimated from the quarterly milk data are usually within 10% of the observed values. The difference was just over 10% in 1972 and increased to 20% in 1973.

The more rapid decline of Sr-90 contamination of milk compared to other foods in recent years indicates the inappropriateness of

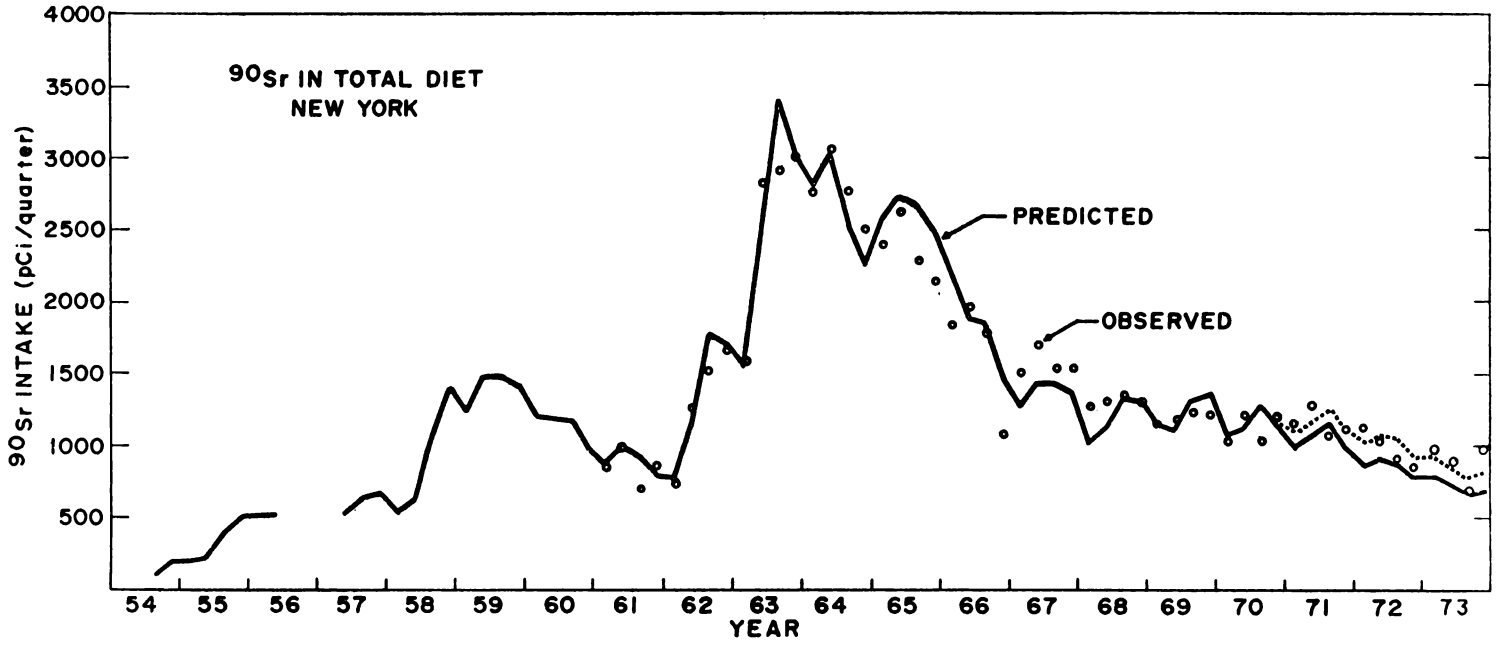


Figure 3. Quarterly intake of Sr-90 in total diet in New York City.

estimating total diet Sr-90 intake based on a constant relationship with the milk levels. A higher value for the proportionality factor is now required to more adequately reflect the measured total diet Sr-90 intake. The value should be increased to 1.6 during 1971 and 1.8 during 1972 and 1973. This modification is indicated by the dotted line in Figure 3.

Anticipated Sr-90 Intake in 1974

Atmospheric nuclear testing activity in recent years in the Northern Hemisphere has included one Chinese test of estimated total yield of 3 MT in each of 1968, 1969, and 1970. Low yield tests were conducted by the Chinese in November 1971 and in

January 1972 and an intermediate test (20-200 kT) in March 1972. There were 5 French tests of varying yields in the South Pacific in 1968, 8 in 1970, 5 in 1971 and 3 of low yield in 1972. During 1973 the Chinese conducted a large test in June, and the French conducted 5 low yield tests in the South Pacific. These recent atmospheric tests may cause Sr-90 deposition in 1974 to be maintained at about the level measured in 1973. Even so, dietary intake of Sr-90 would be expected to decrease during 1974. The large contribution to diet attributed to uptake from the relatively constant cumulative deposit of Sr-90 in soil, however, precludes large decreases in Sr-90 intake from one year to the next. Based on variations in recent years and assuming no increase in atmospheric testing programs, one would qualitatively estimate Sr-90 intakes in 1974 to be 9.0 ± .4 pCi/day in New York and 3.0 ± .2 pCi/day in San Francisco.

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Surface Deposition in the United States

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Abstract

Comparison is made of the surface deposition patterns over the United States as depicted by observations of Strontium 90 in soil, tritium rainout and Strontium 90 in pot and ion-exchange collectors versus the results generated by the general circulation tracer model from the Geophysical Fluid Dynamics Laboratory. It is found that the three observed data sets exhibit certain common characteristics:

1. A general maximum in the Great Plains states.
2. A general minimum in the Southwest.
3. A relatively high value, if not an absolute maximum, in the Salt Lake City area.

The results of the general circulation tracer model calculations present a reasonable "first depiction" of the details of surface deposition and are very encouraging as an indicator of the transport of such conservative trace substances.

I. Introduction

During the proceedings of the second conference on radioactive fallout from nuclear weapons tests, List et al. (1965) presented the results of a worldwide soil-sampling program conducted in late 1963 and early 1964. In particular, they presented a diagram (reproduced in Fig. 1) of Strontium 90 in soil in the contiguous United States and southern Canada. In the overall sense, the pattern of deposition is mainly influenced by precipitation--with the lowest ^{90}Sr fallout appearing in the dry southwestern states. However, there are two obvious exceptions to the above. One is the maximum in the vicinity of the Great Salt Lake, the other is the much larger area of high ^{90}Sr deposition in the central and northern Great Plains states. With respect to the former, it is now considered that the relatively low deposition value at Logan, Utah, to the north of Salt Lake City, may be erroneous--as the soil is calcareous and the ^{90}Sr may have extended below the sampling level (Hardy (HASL), personal communication). Although several possible causes for these apparent anomalies have been discussed by List et al. (1965), Volchok (1972), and Hardy et al. (1972), the explanations have not been vigorously tested--due principally to lack of adequate data. In view of this, it was felt that a comparison of the above results with several additional estimates of surface deposition would be desirable as well as comparison against the results generated by the general

circulation tracer model from the Geophysical Fluid Dynamics Laboratory (Mahlman 1973).

II. Results

The first data set selected for investigation is the tritium rainout data analyzed by the United States Geological Survey at about 12 sites throughout the contiguous United States. The main purpose for collecting and analyzing tritiated water is for tracing water through the hydrologic cycle. However, because the input of tritium into the cycle by nuclear testing masks the natural levels completely, it is also possible to use the tracer as an indication of surface deposition. Tritium is a radioactive isotope of hydrogen and incorporates in the water molecule to form tritiated water which is collected in rainwater samples. Tritium concentrations are measured in tritium units (TU), where one tritium unit is equal to one tritium atom in 10^{18} protium atoms.

The data for this study is based on the rainwater data for the period 1963 through 1968 (Stewart and Hoffman 1966; Stewart and Fainsworth 1968; Stewart and Wyerman 1970) when only an occasional atmospheric nuclear device was tested, and this only outside the United States. The primary source of artificial tritium in this period was the stratospheric reservoir resulting from large-scale nuclear testing in 1962 and earlier years. For comparison purposes, tritium data are integrated over the 6-year period to give the total

deposition shown in Fig. 2. The unit presented (TU-cm) is the product of the tritium concentration times the amount of precipitation during the collection period (1 TU-cm = 3.2×10^{-3} picocuries per cm^2 of surface area).

Before the comparison is made between tritium and soil deposition data, one difficulty unique to the tritium data should be discussed. As seen in Fig. 2, a continentality effect is quite noticeable that is due more to the nature of the hydrologic cycle and less to the deposition processes. For example, stations near the oceans (which get their water vapor for precipitation from maritime air masses) receive precipitation with low tritium concentrations because of the dilution effects of the ocean. In contrast, the precipitation at midcontinent stations has high tritium concentrations which may involve the precipitation of reevaporated continental water.

Inasmuch as the continentality effect appears to dominate the overall deposition pattern within the United States, it is not fair to utilize these data as a general indication of the deposition as compared to the soil sample data in Fig. 1. At the same time, however, we note in Fig. 2 that the broad maximum over the Great Plains extends toward a secondary maximum in the area of Salt Lake City, in virtual agreement with the soil sample data. In addition, an area of relatively low deposition is indicated over the southwest. This pattern, moreover, is very typical of the individual years and is not

simply due to a few anomalous periods, thus arguing in favor of the reality of the Salt Lake City anomaly. Other features that would be desirable to compare between Figs. 1 and 2 are effectively masked by the continentality effect and the sparsity of data.

The third data set available for study is the ^{90}Sr deposition measured monthly at 25 monitoring sites in the contiguous United States by means of pot and ion-exchange collectors using either high walled stainless steel pots with exposed areas of 0.076 square meters or plastic funnels with exposed areas of 0.072 square meters to which are attached ion-exchange columns. For comparison with the previous data sets, the 6-year integrals (1963-1968) of deposition (Health and Safety Laboratory 1973) are presented in Fig. 3.

As in the previous two figures, we see a general maximum in the Great Plains states extending toward the Salt Lake City area with a minimum in the Southwest. The maximum in the Northwest is presumably due to the relatively large amount of precipitation in that area (Alexander et al. 1964). With respect to the data in the Southeast, the soil sample and tritium data are, unfortunately, too sparse in this region to be able to verify the relatively high values of ^{90}Sr located over Alabama. The relatively high value of deposition in the Northeast appears to have its counterpart in the soil sample data, although in the latter case relatively high values extend along the major portion of the east coast.

The remaining discussion will concentrate on the relative agreement of the above deposition patterns to that predicted by the general circulation tracer model. Before we discuss the results, however, it is advisable to give a very brief summary of the deposition process of the model. A more complete description of the entire tracer model is presented by Mahlman (1973).

Deposition in the model simulates a removal process in the lower levels given by,

$$\text{"Sink"} = P_* \{C(\text{dry}) + C(\text{wet})\}R \qquad (1)$$

where P_* is pressure at the earth's surface, R is the tracer mixing ratio, and C(dry) and C(wet) are coefficients for dry and rainfall--dependent removal processes. These coefficients are calibrated so as to be roughly compatible with observed tropospheric residence times of nuclear debris. C(dry) has a nonzero value only in the lowest 50-60 mb of the atmosphere, while C(wet) is assumed to be zero above about 315 mb and dependent on the rainfall rate below.

The tracer simulation shows an encouraging correspondence with the long-term behavior of debris from nuclear detonations. For example, the proper poleward-downward slopes of mixing-ratio isolines in the stratosphere, seasonal variations, mean stratospheric residence times (Machta and Telegadas 1973), and the spring deposition peak in midlatitudes are all successfully simulated by the tracer model.

For this experiment, the only source is a large injection of tracer into the midlatitude Northern Hemisphere winter stratosphere. The center of the initial tracer is at 65 mb at 36°N and 180°E on model date January 1. The model runs through the seasons for an elapsed time of 11 months. The simulated total surface deposition pattern is presented in Fig. 4 in relative units.

We should point out, however, that the deposition patterns depicted in Figs. 1-3 are mainly the results of the 1962 U.S.S.R. injections at about 75°N whereas the input of the model is at 36°N. With this proviso and although computations have been carried out for slightly less than a 1-year period, the results should be representative of the climatology of the model and hence comparable against our previous results which are averages over several years.

The most interesting item to note in Fig. 4 is the maximum deposition in the Nevada region with a tendency of high values toward the Northwest. This is in relative agreement with the general pattern of the pot and ion-column data (Fig. 3), and may provide a model of the Salt Lake City area relative maximum. A second relative maximum is obtained in the Northwest by the tracer model with a value of 24 units at about 50°N, 120°W. On the other hand, neither the maximum in the Plains states nor the minimum in the Southwest is accurately predicted. However, the relatively low value in the Central United States agrees with the soil and the pot and the ion-

column data. Also, the calculated values do decrease toward the South from the area of simulated maximum in the New Mexico area. The relatively high values along the east coast appear to be further south and east of those depicted in the soil data. With respect the the maximum in Nevada, the relationship of this maximum to the rate of precipitation was investigated and it was found that the precipitation maximum was located off the northwest coast. Hence, the Nevada maximum is not caused by the precipitation process, but is a result of total tracer transports simulated by the model and how they correlate with the parameterized removal processes.

In summary, comparison of the three observed data sets suggests that there are several general features common to all and which, presumably, must be basic aspects of the surface deposition:

1. The general maximum in the Great Plains states.
2. The general mimimum in the Southwest.
3. A relatively high value, if not an absolute maximum, in the Salt Lake City area.

Certain other features, such as relatively high deposition values in the Southeast and Northwest, must await further confirmation from additional data. In addition, the results of the general circulation tracer model calculations present a reasonable "first depiction" of the details of surface deposition and are very encouraging for continual improvement.

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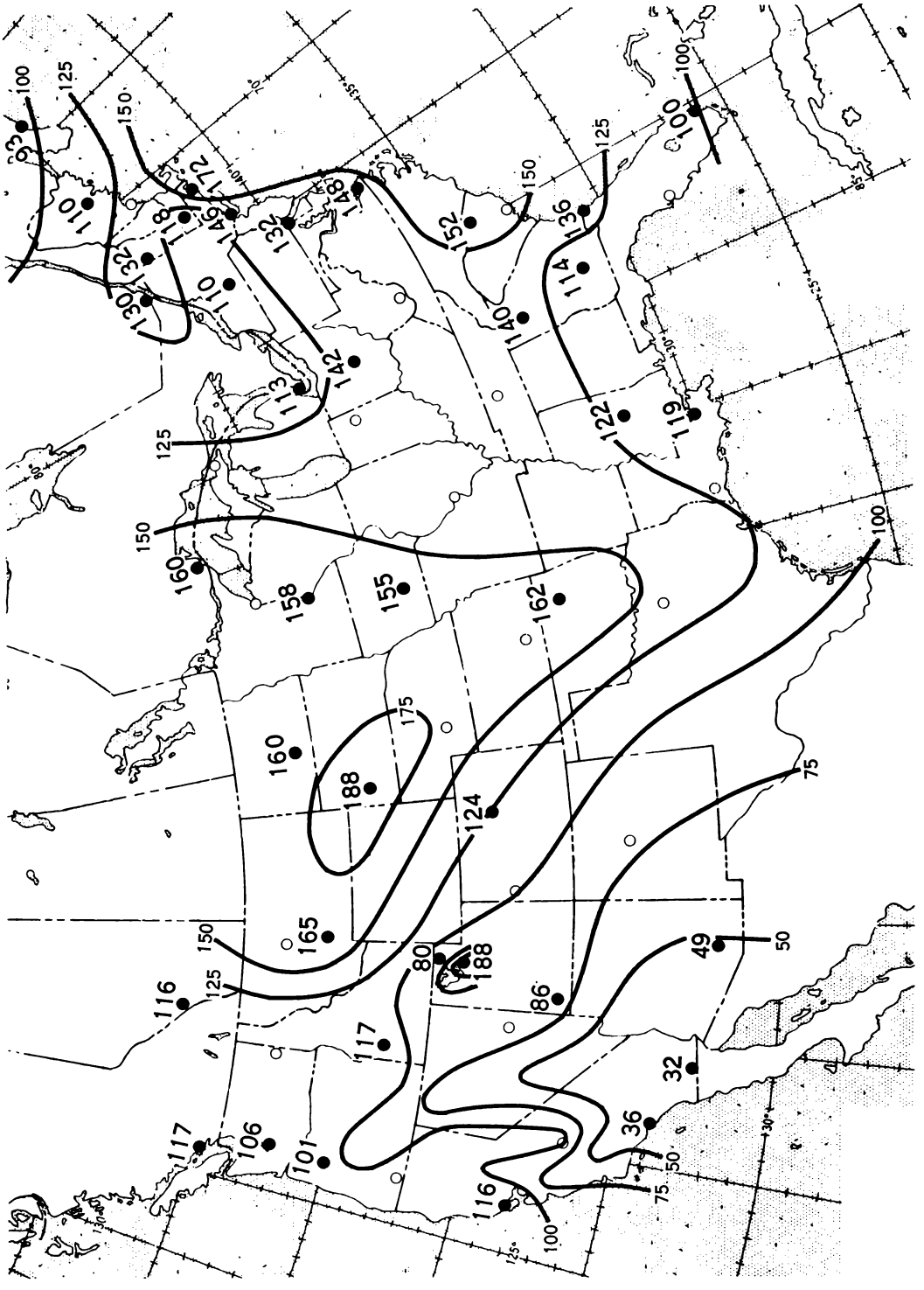

Figure 1 - Strontium-90 in soil in 1963 and early 1964 in the continental United States and Southern Canada, millicuries per square miles. Multiply by 0.386 for $\frac{mCi}{km^2}$.

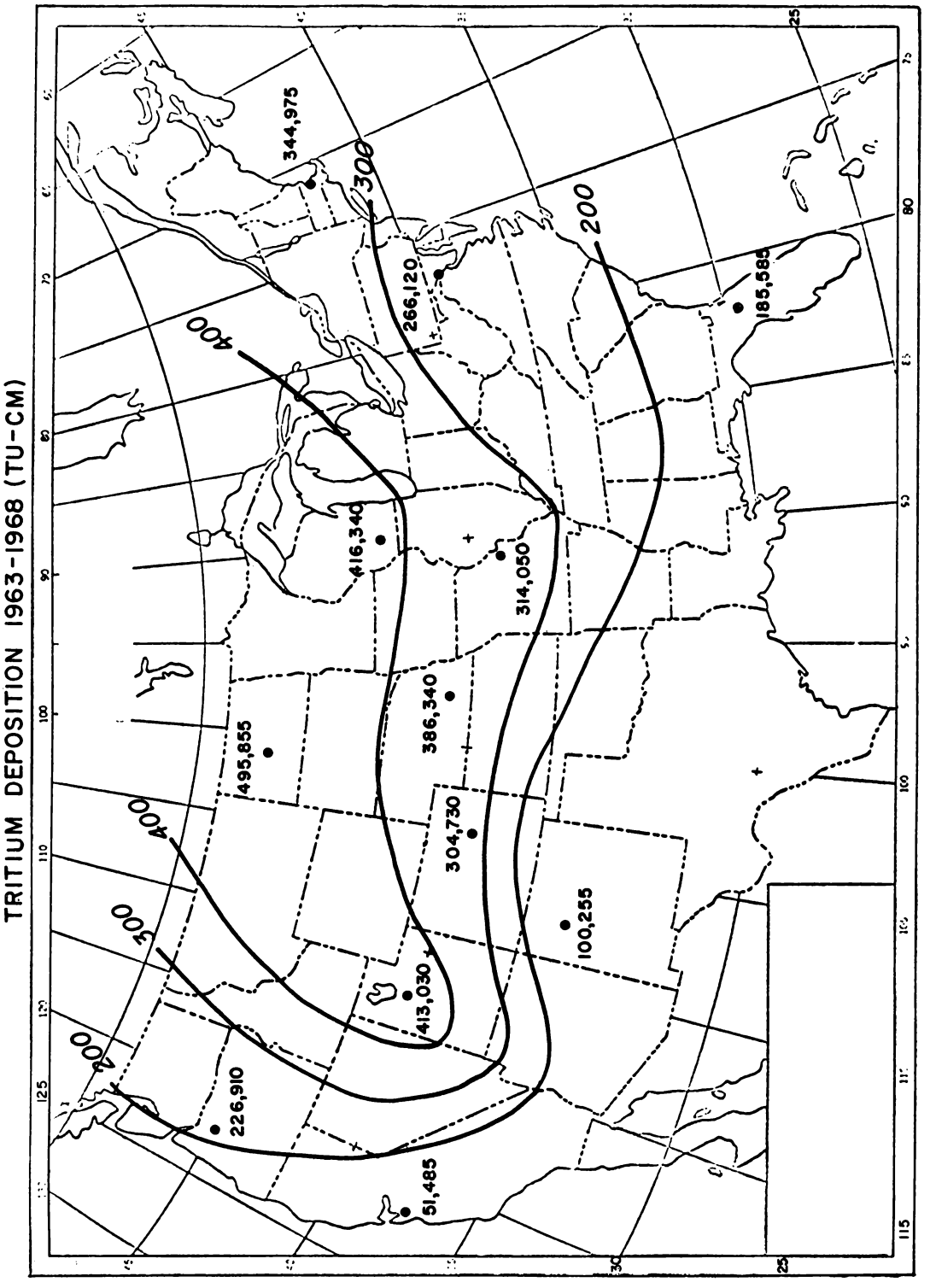

Figure 2 - Total tritium deposition (TU-cm) in the continental United States for the period 1963-1968. Isolines are 10^3 TU-cm units.

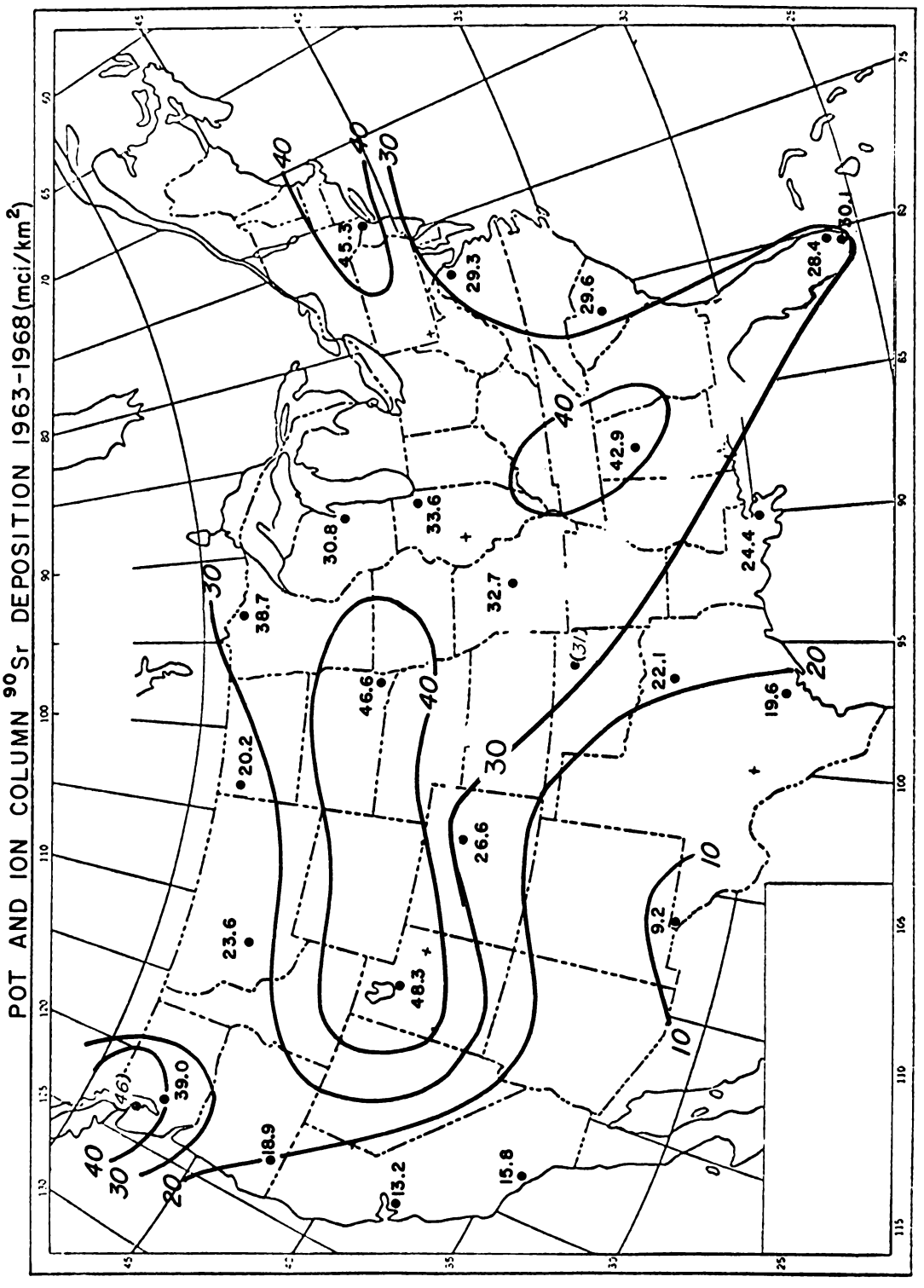

Figure 3 - Total ^{90}Sr deposition in pot and ion-column samples for the period 1963-1968, millicuries per square kilometer. Data in parenthesis represent samples with several missing months and have been adjusted upward by about 2 mCi/km^2.

