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NYO-4862

HEALTH AND SAFETY LABORATORY

SUMMARY OF ANALYTICAL RESULTS FROM THE HASL STRONTIUM PROGRAM JULY THROUGH DECEMBER, 1956

by

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4. To Mr. Eric W. Mood of the New Haven Department of Health for supplying dustfall samples collected by his organization.

This report summarizes the data on samples collected for the HASL strontium program during the period -- July through December of 1956. Previous data was given in NYO-4751 (Revised).

In addition to the analysis of samples collected for the HASL program, the Analytical Branch is responsible for the transmittal of samples to contract laboratories. These samples are part of the overall strontium program of the Division of Biology and Medicine. This activity, including preliminary treatment of certain samples, calculations and administration require the equivalent of one full-time man. Direct analyses and administration require two staff members for the gummed film program and eight for the strontium program.

FALLOUT DOCUMENTATION

Gummed Film Network

Through the cooperation of the United States Weather Bureau and other groups, daily gummed film samples are collected at 40 stations within the continental United States and 75 stations in United States Territories and in other countries. Results through September 1955 have been reported previously (1). The current data carries through September 1956.

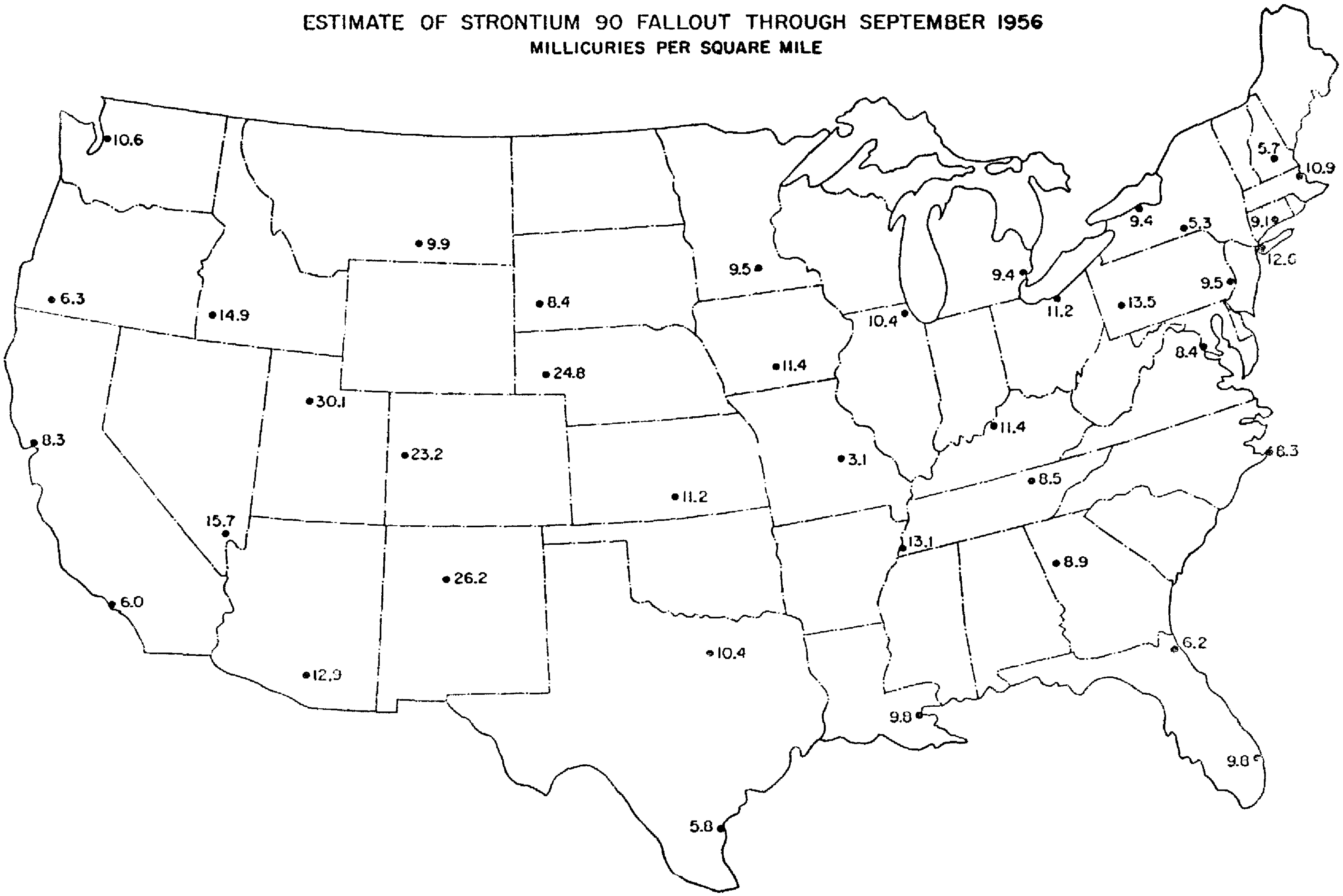
Measurements are made by beta counting of ashed samples. Sr-90 estimates are made by theoretical calculations, assuming a date of origin for the debris. The results are mapped in Fig. 1 for the United States, and in Fig. 2 for the rest of the world.

In previous reports it was decribed how a factor of 1.6 was required to correct gummed film mixed fission product activity to agree with pot samples collected at HASL. This correction has been applied to gummed film results issued since that time for all stations.

Several groups of results in this report would indicate that a much larger correction factor would be in order, but this is not necessarily true. It is believed that the low Sr-90 values calculated from gummed film activity are due to the incorrect arbitrary burst assignments used in the calculations.

The recalculations of the gummed film values will be done, but it will be some time before the results are available. Therefore, gummed film data in this report, particularly after May 1956, should be considered as minimum estimates, and may be low by a considerable factor.

Fig. 1



ESTIMATE OF STRONTIUM 90 FALLOUT THROUGH SEPTEMBER 1956
MILLICURIES PER SQUARE MILE
10.6
6.3
14.9
9.9
8.4
24.8
30.1
23.2
8.3
15.7
6.0
12.9
26.2
9.5
11.4
11.2
3.1
10.4
5.8
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13.1
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5.7
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9.1
12.0

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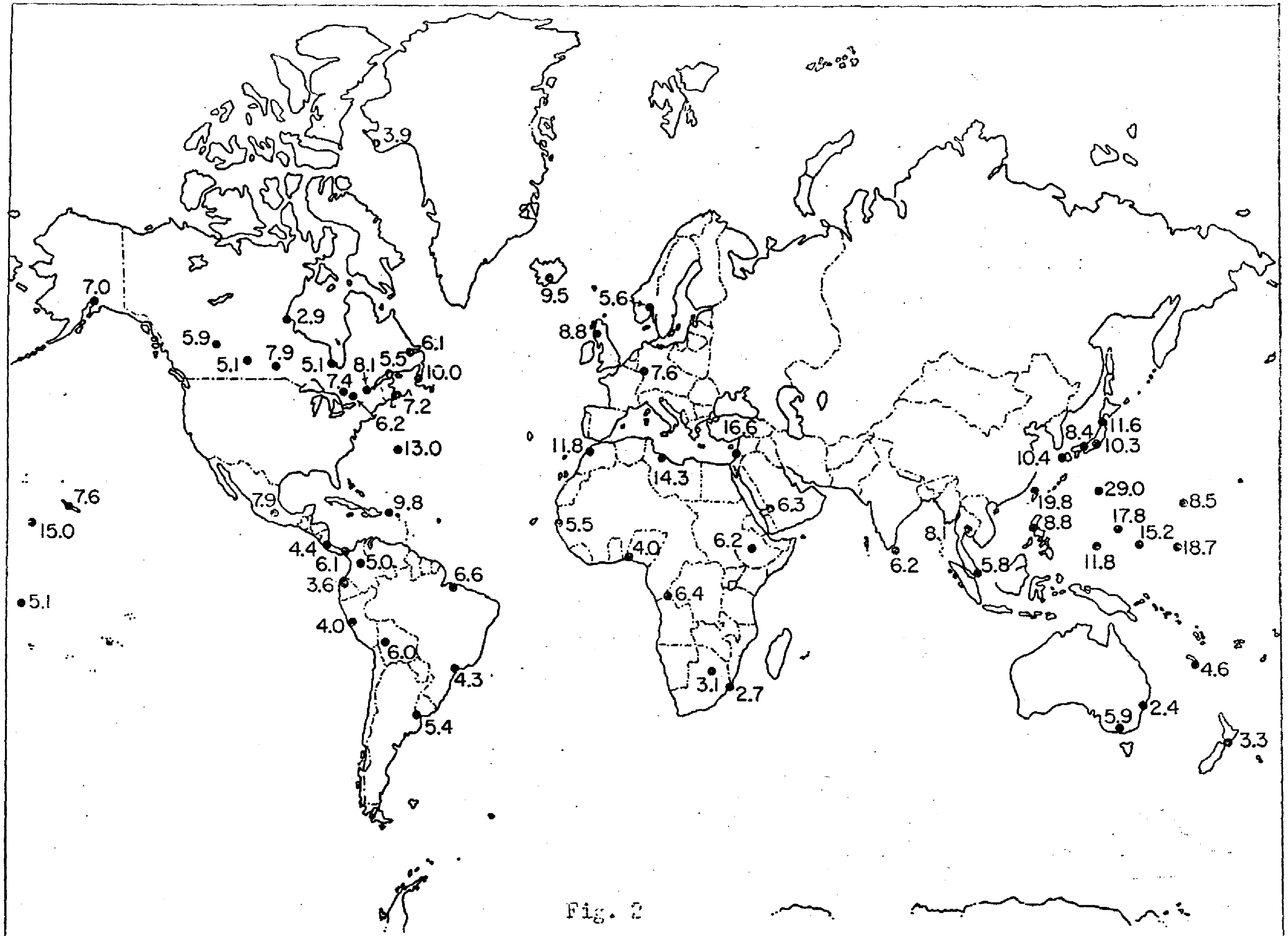