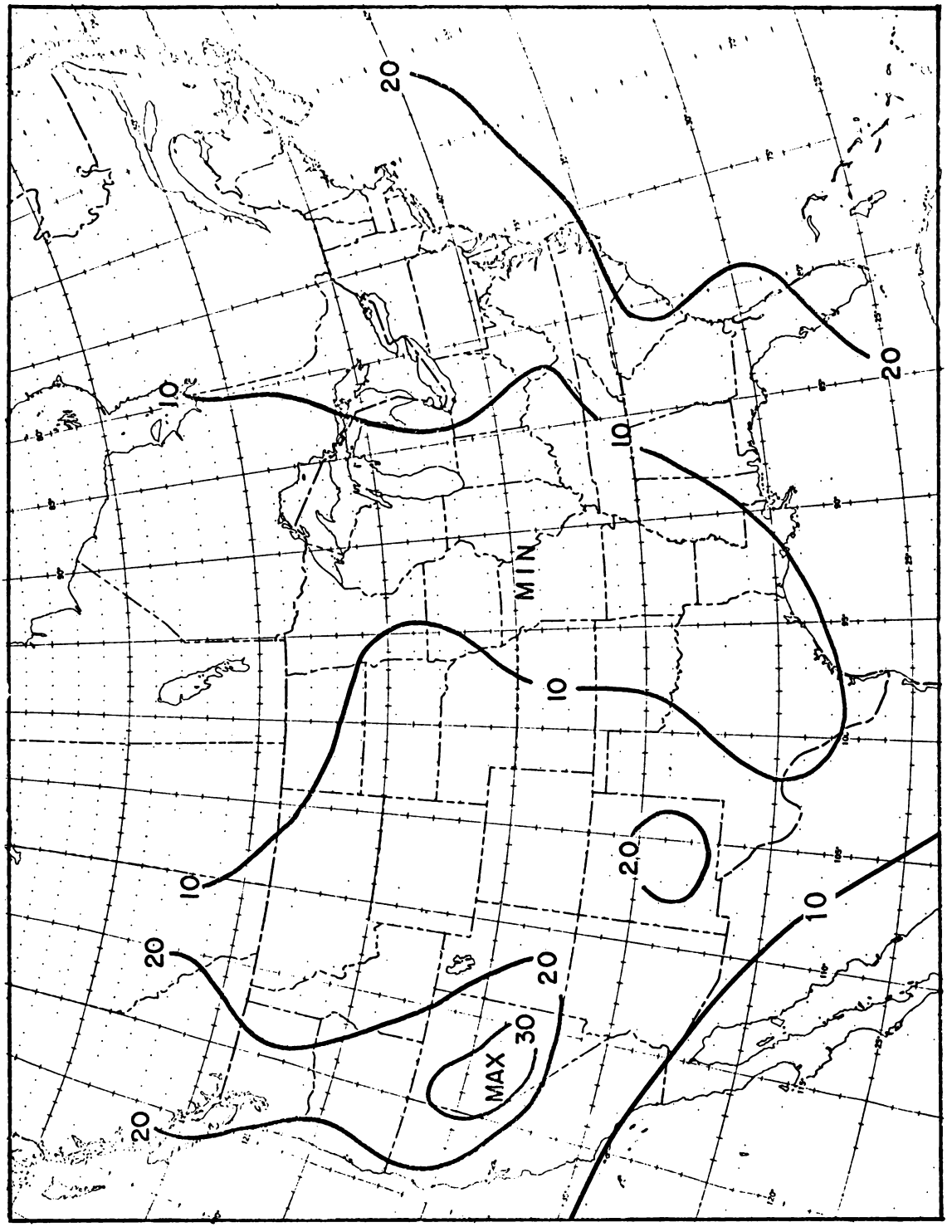

Figure 4 - Total tracer deposition at ground predicted by general circulation tracer model for 11 month period after stratospheric injection of inert tracer (relative units). Grid point values are not plotted (as in Fig. 1-3) because of the closer spacing of points in the tracer model (about 265 km) compared with observation.

Carbon-14 Measurements in the Stratosphere

From a Balloon-Borne Molecular Sieve Sampler (1971-1973)

by
R.E. Sowl (ANL)
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I. Introduction

The U.S. Government has conducted an extensive atmospheric program of whole air collection in the troposphere and stratosphere since 1953. These atmospheric samples were analyzed for C-14 collected in the form of CO_2. Excess C-14 (C-14 due to nuclear testing)data have been derived and the results made available (Hagemann, et al.,1965; ESSA, 1966, 1967, 1969; NOAA, 1971).

The high altitude balloon sampling portion (20 to 30 km) of the whole air collection program terminated in July 1966 while the aircraft program, which sampled in the troposphere and lower stratosphere to 20 km, continued until its termination in July 1969. Beginning in mid-1970, molecular sieve samples designed to replace the whole air samplers were flown operationally on the USAEC balloon flights in the northern and southern hemispheres. The results from mid-1970 to mid-1971 have been reported (Telegadas et al., 1972). This report contains the Carbon-14 measurements from the balloon-borne molecular sieve sampler since mid-1971.

A complete description of the molecular sieve sampler is given by Ashenfelter et al., (1972).

ANL: Argonne National Laboraotry, Chemistry Division, Argonne, Illinois 60439.

ARL: Air Resources Laboratories, NOAA, Silver Spring, Maryland 20910.

II. Sampling Locations

The C-14 sampler can readily be flown on the USAEC balloon-borne particulate sampling missions. Both samplers (molecular sieve and particulate sampler) were normally flown together at altitudes of 21, 24, 27, 32, and 37 km at the following locations:

Location	Latitude
Eielson Air Force Base, Alaska	65°N
Hollaman Air Force Base, New Mexico	33°N
Albrook Air Force Base, Panama Canal Zone	9°N
Longreach, Queensland, Australia	23°S
Mildura, Victoria, Australia	34°S

The complete sampling system is lifted to a pre-determined float altitude where sampling begins for a pre-determined time. Upon completion of the sampling, the system descends by parachute and is recovered. The molecular sieve adsorbents are returned to Argonne National Laboratory (ANL) for quantitative determination of adsorbed CO_2 and for C-14 and C-13 analyses.

III. Determination of Excess Carbon-14

The techniques for separating CO_2 from the molecular sieve pellets and the C-14 counting techniques are given by Ashenfelter, et al. (1972). In addition, a small aliquot of CO_2 is routinely taken for C-13 mass spectrometric analyses.

In the determination of excess C-14, a known quantity of purified CO_2 is transferred into one of six 2-liter low-background counters. The data from these counters are reported in "absolute" disintegrations per minute per gram of carbon (dpm/gC). The technique employed by carbon dating laboratories is to avoid absolute calibration by taking the ratio of the unknown sample to a National Bureau of Standard (NBS) oxalic acid C-14 standard converted to CO_2. The actual value of pre-bomb CO_2 (modern wood) is considered to be equal to 0.95 NBS oxalic acid standard or 13.1 dpm/gC.

The "absolute" activity of the ANL standard gas (2000 dpm/l) has been used to calibrate all counters and the NBS oxalic acid standard. The ANL counters gave a mean value for 0.95 oxalic acid standard of 13.17 $\pm$ 0.04 dpm/gC at the 2-sigma confidence level. Thus, ANL confirms within experimental error the generally accepted value of 13.1 dpm/gC for the oxalic acid standard.

The numbers reported in this paper as excess specific activity (Table 1) are the measured dpm/gC minus 13.1 dpm/gC. In relating excess activity to bomb C-14 concentrations (atoms per gram of air) we have used 74 x 10^5 atoms/g of air as the pre-bomb background (Hagemann, et al., 1965) assuming a CO_2 concentration in air of 313 ppm (by volume). The present day concentration of CO_2 in the atmosphere is about 325 ppmV. If one uses this value instead of 313 ppmV the excess C-14 concentrations reported in Table 1 should be increased by about 5%.

IV. Stratospheric Carbon-14 Measurements

The experimental and operational data using molecular sieve sampler are given in Table 1. An explanation of the table is given:

Column 1. Flight No.

Column 2. Date

The date of collection is given by three two digit groups of month, day and year.

Column 3. Alt.

The mean pressure altitude of the collection is given in kilometers.

Column 4. Bed No.

The data from the two sampling beds are listed as Bed 1 (the primary sampling bed) and Bed 2 (the back-up bed to detect any breakthrough of CO_2 from Bed 1).

Column 5. Vol. CO_2

The volume of CO_2 in cubic centimeters (cc) collected on each bed, computed at 1013 mb and 25°C.

Column 6. δC-13

The measured C-13/C-12 value expressed as the deviation from Craig's (1957) limestone standard in units of per mil (0/00).

$$\delta\text{C-13} = \left[\frac{\text{C-13/C-12 (sample)}}{\text{C-13/C-12 (P.D.B. Standard)}} - 1\right] \times 1000$$

The standard error of the determination is estimated at 0.2%.

Column 7. Excess Spec. Act.

These numbers are the observed specific activity (dpm/gC) minus 13.1 dpm/gC. This is therefore the excess specific activity due to nuclear weapons testing.

The counting error of the observed specific activity at the 95% confidence level is less than 5% in all samples and less than 3% in 90% of the samples.

Column 8. C-14 Excess.

These numbers are the excess specific activity (dpm/gC) converted to C-14 excess concentration in units of 10^5 atoms per gram of air.

$$\text{C-14 Excess} = (\text{Excess Spec. Act. (dpm/gC)}) \left[\frac{74 \times 10^5 \text{ atoms/g air}}{13.1 \text{ dpm/gC}}\right]$$

Column 9. C-14 Excess, Wt. Avg.

These values are the weighted average of the excess C-14 determination from Bed 1 and Bed 2 weighted by the volume of CO_2 collected on each bed and is defined as:

$$\text{C-14 Excess (Wt. Avg.)} = \frac{(\text{C-14 Excess})_1 (\text{Vol } CO_2)_1 + (\text{C-14 Excess})_2 (\text{Vol } CO_2)_2}{(\text{Vol } CO_2)_1 + (\text{Vol } CO_2)_2}$$

Column 10. Remarks

The meaning of each remark is given at the bottom of each each page of Table 1.

References

Ashenfelter, T.E., J. Gray, Jr., R.E. Sowl, M. Svendsen and K. Telegadas, A Lightweight Molecular Sieve Sampler for Measuring Stratospheric Carbon - 14, J. Geophys. Res., 77 (3), 1972.

Craig, H., Isotopic Standards for Carbon and Oxygen Correction Factor for Mass Spectrometric Analysis of Carbon Dioxide, Geochem. et Cosmoch. Acta, 12, 133-149, 1957.

Environmental Science Services Administration, Carbon-14 Measurements in the Atmosphere, HASL-166, January 1966.

Environmental Science Services Administration, Carbon-14 Measurements in the Atmosphere, HASL-174, January 1967.

Environmental Science Services Administration, Carbon-14 Measurements in the Atmosphere, HASL-214, October 1969.

National Oceanic and Atmospheric Administration, Carbon-14 Measurements in the Atmosphere, HASL-242, April 1971.

Telegadas, K., J. Gray, Jr., R.E. Sowl and T.E. Ashenfelter, Carbon-14 Measurements in the Stratosphere from a Balloon-Borne Molecular Sieve Sampler, HASL-246, January 1972.

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

EIELSON AFB, ALASKA 65N

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δ C-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT.AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
108	060471	21.4	1	4450	- 8.2	21.6	122.0	121.6	
			2	900	0.0	21.2	119.8		
115	060173	27.5	1	3000		20.3	114.7	115.8	
			2	1350		20.9	118.1		
116	060473	20.9	1	8645		17.5	98.9	97.8	
			2	2850		16.7	94.3		
117	060473	24.4	1	5000		18.7	105.6	104.3	
			2	1925		17.9	101.3		
118	060573	31.9	1	850		19.7	111.3	113.3	A
			2	750					

A. BED 1 AND 2 COMBINED FOR SPECIFIC ACTIVITY ANALYSIS

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

HOLLAMAN AFB, NEW MEXICO 33N

FLIGHT NO.	DATE	ALT (KM)	BED NO.	VOL. CO-2 (CC)	δ C-13 CONC. (PER MIL)	EXCESS SPEC. ACT. (DPM/GC)	C-14 EXCESS (10^5 ATOMS/G AIR)	C-14 EXCESS WT.AVG.	REMARKS
5	111971	27.4	1	1500	- 6.9	21.3	120.3	118.1	
			2	390	- 3.8	19.4	109.6		
6	040472	21.8	1	9515	-13.2	18.8	106.2	106.4	
			2	2410	- 6.7	19.0	107.3		
8	040772	24.8	1	5300	- 7.2	19.6	110.7	117.2	A
			2	2500	- 6.2	23.2	131.1		
9	042072	27.4	1	2350	- 4.6	19.5	110.2	109.4	
			2	750	- 6.4	18.9	106.8		
10	101672	24.4	1	3800	- 5.4	18.2	102.8	102.8	
			2	1000	- 3.5	18.2	102.8		
11	102472	27.3	1	2950	- 9.9	19.9	112.4	112.1	
			2	1150	- 3.7	19.7	111.3		
12	102772	21.7	1	4200	- 5.6	18.8	106.2	105.2	
			2	750	- 4.8	17.6	99.4		
20	041073	22.3	1	5675		18.1	102.2	100.1	
			2	5070		17.3	97.7		
21	041173	24.9	1	5650		17.4	98.3	100.6	
			2	2275		18.8	106.2		

A. SAMPLER DAMAGED ON IMPACT. POSSIBLE CONTAMINATION.

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

HOLLAMAN AFB, NEW MEXICO 33N

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δ C-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT. AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
23	041773	31.6	1	1785		20.1	113.5	107.6	
			2	950		17.1	96.6		
25	042773	37.4	1	500		18.7	105.6	105.6	A
			2	340					
29	082273	21.2	1	6100		15.3	86.4		
			2	1750					
30	082473	24.1	1	3810		16.8	94.9	96.3	
			2	1470		17.7	100.0		
31	082873	26.6	1	2400		18.4	103.9	106.1	
			2	900		19.8	111.9		
33	103173	27.4	1	2080		18.3	103.4		
			2	1475					B

A. BED 1 AND 2 COMBINED FOR SPECIFIC ACTIVITY ANALYSIS
B. SPECIFIC ACTIVITY NOT COUNTED FOR BED 2. SAMPLE GIVEN TO NCAR.

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

ALBROOK AFB, CANAL ZONE 9N

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δ C-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT.AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
131	030873	20.6	1	7475		10.1	57.1	58.4	
			2	1400		11.6	65.5		
132	030973	23.2	1	4300		12.1	68.4	68.9	
			2	725		12.7	71.7		
134	031273	32.1	1	900		15.6	88.1	88.1	A
			2	600					
137	032473	27.4	1	4255		13.8	78.0	79.9	
			2	1880		14.9	84.2		

A. BED 1 AND 2 COMBINED FOR SPECIFIC ACTIVITY ANALYSIS

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

LONGREACH, AUSTRALIA 23S

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δC-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT.AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
523	042971	23.5	1	3100	- 8.6	22.8	128.8	127.4	
			2	455	- 5.5	20.9	118.1		
568	111272	20.9	1	4500	- 4.1	14.9	84.2	82.7	
			2	600	+ 2.5	12.7	71.7		
569	111372	23.9	1	1600	- 2.0	17.0	96.0	95.4	
			2	150	- 5.9	15.8	89.3		
584	051473	21.2	1	9500		18.4	103.9	104.2	
			2	650		19.1	107.9		
585	051573	24.0	1	6200		16.7	94.3	94.9	
			2	1725		17.2	97.2		
586	051573	26.6	1	2950		17.2	97.2	97.0	
			2	1900		17.1	96.6		
598	110673	24.9	1	4930					
			2	2200		17.5	98.9		

TABLE 1. STRATOSPHERIC CARBON-14 MEASUREMENTS

MILDURA, AUSTRALIA 34S

FLIGHT NO.	DATE	ALT (KM)	BED NO.	VOL. CO-2 (CC)	δ C-13 CONC. (PER MIL)	EXCESS SPEC. ACT. (DPM/GC)	C-14 EXCESS (10^5 ATOMS/G AIR)	C-14 EXCESS WT.AVG. (10^5 ATOMS/G AIR)	REMARKS
518	032371	20.9	1	3150		23.2	131.1	130.3	
			2	265		21.4	120.9		
526	060971	26.4	1	2450	- 5.7	22.6	127.7	128.4	
			2	345	- 1.5	23.6	133.3		
527	061071	23.1	1	3600	-12.6	22.4	126.5	126.1	
			2	800	- 2.2	22.0	124.3		
528	061671	19.9	1	4470	- 7.8	18.9	106.8	106.0	
			2	630	- 0.9	17.8	100.6		
530	062571	31.4	1	1000	-10.3	19.6	110.7	116.9	
			2	440	-11.3	23.2	131.1		
551	050572	24.7	1	4850	- 6.7	20.4	115.2	115.1	
			2	1925	- 6.2	20.3	114.7		
552	050972	24.0	1	7400	- 7.6	19.8	111.9	111.6	
			2	1700	- 1.8	19.5	110.2		
553	051172	20.8	1	9500	- 8.7	19.0	107.3	107.5	
			2	710	+ 1.5	19.6	110.7		
565	101472	20.8	1	10600	- 6.7	18.6	105.1	105.3	
			2	1400	+ 1.7	18.9	106.8		

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

MILDURA, AUSTRALIA 34S

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δC-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT.AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
567	101972	25.3	1	1825	- 5.0	18.9	106.8	104.4	B
			2	2730	- 7.5	18.2	102.8		
579	040373	23.7	1	6100		18.1	102.2	103.0	
			2	1875		18.7	105.6		
580	040473	20.9	1	7750		15.2	85.9	84.8	
			2	2075		14.3	80.8		
581	040673	31.2	1	2115		19.6	110.7	112.6	
			2	825		20.8	117.5		
582	041073	37.1	1	600		21.2	119.8	119.8	A
			2	425					
583	041273	27.0	1	3040		19.2	108.5	112.9	
			2	450		25.3	142.9		
592	082473	23.8	1	5175		18.2	102.8	104.4	
			2	1630		19.4	109.6		
593	090673	27.1	1	3375		18.3	103.4	102.6	
			2	1650		17.9	101.1		

A. BED 1 AND 2 COMBINED FOR SPECIFIC ACTIVITY ANALYSIS
B. BEDS APPEARED TO HAVE BEEN RETURNED TO LABORATORY IN REVERSE

TABLE 1 STRATOSPHERIC CARBON-14 MEASUREMENTS

MILDURA, AUSTRALIA 34S

FLIGHT NO.	DATE	ALT	BED NO.	VOL. CO-2	δ C-13 CONC.	EXCESS SPEC. ACT.	C-14 EXCESS	C-14 EXCESS WT.AVG.	REMARKS
		(KM)		(CC)	(PER MIL)	(DPM/GC)	(10^5 ATOMS/G AIR)		
595	100873	20.7	1	8000					
			2	1100		19.8	111.9		
596	101273	24.4	1	3300		17.4	98.3	102.7	
			2	700		21.9	123.7		
597	101773	27.1	1	3970					
			2	625		20.9	118.1		

ENVIRONMENTAL RADIATION MEASUREMENTS IN THE VICINITY OF A BOILING WATER REACTOR: HASL DATA SUMMARY.

Prepared by G. de P. Burke, (HASL) *

ABSTRACT

Environmental radiation measurements were made over a three year period in the vicinity of a boiling water power reactor. Contributions to total radiation exposures resulting from the gaseous effluents are calculated from a plume exposure model and compared with values determined from ionization chamber and TLD measurements. In almost all cases, exposures attributable to the plant are less than 10 mR/year. Gas sample analyses are also presented.

In April 1971, a study was begun of the radiation environment in the vicinity of a 2000 MW_t (650 MW_e) boiling water reactor. A chronology of this study is given in Table I. A history of gaseous effluent releases during the study is given in Table II. The data accumulated through September, 1972 has been documented in the correspondence with utility personnel and in various HASL reports and journal articles. This report is a summary of the data obtained from October 1972 through March 1974 and analysis of some of the data for determining the exposure in the vicinity of the plant due to the release of gaseous effluent.

* Based on work by the Radiation Physics Division, Health and Safety Laboratory, USAEC, New York.

Table III contains the average total exposure rates for the designated approximately monthly periods determined by thermoluminescence dosimeters in the vicinity of the facility. The measurement locations are indicated on the map in Figure 1. Table IV contains ionization chamber measurements of both the total exposure and the exposure attributable to the plume at seven of the locations in Figure 1. The method by which the exposure due to the plume is determined is given in a publication by Gogolak and Miller[1] and discussed in general by Beck et al.[2] and McLaughlin and Beck[3].

Techniques for estimating background radiation exposures as a function of climatic conditions[4,5] have enabled the separation of total exposure determined from TLD measurements into the background component and that attributable to gaseous effluent. Table V contains estimates of plume exposure for the designated periods from TLD measurements at four of the locations in the vicinity from August 1971 until the shutdown for refueling in August 1972. These estimates are compared with calculations of plume exposure based on effluent release rates and meteorological conditions. Agreement is within the expected error for both techniques assuming the calculations are accurate to within a factor of two[6] and the estimates based on the TLD measurements, in this case, are accurate to within ± 1 mR per year or about ± 0.3 mR per month[7]. In only one case does the exposure due to the release of effluent exceed 10 mR per year and in this case, the location is within the site boundary. A more detailed analysis of these data is being included in a publication now in preparation[7].

Ionization chamber measurements of total gamma plus cosmic radiation exposure and the gamma exposure attributable to the release of effluent from the reactor stack are summarized in Table VI for a period totaling 9072 hours following the shutdown for refueling. Since neither the plant nor the ion chambers were operating for the full period the plume exposure data are also normalized to equivalent annual values. The plant and the chambers are assumed to be in operation for 8760 hours, and the plume exposures actually measured during the hours of plant operation are assumed to yield mean exposure rates that are representative of a full year's operation. In this case, the extrapolated plume exposure is always less than 1 mR per year and less than 0.5 mR per year for five out of the seven locations considered. Estimates of plume exposure from TLD measurements during the period are not included in the table since these exposures are considerably smaller than the error involved in the technique used to extract plume exposures from the TLD measurements.

Analysis of the exposure data is continuing and efforts are presently being directed at refining both the application of the plume model and the techniques for isolating any plume exposure from TLD total exposure measurements.

A comparison of analyses of off-gas samples was undertaken to verify the composition of the reactor effluent to be used as input to plume exposure in calculations. Results are in Table VII. We consider the agreement to be reasonable, taking into account sampling and measurement errors.

References:

1. C. V. Gogolak and K. Miller, Method for Obtaining Radiation Exposure Due to a Boiling Water Reactor Plume from Continuously Monitoring Ionization Chambers, to be published in Health Physics.

2. H. L. Beck, J. A. DeCampo, C. V. Gogolak, W. M. Lowder, J. E. McLaughlin, and P. D. Raft, New Perspectives on Low Level Environmental Radiation Monitoring around Nuclear Facilities, Nuclear Technology 14, 232-239 (1972).

3. J. E. McLaughlin and H. L. Beck, Environmental Radiation Dosimetry for Nuclear Facilities and Problems, IEEE Trans. Nucl. Sci. NS-20, No. 1, 36-42 (1973).

4. G. de P. Burke and D. G. Marcin, Computer Program for Calculating Various Parameters Related to Soil-Water Balance, USAEC HASL-282, April 1974.

5. G. de P. Burke and K. O'Brien, Operating Manual for GRANIA, a Code for the Analysis of Climatic Effects on Natural Environmental Gamma-Ray Exposure Rates, USAEC HASL-283, April 1974.

6. C. V. Gogolak, Comparison of Measured and Calculated Radiation Exposure from a Boiling Water Reactor Plume, USAEC HASL-277, September 1973.

7. G. de P. Burke, to be published (Variations in Natural Environmental Gamma Radiation Exposures and their Effects on the Interpretability of TLD Measurements Made in the Vicinity of Nuclear Power Facilities).

TABLE I

Chronology of the Nuclear Power Facility Study

Date	Event
July 21-22, 1970	Spectral and ionization chamber measurements in the general vicinity of the facility.
Sept. 28 - Oct. 1, 1970	Spectral and ionization chamber measurements in the general vicinity of the facility.
April, 1971	Commencement of TLD monitoring at locations* 12,13,15,20a,20b,21,23.
August 11, 1971	Spectral Measurements in the general vicinity of the facility. Steam Jet Air Ejector Sample Analysis.
June, 1972	Commencement of ionization chamber monitoring at location 13.
August 3, 1972	Spectral Measurements at locations 11 and 13.
August 30, 1972 through March 10, 1973	Reactor Shutdown.
October, 1972	Commencement of TLD monitoring at all locations indicated in Figure 1.
	Commencement of ionization chamber monitoring at locations 2,7,9,10,11,12.
October 11-13, 1972	Spectral measurements at locations 3,5,6,7,10,11,12,13.
November 7-9, 1972	Spectral measurements at locations 2,7,13,14,17,18.
February 27-March 1, 1973	Spectral measurements at locations 1,2,3,5,6,9,10,11,12,13,15,23.
April 22 through July 31,'73	Reactor Shutdown.
July 18 - August 3, 1973	Spectral Measurements at locations 2, 10, 13, 18.
February 28, 1974	Steam Jet Air Ejector Sample Analysis

* See Figure 1 for locations.

TABLE II

Total Monthly Release of Noble Gases
(Curies)

	1971	1972	1973	1974
January	1.75(3)[1]	3.15(4)	0	2.50(4)
February	3.12(3)	5.08(3)	0	1.46(4)
March	5.72(3)	3.24(4)	4.06(3)	2.37(4)
April	7.16(3)	2.79(4)	1.38(4)	
May	1.84(4)	7.55(4)	0	
June	1.59(4)	2.03(5)	0	
July	1.65(4)	1.78(5)	1.87(3)	
August	2.46(4)	2.39(5)	1.66(4)	
September	3.60(4)	0	1.06(4)	
October	2.35(4)	0	1.18(4)	
November	6.44(4)	0	1.13(4)	
December	5.86(4)	0	8.81(3)	

1 ( ) indicates power of 10.

TABLE III

TLD Data (μR/h)

Measurement Period	10/11/72-11/9/72	11/6/72-12/6/72	12/6/72-1/17/73	1/16/73-3/1/73	2/27/73-3/29/73	3/28/73-4/25/73	4/24/73-5/24/73	5/23/73-6/21/73	6/19/73-7/19/73	7/18/73-8/15/73	8/14/73-9/13/73	9/12/73-10/11/73	10/10/73-11/8/73	11/7/73-12/6/73	12/5/73-1/31/74	1/30/74 3/14/74
Total Hours	705	708	1015	1057	728	680	730	679	734	679	729	705	706	705	1374	
Location No.																
11	8.9	8.3	8.7	8.0	8.6	8.0	8.0	Lost	8.8	8.7	9.1	8.6	8.4	8.5	8.2	8.9
13	10.1	8.8	10.3	9.0	9.5	9.8	8.8	9.7	10.3	9.9	10.3	10.5	9.7	9.4	9.6	9.6
21	8.2	8.1	8.9	7.8	8.4	8.6	7.9	8.4	8.8	9.1	8.5	8.7	8.0	8.8	8.2	8.7
20	8.5	8.3	8.3	7.9	8.0	7.8	7.9	8.2	8.8	8.2	8.7	8.3	8.0	8.2	8.0	8.3
15	9.2	9.2	9.7	8.8	Lost	8.9	9.2	9.0	9.9	9.7	9.8	Lost	Disc.	Disc.	Disc.	Disc.
12	8.7	8.7	9.3	8.4	8.9	8.3	8.3	8.7	9.7	9.3	9.7	8.9	8.9	8.9	8.8	9.0
23	9.0	8.7	9.4	8.3	8.6	8.4	8.3	8.9	9.1	9.2	8.9	8.1	7.8	8.5	8.0	8.9
2	-	8.2	9.0	8.1	8.1	7.6	7.7	8.2	8.6	8.3	Lost	8.2	7.9	8.2	8.9	8.1
		Nov. 6 - Jan. 17														
22	9.6	10.2		Lost	9.5	9.9	9.6	10.0	10.6	Lost	9.8	9.7	8.9	9.8	7.9	9.0
17	10.3	10.0		9.1	9.6	9.6	10.2	9.2	10.5	9.8	10.4	9.9	9.9	10.3	8.2	9.6
18	9.3	9.3		8.4	9.3	9.4	9.5	9.1	9.5	9.3	9.7	10.4	9.3	10.6	8.7	9.3
3	9.6	8.8		7.8	8.5	8.8	8.4	8.8	8.9	8.6	9.3	9.2	8.8	9.2	7.9	8.4
4	8.3	7.6		7.8	8.2	8.3	8.3	7.6	8.4	8.3	9.6	9.3	7.9	8.6	6.9	8.4
10	8.8	8.3		7.6	7.9	8.3	8.5	8.1	8.5	8.6	9.5	9.4	8.1	9.3	7.3	8.2
7	9.5	9.6		8.6	8.7	9.3	8.9	9.2	9.9	9.7	10.0	9.9	9.4	10.2	8.4	9.2
8	10.6	10.5		9.0	10.3	10.9	10.7	10.3	10.9	10.7	11.1	11.3	10.2	11.4	9.4	10.8
16	9.9	9.9		9.0	9.0	9.4	9.6	8.9	10.0	9.4	10.2	10.0	9.7	10.5	8.7	9.9
9	9.2	8.7		8.1	8.4	8.6	9.1	8.7	9.1	8.7	9.0	9.4	8.6	9.8	7.5	9.0
5	9.6	9.0		8.9	9.4	10.0	9.3	9.0	9.3	9.1	9.6	10.1	8.9	10.4	8.4	8.8
14	10.8	11.6		9.9	10.3	10.4	10.8	10.9	11.7	10.8	11.1	11.9	10.6	11.8	10.3	Lost
6	9.7	9.0		8.5	8.8	9.1	9.5	9.5	9.6	9.9	10.4	9.9	9.3	10.5	8.1	9.1
1	9.9	9.7		8.7	9.0	9.4	8.9	9.0	10.2	9.4	9.6	9.9	9.9	10.3	8.6	8.6
19	9.8	10.0		8.9	8.5	8.7	9.4	9.0	9.8	9.1	9.9	9.4	9.0	9.8	8.2	Disc

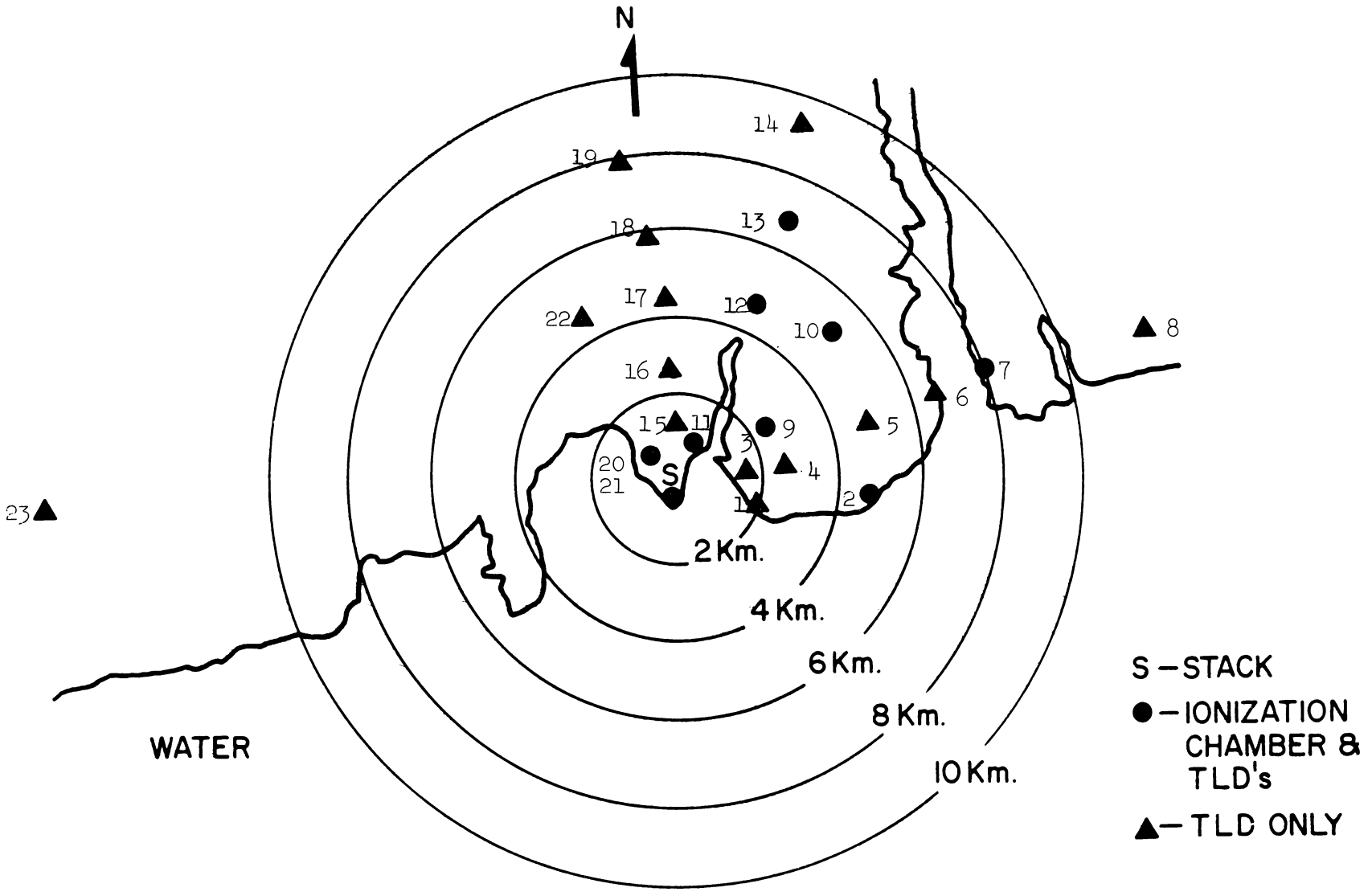


Fig. 1 Area surrounding the Nuclear Power Facility indicating reactor stack and monitoring locations.

TABLE IV

Ion Chamber Data (mR)

Measurement Period		10/12/72-11/8/72	11/8/72-12/6/72	12/6/72-1/17/73	1/17/73-2/28/73	2/28/73-3/24/73	3/29/73-4/25/73	4/25/73-5/24/73	5/24/73-6/20/73	6/20/73-7/19/73	7/19/73-8/15/73	8/15/73-9/13/73	9/13/73-10/11/73	10/11/73-11/8/73	11/8/73-12/6/73	12/6/73-1/30/74	1/30/74-3/14/74
Location No.																	
11	hours	326				716	603	384	496	444	396	633	655	673	673	1330	1008
	total[1]	2.980				6.244	5.305	3.360	4.374	4.027	3.570	6.017	6.154	6.458	6.330	11.233	9.005
	plume	-				.008	.030	-	-	-	.028	.098	.025	.027	.046	.060	.097
12	hours	650	306	282	646	654	333	650	630	617	628	676	672	592	546	1001	382
	total	6.031	2.763	2.586	5.587	5.674	2.913	5.638	5.519	5.557	5.591	6.152	6.020	5.383	4.827	8.610	7.701
	plume	-	-	-	-	.003	.004	-	-	-	.018	.019	.009	.005	.012	.017	.023
13	hours			640	1011	667	579	650	647	525	526	321	618	System	672[2]	1276	301
	total			5.855	9.113	6.009	5.231	5.843	5.931	5.409	4.831	3.068	5.907	Vandalized	5.868	10.613	2.537
	plume			-	-	.001	.002	-	-	-	.015	.008	.006		.012	.015	.007
9	hours	403	649	620		570	554	601	520	699	646	676	650	674	669	1346	877
	total	3.493	5.587	5.218		4.764	4.912	4.988	4.343	5.859	5.427	5.780	5.600	5.904	5.977	11.227	7.302
	plume	-	-	-		.005	.104	-	-	-	.056	.098	.053	.039	.044	.122	.062
10	hours	659	293			681	599	338	289		218	676	670	674	648	1310	914
	total	5.895	2.610			5.851	5.202	2.927	2.491		1.939	6.139	6.045	6.163	5.849	11.014	7.833
	plume	-	-			.004	.031	-	-			.055	.030	.020	.022	.055	.046
7	hours	569	696	869	963	663	624	628	648	629	646	654	673	535	673	1345	997
	total	5.211	6.427	8.100	8.845	6.097	5.747	5.800	6.125	6.051	6.208	6.376	6.499	5.244	6.500	12.276	9.223
	plume	-	-	-	-	.006	.053	-	-	-	.027	.039	.013	.011	.011	.051	.019
2	hours		291	570	950	622	594	337	339	640	648	544	294	534	262	1302	992
	total		2.602	4.968	8.110	5.330	5.148	2.912	2.980	5.611	5.724	4.928	2.675	4.990	2.407	11.330	-[2]
	plume		-	-	-	.003	.052	-	-	-	.006	.022	.008	.013	.011	.065	.026

1 Total includes Cosmic, terrestrial γ, and plume, where cosmic is assumed to contribute 3.6 μR/h
2 Location changed

TABLE V

Calculated and TLD Estimates of Plume Exposure (mR)

Period	Exposure Time (hours	Location 20 (1.0 km NNW)		Location 15 (1.6 km N)		Location 13 (6.8 km NNE)		Location 23 (14.3 km W)	
		TLD	CALC	TLD	CALC	TLD	CALC	TLD	CALC
8/11/71-9/15	848.5	-	-	.509	.083	-.051	.063	.356	.015
9/15 - 10/5	488.0	-	-	.151	-	.176	-	.151	-
10/5-11/16	1016.5	-	-	.701	.200	-.081	.069	-.071	.018
11/16-12/14	699.0	-	-	-.209	.018	.244	.027	-.154	.003
12/14-1/13/72	728.25	.481	.448	.299	.125	.364	.066	.291	.016
1/13 - 2/8	631.75	.076	.036	.139	.023	-.366	.010	.057	.002
2/8-3/9	712.5	.029	.025	-.271	.039	-.199	.034	.099	.005
3/7-4/19	1054.0	.221	.187	-.158	.131	-.126	.035	-.337	.015
4/19-5/18	746.0	.709	.188	.187	.166	.052	.077	.209	.016
5/18-6/28	1010.67	3.103	1.971	2.709	1.500	2.628	.873	.768	.162
6/28-8/10	1042.0	2.334	2.546	3.636	2.571	2.407	.773	.531	.085
8/10-9/12	802.0	1.917	1.625	1.788	1.025	.658	.637	.168	.005
TOTAL	9779.17	8.86(1)	7.086(1)	9.48	-	5.70	-	2.07	-
TOTAL* Minus 9/15-10/5	9291.17	8.86(1)	7.086(1)	9.33	5.88	5.53	2.66	1.92	.34
*Normalized to 1 year	8760	11.5	9.2	8.8	5.5	5.2	2.5	1.8	.3

1. Total is over 6727 hours.

TABLE VI

Estimated Plume Exposures (5,000 μCi/sec noble gas release)

Jan. 17, 1973 - Jan. 30, 1974

Total Hours - 9072 Hours Plant Operation - ~ 5300

Ion Chamber Location Identification	Operation (hrs) Total	Plant Oper.	Total Exposure (mR) Meas.	Extrap.[a]	Plume Exposure (mR) Meas.	Extrap.[b]	1 Yr. Cont.[c]
11 (1.6 km NNE)	7003	~ 5100	63.1	82	0.322	0.33	0.55
12 (5.0 km NNE)	7645	~ 4600	67.5	80	0.087	0.10	0.17
13 (7.1 km NNE)	5604(7552)[d]	~ 4000	57.2(73.7)[d]	93(89)[d]	0.059	0.08	0.13
9 (2.6 km NE)	7605	~ 5100	64.5	77	0.521	0.54	0.89
10 (5.3 km NE)	6130	~ 5000	53.6	79	0.217	0.23	0.38
7 (7.9 km ENE)	8681	~ 5200	81.8	86	0.211	0.21	0.36
2 (4.7 km E)	7066	~ 4200	62.1	80	0.180	0.23	0.38

(a) Extrapolation to total 9072 hour period.

(b) Extrapolation to 5300 hours of plant operation.

(c) Extrapolation to nominal 8760 hour year.

(d) Includes 1948 hours at a nearby site.

TABLE VII

Gas Sample Analyses (Steam Jet Air Ejector)
(μCi/ml at sampling time)

	8/11/71		2/28/74	2/27/74
Nuclide	HASL	Operator	HASL	Operator
^{133}Xe	3.05(-2)	4.11(-2)	2.46(-2)	3.04(-2)
^{133m}Xe	1.04(-3)	-	-	-
^{135}Xe	6.55(-2)	7.11(-2)	3.04(-2)	2.90(-2)
^{138}Xe	-	1.61(-1)	3.30(-1)	3.32(-1)
^{85m}Kr	1.74(-2)	2.28(-2)	6.81(-3)	7.27(-3)
^{87}Kr	5.03(-2)	4.70(-2)	2.84(-2)	2.59(-2)
^{88}Kr	2.82(-2)	3.78(-2)	2.22(-2)	1.76(-2)

PART II

HASL FALLOUT PROGRAM DATA

1. Fallout Deposition

1.1 Monthly Precipitation

1.11 Sr-90 and Sr-89 in Monthly Deposition at World Land Sites

Precipitation and dry fallout are collected over monthly periods at stations in the United States and overseas. The samples are analyzed for Sr-90 and prior to 1971, for Sr-89 whenever possible. A description of the sampling network and available data for each site are given in the Appendix, Section A.

1.12 Other Isotopes at Selected Sites

At a number of stations in the United States, monthly deposition collections were analyzed for radiostrontium and other nuclides of interest to the Atomic Energy Commission. Multinuclide analyses were discontinued as of July 1967 and the complete data reported in HASL-193, p. II-4 thru II-25.

Plutonium analyses of monthly deposition were carried out at New York City, Melbourne, Seattle, Honolulu, Salisbury, Durban, and Rio de Janeiro. This program has been terminated and the complete data are given in HASL-237 on pages II-4 thru II-13.

1.2 Sr-90 and Sr-89 Deposition at Atlantic Ocean Weather Stations

Measurements of radiostrontium in precipitation and dry fallout collections at four U. S. Coast Guard Stations in the North Atlantic Ocean were carried out for comparison with land stations in the same latitude band. This program was terminated in the spring of 1972. A description of the stations and available data are given on pp. II-4 thru II-17 of HASL-274.

2. Surface Air Sampling Program

The Health and Safety Laboratory has been collecting surface air particulate samples at stations in the Western Hemisphere since January 1963. The filters are analyzed for a number of fission and activation product radionuclides as well as stable lead. A description of the program and available data are given in the Appendix, Section B.

3. Project Airstream

The Health and Safety Laboratory measures radioactivity in the lower stratosphere employing the WB-57F aircraft as a sampling platform. The aircraft are flown by the 58th Weather Reconnaissance Squadron under the direction of the 9th Weather Wing of the Air Weather Service. The missions are scheduled quarterly and the coverage extends from 75°N to 51°S latitude in the Western Hemisphere. Air filter samples are collected from 12 to 19 km altitude and analyzed for a number of radionuclides. A more complete description of the program and available data are given on pages II-7 to II-102 of this report.

4. High Altitude Balloon Sampling Program

Balloon borne filtering devices are used to collect nuclear debris at altitudes from 21 - 32 km. Balloon launchings are conducted annually at Fairbanks, Alaska, 65°N; Sioux City, Iowa, 42°N; Alamagordo, N.M., 33°N; and Panama C.Z., 9°N and quarterly at Mildura, Australia, 34°S. Filters are analyzed for a number of radionuclides. A more complete description of the program and available data are given on pages II-103 to II-139 of this report.

5. Radiostrontium in Milk and Tap Water

Strontium^{90} levels in fresh milk distributed in New York City and tap water sampled at the Health and Safety Laboratory, have been measured on a monthly basis since 1954. These data are summarized in tabular and graphical form in the Appendix, Section C, of this report.

6. Strontium^{90} in Diets

Quarterly estimates of the annual dietary intake of Sr^{90} of New York City and San Francisco residents have been made based on analyses of foods purchased at these cities every three months since 1960. Sampling in Chicago was discontinued in 1967. The program is described and available data reported on page II-4 to II-6 of this report. The 1973 data are evaluated beginning on p. I-34 of this report.

7. Strontium^{90} in Human Bone

Specimens of human vertebrae from New York City and San Francisco have been made available for Sr^{90} analysis since 1961. The results for 1972 are evaluated beginning on page I-13 of HASL-274.

Human vertebral specimens are also received, through the World Health Organization, from countries where western-type diets are not typical. The Sr^{90} data for samples received in 1973 are reported on pages II-7 to II-8 of HASL-281.

6. HASL Diet Studies: 4th Quarter 1973

Results of the measurements of the Sr-90 content of foods purchased in New York City and San Francisco during the fourth quarter of 1973 are given in the following table. Also listed are estimates of the total diet intake of Sr-90 based on these measurements and on recent consumption statistics compiled by the U. S. Department of Agriculture (1).

The estimates of dietary intake of Sr-90 are a continuation of the HASL Tri-City diet studies which were started in March of 1960. Results of the earlier measurements along with those made during the fourth quarter of 1973 are shown graphically in the figure on page II-6. More detailed discussion of the results for the entire sampling program through 1973 is presented in HASL-284 (2). A description of the sampling methods and philosophy of the HASL diet studies is given in HASL-147 (3).

REFERENCES

(1) Food consumption of Households in the United States - Spring 1964
A Preliminary Report, U.S.D.A. ARS 62-16, August 1967

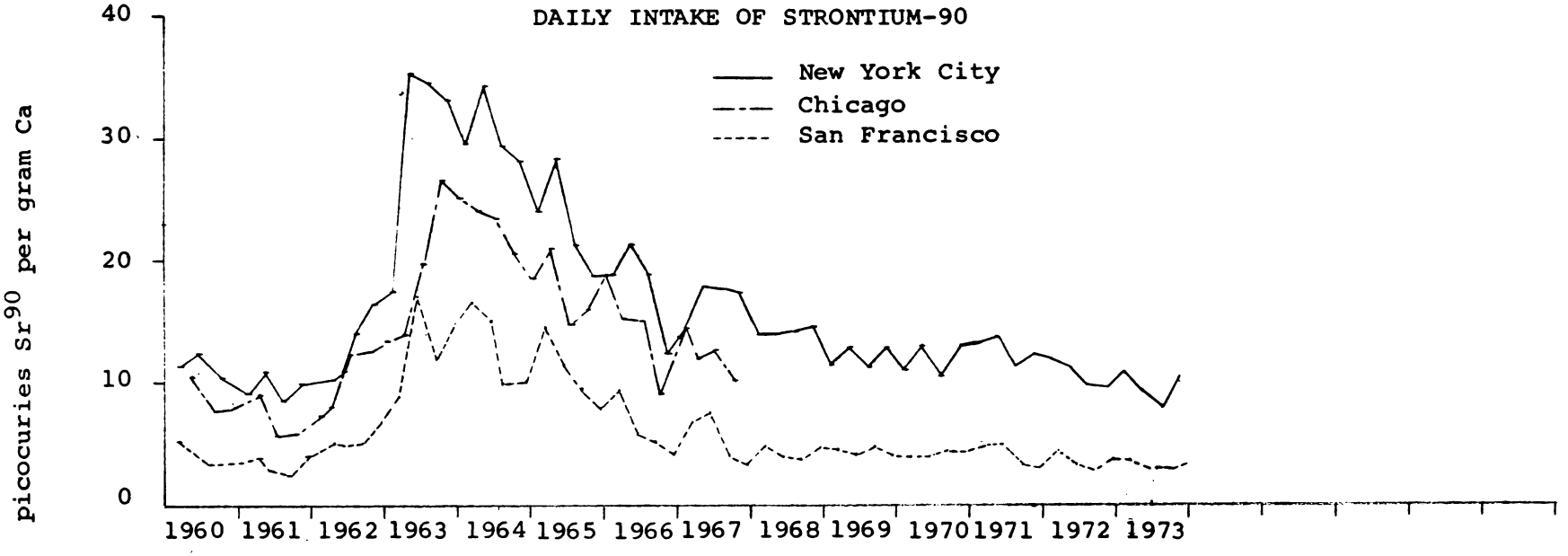
(2) Bennett, B.G.
Strontium-90 in the Diet - Results through 1973
USAEC Report HASL-284, July (1974), p. I-34

(3) Rivera, J. and Harley, J. H.
HASL Contributions to the Study of Fallout in Food Chains
USAEC Report HASL-147, July (1964)

STRONTIUM-90 IN NEW YORK CITY AND SAN FRANCISCO DIETS

- Fourth Quarter 1973 -

Diet Category	kg/yr	gCa/yr	% of yearly intake of Ca	NEW YORK CITY - NOVEMBER pCi ^{90}Sr/kg	NEW YORK CITY - NOVEMBER pCi ^{90}Sr/yr	NEW YORK CITY - NOVEMBER % of yearly intake of ^{90}Sr	SAN FRANCISCO - DECEMBER pCi ^{90}Sr/kg	SAN FRANCISCO - DECEMBER pCi ^{90}Sr/yr	SAN FRANCISCO - DECEMBER % of yearly intake of ^{90}Sr
DAIRY PRODUCTS	200	216.0		5.1	1023		1.3	262	
			58			27			22
FRESH VEGETABLES	48	18.7		15.5	745		2.1	99	
CANNED VEGETABLES	22	4.4		9.5	209		4.7	103	
ROOT VEGETABLES	10	3.8		8.9	89		3.3	33	
POTATOES	38	3.8		6.5	249		5.1	193	
DRY BEANS	3	2.1		23.0	69		10.9	33	
			9			35			38
FRESH FRUIT	59	9.4		13.3	787		1.9	110	
CANNED FRUIT	11	0.6		1.1	12		0.9	10	
FRUIT JUICES	28	2.5		3.1	87		1.7	49	
			3			23			14
BAKERY PRODUCTS	44	53.7		4.5	196		2.5	111	
FLOUR	34	6.5		5.2	176		2.6	87	
WHOLE GRAIN PRODUCTS	11	10.3		7.8	86		4.2	46	
MACARONI	3	0.6		3.4	10		2.5	7	
RICE	3	1.1		1.4	4		1.3	4	
			20			12			21
MEAT	79	12.6		0.8	63		0.4	35	
POULTRY	20	6.0		0.6	12		0.5	10	
EGGS	15	8.7		1.5	22		0.9	14	
FRESH FISH	8	7.6		0.4	3		0.6	5	
SHELL FISH	1	1.6		1.4	1		0.9	1	
			10			3			5
YEARLY INTAKE		370g			3843 pCi			1212 pCi	
DAILY INTAKE					10.4 pCi/gCa			3.3 pCi/gCa	


DAILY INTAKE OF STRONTIUM-90
New York City
Chicago
San Francisco
picocuries Sr^{90} per gram Ca
40
30
20
10
0
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973

NOTICE

Project Airstream to Continue

In a recent significant development concerning stratospheric sampling and research, the National Aeronautics and Space Administration has agreed to operate a WB-57F for the Atomic Energy Commission and the Department of Transportation. This aircraft will be used to conduct a modified version of Project Airstream and the monitoring and experiments sub-program of the Climatic Impact Assessment Program.

Project Airstream will be conducted three times a year (July, October, and April) from the Johnson Space Center, Houston, Texas, to provide samples at four stratospheric altitudes from 75°N latitude to 10°S, approximately along the old Airstream track. The first Airstream cycle under this new arrangement will be conducted in October 1974.

The balloon borne sampler program (Project Ash Can) will be scheduled to extend sampling altitudes to 70, 80, and 90K ft three times a year at Holloman Air Force Base to coincide with the aircraft program, and annually in Spring at Panama and Alaska.

This notice supersedes the announcements concerning Project Airstream appearing in HASL-276, October 1, 1973, and HASL-281, April 1, 1974.

3. PROJECT AIRSTREAM

by P. W. Krey, (HASL)
L. E. Toonkel, (HASL)
M. Schonberg, (HASL)

Project Airstream is HASL's study of radioactivity in the lower stratosphere employing the RB-57F aircraft as a sampling platform. The aircraft are flown by the 58th Weather Reconnaissance Squadron under the direction of the 9th Weather Wing of the Air Weather Service. This project is a continuation of the Defense Atomic Support Agency's Project Stardust except that Airstream's sampling missions are limited to only one per season.

This report contains the radiochemical data from the missions flown in January, September and November 1973 and in January 1974. Previous reports containing results from this program are given in references 1 through 21.

FLIGHT SCHEDULE

Airstream missions are generally scheduled for January, April, July and October with a ± one month slippage. In calendar year 1973, however, the missions were flown in January, June, September, and November. Each mission is usually completed within a nine day interval. The first Airstream mission was flown in August 1967.

Because of budgeting and other compelling considerations Project Airstream as it is presently structured will terminate after the April 1974 mission. The flight trajectory and altitude coverage of a current Airstream mission are shown in Figures 3a and 3b respectively.

The coverage in Figure 3b extends almost continuously at the indicated altitudes from 75°N to 51°S latitude except for a slight discontinuity between 10°S to 16°S. Each mission is accomplished by conducting return flights northward and southward from each of the four Air Force Bases of operation:

Eielson AFB	64°40'N	147°06'W
Kirtland AFB	35°03'N	106°36'W
Albrook AFB	08°57'N	79°34'W
Mendoza AFB	32°49'S	68°47'W

Because of equipment failure in the September 1973 mission, coverage from 11°S to 33°S at 19.2 km and from 9°N to 32°S at 18.3 km is missing.

AIR FILTER SAMPLES

Air filter samples are collected along the flight tract at latitude increments of approximately 3 to 4° at each of the prescribed altitudes using the U-1 foil system. This system permits the sequential insertion of up to 13 IPC No. 1478 filter papers (diameter $16\frac{3}{8}$") into the sampling duct near the bomb bay on the

right side of the aircraft. The volume of air sampled by each filter is calculated by the methods developed under Project Stardust and updated by Krajewski, (22) and are reported as standard cubic meters (SCM) under the ICAO standard atmosphere (760 mm Hg and 15°C).

Beginning with the July 1972 mission, a cooperative program was initiated with the National Center for Atmospheric Research (NCAR) in which the filters from the Airstream missions are shared. NCAR is investigating the concentrations of stable tracers in the stratosphere with emphasis on water soluble stable tracers. To minimize the background contamination of these tracers in the filter material, NCAR washes each filter prior to exposure in the aircraft and special precautions are then taken in their installation and recovery. Tests conducted by NCAR and HASL show no demonstrable difference in collection efficiency between washed and unwashed filters. (16)

TOTAL GAMMA AND GAMMA SPECTRUM MEASUREMENTS

The filters are sent to NCAR where they are cut into sixths under "clean room" conditions. To minimize the impact of any heterogeneity of debris on the filter, opposite sixths are combined into composite thirds. One third is analyzed by NCAR; one third

is analyzed by HASL; and one third is reserved for the HASL library of stratospheric samples.

At HASL the one third fraction intended for analysis is folded and placed in a plastic box, 8 cm X 6.5 cm X 3.1 cm deep, for a gross gamma measurement on an 8" X 4" NaI (Tl) crystal. The total gamma activity is integrated between 100 keV and 2.0 MeV, and the gamma concentration is reported as counts per minute (cpm) per 100 SCM on the counting date.

Based upon the gamma measurements, the one-third sections of each filter are usually combined into appropriate composite samples which are submitted to gamma spectral analysis at HASL by lithium drifted germanium diode detectors. The composite samples are compressed into a 6 cm diameter by 3.5 cm depth aluminum can. The detectors are closed-end coaxial diodes of approximately 50 cm^3 volume with the following characteristics for the 1.33 MeV photon of Co-60:

Point source efficiency at diode face: 1.2 - 1.7%
Resolution: 2.1 - 2.6 keV
Peak-to-Compton: about 30 to 1

The diode responses are stored in 3000 channels of a computer based pulse height analyzer. A computer program resolves and

reduces these spectra data by least squares fitting and has a subroutine which adjusts for the density of the sample. Presently the nuclides of interest from the diode spectrometry are Be-7, Zr-95, Cs-137 and Ce-144. The germanium diode systems have been calibrated with standard solutions prepared at HASL. An efficiency versus energy curve has been prepared (shown in Figure 3c) which illustrates the interrelation between standards and which lends greater reliability to the individual photon energy efficiencies.

RADIOCHEMICAL ANALYSIS

After the gamma measurements are completed, the composite samples are sent to contractor laboratories for detailed radiochemical analyses including some of the following nuclides:

Sr-89	Pb-210	Pu-238
Sr-90	Po-210	Pu-239, 240

At the present time, Laboratory for Electronics Environmental Analysis Laboratory (formerly Trapelo Division/West), Richmond, California is performing these analyses. Nuclide concentrations from radiochemical analyses are reported as picocuries per 100 standard cubic meters of air (pCi/100 SCM) at collection time. To convert pCi/100 SCM to disintegrations per minute per 10^3 standard cubic feet multiply by 0.629.

One standard deviation of the counting error for all data in this report is less than ±20% unless annotated with the symbols:

A: One standard deviation of the counting error is between ±20 - 50%.

B: One standard deviation of the counting error is between ±51 - 100%.

*: Activity is not detectable. This designation is applied to data when one standard deviation of the counting error is greater than ±100%.

?: The nuclide concentration of a specific sample is considered suspect because it is inconsistent with the concentration of the same nuclide in adjacent samples in space and time or because it is inconsistent with other nuclides in the same sample.

The nuclide activity for each sample is corrected for the normal radiochemical parameters such as chemical yield and detection efficiency.

Po-210 is analyzed as rapidly as possible after the samples are received in the laboratory. The Po-210 data are reported as concentrations at collection time, and are corrected for the Po-210 which grew in from Pb-210 during the interval between collection and analysis of the filter. If the Po-210 at the time of analysis exceeds the Pb-210, the excess is corrected with a 138 day half-life to collection and added to the equilibrium value of the Pb-210. This rarely happens, and the data is likely to be considered suspect when it does.

Pb-210 is analyzed by measuring the Po-210 ingrowth during a four month interval from a purified lead fraction to provide a greater sensitivity of analysis. Because of this ingrowth interval, the Pb-210 and Po-210 results are reported at a later time than the other radionuclides.

QUALITY CONTROL

To evaluate HASL's gamma ray spectrometry and the contractor's radiochemistry, blind blanks, standards and duplicates are routinely submitted for analysis. Some blanks represent pre-washed filters exposed at altitudes for 5 seconds in filter position number 4 or 7 of the U-1 foil system. It has been shown that these blanks can be contaminated by stratospheric particulates as a result of their short exposure time and because of leakage of sealant gaskets in the U-1 system. (21) To test the degree of contamination introduced by normal laboratory analyses only, appropriate sizes of filter material taken from stock are also submitted as blind blanks.

The duplicates are identical composites of one sixth of each filter. To reduce the effect of heterogeneity of debris on the filter and thereby improve the quality of the duplicate, each one sixth is made up of opposite one twelfths of the original filter.

Standards for radioachemistry are unwashed and unexposed filters of IPC-1478 paper on to which calibrated solutions of various nuclides have been evaporated. These calibrated solutions are available from a number of sources (i.e., Radiochemistry Center, IAEA, Nuclear Chicago) and are recalibrated at HASL. Generally, the agreement between HASL's value and the reported value is very good.

For gamma ray spectrometry prepared standards are made by mixing calibrated solutions of gamma emitting radionuclides with a 1% solution of Agar-Agar. These were found to be a reliable index of quality control for spectrometry because of the uniform distribution of radioactivity within the sample can. (15) The Agar standards are used exclusively to evaluate the quality of the gamma ray spectrometric analyses. The sample numbers of the standards are changed after each analysis so that they can be re-used many times. Because of a reduction in activity in the current Agar standards due to radioactive decay, a new set was prepared beginning with the November 1973 mission.

RESULTS

The Pb-210 and Po-210 results from the January 1973 mission are reported in Table 3a. Radiochemical data for the September 1973

mission are given in Table 3b, and the gamma spectral results for the November 1973 flights are presented in Table 3c. Gross gamma concentrations and gamma spectrometry results for January 1974 are reported in Tables 3d and 3e, respectively.

The samples in these tables are grouped according to altitude of collection beginning with 19.2 km. Within each altitude group, the samples are then listed with decreasing latitude. The 1/3 fraction of each individual filter making up the composite are listed immediately below the composite sample number. In the case of duplicates, the ½ fraction reported in the tables is one half of the 1/3 section and in reality is 1/6 of the exposed filter. The collection parameters of the composite sample and the contractor laboratory performing the analyses are given prior to the nuclide concentrations.

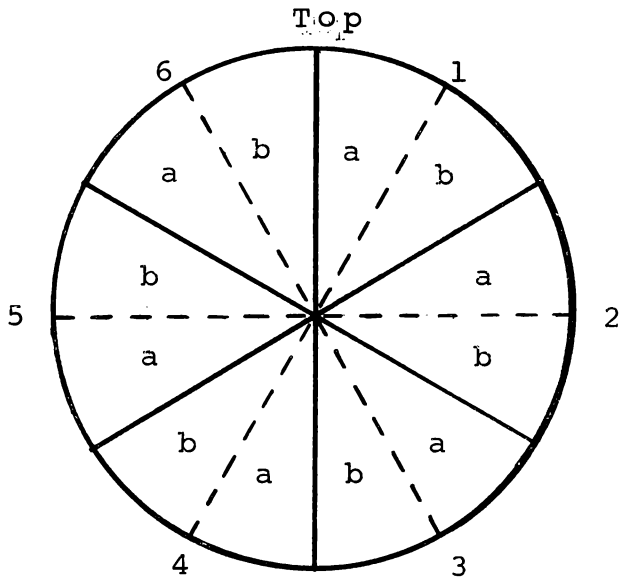
The results of the quality control program for Pb-210 and Po-210 analyses are given in Table 3f. Similar quality control data for Be-7 and the artificially produced radionuclides are reported in Table 3g.

Blanks

Six blanks from the September 1973 mission which had relatively high gross gamma contamination were autoradiographed and found

to have uniform activity density.(21) Some of these blank filters were exposed for a few seconds to the airstream during stratospheric flights while others remained in the storage magazine of the U-1 filter system throughout the flight. To more quantitatively define the activity density of these blank filters, each of the four 1/6 sections received were gamma counted, and the data are listed in Table 3h.

The filters are cut at NCAR in a reproducible manner and the same sections of all filters are reserved for specific analyses. For example:



NCAR analyzes the 1/6 sections labeled 3-6, HASL analyzes the 2-5 sections, and the 1-4 sections are usually reserved in the library of samples. Table 3h verifies the uniform density of the

autoradiographs and shows only a slight enhancement of activity in the 2, 3, 4 sections of the exposed blanks. This enhancement can be due to the off-center placement of the sampling port of the U-1 filter system and a preferential direction of influent air by the inlet butterfly valve.

The conclusion of these studies remains as originally proposed.[21] The flown blanks are contaminated in the magazine storage compartment of the U-1 filter system as a result of leakage to the ambient atmosphere. In addition those blanks which are inserted into the sampling duct for only a few seconds are contaminated further. The degree of contamination from either cause is related to the ambient concentrations and their gradients at flight altitude.

The blank filters analyzed in Tables 3f and 3g were selected from gross gamma measurements as normal blanks in that they reflected no excessive radioactivity. Some of these blanks were installed in the aircraft and exposed at altitude for a few seconds, some were installed in the aircraft and not exposed, and one was taken from stock and not installed at all. The analyses of these normal blanks indicated that the contamination inherent in the filter or introduced during normal handling and laboratory operations is either not detectable or unimportant to the activities encountered in the collected samples.

Standards

The results of the Pb-210 standards given in Table 3f reflect a positive bias of 10% which has been a consistent but unresolved pattern for the last 6 missions. The Po-210 data show a negative bias of 20% which is caused by the inaccuracy of the Pb-210 measurements.

As described earlier, (21) the Po-210 radioassay at the time of its separation from Pb-210 is adjusted for the quantity of Po-210 which grows in between separation time and the fictitious date assigned as collection time for the blind standard. An error in the Pb-210 analysis builds in an error in the reported Po-210 result. The excellent agreement in Table 3f between the Po-210 results at separation time and the added quantities demonstrates this effect and recommends the accuracy of the Po-210 analysis.

The analyses of the radiochemical standards prepared for the September 1973 mission in Table 3g demonstrate an accuracy of within ±8% for the nuclides examined.

The data from the gamma spectrometric analyses of the Agar standards in Table 3g shows agreement for all nuclides to within ±10%. There appears to be a negative bias of about 8% for Zr-95

and a positive bias of about 10% for Ce-144. These results are similar to the long term trends observed from the earlier set of Agar standards (21) and suggests some small defect in the preparation of these standards or a slight error in the calibration curve of the lithium diode detector.

Duplicates

The percent deviation between the analyses of duplicate samples is shown in Tables 3f and 3g. It represents the range between duplicates divided by the mean and expressed in percent. The results with few exceptions indicate agreement between duplicates within the precision of the individual measurements.

Representivity of Aliquots

To test the representivity of analyzing the 1/3 sections of each filter and the reliability of preparing duplicates from 1/6 sections of some filters, relatively high activity samples from the September 1973 mission were cut according to the diagram presented earlier. The 1/6 sections were bisected into "a" and "b" fractions as indicated which are 1/12 fractions of the original filters.

Opposite 1/12 fractions ("a's" or "b's") were then recombined into 1/6 sections and radioassayed to test for reproducibility. For example the identification of the opposite 1/12 "a" fractions of sections 1 and 4 of sample 7227 which are recombined into a 1/6 section is 7227-1,4-a. The combined 1/12 "b" fractions of the same two sections is 7227-1,4-b. The gross gamma activity and some gamma spectrometry results of these 1/6 sections are presented in Table 3j.

The average percent deviation of the gross gamma measurements between the 1/6 duplicate sections of each filter defined as the spread between duplicates divided by the mean is 9.2%. For the gamma spectroscopy results the average deviation is 4.6%. Therefore under normal circumstances the precision between the 1/6 duplicates as routinely prepared under the quality control program of this project should be within 10%.

From this precision it follows that the 1/6 sections should be very representative of the entire filter, and indeed they are as shown by the last column of Table 3j. It also follows that if these 1/6 sections are representative, then surely the 1/3 sections prepared from opposite 1/6 sections would also be representative which is the normal method of aliquoting filters in Project Airstream.

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10. Ibid, USAEC Report HASL-239, January (1971)

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12. Ibid, USAEC Report HASL-243, July (1971)

13. Ibid, USAEC Report HASL-245, October (1971)

14. Ibid, USAEC Report HASL-249, April (1972)

15. Ibid, USAEC Report HASL-259, October (1972)

16. Ibid, USAEC Report HASL-268, January (1973)

17. Ibid, USAEC Report HASL-273, April (1973)

18. Ibid, USAEC Report HASL-274, July (1973)

19. Ibid, USAEC Report HASL-276, October (1973)

20. Ibid, USAEC Report HASL-278, January (1974)

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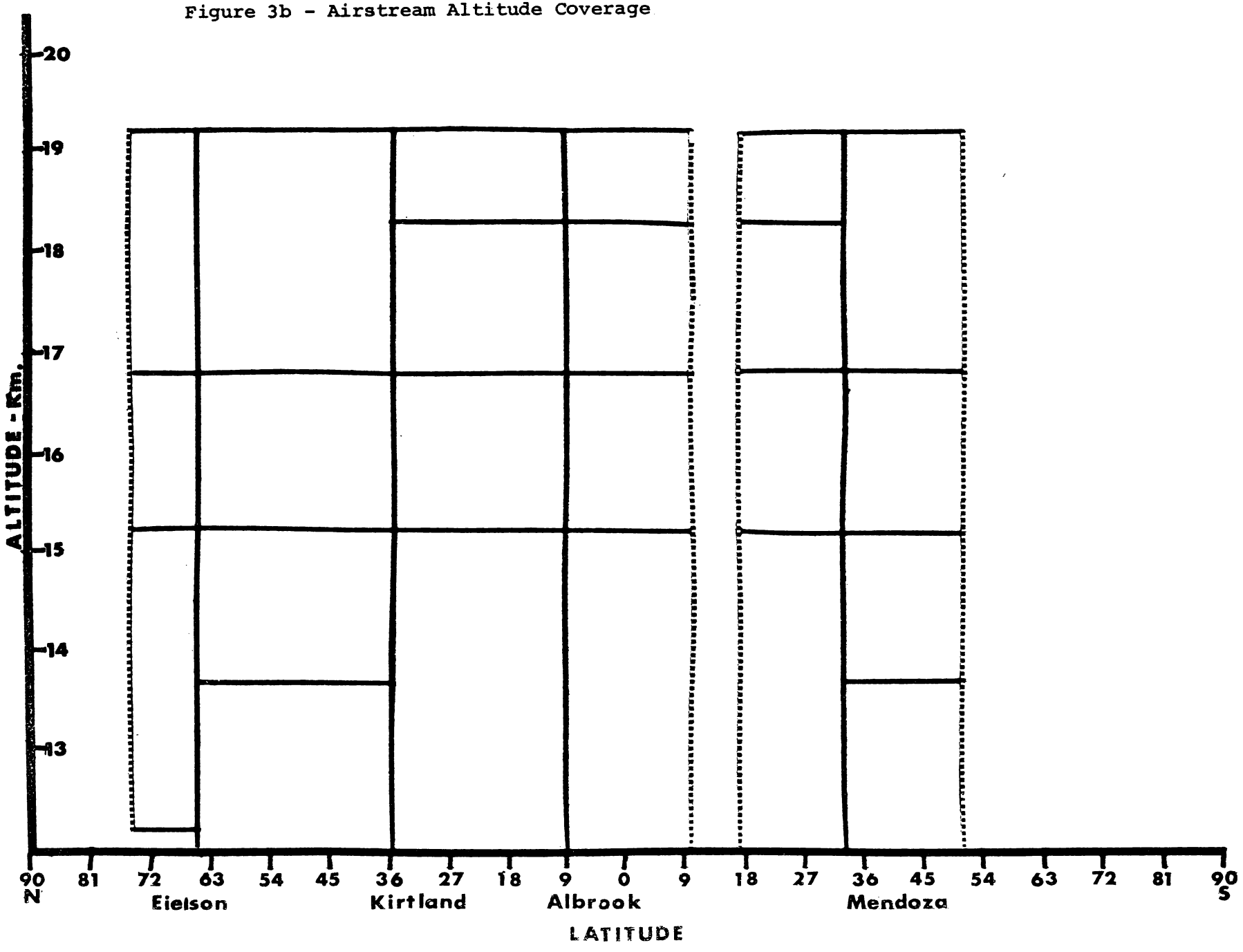
22. Krajewski, B.
    Calculations of Stratospheric Air Sample Volumes
    USAEC Report HASL-211, July (1969)

Figure 3a - Airstream Flight Trajectory

Figure 3b - Airstream Altitude Coverage



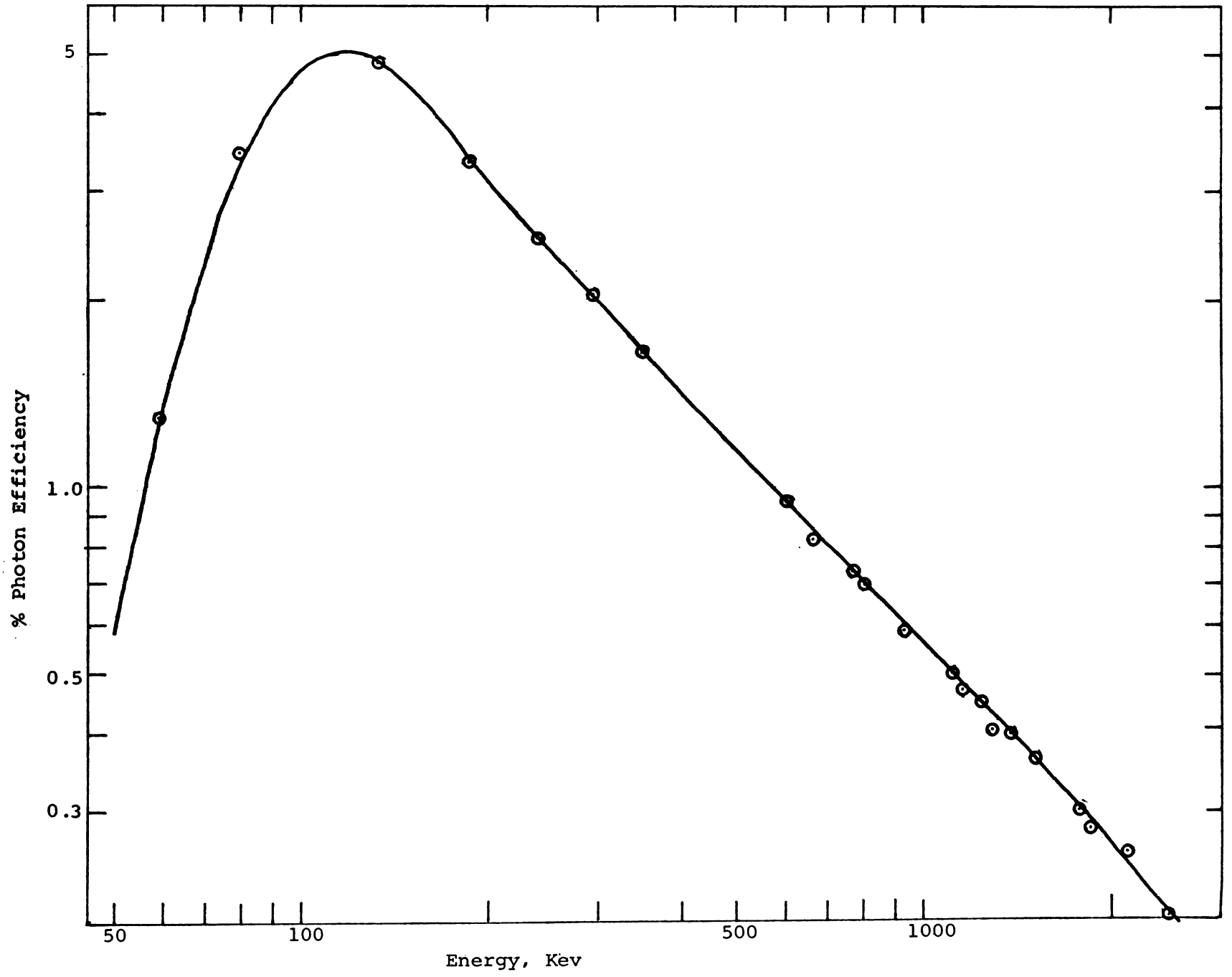


Fig. 3c - Calibration Curve of Germanium (Li) Diode Spectrometer

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

			19.2 KM		
SAMPLE No.	6847	6848	6849	6914	6850
COMPOSED OF:	6636	6625	1/2:6791 6792 6793 6709	1/2:6791 6792 6793 6709	6708 6707
MIDPOINT OF COLLECTION					
DATE	1/23/73	1/17/73	1/26/73	1/26/73	1/24/73
LAT.	68N-65N	64N-62N	43N-31N	43N-31N	31N-25N
LONG.	146W-144W	146W-140W	122W-100W	122W-100W	100W-90W
VOL. OF AIR (100 SCM)	0.670	0.820	2.060	2.060	2.730
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.428A	0.539A	0.714	0.633	0.694
PO-210	0.568	*	0.300	0.432A	0.693A

			19.2 KM		
SAMPLE NO.	6852	6853	6854	6855	6856
COMPOSED OF:	6680	6682 6683	6684 6685	6745 6744 6743 6742	6740 6776
MIDPOINT OF COLLECTION					
DATE	1/16/73	1/16/73	1/16/73	1/23/73	1/21/73
LAT.	23N-20N	20N-14N	14N-9N	9N-7S	7S-18S
LONG.	88W-86W	86W-82W	82W-79W	79W-79W	79W-76W
VOL. OF AIR (100 SCM)	1.270	2.130	1.720	4.280	2.280
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.866	1.239	0.854	1.088	0.886
PO-210	0.539B	0.511B	1.033A	0.794A	0.758A

A: COUNTING ERROR IS 20-50 PERCENT *: NOT DETECTABLE
B: COUNTING ERROR IS 51-100 PERCENT
?: DATA SUSPECT

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

19.2 KM

SAMPLE NO.	6857	6915
COMPOSED OF:	1/2:6778 6779 6780 6781	1/2:6778 6779 6780 6781
MIDPOINT OF COLLECTION		
DATE	1/19/73	1/19/73
LAT.	18S-33S	18S-33S
LONG.	76W- 68W	76W- 68W
VOL. OF AIR (100 SCM)	.2.300	2.300
		PC/100 SCM
LAB:	LFE	LFE
PB-210	0.774	0.756
PO-210	0.731A	0.538A

18.9 KM

SAMPLE NO.	6858	6859	6860
COMPOSED OF:	6634 6635	6624 6623 6622	6788 6790
MIDPOINT OF COLLECTION			
DATE	1/23/73	1/17/73	1/27/73
LAT.	74N-68N	62N-53N	49N-43N
LONG.	144W-141W	138W-121W	122W-114W
VOL. OF AIR (100 SCM)	1.590	2.930	1.810
			PC/100 SCM
LAB:	LFE	LFE	LFE
PB-210	0.569	0.660	0.471
PO-210	0.344B	0.412A	0.402A

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

18.3 KM

SAMPLE NO.	6861	6862	6863	6864	6865
COMPOSED OF:	6588	6676 6677 6679	6704	6703	6701 6700 6672 6721
MIDPOINT OF COLLECTION					
DATE	1/16/73	1/16/73	1/24/73	1/24/73	1/23/73
LAT.	35N-33N	32N-24N	23N-20N	20N-17N	17N- 5N
LONG.	106W-104W	102W- 89W	88W- 86W	86W- 84W	84W- 79W
VOL. OF AIR (100 SCM)	0.900	4.380	1.230	1.310	4.210
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.544	0.806	0.427	1.415	0.801
PO-210	0.424B	0.396A	*	0.750A	0.320A

18.3 KM

SAMPLE NO.	6866	6867	6868	6869
COMPOSED OF:	6720 6719 6718 6716	6728 6730 6731	6732 6733	6757 6756 6755 6754
MIDPOINT OF COLLECTION				
DATE	1/22/73	1/17/73	1/17/73	1/20/73
LAT.	5N-14S	15S-25S	25S-33S	33S-50S
LONG.	79W- 77W	77W- 73W	73W- 68W	68W- 65W
VOL. OF AIR (100 SCM)	6.770	3.890	3.600	4.900
			PC/100 SCM	
LAB:	LFE	LFE	LFE	LFE
PB-210	0.726	0.842	0.774	0.434
PO-210	0.263A	0.218B	0.357A	0.248A

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

16.8 KM

SAMPLE NO.	6870	6871	6872	6873	6874
COMPOSED OF:	6632 6631 6629	6628 6784 6785	6787 6620 6619	6617 6616 6587	6661 6660
MIDPOINT OF COLLECTION					
DATE	1/23/73	1/26/73	1/20/73	1/17/73	1/23/73
LAT.	75N-66N	66N-56N	56N-43N	43N-35N	35N-28N
LONG.	145W-143W	145W-125W	125W-113W	113W-106W	106W- 95W
VOL. OF AIR (100 SCM)	2.890	5.350	4.710	3.820	5.800
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.407	0.592	0.798	0.914	0.870
PO-210	0.298A	0.184B	0.500A	0.529A	0.532A

16.8 KM

SAMPLE NO.	6875	6876	6877	6878	6879
COMPOSED OF:	6659 6644	6646 6647 6648 6649	6671 6668 6736 6737	6738 6739 6775	6774 6773 6772
MIDPOINT OF COLLECTION					
DATE	1/19/73	1/15/73	1/23/73	1/22/73	1/19/73
LAT.	28N-20N	20N- 9N	9N- 3S	3S-19S	19S-31S
LONG.	95W- 86W	86W- 79W	79W- 79W	79W- 75W	75W- 69W
VOL. OF AIR (100 SCM)	5.700	6.270	5.620	6.560	6.220
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.893	0.635	0.647	0.795	0.614
PO-210	0.494A	*	0.205B	0.125B	0.176B

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

16.8 KM

SAMPLE NO.	6880	6881
COMPOSED OF:	6768	6767 6766 6764
MIDPOINT OF COLLECTION		
DATE	1/19/73	1/19/73
LAT.	31S-36S	36S-51S
LONG.	66W- 65W	68W- 65W
VOL. OF AIR (100 SCM)	2.300	6.320
	PC/100 SCM	
LAB:	LFE	LFE
PB-210	0.810	0.840
PO-210	0.554B	0.760A

15.2 KM

SAMPLE NO.	6882	6883	6884	6885	6886
COMPOSED OF:	6608 6611 6612 6697	6696 6695 6694	6595 6594 6593 6592	6585 6584	6640 6641
MIDPOINT OF COLLECTION					
DATE	1/26/73	1/26/73	1/15/73	1/16/73	1/15/73
LAT.	75N-61N	61N-53N	51N-37N	37N-32N	33N-27N
LONG.	148W-136W	136W-122W	119W-108W	108W-104W	104W- 93W
VOL. OF AIR (100 SCM)	9.550	5.950	9.170	3.700	6.110
	PC/100 SCM				
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.773	0.753	0.848	*?	0.877
PO-210	0.595A	0.561	0.654	*?	0.497

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

15.2 KM

SAMPLE NO.	6887	6888	6889	6890	6891
COMPOSED OF:	6643 6656 6655 6653 6652	6664 6665 6667 6724	6725 6726 6727	6715 6714 6713	6712 6748
MIDPOINT OF COLLECTION					
DATE	1/21/73	1/22/73	1/17/73	1/22/73	1/21/73
LAT.	27N-12N	12N- 1N	1N-12S	15S-27S	27S-37S
LONG.	92W- 81W	81W- 79W	79W- 78W	77W- 72W	72W- 65W
VOL. OF AIR (100 SCM)	10.440	7.580	9.930	7.880	5.700
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
PB-210	0.536	0.456	0.581	1.280 ?	0.944
PO-210	0.113B	*	*	*	*

15.2 KM

SAMPLE NO.	6892	6893
COMPOSED OF:	6749 6750	6751 6752
MIDPOINT OF COLLECTION		
DATE	1/20/73	1/20/73
LAT.	37S-43S	43S-51S
LONG.	66W- 65W	69W- 66W
VOL. OF AIR (100 SCM)	3.350	4.840
	PC/100 SCM	
LAB:	LFE	LFE
PB-210	0.797	0.761
PO-210	0.438A	0.255A

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3A

RADIOCHEMICAL ANALYSIS OF JANUARY 1973 COMPOSITES

			13.7 KM
SAMPLE NO.	6894	6895	6896
COMPOSED OF:	6688 6689 6690 6691 6692	6596 6598 6599 6601	6760 6761 6762 6763
MIDPOINT OF COLLECTION			
DATE	1/26/73	1/15/73	1/19/73
LAT.	63N-53N	51N-35N	34S-51S
LONG.	143W-121W	119W-106W	68W- 65W
VOL. OF AIR (100 SCM)	10.070	10.320	14.730
			PC/100 SCM
LAB:	LFE	LFE	LFE
PB-210	0.848	0.931	0.574
PO-210	0.457	0.349A	*

			12.2 KM
SAMPLE NO.	6897	6898	
COMPOSED OF:	6607	6605 6604	
MIDPOINT OF COLLECTION			
DATE	1/26/73	1/26/73	
LAT.	75N-71N	71N-65N	
LONG.	143W-143W	148W-143W	
VOL. OF AIR (100 SCM)	3.140	5.330	
			PC/100 SCM
LAB:	LFE	LFE	
PB-210	1.019	0.980	
PO-210	0.549A	0.370A	

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7398	7455	7399	7400	7401	
COMPOSED OF:	1/2:7303	1/2:7303	7304 7305	7306	7342	
MIDPOINT OF COLLECTION						
DATE	9/ 7/73	9/ 7/73	9/ 7/73	9/ 7/73	9/ 6/73	
LAT.	75N-72N	75N-72N	72N-67N	67N-65N	65N-62N	
LONG.	145W-143W	145W-143W	147W-145W	148W-147W	148W-138W	
VOL. OF AIR (100 SCM)	0.330	0.330	1.210	0.570	1.150	
			PC/100 SCM			
LAB:	LFE	LFE	LFE	LFE	LFE	
BE-7	14100.000A	*	983.000A	*	*	
SR-89	140000.000	178000.000	32100.000	10300.000	123000.000	
SR-90	2590.000	2890.000	528.000	179.000	1830.000	
ZR-95	334000.000	344000.000	49900.000	18400.000	10100.000	?
CS-137	5110.000	4970.000	759.000	287.000	140.000	?
CE-144	118000.000	127000.000	17600.000	6620.000	3480.000	?
PU-238	0.276B	0.395A	0.111A	0.095B	0.286	
PU-239	48.800	54.900	9.750	3.261	35.800	

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7402	7403	7404	7405	7406
COMPOSED OF:	7341	7340 7339	7231 7233	7234	7235 7236 7266
MIDPOINT OF COLLECTION					
DATE	9/ 6/73	9/ 6/73	9/10/73	9/10/73	9/12/73
LAT.	62N-59N	59N-52N	50N-43N	43N-40N	40N-31N
LONG.	138W-130W	130W-120W	118W-112W	112W-110W	110W-100W
VOL. OF AIR (100 SCM)	1.140	2.200	2.070	0.890	3.530
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	*	*	*	1650.000A	1250.000
SR-89	24500.000	6530.000	39400.000	16800.000	956.000
SR-90	401.000	123.000	653.000	289.000	29.200
ZR-95	41900.000	11700.000	66800.000	26700.000	1600.000
CS-137	668.000	190.000	979.000	410.000	46.600
CE-144	14300.000	4180.000	24600.000	10100.000	651.000
PU-238	0.101A	0.042B	0.117	*	0.034A
PU-239	7.393	2.371	12.000	5.147	0.506

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7407	7408	7409	7410	7411
COMPOSED OF:	7265 7264	7273 7275 7276 7277	7278	7375 7374 7373	7372 7370
MIDPOINT OF COLLECTION					
DATE	9/15/73	9/ 5/73	9/ 5/73	9/19/73	9/19/73
LAT.	31N-25N	23N-11N	11N- 9N	9N- 3S	3S-11S
LONG.	100W- 90W	87W- 80W	80W- 79W	79W- 79W	79W- 78W
VOL. OF AIR (100 SCM)	2.560	3.260	0.540	3.090	2.050

PC/100 SCM

LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	820.000	669.000	727.000A	383.000	385.000
SR-89	471.000	110.000	230.000	27.500A	11.200A
SR-90	20.600	12.500	14.400	12.000	11.100
ZR-95	820.000	188.000	219.000	48.100	*
CS-137	31.700	16.900	16.000A	17.200	15.500
CE-144	331.000	91.100	204.000	55.800	35.600
PU-238	0.035B	0.038A	0.119B	0.046A	0.044B
PU-239	0.382	0.257	0.774 ?	0.275	0.228

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7412
COMPOSED OF:	7256 7255 7254
MIDPOINT OF COLLECTION	
DATE	9/ 9/73
LAT.	33S-44S
LONG.	67W- 65W
VOL. OF AIR (100 SCM)	2.800

PC/100 SCM

LAB:	LFE
BE-7	1350.000
SR-89	*
SR-90	28.000
ZR-95	4.826
CS-137	40.500
CE-144	97.200
PU-238	0.063A
PU-239	0.502

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

18.9 KM

SAMPLE NO.	7413
COMPOSED OF:	7253
MIDPOINT OF COLLECTION	
DATE	9/ 9/73
LAT.	44S-47S
LONG.	67W- 67W
VOL. OF AIR (100 SCM)	0.770

PC/100 SCM

LAB:	LFE
BE-7	731.000
SR-89	*
SR-90	30.700
ZR-95	46.300B
CS-137	37.700
CE-144	98.900
PU-238	*
PU-239	0.464

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

18.3 KM

SAMPLE NO.	7414	7415	7416	7417
COMPOSED OF:	7243 7269 7270	7271 7272	7393	7394 7395 7396
MIDPOINT OF COLLECTION				
DATE	9/10/73	9/ 5/73	9/18/73	9/18/73
LAT.	35N-27N	27N-25N	24N-20N	20N- 9N
LONG.	106W- 93W	93W- 90W	88W- 86W	86W- 79W
VOL. OF AIR (100 SCM)	4.250	1.130	1.350	4.410

PC/100 SCM

LAB:	LFE	LFE	LFE	LFE
BE-7	1430.000	1390.000A	637.000	501.000
SR-89	3510.000	Lost	624.000	377.000
SR-90	66.400	Lost	22.200	13.000
ZR-95	6250.000	3030.000	1270.000	616.000
CS-137	102.000	55.800	32.600	18.500
CE-144	2270.000	1080.000	497.000	265.000
PU-238	0.050A	*	*	0.022B
PU-239	1.327	0.651	0.352	0.250

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7418	7419	7420	7456	7421
COMPOSED OF:	7301 7300 7298	7297	1/2:7227	1/2:7227	7228 7230
MIDPOINT OF COLLECTION					
DATE	9/ 7/73	9/ 7/73	9/10/73	9/10/73	9/10/73
LAT.	75N-66N	66N-63N	63N-60N	63N-60N	60N-52N
LONG.	145W-143W	145W-142W	142W-133W	142W-133W	133W-120W
VOL. OF AIR (100 SCM)	3.200	1.750	0.960	0.960	4.230
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	*	2310.000	2360.000A	*	1220.000A
SR-89	25000.000	7600.000	17400.000	18000.000	2860.000
SR-90	421.000	116.000	283.000	307.000	58.000
ZR-95	40500.000	14300.000	37100.000	34600.000	5140.000
CS-137	588.000	239.000	563.000	568.000	97.800
CE-144	14800.000	4920.000	13100.000	12600.000	1870.000
PU-238	0.117	0.068A	0.063B	0.058B	0.042A
PU-239	7.683	2.532	6.067	6.001	1.092

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7422	7423	7424	7425	7426
COMPOSED OF:	7337 7336	7334 7333	7242	7260 7261	7219
MIDPOINT OF COLLECTION					
DATE	9/ 6/73	9/ 6/73	9/19/73	9/15/73	9/ 5/73
LAT.	50N-43N	43N-37N	37N-32N	31N-25N	23N-20N
LONG.	118W-112W	112W-108W	108W-101W	100W- 90W	89W- 86W
VOL. OF AIR (100 SCM)	3.440	2.980	0.950	5.090	2.300
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1130.000A	857.000	849.000	751.000	868.000
SR-89	2270.000	618.000	844.000	166.000	505.000
SR-90	42.600	13.300	19.200	5.657	12.200
ZR-95	3890.000	1130.000	1550.000	319.000	793.000
CS-137	69.100	20.700B	31.100	8.027	18.000
CE-144	1450.000	399.000	593.000	122.000	288.000
PU-238	0.026B	0.019B	*	*	*
PU-239	0.830	0.297	0.356	0.098	0.254

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7427	7428	7429	7430	7431
COMPOSED OF:	7221 7222	7378 7357 7358	7359 7360	7313 7315 7316 7317	7318 7289 7288
MIDPOINT OF COLLECTION					
DATE	9/ 5/73	9/18/73	9/17/73	9/ 7/73	9/ 8/73
LAT.	20N-14N	9N- 3S	3S-10S	15S-29S	29S-42S
LONG.	86W- 82W	79W- 73W	79W- 78W	77W- 71W	71W- 65W
VOL. OF AIR (100 SCM)	3.170	5.550	3.410	6.460	6.360
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	558.000	256.000	297.000	625.000	864.000
SR-89	141.000	39.100	34.000	7.112	4.672A
SR-90	4.851	2.571	2.420	5.583	11.900
ZR-95	252.000	72.800	60.800	14.100A	3.966B
CS-137	7.304	3.271	4.795	8.716	17.400
CE-144	84.800	34.700	32.000	26.500	46.200
PU-238	0.029B	*	*	0.010B	0.046
PU-239	0.109	0.061	0.036A	0.095	0.199

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7432
COMPOSED OF:	7287 7285
MIDPOINT OF COLLECTION	
DATE	9/ 9/73
LAT.	42S-51S
LONG.	69W- 66W
VOL. OF AIR (100 SCM)	3.720

PC/100 SCM

LAB:	LFE
BE-7	1140.000
SR-89	4.583B
SR-90	17.500
ZR-95	*
CS-137	26.300
CE-144	64.300
PU-238	0.086
PU-239	0.301

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7433	7434	7435	7436	7437
COMPOSED OF:	7207	7210	7211	7330 7329 7328	7327 7348
MIDPOINT OF COLLECTION					
DATE	9/ 9/73	9/ 9/73	9/ 9/73	9/ 8/73	9/10/73
LAT.	75N-71N	71N-68N	68N-65N	65N-55N	55N-47N
LONG.	144W-143W	145W-144W	147W-145W	148W-124W	124W-115W
VOL. OF AIR (100 SCM)	2.310	1.710	1.590	8.180	4.670
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1020.000A	136.000A	1610.000	1310.000	1030.000
SR-89	3570.000	24.600	295.000	2640.000	717.000
SR-90	67.200	1.137	10.200	53.300	17.000
ZR-95	6550.000	*	476.000	4150.000	1330.000
CS-137	99.600	4.241B	15.400	70.500	28.000
CE-144	2240.000	19.200A	198.000	1550.000	496.000
PU-238	0.049A	*	0.065A	0.039	*
PU-239	1.270	0.033A	0.220	0.910	0.304

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7438	7439	7440	7441	7442
COMPOSED OF:	7347 7346 7345	7240 7239	7215	7216 7218 7391	7390 7389
MIDPOINT OF COLLECTION					
DATE	9/12/73	9/19/73	9/ 5/73	9/ 9/73	9/18/73
LAT.	47N-37N	37N-33N	33N-30N	30N-20N	20N-13N
LONG.	115W-108W	108W-103W	104W- 99W	99W- 86W	86W- 81W
VOL. OF AIR (100 SCM)	7.030	3.590	3.490	8.850	4.980
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	586.000	274.000	461.000	171.000	354.000
SR-89	107.000	14.900	81.900	13.000	24.200
SR-90	3.796	0.891	2.491	0.534	1.264
ZR-95	184.000	30.900A	24.800B?	18.100	46.700
CS-137	5.812	2.522B	25.000 ?	0.921	1.728A
CE-144	73.000	12.800A	48.100	10.200	20.200
PU-238	0.008B	*	*	*	*
PU-239	0.068	0.022A	0.084	0.017	0.027

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7443	7444	7445
COMPOSED OF:	7388 7387	7293 7247 7248	7249 7250
MIDPOINT OF COLLECTION			
DATE	9/18/73	9/ 9/73	9/ 9/73
LAT.	13N- 5N	31S-40S	40S-47S
LONG.	81W- 79W	68W- 65W	68W- 66W
VOL. OF AIR (100 SCM)	5.430	5.390	3.680
			PC/100 SCM
LAB:	LFE	LFE	LFE
BE-7	126.000	440.000	750.000
SR-89	6.999	11.100	*
SR-90	0.366	2.332	8.147
ZR-95	8.627A	17.200	12.100A
CS-137	0.921B	4.296	11.700
CE-144	5.774	16.400	30.800
PU-238	0.009B	*	0.015B
PU-239	0.015A	0.047	0.140

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

13.7 KM

SAMPLE NO.	7446	7447	7448	7449	7450
COMPOSED OF:	7321 7322	7324 7325 7349	7351	7352 7353 7354	7281 7282
MIDPOINT OF COLLECTION					
DATE	9/ 8/73	9/ 9/73	9/12/73	9/12/73	9/ 9/73
LAT.	64N-57N	57N-47N	47N-44N	44N-35N	34S-42S
LONG.	146W-127W	127W-115W	115W-113W	113W-106W	66W- 65W
VOL. OF AIR (100 SCM)	7.340	7.970	2.240	7.690	6.160
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1400.000	712.000	461.000	183.000	548.000
SR-89	956.000	136.000	61.000	11.300	2.909B
SR-90	22.900	4.667	2.411	0.569	4.244
ZR-95	1770.000	228.000	97.900	10.700A	7.313A
CS-137	32.500	7.234	3.439	0.531A?	6.340
CE-144	620.000	91.600	41.000	9.314A	17.300
PU-238	0.025A	*	*	0.009B	0.010B
PU-239	0.394	0.086	0.052	0.011A	0.077

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

13.7 KM

SAMPLE NO.	7451
COMPOSED OF:	7283 7284
MIDPOINT OF COLLECTION	
DATE	9/ 9/73
LAT.	42S-51S
LONG.	69W- 66W
VOL. OF AIR (100 SCM)	6.230

PC/100 SCM

LAB:	LFE
BE-7	991.000
SR-89	*
SR-90	9.855
ZR-95	*
CS-137	11.700
CE-144	32.800
PU-238	0.033A
PU-239	0.163

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3B

RADIOCHEMICAL ANALYSIS OF SEPTEMBER 1973 COMPOSITES

12.2 KM

SAMPLE NO.	7452	7453	7454
COMPOSED OF:	7206	7204	7203
MIDPOINT OF COLLECTION			
DATE	9/ 9/73	9/ 9/73	9/ 9/73
LAT.	75N-71N	71N-68N	68N-65N
LONG.	144W-143W	145W-144W	147W-145W
VOL. OF AIR (100 SCM)	3.420	2.740	2.570
			PC/100 SCM
LAB:	LFE	LFE	LFE
BE-7	946.000	14.100A	694.000
SR-89	121.000	11.300	1400.000
SR-90	5.482	0.190	29.700
ZR-95	236.000	12.300	2350.000
CS-137	9.022	*	45.600
CE-144	99.000	9.995	904.000
PU-238	*	*	0.027B
PU-239	0.095	0.008B	0.512

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7733	7734	7735	7799	7800
COMPOSED OF:	7503	7504 7505 7719 7718 7717 7716	7706 7707 7586 7585 7584	7593 7595 7596	7597 7598
MIDPOINT OF COLLECTION					
DATE	11/ 1/73	11/ 1/73	11/ 7/73	10/30/73	10/30/73
LAT.	72N-69N	69N-52N	40N-25N	23N-14N	14N- 9N
LONG.	143W-140W	147W-120W	111W- 90W	89W- 82W	82W- 80W
VOL. OF AIR (100 SCM)	0.730	5.960	5.940	2.590	1.430
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1750.000	2260.000	1710.000	563.000	406.000
ZR-95	2160.000	10100.000	14500.000	583.000	314.000
CS-137	58.500	292.000	429.000	30.400	20.900
CE-144	1440.000	6010.000	8570.000	346.000	187.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

19.2 KM

SAMPLE NO.	7736	7737	7738	7739
COMPOSED OF:	7671 7670 7669	7668 7666 7618 7620	7621 7622	7623 7574 7573 7572 7571
MIDPOINT OF COLLECTION				
DATE	11/ 8/73	11/ 6/73	11/ 4/73	11/ 3/73
LAT.	9N- 3S	3S-21S	21S-29S	29S-50S
LONG.	80W- 80W	80W- 75W	75W- 72W	72W- 66W
VOL. OF AIR (100 SCM)	2.890	3.480	2.220	5.330
			PC/100 SCM	
LAB:	LFE	LFE	LFE	LFE
BE-7	293.000	528.000	838.000	1580.000
ZR-95	92.100	29.900	5.925A	*
CS-137	16.700	20.700	30.000	41.200
CE-144	83.200	63.700	60.500	92.100

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

18.9 KM

SAMPLE NO.	7741	7742
COMPOSED OF:	7502	7702 7704 7705
MIDPOINT OF COLLECTION		
DATE	11/ 1/73	11/ 4/73
LAT.	75N-72N	51N-40N
LONG.	143W-140W	119W-111W
VOL. OF AIR (100 SCM)	1.070	3.200
		PC/100 SCM
LAB:	LFE	LFE
BE-7	30.700A?	2390.000
ZR-95	117.000 ?	6500.000
CS-137	3.397A?	200.000
CE-144	46.700 ?	3790.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

18.3 KM

SAMPLE NO.	7743	7744	7793	7745	7746
COMPOSED OF:	7515 7527 7516 7528	1/2:7731 7730 7729 7714 7713	1/2:7731 7730 7729 7714 7713	7537 7538 7711 7710 7589 7590	7581 7580 7578 7577 7609 7592
MIDPOINT OF COLLECTION					
DATE	11/ 4/73	11/ 1/73	11/ 1/73	11/ 3/73	11/ 7/73
LAT.	72N-65N	65N-43N	65N-43N	43N-27N	27N- 9N
LONG.	148W-144W	147W-113W	147W-113W	113W- 94W	94W- 80W
VOL. OF AIR (100 SCM)	3.420	3.660	3.660	7.200	6.250
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1330.000A	2130.000	2020.000	982.000	923.000
ZR-95	12300.000	15400.000	15600.000	4280.000	1790.000
CS-137	349.000	426.000	432.000	127.000	65.000
CE-144	7020.000	8950.000	9170.000	2440.000	1070.000

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

18.3 KM

SAMPLE NO.	7747	7748	7749	7750	7751
COMPOSED OF:	7562	7561	7560	7559	7557 7630 7632
MIDPOINT OF COLLECTION					
DATE	11/ 6/73	11/ 6/73	11/ 6/73	11/ 6/73	11/ 3/73
LAT.	9N- 5N	5N- 1N	1N- 3S	3S- 7S	7S-22S
LONG.	80W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 75W
VOL. OF AIR (100 SCM)	1.470	1.520	1.420	1.240	6.290
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	738.000	*	628.000	128.000A	700.000
ZR-95	15.300A?	*	104.000	17.300B	12.900
CS-137	4.321A	*	15.400	3.295A	14.500
CE-144	22.900	6.312A	83.100	16.900	36.600

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

18.3 KM

SAMPLE NO.	7752
COMPOSED OF:	7633 7634 7635
MIDPOINT OF COLLECTION	
DATE	11/ 2/73
LAT.	22S-33S
LONG.	75W- 69W
VOL. OF AIR (100 SCM)	4.530

PC/100 SCM

LAB:	LFE
BE-7	295.000
ZR-95	2.009B
CS-137	6.921
CE-144	17.100

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7753	7755	7794	7756	7757
COMPOSED OF:	7500 7499 7497 7496 7698 7699	1/2:7701 7726 7725	1/2:7701 7726 7725	7723 7722	7535 7695
MIDPOINT OF COLLECTION					
DATE	11/ 2/73	11/ 2/73	11/ 2/73	11/ 1/73	11/ 8/73
LAT.	75N-56N	56N-43N	56N-43N	43N-37N	37N-31N
LONG.	146W-126W	125W-113W	125W-113W	113W-108W	108W-100W
VOL. OF AIR (100 SCM)	10.490	2.670	2.670	3.060	1.550
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	2330.000	2430.000	2060.000A	1650.000	1530.000
ZR-95	13400.000	16900.000	18400.000	6930.000	1320.000
CS-137	383.000	472.000	516.000	205.000	50.900
CE-144	7560.000	10000.000	10500.000	3960.000	892.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

16.8 KM

SAMPLE NO.	7758	7740	7754	7759	7760
COMPOSED OF:	7694 7693	7642	7644 7645 7646 7647 7608	7605 7662 7663	7664 7665 7617
MIDPOINT OF COLLECTION					
DATE	11/ 8/73	10/30/73	11/ 1/73	11/ 8/73	11/ 7/73
LAT.	31N-24N	25N-20N	20N- 7N	7N- 3S	3S-19S
LONG.	100W- 88W	90W- 86W	86W- 80W	80W- 80W	80W- 76W
VOL. OF AIR (100 SCM)	6.750	3.190	7.030	5.650	6.840
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	328.000	675.000	711.000	197.000	126.000
ZR-95	67.400	381.000	5.049B?	11.900	7.705
CS-137	4.104	14.500	13.100	1.610	0.863A
CE-144	39.800	209.000	50.700	10.700	4.254

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

			16.8 KM
SAMPLE No.	7761	7762	7763
COMPOSED OF:	7616 7615 7614	7682 7681	7680 7678
MIDPOINT OF COLLECTION			
DATE	11/4/73	11/5/73	11/5/73
LAT.	19S-31S	31S-41S	41S-51S
LONG.	76W-70W	67W-66W	69W-67W
VOL. OF AIR (100 SCM)	6.650	4.240	3.620
			PC/100 SCM
LAB:	LFE	LFE	LFE
BE-7	425.000	392.000	604.000
ZR-95	6.300	6.109A	132.000
CS-137	6.211	2.677	6.894
CE-144	22.700	9.232	82.000

A: COUNTING ERROR IS 20-50 PERCENT *: NOT DETECTABLE
B: COUNTING ERROR IS 51-100 PERCENT
?: DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7764	7765	7767	7768	7769
COMPOSED OF:	7488	7491 7492 7480	7479	7478 7477	7544
MIDPOINT OF COLLECTION					
DATE	11/ 2/73	11/ 2/73	11/ 2/73	11/ 2/73	11/ 7/73
LAT.	75N-71N	71N-61N	61N-58N	58N-54N	51N-47N
LONG.	144W-143W	148W-136W	136W-128W	128W-123W	119W-115W
VOL. OF AIR (100 SCM)	2.080	7.520	2.500	3.620	2.970
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	825.000	922.000	1360.000A	1870.000	1510.000
ZR-95	635.000	1150.000	3330.000	14100.000	4130.000
CS-137	23.600	39.300	96.400	386.000	127.000
CE-144	359.000	689.000	1930.000	7900.000	2400.000

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7770	7771	7766	7777	7772
COMPOSED OF:	7543 7542	7541 7533	7532	7638	7690 7689 7687 7686 7639 7641
MIDPOINT OF COLLECTION					
DATE	11/ 7/73	11/ 8/73	11/ 8/73	10/30/73	11/ 5/73
LAT.	47N-40N	40N-35N	35N-33N	33N-30N	30N-12N
LONG.	115W-111W	111W-107W	107W-104W	104W- 98W	98W- 81W
VOL. OF AIR (100 SCM)	5.130	4.030	2.220	3.320	14.070
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	992.000	473.000	205.000	438.000	141.000
ZR-95	1260.000	322.000	32.100A	278.000	7.203
CS-137	44.500	13.000	1.635A	9.036	0.515
CE-144	783.000	207.000	12.200	151.000	4.098

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

15.2 KM

SAMPLE NO.	7773	7774	7775	7776
COMPOSED OF:	7626 7627 7628	7629 7556	7555 7554 7553	7683 7565 7566 7567 7568 7569
MIDPOINT OF COLLECTION				
DATE	11/ 2/73	11/ 4/73	11/ 6/73	11/ 3/73
LAT.	5N- 7S	7S-19S	19S-31S	31S-51S
LONG.	80W- 80W	80W- 77W	77W- 70W	69W- 65W
VOL. OF AIR (100 SCM)	8.170	6.240	9.340	10.390
			PC/100 SCM	
LAB:	LFE	LFE	LFE	LFE
BE-7	20.900	29.200	56.400 ?	1030.000
ZR-95	*	*	22.400 ?	9.538
CS-137	0.389B	0.218A	1.312 ?	13.800
CE-144	0.450A	0.489A	18.900 ?	48.100

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

13.7 KM

SAMPLE NO.	7778	7779	7780	7781	7782
COMPOSED OF:	7512 7511 7509 7508	7472 7473	7475	7545 7547	7548 7549
MIDPOINT OF COLLECTION					
DATE	11/ 3/73	11/ 2/73	11/ 2/73	11/ 7/73	11/ 7/73
LAT.	75N-65N	64N-57N	57N-54N	51N-44N	44N-38N
LONG.	147W-143W	145W-129W	129W-123W	119W-114W	114W-109W
VOL. OF AIR (100 SCM)	8.560	7.460	3.030	5.490	5.000
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	721.000	664.000	1610.000	793.000	494.000
ZR-95	3280.000	277.000	2220.000	551.000	162.000
CS-137	94.700	10.700	73.100	21.200	7.081
CE-144	1900.000	165.000	1280.000	336.000	99.100

A:COUNTING ERROR IS 20-50 PERCENT
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT
*:NOT DETECTABLE

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

13.7 KM

SAMPLE NO.	7783
COMPOSED OF:	7674 7675 7676 7677
MIDPOINT OF COLLECTION	
DATE	11/ 5/73
LAT.	34S-51S
LONG.	69W- 65W
VOL. OF AIR (100 SCM)	12.390

PC/100 SCM

LAB:	LFE
BE-7	1010.000
ZR-95	6.471
CS-137	11.500
CE-144	30.700

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3C

GAMMA SPECTRAL ANALYSES OF NOVEMBER 1973 COMPOSITES

12.2 KM

SAMPLE NO.	7784	7785	7786	7787	7788
COMPOSED OF:	7487 7485 7484	7650	7651 7652 7653 7654	7656 7657	7658 7659
MIDPOINT OF COLLECTION					
DATE	11/ 2/73	11/ 5/73	11/ 5/73	11/ 5/73	11/ 5/73
LAT.	75N-65N	63N-60N	60N-46N	46N-40N	40N-36N
LONG.	148W-143W	142W-133W	133W-115W	115W-111W	111W-107W
VOL. OF AIR (100 SCM)	13.540	4.970	16.470	6.330	4.800
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	339.000	723.000	1310.000	417.000	174.000
ZR-95	47.600	220.000	632.000	79.000	19.100
CS-137	2.515	10.100	24.100	4.448	0.756A
CE-144	28.000	131.000	375.000	49.700	11.400

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 19.2 KM

SAMPLE NO.	7874	7875	8018	8017	8016
FLIGHT NO.	289	289	296	296	296
DATE	1/27/74	1/27/74	2/ 2/74	2/ 2/74	2/ 2/74
TIME	0837-0910	0910-0929	1830-1923	1744-1830	1643-1744
LAT.	40N-37N	37N-35N	35N-31N	31N-28N	28N-24N
LONG.	111W-108W	108W-107W	106W-100W	100W- 95W	95W- 89W
VOL. OF AIR (100 SCM)	0.98	0.57	1.73	1.52	2.07
GROSS GAMMA/ M/100 SCM	3390.	2050.	2870.	2610.	2440.
COUNT DATE	03/19/74	03/19/74	04/03/74	04/03/74	04/03/74

SAMPLE NO.	7958	7960	7961	7962	7963
FLIGHT NO.	298	298	298	298	298
DATE	1/22/74	1/22/74	1/22/74	1/22/74	1/22/74
TIME	1853-1932	1932-2005	2005-2034	2034-2102	2102-2122
LAT.	24N-20N	20N-17N	17N-14N	14N-11N	11N- 9N
LONG.	89W- 86W	86W- 84W	84W- 82W	82W- 81W	81W- 80W
VOL. OF AIR (100 SCM)	1.24	1.04	0.92	0.90	0.64
GROSS GAMMA/ M/100 SCM	4120.	3720.	4100.	3070.	2500.
COUNT DATE	03/29/74	03/29/74	03/29/74	04/01/74	04/01/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 19.2 KM

SAMPLE NO.	7941	7940	7939	7938	7936
FLIGHT NO.	296	296	296	296	296
DATE	1/30/74	1/30/74	1/30/74	1/30/74	1/30/74
TIME	1950-2025	1915-1950	1841-1915	1805-1841	1717-1805
LAT.	9N- 5N	5N- 1N	1N- 3S	3S- 7S	7S-12S
LONG.	80W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 78W
VOL. OF AIR (100 SCM)	1.13	1.10	1.05	1.11	1.49
GROSS GAMMA/ M/100 SCM	602.	427.	314.	126.	114.
COUNT DATE	03/26/74	03/26/74	03/26/74	03/26/74	03/26/74

SAMPLE NO.	7903	7905	7906	7907	7908
FLIGHT NO.	296	296	296	296	296
DATE	1/27/74	1/27/74	1/27/74	1/27/74	1/27/74
TIME	1624-1649	1649-1719	1719-1756	1756-1831	1831-1919
LAT.	15S-18S	18S-21S	21S-25S	25S-29S	29S-33S
LONG.	75W- 75W	75W- 74W	74W- 73W	73W- 72W	72W- 69W
VOL. OF AIR (100 SCM)	0.80	0.96	1.18	1.11	1.34
GROSS GAMMA/ M/100 SCM	75.	94.	68.	72.	90.
COUNT DATE	03/22/74	03/22/74	03/22/74	03/22/74	03/22/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 19.2 KM

SAMPLE NO.	7854	7853	7852	7851
FLIGHT NO.	296	296	296	296
DATE	1/26/74	1/26/74	1/26/74	1/26/74
TIME	1923-2007	1845-1923	1812-1845	1735-1812
LAT.	33S-37S	37S-41S	41S-45S	45S-50S
LONG.	68W- 66W	67W- 66W	67W- 67W	69W- 67W
VOL. OF AIR (100 SCM)	1.39	1.16	1.00	1.14
GROSS GAMMA/ M/100 SCM	65.	52.	170.	123.
COUNT DATE	03/18/74	03/18/74	03/18/74	03/18/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 18.9 KM

SAMPLE NO.	7821	7822	7823	7929	7928
FLIGHT NO.	289	289	289	289	289
DATE	1/25/74	1/25/74	1/25/74	1/23/74	1/23/74
TIME	0501-0525	0525-0541	0541-0559	1946-2033	1904-1946
LAT.	72N-69N	69N-67N	67N-65N	62N-59N	59N-56N
LONG.	144W-143W	145W-144W	147W-145W	139W-132W	132W-126W
VOL. OF AIR (100 SCM)	0.72	0.47	0.53	1.49	1.32
GROSS GAMMA/ M/100 SCM	1960.	1450.	1790.	3300.	2930.
COUNT DATE	03/16/74	03/16/74	03/16/74	03/26/74	03/25/74

SAMPLE NO.	7927
FLIGHT NO.	289
DATE	1/23/74
TIME	1813-1904
LAT.	56N-52N
LONG.	126W-120W
VOL. OF AIR (100 SCM)	1.58
GROSS GAMMA/ M/100 SCM	2770.
COUNT DATE	03/25/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 18.6 KM

SAMPLE NO.	7820	7870	7872	7873
FLIGHT NO.	289	289	289	289
DATE	1/25/74	1/27/74	1/27/74	1/27/74
TIME	0437-0501	0703-0741	0742-0809	0809-0837
LAT.	75N-72N	50N-46N	46N-43N	43N-40N
LONG.	143W-143W	118W-115W	115W-113W	113W-111W
VOL. OF AIR (100 SCM)	0.78	1.09	0.83	0.94
GROSS GAMMA/M/100 SCM	1490.	1680.	2300.	3450.
COUNT DATE	03/16/74	03/19/74	03/19/74	03/19/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 18.3 KM

SAMPLE NO.	7829	7954	7955	7957	8013
FLIGHT NO.	302	298	296	296	296
DATE	1/22/74	1/22/74	1/22/74	1/22/74	2/ 2/74
TIME	2006-2045	1647-1734	1734-1804	1804-1840	1559-1627
LAT.	35N-32N	32N-29N	29N-27N	27N-24N	23N-20N
LONG.	107W-104W	102W- 97W	97W- 94W	94W- 90W	88W- 86W
VOL. OF AIR (100 SCM)	1.50	1.78	1.15	1.39	1.16
GROSS GAMMA/ M/100 SCM	2870.	3600.	3980.	2300.	1280.
COUNT DATE	03/16/74	03/27/74	03/29/74	03/29/74	04/03/74

SAMPLE NO.	8012	8010	8009	7952	7886
FLIGHT NO.	296	296	296	296	298
DATE	2/ 2/74	2/ 2/74	2/ 2/74	1/29/74	1/28/74
TIME	1530-1559	1503-1530	1443-1503	2001-2031	2004-2027
LAT.	20N-17N	17N-14N	14N-12N	12N- 9N	8N- 5N
LONG.	86W- 84W	84W- 82W	82W- 81W	81W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	1.20	1.08	0.80	1.19	0.87
GROSS GAMMA/ M/100 SCM	2240.	1130.	1350.	2170.	471.
COUNT DATE	04/03/74	04/03/74	04/03/74	03/27/74	03/20/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 18.3 KM

SAMPLE NO.	7919	7885	7918	7884	7917
FLIGHT NO.	296	298	296	298	296
DATE	1/28/74	1/28/74	1/28/74	1/28/74	1/28/74
TIME	1933-2005	1928-2004	1857-1933	1852-1928	1822-1857
LAT.	9N- 5N	5N- 1N	5N- 1N	1N- 3S	1N- 3S
LONG.	80W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	1.31	1.41	1.46	1.43	1.41
GROSS GAMMA/ M/100 SCM	458.	440.	404.	175.	206.
COUNT DATE	03/25/74	03/20/74	03/25/74	03/20/74	03/25/74

SAMPLE NO.	7883	7916	7881	7914	7969
FLIGHT NO.	298	296	298	296	298
DATE	1/28/74	1/28/74	1/28/74	1/28/74	1/24/74
TIME	1817-1852	1746-1822	1705-1817	1640-1746	1715-1805
LAT.	3S- 7S	3S- 7S	7S-14S	7S-14S	14S-19S
LONG.	80W- 80W	80W- 80W	80W- 76W	80W- 76W	76W- 74W
VOL. OF AIR (100 SCM)	1.37	1.47	2.98	2.71	1.97
GROSS GAMMA/ M/100 SCM	88.	109.	57.	74.	56.
COUNT DATE	03/20/74	03/25/74	03/20/74	03/25/74	04/01/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 18.3 KM

SAMPLE NO.	7971	7972	7973	7974
FLIGHT NO.	298	298	298	298
DATE	1/24/74	1/24/74	1/24/74	1/24/74
TIME	1805-1833	1833-1859	1859-1936	1936-2023
LAT.	19S-22S	22S-25S	25S-29S	29S-33S
LONG.	74W- 74W	74W- 73W	73W- 72W	72W- 69W
VOL. OF AIR (100 SCM)	1.10	1.01	1.42	1.80
GROSS GAMMA/ M/100 SCM	64.	50.	444.	61.
COUNT DATE	04/01/74	04/01/74	04/01/74	04/01/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 16.8 KM

SAMPLE NO.	7818	7817	7815	7814	7866
FLIGHT NO.	289	289	289	289	289
DATE	1/25/74	1/25/74	1/25/74	1/25/74	1/27/74
TIME	0353-0421	0326-0353	0257-0325	0218-0257	0450-0526
LAT.	75N-72N	72N-69N	69N-66N	66N-63N	63N-60N
LONG.	143W-143W	144W-134W	146W-144W	146W-142W	142W-133W
VOL. OF AIR (100 SCM)	1.40	1.33	1.35	1.82	1.69
GROSS GAMMA/ M/100 SCM	3400.	4740.	3830.	3350.	4250.
COUNT DATE	03/16/74	03/16/74	03/16/74	03/16/74	03/19/74

SAMPLE NO.	7867	7869	7925	7924	7922
FLIGHT NO.	289	289	289	289	289
DATE	1/27/74	1/27/74	1/23/74	1/23/74	1/23/74
TIME	0526-0607	0608-0645	1705-1750	1633-1705	1602-1633
LAT.	60N-56N	56N-52N	50N-46N	46N-43N	43N-40N
LONG.	133W-126W	126W-120W	118W-115W	115W-113W	113W-111W
VOL. OF AIR (100 SCM)	1.94	1.77	2.23	1.58	1.52
GROSS GAMMA/ M/100 SCM	4610.	4610.	2770.	4630.	2840.
COUNT DATE	03/19/74	03/19/74	03/25/74	03/25/74	03/25/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 16.8 KM

SAMPLE NO.	7921	7828	7996	7995	7994
FLIGHT NO.	289	302	298	298	298
DATE	1/23/74	1/22/74	1/31/74	1/31/74	1/31/74
TIME	1531-1602	1900-1918	2018-2123	1925-2018	1820-1925
LAT.	40N-37N	37N-35N	35N-31N	31N-28N	28N-24N
LONG.	111W-108W	108W-107W	107W-100W	100W- 95W	95W- 89W
VOL. OF AIR (100 SCM)	1.53	0.93	3.37	2.85	3.53
GROSS GAMMA/ M/100 SCM	4460.	2050.	795.	744.	77.
COUNT DATE	03/25/74	03/16/74	04/02/74	04/02/74	04/02/74

SAMPLE NO.	8002	8004	8005	8006	7951
FLIGHT NO.	296	296	296	296	296
DATE	1/22/74	1/22/74	1/22/74	1/22/74	1/29/74
TIME	1750-1839	1839-1913	1913-1942	1942-2013	1928-1948
LAT.	24N-20N	20N-17N	17N-14N	14N-11N	11N- 9N
LONG.	90W- 86W	86W- 84W	84W- 82W	82W- 82W	81W- 80W
VOL. OF AIR (100 SCM)	2.62	1.84	1.58	1.71	1.14
GROSS GAMMA/ M/100 SCM	240.	92.	70.	23.	61.
COUNT DATE	04/03/74	04/03/74	04/03/74	04/03/74	03/27/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 16.8 KM

SAMPLE NO.	7950	7947	7932	7933	7934
FLIGHT NO.	296	296	296	296	296
DATE	1/29/74	1/29/74	1/30/74	1/30/74	1/30/74
TIME	1907-1928	1847-1907	1428-1505	1505-1543	1543-1619
LAT.	9N- 7N	7N- 5N	5N- 1N	1N- 3S	3S- 7S
LONG.	80W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	1.18	1.13	2.05	2.10	1.99
GROSS GAMMA/ M/100 SCM	51.	44.	220.	86.	45.
COUNT DATE	03/27/74	03/27/74	03/26/74	03/26/74	03/26/74

SAMPLE NO.	7935	7880	7902	7879	7901
FLIGHT NO.	296	298	296	298	296
DATE	1/30/74	1/28/74	1/27/74	1/28/74	1/27/74
TIME	1619-1707	1618-1655	1531-1610	1543-1618	1455-1531
LAT.	7S-12S	15S-19S	15S-19S	19S-23S	19S-23S
LONG.	80W- 78W	75W- 74W	75W- 74W	74W- 73W	74W- 74W
VOL. OF AIR (100 SCM)	2.68	2.05	2.12	1.95	1.96
GROSS GAMMA/ M/100 SCM	26.	34.	38.	36.	41.
COUNT DATE	03/26/74	03/20/74	03/20/74	03/19/74	03/20/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 16.8 KM

SAMPLE NO.	7878	7900	7877	7899	7842
FLIGHT NO.	298	296	298	296	298
DATE	1/28/74	1/27/74	1/28/74	1/27/74	1/26/74
TIME	1505-1543	1422-1455	1422-1505	1340-1422	1920-2006
LAT.	23S-27S	23S-27S	27S-31S	27S-31S	31S-36S
LONG.	73W- 72W	74W- 72W	72W- 70W	72W- 70W	66W- 66W
VOL. OF AIR (100 SCM)	2.10	1.78	2.27	2.27	2.47
GROSS GAMMA/ M/100 SCM	43.	56.	49.	44.	32.
COUNT DATE	03/19/74	03/20/74	03/19/74	03/20/74	03/16/74

SAMPLE NO.	7841	7840	7838
FLIGHT NO.	298	298	298
DATE	1/26/74	1/26/74	1/26/74
TIME	1836-1920	1751-1836	1703-1751
LAT.	36S-41S	41S-46S	46S-51S
LONG.	66W- 66W	67W- 66W	69W- 67W
VOL. OF AIR (100 SCM)	2.32	2.23	2.23
GROSS GAMMA/ M/100 SCM	69.	85.	85.
COUNT DATE	03/16/74	03/16/74	03/16/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 15.2 KM

SAMPLE NO.	7807	7810	7811	7864	7863
FLIGHT NO.	289	289	289	289	289
DATE	1/25/74	1/25/74	1/25/74	1/26/74	1/26/74
TIME	0103-0134	0135-0204	0204-0232	2305-0007	2219-2305
LAT.	75N-71N	71N-68N	68N-65N	65N-61N	61N-58N
LONG.	144W-143W	145W-144W	148W-145W	146W-136W	136W-129W
VOL. OF AIR (100 SCM)	2.03	1.85	1.75	4.00	2.95
GROSS GAMMA/ M/100 SCM	5540.	3400.	5180.	3660.	5580.
COUNT DATE	03/16/74	03/16/74	03/16/74	03/19/74	03/19/74

SAMPLE NO.	7862	7861	7891	7890	7889
FLIGHT NO.	289	289	302	302	302
DATE	1/26/74	1/26/74	1/25/74	1/25/74	1/25/74
TIME	2137-2219	2059-2137	1819-1902	1740-1819	1707-1740
LAT.	58N-55N	55N-52N	51N-47N	47N-43N	43N-40N
LONG.	129W-124W	124W-121W	119W-115W	115W-113W	113W-111W
VOL. OF AIR (100 SCM)	2.71	2.48	2.83	2.57	2.30
GROSS GAMMA/ M/100 SCM	4990.	3730.	4230.	2620.	513.
COUNT DATE	03/19/74	03/19/74	03/20/74	03/20/74	03/20/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 15.2 KM

SAMPLE NO.	7888	7826	7825	7998	7999
FLIGHT NO.	302	302	302	296	296
DATE	1/25/74	1/22/74	1/22/74	1/22/74	1/22/74
TIME	1632-1707	1830-1852	1800-1830	1536-1623	1623-1711
LAT.	40N-37N	37N-35N	35N-33N	33N-30N	30N-27N
LONG.	111W-108W	108W-107W	107W-104W	104W- 99W	99W- 94W
VOL. OF AIR (100 SCM)	2.57	1.50	2.05	3.23	3.33
GROSS GAMMA/ M/100 SCM	136.	2500.	380.	74.	174.
COUNT DATE	03/20/74	03/16/74	03/16/74	04/03/74	04/03/74

SAMPLE NO.	8001	7991	7990	7988	7987
FLIGHT NO.	296	298	298	298	298
DATE	1/22/74	1/31/74	1/31/74	1/31/74	1/31/74
TIME	1711-1739	1735-1815	1703-1735	1636-1703	1616-1636
LAT.	27N-25N	24N-20N	20N-17N	17N-14N	14N-12N
LONG.	94W- 91W	89W- 86W	86W- 84W	84W- 82W	82W- 81W
VOL. OF AIR (100 SCM)	1.93	2.81	2.29	1.96	1.46
GROSS GAMMA/ M/100 SCM	192.	29.	13.	15.	7.
COUNT DATE	04/03/74	04/02/74	04/02/74	04/02/74	04/02/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 15.2 KM

SAMPLE NO.	7943	7944	7946	7965	7976
FLIGHT NO.	296	296	296	298	296
DATE	1/29/74	1/29/74	1/29/74	1/24/74	1/24/74
TIME	1733-1804	1804-1821	1821-1841	1405-1443	1430-1506
LAT.	12N- 9N	9N- 7N	7N- 5N	5N- 3N	5N- 1N
LONG.	81W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	2.22	1.21	1.46	2.84	2.41
GROSS GAMMA/ M/100 SCM	14.	17.	7.	18.	21.
COUNT DATE	03/27/74	03/27/74	03/27/74	04/01/74	04/01/74

SAMPLE NO.	7966	7977	7967	7978	7968
FLIGHT NO.	298	296	298	296	298
DATE	1/24/74	1/24/74	1/24/74	1/24/74	1/24/74
TIME	1443-1522	1506-1547	1522-1600	1547-1624	1600-1652
LAT.	3N- 3S	1N- 3S	3S- 7S	3S- 7S	7S-12S
LONG.	80W- 80W	80W- 80W	80W- 80W	80W- 80W	80W- 77W
VOL. OF AIR (100 SCM)	2.89	2.76	2.82	2.50	3.86
GROSS GAMMA/ M/100 SCM	10.	7.	14.	4.	8.
COUNT DATE	04/01/74	04/02/74	04/01/74	04/02/74	04/01/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 15.2 KM

SAMPLE NO.	7979	7913	7980	7982	7912
FLIGHT NO.	296	296	296	296	296
DATE	1/24/74	1/28/74	1/24/74	1/24/74	1/28/74
TIME	1624-1719	1555-1630	1751-1832	1833-1900	1517-1555
LAT.	7S-12S	15S-19S	15S-19S	19S-22S	19S-23S
LONG.	80W- 77W	75W- 75W	75W- 74W	74W- 74W	75W- 74W
VOL. OF AIR (100 SCM)	3.72	2.67	2.79	1.85	2.94
GROSS GAMMA/ M/100 SCM	8.	11.	14.	16.	10.
COUNT DATE	04/02/74	03/25/74	04/02/74	04/02/74	03/25/74

SAMPLE NO.	7983	7911	7986	7910	7843
FLIGHT NO.	296	296	296	296	298
DATE	1/24/74	1/28/74	1/24/74	1/28/74	1/26/74
TIME	1900-1930	1438-1517	1930-2006	1352-1438	2008-2034
LAT.	22S-25S	23S-27S	25S-29S	27S-31S	31S-33S
LONG.	74W- 73W	74W- 72W	73W- 72W	72W- 70W	69W- 67W
VOL. OF AIR (100 SCM)	2.06	3.02	2.44	3.56	1.77
GROSS GAMMA/ M/100 SCM	10.	13.	8.	17.	34.
COUNT DATE	04/02/74	03/25/74	04/02/74	03/22/74	03/18/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 15.2 KM

SAMPLE NO.	7845	7846	7847	7848	7849
FLIGHT NO.	296	296	296	296	296
DATE	1/26/74	1/26/74	1/26/74	1/26/74	1/26/74
TIME	1432-1501	1501-1528	1528-1558	1558-1637	1637-1711
LAT.	34S-37S	37S-40S	40S-43S	43S-47S	47S-51S
LONG.	66W- 65W	66W- 66W	67W- 66W	68W- 67W	69W- 68W
VOL. OF AIR (100 SCM)	2.13	1.96	2.12	2.60	2.15
GROSS GAMMA/ M/100 SCM	14.	46.	47.	73.	79.
COUNT DATE	03/18/74	03/18/74	03/18/74	03/18/74	03/18/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 13.7 KM

SAMPLE NO.	7855	7856	7858	7859	7892
FLIGHT NO.	289	289	289	289	302
DATE	1/26/74	1/26/74	1/26/74	1/26/74	1/25/74
TIME	1840-1928	1928-2003	2003-2036	2036-2054	1909-1951
LAT.	64N-60N	60N-57N	57N-54N	54N-52N	51N-47N
LONG.	145W-133W	133W-128W	128W-123W	123W-121W	119W-115W
VOL. OF AIR (100 SCM)	3.68	2.70	2.56	1.40	3.13
GROSS GAMMA/ M/100 SCM	3210.	1240.	2300.	2660.	4650.
COUNT DATE	03/18/74	03/18/74	03/18/74	03/18/74	03/20/74

SAMPLE NO.	7894	7895	7896	7897	7834
FLIGHT NO.	302	302	302	302	298
DATE	1/25/74	1/25/74	1/25/74	1/25/74	1/26/74
TIME	1952-2019	2019-2051	2051-2124	2124-2155	1400-1440
LAT.	47N-44N	44N-41N	41N-38N	38N-35N	34S-38S
LONG.	115W-114W	114W-111W	111W-109W	109W-107W	66W- 65W
VOL. OF AIR (100 SCM)	2.10	2.50	2.62	2.47	3.20
GROSS GAMMA/ M/100 SCM	4400.	1340.	38.	41.	6.
COUNT DATE	03/20/74	03/20/74	03/20/74	03/20/74	03/16/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 13.7 KM

SAMPLE NO.	7835	7836	7837
FLIGHT NO.	298	298	298
DATE	1/26/74	1/26/74	1/26/74
TIME	1440-1518	1518-1558	1558-1651
LAT.	38S-42S	42S-46S	46S-51S
LONG.	67W- 66W	67W- 67W	70W- 67W
VOL. OF AIR (100 SCM)	3.01	3.16	4.10
GROSS GAMMA/ M/100 SCM	17.	19.	49.
COUNT DATE	03/16/74	03/16/74	03/16/74

TABLE 3D
TOTAL GAMMA CONCENTRATIONS FROM JANUARY 1974 MISSION

ALTITUDE 12.2 KM

SAMPLE NO.	7806	7804	7803
FLIGHT NO.	289	289	289
DATE	1/25/74	1/25/74	1/25/74
TIME	0011-0059	2336-0011	2302-2336
LAT.	75N-71N	71N-68N	68N-65N
LONG.	144W-144W	145W-144W	148W-145W
VOL. OF AIR (100 SCM)	4.27	3.04	2.87
GROSS GAMMA/ M/100 SCM	2360.	5710.	2660.
COUNT DATE	03/16/74	03/16/74	03/16/74

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

19.2 KM

SAMPLE NO.	8031	8032	8033	8034	8035
COMPOSED OF:	7874 7875 8018	8017 8016	7958 7960 7961	7962 7963	7941 7940 7939
MIDPOINT OF COLLECTION					
DATE	1/28/74	2/ 2/74	1/22/74	1/22/74	2/ 2/74
LAT.	40N-31N	31N-24N	24N-14N	14N- 9N	9N- 3S
LONG.	111W-100W	100W- 89W	89W- 82W	82W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	3.280	3.590	3.200	1.540	3.280
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	909.000	901.000	1010.000	842.000A	467.000
ZR-95	1520.000	1570.000	2440.000	2080.000	104.000
CS-137	130.000	124.000	173.000	147.000	30.800
CE-144	1910.000	1890.000	2760.000	2360.000	302.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

19.2 KM

SAMPLE NO.	8036	8037	8038	8039
COMPOSED OF:	7938 7936	7903 7905 7906 7907	7908 7854 7853	7852 7851
MIDPOINT OF COLLECTION				
DATE	2/ 2/74	1/27/74	1/26/74	1/26/74
LAT.	3S-12S	15S-29S	29S-41S	41S-50S
LONG.	80W- 78W	75W- 72W	72W- 66W	69W- 67W
VOL. OF AIR (100 SCM)	2.600	4.050	3.890	2.140

PC/100 SCM

LAB:	LFE	LFE	LFE	LFE
BE-7	495.000	902.000	885.000	1910.000
ZR-95	49.200	3.481B	*	*
CS-137	18.200	15.600	16.300	26.500
CE-144	81.400	33.700	42.000	62.300

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

18.9 KM

SAMPLE NO.	8040	8041
COMPOSED OF:	7821 7822 7823	7929 7928 7927
MIDPOINT OF COLLECTION		
DATE	1/25/74	1/23/74
LAT.	72N-65N	62N-52N
LONG.	147W-143W	139W-120W
VOL. OF AIR (100 SCM)	1.720	4.390
		PC/100 SCM
LAB:	LFE	LFE
BE-7	1440.000	952.000
ZR-95	1070.000	1640.000
CS-137	90.600	122.000
CE-144	1250.000	1940.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

18.6 KM

SAMPLE NO.	8042	8043
COMPOSED OF:	7820	7870 7872 7873
MIDPOINT OF COLLECTION		
DATE	1/25/74	1/27/74
LAT.	75N-72N	50N-40N
LONG.	143W-143W	118W-111W
VOL. OF AIR (100 SCM)	0.780	2.860
		PC/100 SCM
LAB:	LFE	LFE
BE-7	1970.000	1210.000
ZR-95	705.000	1320.000
CS-137	52.300	101.000
CE-144	791.000	1620.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

18.3 KM

SAMPLE NO.	8044	8091	8045	8046	8047
COMPOSED OF:	1/2:7829 7954 7955 7957	1/2:7829 7954 7955 7957	8013 8012 8010	8009 7952	7919 7918
MIDPOINT OF COLLECTION					
DATE	1/22/74	1/22/74	2/ 2/74	2/ 2/74	1/28/74
LAT.	35N-24N	35N-24N	23N-14N	14N- 9N	9N- 1N
LONG.	107W- 90W	107W- 90W	88W- 82W	82W- 80W	80W- 80W
VOL. OF AIR (100 SCM)	2.910	2.910	3.440	1.990	2.770
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	960.000	763.000	576.000	675.000	421.000A
ZR-95	2040.000	2000.000	907.000	973.000	221.000
CS-137	141.000	139.000	68.900	79.000	20.200
CE-144	2320.000	2350.000	1110.000	1220.000	283.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

18.3 KM

SAMPLE NO.	8048	8049	8050
COMPOSED OF:	7884 7916	7914 7969 7971	7972 7974
MIDPOINT OF COLLECTION			
DATE	1/28/74	1/25/74	1/24/74
LAT.	1N- 7S	7S-22S	22S-33S
LONG.	80W- 80W	80W- 74W	74W- 69W
VOL. OF AIR (100 SCM)	2.900	5.780	2.810
		PC/100 SCM	
LAB:	LFE	LFE	LFE
BE-7	455.000	724.000	802.000
ZR-95	68.000	8.651A	*
CS-137	13.900	9.274	10.700
CE-144	92.300	26.600	24.500

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

16.8 KM

SAMPLE NO.	8051	8052	8053	8054	8055
COMPOSED OF:	7818 7817 7815 7814	7866 7867 7869	7925 7924	7922 7921 7828	7996 7995
MIDPOINT OF COLLECTION					
DATE	1/25/74	1/27/74	1/23/74	1/23/74	2/ 3/74
LAT.	75N-63N	63N-52N	50N-43N	43N-35N	35N-28N
LONG.	146W-134W	142W-120W	118W-113W	113W-107W	107W- 95W
VOL. OF AIR (100 SCM)	5.900	5.400	3.810	3.980	6.220
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1750.000	1300.000	1010.000	1190.000	456.000
ZR-95	2240.000	2330.000	2120.000	1910.000	437.000
CS-137	160.000	173.000	150.000	127.000	36.100
CE-144	2600.000	2790.000	2320.000	2130.000	568.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

16.8 KM

SAMPLE NO.	8056	8057	8058	8059	8060
COMPOSED OF:	7994 8004 8005	8006 7951 7950 7947	7933 7934	7935 7902 7901	7900 7899 7842
MIDPOINT OF COLLECTION					
DATE	1/25/74	1/27/74	2/ 2/74	1/28/74	1/27/74
LAT.	28N-14N	14N- 5N	1N- 7S	7S-23S	23S-36S
LONG.	95W- 82W	82W- 80W	80W- 80W	80W- 74W	74W- 66W
VOL. OF AIR (100 SCM)	6.950	5.160	4.090	6.760	6.520
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	227.000	179.000	185.000	380.000	665.000
ZR-95	45.300	27.700	24.800	8.196	6.625A
CS-137	4.634	2.462	2.775	3.085	5.492
CE-144	54.200	30.700	41.400	13.100	17.200

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

16.8 KM

SAMPLE NO.	8061
COMPOSED OF:	7841 7840 7838
MIDPOINT OF COLLECTION	
DATE	1/26/74
LAT.	36S-51S
LONG.	69W- 66W
VOL. OF AIR (100 SCM)	6.780

PC/100 SCM

LAB:	LFE
BE-7	1200.000
ZR-95	7.574
CS-137	13.500
CE-144	31.400

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

15.2 KM

SAMPLE NO.	8064	8090	8065	8066	8067
COMPOSED OF:	1/2:7807 7810 7811	1/2:7807 7810 7811	7864 7863 7862	7861 7891 7890	7889 7888
MIDPOINT OF COLLECTION					
DATE	1/25/74	1/25/74	1/26/74	1/25/74	1/25/74
LAT.	75N-65N	75N-65N	65N-55N	55N-43N	43N-37N
LONG.	148W-143W	148W-143W	146W-124W	124W-113W	113W-108W
VOL. OF AIR (100 SCM)	2.810	2.810	9.660	7.880	4.870
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1880.000	1780.000	1620.000	1170.000	204.000
ZR-95	2610.000	2710.000	2630.000	2070.000	156.000
CS-137	188.000	192.000	189.000	154.000	11.700
CE-144	3140.000	3080.000	3070.000	2420.000	195.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

15.2 KM

SAMPLE NO.	8068	8069	8070	8071	8072
COMPOSED OF:	7826	7825 7998	7999 8001	7991 7990 7988	7987 7943 7944 7946
MIDPOINT OF COLLECTION					
DATE	1/22/74	1/22/74	1/22/74	2/ 3/74	2/ 2/74
LAT.	37N-35N	35N-30N	30N-25N	24N-14N	14N- 5N
LONG.	108W-107W	107W- 99W	99W- 91W	89W- 82W	82W- 80W
VOL. OF AIR (100 SCM)	1.500	5.280	5.260	7.060	6.350
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	943.000	262.000	247.000	121.000	97.900
ZR-95	1670.000	104.000	116.000	4.345	5.278A
CS-137	116.000	7.473	8.452	0.577	0.499A
CE-144	1930.000	122.000	127.000	6.444	5.810

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

15.2 KM

SAMPLE NO.	8073	8074	8075	8076	8077
COMPOSED OF:	7965 7966 7967	7968 7913 7912	7911 7910 7843 7845	7846 7847	7848 7849
MIDPOINT OF COLLECTION					
DATE	1/24/74	1/27/74	1/27/74	1/26/74	1/26/74
LAT.	.5N- 7S	7S-23S	23S-37S	37S-43S	43S-51S
LONG.	80W- 80W	80W- 74W	74W- 65W	67W- 66W	69W- 67W
VOL. OF AIR (100 SCM)	8.550	9.470	10.480	4.080	4.750
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	106.000	117.000	156.000	285.000	1080.000
ZR-95	2.782A	6.231 ?	6.834	14.200	10.500A
CS-137	0.585A	0.528	1.040	2.672	9.957
CE-144	4.562	3.320	8.124	22.400	49.100

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

13.7 KM

SAMPLE NO.	8080	8081	8082	8083	8084
COMPOSED OF:	7855 7856	7858 7859 7892 7894 7895	7896 7897	7834 7835 7836	7837
MIDPOINT OF COLLECTION					
DATE	1/26/74	1/25/74	1/25/74	1/26/74	1/26/74
LAT.	64N-57N	57N-41N	41N-35N	34S-46S	46S-51S
LONG.	145W-128W	128W-111W	111W-107W	67W- 65W	70W- 67W
VOL. OF AIR (100 SCM)	6.380	11.690	5.090	9.370	4.100
			PC/100 SCM		
LAB:	LFE	LFE	LFE	LFE	LFE
BE-7	1000.000	1320.000	158.000	179.000	743.000
ZR-95	1330.000	1920.000	17.400	5.865A	*
CS-137	94.600	135.000	1.336	1.163	6.526
CE-144	1500.000	2230.000	27.100	6.586	15.100

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

TABLE 3E

GAMMA SPECTRAL ANALYSES OF JANUARY 1974 COMPOSITES

12.2 KM

SAMPLE NO.	8087
COMPOSED OF:	7806 7804 7803
MIDPOINT OF COLLECTION	
DATE	1/25/74
LAT.	75N-65N
LONG.	148W-144W
VOL. OF AIR (100 SCM)	10.180

PC/100 SCM

LAB:	LFE
BE-7	1160.000
ZR-95	1960.000
CS-137	138.000
CE-144	2250.000

A:COUNTING ERROR IS 20-50 PERCENT *:NOT DETECTABLE
B:COUNTING ERROR IS 51-100 PERCENT
?:DATA SUSPECT

Table 3f

Pb-210, Po-210 QUALITY CONTROL RESULTS

dpm ± % Standard Deviation

Sample No.	Reference Date		Pb-210	Po-210	Po-210 at Separation time
Exposed Blanks					
6916	1/21/73		.31±64	*	
6917	1/21/73		*	*	
Standards					
6922	1/21/73	added	5.23	5.23	
		found	5.76±7	4.20±30	5.20±6
		% deviation	+10	-20	
6923	1/21/73	added	4.61	4.61	
		found	5.13	3.53	4.56±6
		% deviation	+11	-23	

pCi/100 SCM ± % Standard Deviation

Duplicates			
6849	1/26/73	.714±9	.300±68
6914	"	.633±9	.432±39
% deviation between duplicates		12	36
6857	1/19/73	.774±8	.731±32
6915	"	.756±8	.538±38
% deviation between duplicates		24	30

Table 3g

QUALITY CONTROL RESULTS FOR Be-7 AND THE ARTIFICIAL RADIONUCLIDES

dpm ± % Standard Deviation

Sample No.	Reference date		Be-7	Sr-89	Sr-90	Zr-95	Cs-137	Ce-144	Pu-238	Pu-239
Exposed Blanks										
7457	9/12/73		108±82	28±15	2.0±16	37±30	*	16±25	*	.05±43
7458	9/12/73		170±78	26±16	.4±80	57±63	8±88	*	*	.06±56
7795	11/4/73		*			24±71	6±50	*		
7796	11/4/73		*			14±50	*	*		
8062	1/27/74		*			*	*	*		
8078	1/27/74		*			*	*	*		
Unexposed Blanks										
7471 (not on	9/12/73			*	.7±25				*	*
7472 aircraft)	9/12/73			*	*				*	*
7797 (carried	11/4/73		*			*	*	28±47		
7798 on aircraft)	11/4/73		*			15±50	*	19±43		
8088 (carried	1/27/74		308±71			*	*	*		
8089 on aircraft)	1/27/74		*			*	2±50	*		
Standards										
7465	9/12/73	added		2980	188				10.2	11.4
		found		2815±2	174±2				9.77±3	11.7±3
		% deviation		-5.5	-7.4				-4.6	+2.4
7466	**9/12/73**	**added**		**3120**	**218**				**6.98**	**9.00**
		found		**3033±3**	**204±3**				**7.10±3**	**9.12±3**
		% deviation		**-2.7**	**-6.7**				**+1.8**	**+1.3**
Agar-Agar Standards										
7789	**11/4/73**	**added**	$1.65X10^6$			**38700**	**515**	**3880**		
		found	$1.62X10^6$±1			**35100±2**	**488±10**	**3900±8**		
		% deviation	-1.9			**-9.2**	**-5.2**	**+0.6**		
7790	**11/4/73**	**added**	$1.89X10^6$			**37100**	**589**	**2710**		
		found	$1.98X10^6$±2			**34400±2**	**619±6**	**3160±10**		
		% deviation	+5.2			**-7.2**	**+5.1**	**+16**		
7791	11/4/73	added	$1.59X10^6$			36800	405	2560		
		found	$1.58X10^6$±1			33400±2	394±8	2790		
		% deviation	-0.5			-9.3	-2.6	+9.0		
7792	11/4/73	added	$1.66X10^6$			34000	578	2360		
		found	$1.65X10^6$±1			31200±3	539±9	2640±13		
		% deviation	-0.6			-8.1	-8.2	+12		

Table 3g (cont'd)

QUALITY CONTROL RESULTS FOR Be-7 AND THE ARTIFICIAL RADIONUCLIDES

dpm ± % Standard Deviation

Sample No.	Reference Date		Be-7	Sr-89	Sr-90	Zr-95	Cs-137	Ce-144	Pu-238	Pu-239
Agar-Agar Standards										
7789	1/27/74	added	$5.57X10^5$			15800	512	3160		
		found	$5.50X10^5$±1			14100±2	542±4	3570±3		
		% deviation	-1.2			-11	+5.8	+13		
	% dev. from earlier measurement		-1.9			-9.2	-5.2	+0.6		
7790	1/27/74	added	$6.37X10^5$			15100	586	2210		
		found	$6.32X10^5$±1			13800±2	614±6	2400±6		
		% deviation	-0.7			-8.5	+4.9	+8.6		
	% dev. from earlier measurement		+5.2			-7.2	+5.1	+16		
7791	1/27/74	added	$5.37X10^5$			15000	403	2090		
		found	$5.52X10^5$±1			14000±2	421±8	2200±6		
		% deviation	+2.7			-6.8	+4.5	+5.3		
	% dev. from earlier measurement		-0.5			-9.3	-2.6	+9.0		
7792	1/27/74	added	$5.60X10^5$			13900	575	1920		
		found	$5.64X10^5$±1			12800±2	587±5	2080±6		
		% deviation	+0.6			-7.5	+2.2	+8.0		
	% dev. from earlier measurement		-0.6			-8.1	-8.2	+12		

pCi/100 SCM ± Standard Deviation

Duplicates										
7398	9/7/73		14100±47	140000±1	2590±1	334000±1	5106±2	118000±1	.276±55	48.8±3
7455	9/7/73		*	178000±1	2890±2	344000±1	4970±2	127000±0	395±36	54.9±2
% dev. between duplicates				24	11	2.9	2.7	7.4	35	12
7420	9/10/73		2360±28	17400±1	283±4	37100±1	563±4	13100±1	.063±86	6.07±3
7456	9/10/73		*	18000±1	307±3	34600±2	568±7	12600±2	.058±82	6.00±3
% dev. between duplicates				3.4	8.1	7.0	0.9	3.9	8.3	1.1
7744	11/1/73		2130±17			15400±1	426±0	8950±0		
7793	11/1/73		2020±17			15600±1	432±1	9170±0		
% dev. between duplicates			5.3			1.3	1.4	2.4		
7755	11/2/73		2430±12			16900±1	472±1	10000±1		
7794	11/2/73		2060±20			18400±1	516±1	10500±1		
% dev. between duplicates			16			8.5	8.9	4.9		
8044	1/22/74		960±14			2040±2	141±2	2320±1		
8091	1/22/74		763±11			2000±2	139±2	2350±1		
% dev. between duplicates			23			2.0	1.4	1.3		
8064	1/25/74		1880±12			2610±2	188±4	3140±1		
8090	1/25/74		1780±6			2710±2	192±2	3080±1		
% dev. between duplicates			5.5			3.8	2.1	1.9		

Table 3h

GROSS GAMMA CONCENTRATIONS OF CONTAMINATED BLANK FILTERS FROM SEPTEMBER 1973 MISSION

Sample No.	γ cpm ± σ*	Sample No.	γ cpm ± σ*
Exposed Filters Sixths			
T-7299-1	4055±30	T-7302-1	768±20
-2	4854±30	-2	875±20
-4	4667±30	-4	804±20
-5	4178±30	-5	807±20
T-7338-1	372±20		
-2	377±20		
-4	326±20		
-5	375±20		
Unexposed Filters Sixths			
T-7307-1	77±10	T-7343-1	218±20
-2	79±10	-2	217±20
-4	70±10	-4	201±20
-5	68±10	-5	214±20

σ = one standard deviation of the counting error.

Table 3j

ACTIVITY OF 1/6 SECTIONS OF FILTER COMPOSED OF OPPOSITE 1/12 SECTIONS

Sample No.	Gross γ cpm ±σ	% Deviation Between Duplicates	% Dev. of Average of 2, 5 Sections from Sample Mean
7227-1,4-a	31680±60	9.3	
-1,4-b	34770±60		
-2,5-a	35000±60	21	-2.4
-2,5-b	28320±60		
mean	32440±3140		
7231-1,4-a	39670±60	7.4	
-1,4-b	42700±70		
-2,5-a	48770±70	1.4	+8.7
-2,5-b	49480±70		
mean	45160±4750		
7300-1,4-a	26880±50	11	
-1,4-b	23970±50		
-2,5-a	31310±60	1.7	+10
-2,5-b	30790±60		
mean	28240±3460		

Table 3j (cont'd)

ACTIVITY OF 1/6 SECTIONS OF FILTER COMPOSED OF OPPOSITE 1/12 SECTIONS

Sample No.	Gross γ cpm $\pm\sigma$	% Deviation Between Duplicates	% Dev. of Average of 2, 5 Sections from Sample Mean
7303-1,4-a	88740±100	12	
-1,4-b	99900±100		
-2,5-a	103250±100	10	+6.9
-2,5-b	113570±100		
mean	101400±10200		
Avg. % dev. of gross gamma measurements		9.2	+5.8
	Zr-95 dpm$\pm\sigma$		
7227-1,4-a	21500±200	2.3	
-1,4-b	21000±400		
7303-1,4-a	74400±900	9.3	
-1,4-b	67800±950		
	Cs-137 dpm$\pm\sigma$		
7227-1,4-a	1150±50	15	
-1,4-b	992±70		
7303-1,4-a	3490±100	0.1	
	3450±120		
	Ce-144 dpm$\pm\sigma$		
7227-1,4-a	20400±200	0.9	
-1,4-b	20200±300		
7303-1,4-a	66300±1000	0.1	
-1,4-b	66400±400		
Avg. % dev. of gamma spectroscopy measurements		4.6	

4. HIGH ALTITUDE BALLOON SAMPLING PROGRAM

by Philip W. Krey (HASL)
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The U. S. Atomic Energy Commission's program for measuring upper atmospheric nuclear debris collected by balloon-borne filtering devices has been in continuous operation since 1956. This report contains results from samples collected in calendar year 1972 and 1973. Previous reports on this program are listed in references 1 through 23.

LAUNCH SITES AND COLLECTION PARAMETERS

Balloon flights were made at three or more altitudes from 21 km up to a maximum of 42 km at locations given in Table 4a. The launch site at San Angelo, Texas was discontinued after July 1971, and the operations transferred to Holloman Air Force Base, New Mexico. Detachment 31, 6th Weather Wing (MAC) was deactivated in June 1971, and all Northern Hemispheric balloon launches after that time have been conducted by the Air Force Cambridge Research Laboratory.

Information pertaining to the collection of the balloon samples is provided by the Air Resources Laboratories of the National Oceanic and Atmospheric Administration where flight data prepared

by the balloon operations organizations are summarized and evaluated. Altitude data are obtained from barometric readings on the balloon gondola and refer to pressure altitude in the ICAO Standard Atmosphere. The predominant sampling altitude is given in units of 1000 meters (km).

The entire sample is collected within ±0.6 km of the predominant altitude unless annotated with the symbol, @. This symbol indicates that:

1. The altitude varies greater than the allowed ±0.6 km, or

2. The altitude is estimated or uncertain because of flight operational difficulties, or

3. The volume assigned to the filter is uncertain or estimated also because of the flight operational difficulties.

SAMPLING UNITS

Collections at the lower altitudes are made with the "Direct Flow Sampler", referred to as Unit D7. This system utilizes one square foot of I.P.C. No. 1478 filter paper together with a Westinghouse motor and a Torrington 704 blower. A discussion of this sampling unit has been presented by Wood[24]. A modification to the sampling door to provide a better seal has been developed by the

Air Resources Laboratories. This modified unit, referred to as D7-M, was flight tested many times prior to September 1970 but then replaced the D-7 after that time. When duplicate sampling units are flown on the same balloon for experimental purposes, the individual samples are identified as D7M1 and D7M2.

Samples at the higher altitudes (32 km and above) are collected by an Air Ejector pump, referred to as unit AE. This system employs two square feet of I.P.C. No. 1478 filter paper. The air is drawn through the filter by the aspirator action of escaping nitrogen gas released downstream of the filter. This sampler was developed by the Applied Science Division, Litton Sytems, Inc. under Contract AT(11-1)-401 to the U. S. Atomic Energy Commission[25].

A larger model Air Ejector system has been developed by the Applied Science Division[26] to sample greater volumes of air particularly at the upper altitudes. This system, identified as HV3K, uses 8 square feet of IPC filter paper and filters about 50% more volume at sampling altitudes than the air ejector. Ashenfelter and Telegadas[27] have shown that this system may be contaminated by radioactive debris during ascent, and conclude that all HV3K data prior to December 1970 should be viewed with caution. A modification to the sampling doors has been developed

by the Air Resources Laboratories which has been shown to insure the HV3K filter against contamination during ascent and descent[28].

ANALYSIS

The filters are forwarded to the Health and Safety Laboratory for analyses where they are coded with a HASL number. When samples are split for duplicate analysis, each half is assigned a separate HASL number. Two types of analyses are made: a non-destructive gamma measurement at HASL, and an individual radionuclide assay at a contractor laboratory.

GAMMA MEASUREMENT

As of January 1972, all samples are compressed and sealed into a 6 cm diameter by 3.5 cm depth aluminum can. The samples are then analyzed spectrometrically for Be-7, Zr-95, Cs-137, and Ce-144 by lithium drifted germanium diode systems. These systems are described in the report of Project Airstream in this HASL Quarterly.

The large filters from the HV3K sampler are quartered and each quarter counted separately. The activity reported is the sum of the four individual measurements.

RADIOCHEMICAL ANALYSIS

Each filter collected by a successful flight is sent to a contractor laboratory and analyzed radiochemically. Because the

Chinese and French conducted large atmospheric nuclear tests in recent years the stratospheric concentrations of both short and long-lived weapon related nuclides are of interest. These include Sr-89, Sr-90, Pu-238 and Pu-239. Pu-238 is of additional interest because about 17 kilo curies of this isotope were released in the upper atmosphere by the re-entry burn-up of the SNAP-9A power source in April 1964[29]. Starting in fiscal year 1973 some samples were also analyzed for Pb-210 and Po-210 to compliment the airstream program in the stratospheric study of nuclides of terrestrial origin.

QUALITY CONTROL PROGRAM

To evaluate the analytical performance of the contractor laboratories, HASL routinely submits coded blank, duplicate and standard samples for analysis. A blank is an appropriate sized piece of unexposed IPC filter paper taken from the roll of paper currently used by the flight organizations. Duplicate samples are fractions of a single filter which are divided in half or filters from two samplers carried aloft on the same balloon. A standard is prepared by evaporating weighed aliquots of various tracer solutions onto a regulation size blank of IPC paper. These calibrated solutions are available from a number of sources (i.e., Radiochemistry Center, IAEA, Nuclear Chicago, etc.) and are recalibrated at HASL. Generally, the agreement between HASL's measurement and the reported value is very good.

RESULTS

RADIOCHEMICAL ANALYSES

The radiochemical concentrations for samples collected in 1972 and 1973 are given in Tables 4b and 4c. Although most 1972 data were reported earlier, there were some corrections and additions to those results, and thus all 1972 data are repeated. The results of the quality control program for 1973 samples are given in Table 4d. The 1972 quality control data have been reported and discussed in reference 23.

The concentrations in Tables 4b and 4c are expressed in units of picocuries per 10^3 standard cubic meters of air (pCi/KSCM) at collection. To convert pCi/KSCM to dpm per 10^3 standard cubic feet multiply by 0.0629. Most filters sample between 50 and 300 SCM depending upon altitude of collection. The volume of air filtered is computed at 1013 millibars and 15°C such that 1 SCM = 1.225 kilograms of air.

One standard deviation of the counting error for all data in Tables 4b and 4c is less than ±20% unless annotated with these symbols:

A - One standard deviation of the counting error is between ±20-50%.

B - One standard deviation of the counting error is between ±51-100%.

* - Activity is not detectable. This designation is applied to data when one standard deviation of the counting error is greater than 100%.

? - The datum is considered suspect because:

1. The magnitude of the concentration is inconsistent with adjacent samples in space and time; or

2. The relative activity of the nuclide is inconsistent with other nuclides in the same sample.

The nuclide activity of each sample is corrected for the normal radiochemical parameters such as chemical yield and detection efficiency.

QUALITY CONTROL

The blank data in Table 4d indicate that little or no contamination is introduced by the normal handling and radiochemical analyses of the filter. The inherent Sr-90 content of unexposed IPC-1478 paper can represent a significant part of the total Sr-90 activity collected at altitudes ≥27 km.

The percent deviation between duplicate samples in Table 4d represents the difference divided by the mean and expressed as a percent. The second set of duplicates (3618 and 3619) shows agreement for all nuclides within twice the respective counting errors. Sample 3600 of the first set of duplicates is higher than 3599 for all nuclides by an average of about 20%. Both the

radiochemical and gamma spectral analyses exhibit this trend, so it is unlikely to be the result of analytical errors. Possibly the cutting of the filter into equal halves was off to a substantial degree, or the activity was not uniformly distributed across the filter face.

The radiochemical analysis of the standard sample in Table 4c shows reasonable accuracy for Sr-90, Pu-238 and Pu-239. The gamma spectrometry of the balloon samples is identical to the method used in the spectral analysis of Project Airstream samples. The accuracy of this method has been discussed earlier[30] and has been shown to be less than ±10% for Zr-95, Cs-137 and Ce-144 in most cases.

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USAEC Report HASL-246, p. I-54 to I-68, January (1972)

(29) Harley, J. H.
Possible Pu-238 Distribution from a Satellite Failure
USAEC Report HASL-149, p. 138, October (1964)

(30) Krey, P. W. and L. E. Toonkel
Project Airstream
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TABLE 4a

HIGH ALTITUDE BALLOON LAUNCHING SITES

Location	Latitude	Flight Organization
Eielson Air Force Base, Alaska	65°N	Air Force Cambridge Research Lab.
Sioux City, Iowa	42°N	" " " "
Holloman Air Force Base, N. M.	33°N	" " " "
Albrook Air Force Base, Panama Canal Zone	9°N	" " " "
Longreach, Queensland, Australia	23°S	Department of Supply, Commonwealth of Australia
Mildura, Australia	34°S	" " "

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JUNE 1972
LATITUDE, 65N EIELSON AIR FORCE BASE, ALASKA

ALTITUDE (KM)	21	23
FLIGHT DAY	5	6
HASL NUMBER	3551	3552
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	231.9	143.5
	PC/KSCM	
BERYLLIUM-7	17700	19100
STRONTIUM-89	*	*
STRONTIUM-90	267	156
ZIRCONIUM-95	25.7	*
CESIUM-137	422	205
CERIUM-144	1610	602
PLUTONIUM-238	.604A	.487A
PLUTONIUM-239	4.57	1.87

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING APRIL 1972
LATITUDE, 42N SOUIX CITY,IOWA

ALTITUDE (KM)	21	24
FLIGHT DAY	24	25
HASL NUMBER	3542	3543
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	280.6	157.1
	PC/KSCM	
BERYLLIUM-7	11500	13400
STRONTIUM-89	*	*
STRONTIUM-90	378	151
ZIRCONIUM-95	107A	*
CESIUM-137	655	215
CERIUM-144	2930	640
PLUTONIUM-238	.677	.317B
PLUTONIUM-239	6.56	2.61

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING APRIL 1972
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	22	24	32
FLIGHT DAY	4	7	06
HASL NUMBER	3536	3537	3539
COLLECTION UNIT	D7M1	D7M1	HV3K
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	219.7	120.3	251.4
	PC/KSCM		
BERYLLIUM-7	8860	7750	2030
STRONTIUM-89	*	*	*
STRONTIUM-90	365	213	5.61
ZIRCONIUM-95	261A	71.0A	*
CESIUM-137	545	307	27.7A
CERIUM-144	2770	1070	*
PLUTONIUM-238	.591A	*	*
PLUTONIUM-239	6.19	3.07	.040B

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING OCTOBER 1972
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	22
FLIGHT DAY	27
HASL NUMBER	3564
COLLECTION UNIT	D7M1
ANALYTICAL LABORATORY	LFE
VOLUME (SCM)	88.3

	PC/KSCM
BERYLLIUM-7	16100
STRONTIUM-89	*
STRONTIUM-90	166
ZIRCONIUM-95	*
CESIUM-137	293
CERIUM-144	752
LEAD-210	1.92B
POLONIUM-210	*
PLUTONIUM-238	*
PLUTONIUM-239	3.62

B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING NOVEMBER 1972
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	32
FLIGHT DAY	03
HASL NUMBER	3566
COLLECTION UNIT	HV3K
ANALYTICAL LABORATORY	LFE
VOLUME (SCM)	126.3

	PC/KSCM
BERYLLIUM-7	10500
STRONTIUM-89	*
STRONTIUM-90	7.59?
ZIRCONIUM-95	*
CESIUM-137	293?
CERIUM-144	*
LEAD-210	4.67
POLONIUM-210	4.67A
PLUTONIUM-238	.158B
PLUTONIUM-239	.554A

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING MARCH 1972
LATITUDE, 09N ALBROOK AIR FORCE BASE, CANAL ZONE

ALTITUDE (KM)	21	24
FLIGHT DAY	21	24
HASL NUMBER	3531	3533
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	275.5	158.8
	PC/KSCM	
BERYLLIUM-7	4650	2980
STRONTIUM-89	*	*
STRONTIUM-90	499	639
ZIRCONIUM-95	353	219
CESIUM-137	709	994
CERIUM-144	4130	5300
PLUTONIUM-238	1.02	2.07
PLUTONIUM-239	8.75	11.8

*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JUNE 1972
LATITUDE, 23S LONGREACH,AUSTRALIA

ALTITUDE (KM)	21	24	27
FLIGHT DAY	9	7	6
HASL NUMBER	3549	3548	3547
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	173.0	120.6	73.9
	PC/KSCM		
BERYLLIUM-7	10600	11100	5240
STRONTIUM-89	235	14.1B	32.7B
STRONTIUM-90	278	76.6	140
ZIRCONIUM-95	792	39.9A	*
CESIUM-137	370	132	253
CERIUM-144	2370	407	917
PLUTONIUM-238	.751A	*	*
PLUTONIUM-239	4.05	1.99	2.71

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING NOVEMBER 1972
LATITUDE, 23S LONGREACH,AUSTRALIA

ALTITUDE (KM)	21	24
FLIGHT DAY	12	13
HASL NUMBER	3570	3569
COLLECTION UNIT	D7M1	D7M2
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	256.0	126.5
	PC/KSCM	
BERYLLIUM-7	5480	6710
STRONTIUM-89	*	427A
STRONTIUM-90	434	248
ZIRCONIUM-95	240	135
CESIUM-137	629	481
CERIUM-144	3340	2140
PLUTONIUM-238	.898A	*
PLUTONIUM-239	6.75	4.82

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JANUARY 1972
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	22	22	24	24	27
FLIGHT DAY	17	17	14	14	15
HASL NUMBER	3528	3529	3525	3526	3527
COLLECTION UNIT	D7M1	D7M2	D7M1	D7M2	AE-1
ANALYTICAL LABORATORY	LFE	LFE	LFE	LFE	LFE
VOLUME (SCM)	62.0	63.1	68.5	58.6	78.7
			PC/KSCM		
BERYLLIUM-7	18300	18300	7500	8610	9190
STRONTIUM-90	220	228	188	248	46.5
ZIRCONIUM-95	401	408	*	*	98.8A
CESIUM-137	381	353	319	373	86.7
CERIUM-144	1690	1530	1350	1510	182
PLUTONIUM-238	.806A	.633B	.438B	.852A	*
PLUTONIUM-239	3.54	4.12	3.06	5.11	.762

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING MAY 1972
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	24	32
FLIGHT DAY	11	9	3
HASL NUMBER	3541	3540	3545
COLLECTION UNIT	D7M1	D7M1	HV3K
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	191.1	151.2	89.2
	PC/KSCM		
BERYLLIUM-7	9110	4500	9130?
STRONTIUM-89	852	85.8A	*
STRONTIUM-90	561	391	18.7
ZIRCONIUM-95	2520	379	199?
CESIUM-137	678	644	15.4B
CERIUM-144	5810	2810	*
PLUTONIUM-238	1.19	1.26	146?
PLUTONIUM-239	7.95	6.68	.335A

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING AUGUST 1972
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	24
FLIGHT DAY	17
HASL NUMBER	3556
COLLECTION UNIT	D7M1
ANALYTICAL LABORATORY	LFE
VOLUME (SCM)	105.6

	PC/KSCM
BERYLLIUM-7	5560
STRONTIUM-89	84.4A
STRONTIUM-90	140
ZIRCONIUM-95	*
CESIUM-137	167
CERIUM-144	491
LEAD-210	1.42B
POLONIUM-210	*
PLUTONIUM-238	.379B
PLUTONIUM-239	2.56

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4b

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING OCTOBER 1972
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	25	25
FLIGHT DAY	14	18	19
HASL NUMBER	3561	3558	3557
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	220.6	114.9	72.2
	PC/KSCM		
BERYLLIUM-7	8660	10500	9070
STRONTIUM-89	79.2B	28.4B	45.4B
STRONTIUM-90	285	164	139
ZIRCONIUM-95	145	*	*
CESIUM-137	435	238	208
CERIUM-144	1990	744	629
LEAD-210	2.90	2.09A	1.66B
POLONIUM-210	2.13A	*	*
PLUTONIUM-238	.635A	*	.553B
PLUTONIUM-239	4.94	3.04	3.05

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JUNE 1973
LATITUDE, 65N EIELSON AIR FORCE BASE, ALASKA

ALTITUDE (KM)	21	24	27
FLIGHT DAY	4	4	1
HASL NUMBER	3595	3596	3594
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	206.7	118.6	65.7
	PC/KSCM		
BERYLLIUM-7	20600	24500	27600
STRONTIUM-89	*	53.3B	*
STRONTIUM-90	216	98.2	27.7
ZIRCONIUM-95	49.5A	*	*
CESIUM-137	376	188	55.6
CERIUM-144	921	483	90.1
PLUTONIUM-238	.290B	*	*
PLUTONIUM-239	4.16	2.28A	*

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING APRIL 1973
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	22	25
FLIGHT DAY	24	11
HASL NUMBER	3587	3580
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	169.6	114.6
	PC/KSCM	
BERYLLIUM-7	9670	12100
STRONTIUM-89	60.6?	*
STRONTIUM-90	223	88.5
ZIRCONIUM-95	25.7A	10.0A
CESIUM-137	362	179
CERIUM-144	949	508
PLUTONIUM-238	.588B	*
PLUTONIUM-239	4.66	2.01

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JULY 1973
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	20	20
FLIGHT DAY	30	30
HASL NUMBER	3599	3600
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	99.9	99.9
	PC/KSCM	
BERYLLIUM-7	9790	11600
STRONTIUM-89	97.4A	115
STRONTIUM-90	219	207
ZIRCONIUM-95	154	166
CESIUM-137	278	351
CERIUM-144	551	736
PLUTONIUM-238	*	*
PLUTONIUM-239	4.00	3.00

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING AUGUST 1973
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	21	24	27
FLIGHT DAY	22	24	28
HASL NUMBER	3602	3607	3608
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	207.0	75.8	46.7
	PC/KSCM		
BERYLLIUM-7	16300	6650	8680
STRONTIUM-89	182	*	*
STRONTIUM-90	208	209	88.8
ZIRCONIUM-95	254	15.0A	*
CESIUM-137	395	287	174
CERIUM-144	903	610	199
PLUTONIUM-238	.917A	*	*
PLUTONIUM-239	3.67	4.08	1.71A

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING OCTOBER 1973
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	22
FLIGHT DAY	24
HASL NUMBER	3614
COLLECTION UNIT	D7M1
ANALYTICAL LABORATORY	LFE
VOLUME (SCM)	143.2

	PC/KSCM
BERYLLIUM-7	11500
STRONTIUM-89	58400
STRONTIUM-90	1910
ZIRCONIUM-95	118000
CESIUM-137	3150
CERIUM-144	61300
PLUTONIUM-238	.558B
PLUTONIUM-239	37.5

B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING NOVEMBER 1973
LATITUDE, 33N HOLLOMAN AIR FORCE BASE, NEW MEXICO

ALTITUDE (KM)	24
FLIGHT DAY	6
HASL NUMBER	3616
COLLECTION UNIT	D7M1
ANALYTICAL LABORATORY	LFE
VOLUME (SCM)	152.3

	PC/KSCM
BERYLLIUM-7	5970
STRONTIUM-89	*
STRONTIUM-90	161
ZIRCONIUM-95	56.4A
CESIUM-137	215
CERIUM-144	466
PLUTONIUM-238	*
PLUTONIUM-239	2.68

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING MARCH 1973
LATITUDE, 09N ALBROOK AIR FORCE BASE, CANAL ZONE

ALTITUDE (KM)	21	23
FLIGHT DAY	8	9
HASL NUMBER	3582	3581
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	214.3	90.0
	PC/KSCM	
BERYLLIUM-7	4290	3830
STRONTIUM-89	*	*
STRONTIUM-90	216	397
ZIRCONIUM-95	28.9A	211A
CESIUM-137	347	632
CERIUM-144	1090	2200
PLUTONIUM-238	.419B	.887B
PLUTONIUM-239	3.64	6.99

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING MAY 1973
LATITUDE, 23S LONGREACH,AUSTRALIA

ALTITUDE (KM)	21	24	27
FLIGHT DAY	14	15	19
HASL NUMBER	3590	3591	3593
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	179.2	133.6	30.0
	PC/KSCM		
BERYLLIUM-7	12500	4940	2710
STRONTIUM-89	*	*	*
STRONTIUM-90	206	310	184
ZIRCONIUM-95	5.75A	24.4A	*
CESIUM-137	299	415	228
CERIUM-144	939	1210	599
PLUTONIUM-238	.334B	*	*
PLUTONIUM-239	3.68	4.94	3.33A

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING NOVEMBER 1973
LATITUDE, 23S LONGREACH,AUSTRALIA

ALTITUDE (KM)	22	22	25
FLIGHT DAY	7	7	6
HASL NUMBER	3618	3619	3617
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	79.5	79.5	96.2
	PC/KSCM		
BERYLLIUM-7	7150	7830	7040
STRONTIUM-89	*	*	*
STRONTIUM-90	195	199	120
ZIRCONIUM-95	18.7A	12.6A	79.2?
CESIUM-137	246	286	146
CERIUM-144	549	544	356
PLUTONIUM-238	*	*	*
PLUTONIUM-239	3.27	3.77	2.18

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING JANUARY 1973
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	24	26
FLIGHT DAY	16	17	23
HASL NUMBER	3574	3575	3576
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	162.2	127.1	82.6
	PC/KSCM		
BERYLLIUM-7	13500	16000	15000
STRONTIUM-89	*	*	*
STRONTIUM-90	208	116	139
ZIRCONIUM-95	38.9A	22.9A	*
CESIUM-137	299	186	175
CERIUM-144	1300	601	525
PLUTONIUM-238	*	*	*
PLUTONIUM-239	3.32	1.96	2.05

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING APRIL 1973
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	24	28
FLIGHT DAY	4	3	12
HASL NUMBER	3578	3585	3586
COLLECTION UNIT	D7M1	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	186.3	130.2	33.9
	PC/KSCM		
BERYLLIUM-7	8790	7400	13700
STRONTIUM-89	*	65.5?	*
STRONTIUM-90	300	226	125
ZIRCONIUM-95	40.5A	31.5A	394?
CESIUM-137	491	397	187A
CERIUM-144	1940	1340	716A
PLUTONIUM-238	.537B	*	*
PLUTONIUM-239	4.62	4.44	1.47A

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING AUGUST 1973
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	24
FLIGHT DAY	21	24
HASL NUMBER	3604	3606
COLLECTION UNIT	D7M1	D7M1
ANALYTICAL LABORATORY	LFE	LFE
VOLUME (SCM)	162.2	123.7
	PC/KSCM	
BERYLLIUM-7	LOST	8530
STRONTIUM-89	29.5A	23.7B
STRONTIUM-90	208	99
ZIRCONIUM-95	LOST	*
CESIUM-137	LOST	162
CERIUM-144	LOST	379
PLUTONIUM-238	*	*
PLUTONIUM-239	3.20	1.78

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE

TABLE 4c

STRATOSPHERIC RADIONUCLIDE CONCENTRATIONS

BALLOON SAMPLES COLLECTED DURING OCTOBER 1973
LATITUDE, 34S MILDURA, AUSTRALIA

ALTITUDE (KM)	21	24	27
FLIGHT DAY	8	12	17
HASL NUMBER	3610	3611	3612
COLLECTION UNIT	D7M1	D7M1	AE-1
ANALYTICAL LABORATORY	LFE	LFE	LFE
VOLUME (SCM)	177.0	79.5	79.5
	PC/KSCM		
BERYLLIUM-7	10200	7260	8920
STRONTIUM-89	*	*	253?
STRONTIUM-90	206	134	65.7
ZIRCONIUM-95	*	13.3A	*
CESIUM-137	324	229	91.5
CERIUM-144	738	556	178
PLUTONIUM-238	.282B	*	*
PLUTONIUM-239	3.44	2.14	1.38

A: ONE STANDARD DEVIATION OF COUNTING ERROR IS >20% TO 50% OF COUNT.
B: ONE STANDARD DEVIATION OF COUNTING ERROR IS >50% TO 100% OF COUNT.
*: STANDARD DEVIATION GREATER THAN DATA VALUE
?: DATA SUSPECT

TABLE 4d

1973 QUALITY CONTROL RESULTS

HASL No.	Reference date		Be-7	Sr-89	Sr-90	Zr-95	Cs-137	Cs-144	Pu-238	Pu-239
			dpm ± % Standard Deviation							
Blanks										
3577	3/1/74		*	*	1.2±25	*	*	*	*	.05±47
3589	4/14/73			*	.8±76				*	*
3605	8/1/73			*	.7±63				*	*
Standards										
3588	3/10/73	added		2895	82.9				5.67	7.78
		found		2800±1	77.6±4				5.79±6	8.49±5
		% deviation		-3	-6				+2	+9
3598	5/30/73	added		900	160				6.12	7.61
		found		940±4	141±3				6.04±4	7.86±4
		% deviation		+5	-12				-1	-2
			pCi/KSCM ± % Standard Deviation							
Duplicate										
3599	7/30/73		9790±0	97.4±29	219±3	154±12	278±3	551±3	*	4.00±11
3600	7/30/73		11600±1	115±1	207±2	166±12	351±2	736±4	*	3.00±10
% deviation between duplicates			17	17	6	8	23	29		29
3618	11/7/73		7150±3	*	195±4	18.7±33	246±4	549±4	*	3.27±10
3619	11/7/73		7830±2	*	199±3	12.6±50	286±3	544±3	*	3.77± 8
% deviation between duplicates			9		2	39	15	1		14

Part III

DATA FROM SOURCES OTHER THAN HASL

Numerous fallout studies are conducted by other organizations in the United States and abroad. Some of these are sent to the editors for dissemination in these HASL Quarterly Reports. Submitted data are reproduced essentially as received and no interpretation by HASL is attempted.

1. Radiological and Environmental Research Division
   Argonne National Laboratory
   Cesium-137 in Various Chicago Foods
   (collection month April 1974)
   by J. O. Karttunen

Cesium-137 in Various Chicago Foods *

(Collection Month April 1974)

J. O. Karttunen

Radiological and Environmental Research Division
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Since April 1961, the ^{137}Cs and potassium content of the Chicago portion of Tri-City Diet Sampling Program has been determined [1-5] in bulk food samples by gamma ray spectrometry using a 4" x 4" NaI (Tl) crystal. Each variety of food (all fresh vegetables, all fresh fruits, etc.) is composited before measurement, and each sample is counted 400-1000 minutes. From these measurements composite daily and yearly food intakes are obtained. The results for the April 1974 semi-annual are tabulated in Tables I and II.

* Work performed under the auspices of the U.S. Atomic Energy Commission.

Table I

Cesium-137 in Chigao Diets

April 1974

	kg/yr	Potassium g/kg	^{137}Cs pCi/kg	Potassium g/yr	^{137}Cs pCi/yr
White Bread	37	1.2	9.9	44	366
Whole Wheat Breat	11	2.7	15	30	165
Eggs	16	1.6	6.1	26	98
Fresh Vegetables	43	3.2	< 4*	138	86
Root Vegetables	17	3.3	10	56	170
Milk	221	1.6	5.3	354	1,171
Poultry	17	2.8	5	48	85
Fresh Fish**	8	3.9	35	31	280
Flour	43	1.2	16	52	688
Macaroni	3	1.5	8.3	4	25
Meat	73	3.0	8.3	219	606
Dried Beans	3	15.9	6	48	18
Fresh Fruit	68	2.2	7.2	150	490
Potatoes	45	4.1	12	184	540
Canned Fruits	26	0.8	5	21	130
Canned Fruit Juices	19	1.9	9.1	36	173
Canned Vegetables	20	1.3	< 4	26	40
Total/yr				1467	5131
Total/day				4.0	14

*Samples containing <4 pCi/kg (approximately our limit of detection for this type of sample) are assumed to have 2 pCi/kg.

**It is assumed in arriving at the average that nine times more ocean fish is consummed than fresh water fish.

Table II

Cesium-137 in Chicago Diets

(Infants)

April 1974

	kg/yr	Potassium g/kg	^{137}Cs pCi/kg	Potassium g/yr	^{137}Cs pCi/yr
Evaporated Milk	137	3.2	9.3	438	1274
Formula Milk	37	1.7	7.3	63	270
Cereals	8	4.7	31	38	248
Fruits	23	1.0	< 4*	23	46
Meats	17	2.0	9.1	34	155
Vegetables	23	1.6	< 4	37	46
Total/yr				633	2039
Total/day				1.7	6

*Samples containing <4 pCi/kg (approximately our limit of detection for this type of sample) are assumed to have 2 pCi/kg.

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