Fig. 2

ESTIMATE OF STRONTIUM 90 FALLOUT THROUGH SEPTEMBER 1956

MILLICURIES PER SQUARE MILE

U. S. Soil Program

The advantages and disadvantages of gummed film for fallout measurement have been discussed many times previously. One possible calibration is the comparison of cumulative gummed film results with analyses of soils taken at identical locations. The first such collection was undertaken at 17 Weather Bureau stations in October 1955 and was repeated in October 1956. In both cases, 0-2 inch and 2-6 inch depths were taken, and Sr-90 leached with 6N HCl.

The 0-2" depths for the 1955 samples were reported in NYO-4751.[2] The 2-6" depths gave the analysts considerable difficulty due to interference from thorium chain isotopes and they were not reported. A procedure has been worked out for these soils and those having residual sample available will be reanalyzed.

The data for the 1956 samples is shown in Table 1 and a plot of soil activity against the values estimated from the gummed film is shown in Fig. 3. As in the 1955 data, Albuquerque, Grand Junction, and Salt Lake City show lower soil values than predicted. The mean ratio of soil/film is 2.33 for the 14 "normal" samples. (Gummed film values already multiplied by 1.6 correction factor.)

If the 1955 samples are corrected to total mc/mi^2 using the 1956 ratio for total to top-soil activity, the mean ratio becomes 2.4. The value of 1.6 reported in NYO-4751 was for the 0-2" depths only.

TABLE 1

Sr^{90} Data for 1956 Continental U.S. Survey Soils Sr^{90} Extracted with 6N HCl at Room Temperature, Sampled Week of October 8, 1957 (replicates represent individual soil aliquots taken after sampling)

Sampling Site	Depth	d/m/gm soil*	mc/mi²	mc/mi² Ave.	mc/mi² Total
1. Albuquerque, N.M.	0-2"	0.078 ± 0.001	7.5 ± 0.1	7.3	
		0.075 ± 0.001	7.2 ± 0.1		
	2-10½"	0.008 ± 0.002	4.4 ± 0.9	3.4	10.7
		0.005 ± 0.002	2.4 ± 0.8		
	0-2"	0.10 ± 0.004	10 ± 0.4	10	
		0.10 ± 0.004	10 ± 0.4		
2. Atlanta, Ga.	0-2"	0.35 ± 0.007	14 ± 0.3	15	
		0.42 ± 0.009	16 ± 0.4		
	2-6"	0.018 ± 0.004	2.8 ± 0.6	3.0	18.0
		0.021 ± 0.003	3.3 ± 0.5		
3. Binghamton, N.Y.	0-2"	0.32 ± 0.007	17 ± 0.4	18	
		0.35 ± 0.007	18 ± 0.4		
	2-6"	0.019 ± 0.003	4.4 ± 0.8	5.0	23.0
		0.024 ± 0.005	5.6 ± 1.1		
4. Boise, Id.	0-2"	0.23 ± 0.006	20 ± 0.6	22	
		0.26 ± 0.006	23 ± 0.6		
	2-6"	0.012 ± 0.002	3.1 ± 0.6	3.5	25.5
		0.015 ± 0.002	4.0 ± 0.6		
5. Des Moines, Ia.	0-2"	0.31 ± 0.007	23 ± 0.5	23	
		0.31 ± 0.007	23 ± 0.5		
	2-6"	0.028 ± 0.002	7.6 ± 0.7	7.1	30.1
		0.024 ± 0.003	6.6 ± 0.7		
6. Detroit, Mich.	0-2"	0.26 ± 0.006	20 ± 0.5	20	
		0.27 ± 0.006	20 ± 0.5		
	2-6"	0.038 ± 0.003	7.3 ± 0.5	7.8	27.8
		0.044 ± 0.003	8.4 ± 0.6		
7. Grand Junction, Colo.	0-2"	0.10 ± 0.001	7.8 ± 0.1	7.0	
		0.091 ± 0.001	7.1 ± 0.1		
		0.11 ± 0.019	8.2 ± 1.4**		
		0.070 ± 0.013	5.1 ± 1.0**		
	2-10½"	≤0.002	≤0.45	≤0.48	7.5
		≤0.002	≤0.51		
8. Jacksonville, Fla.	0-2"	0.11 ± 0.009	7.3 ± 0.6	7.3	
		Sample Lost			
	2-6"	0.013 ± 0.004	2.7 ± 0.9	3.4	10.7
		0.020 ± 0.005	4.0 ± 1.0		
9. Los Angeles, Calif.	0-2"	0.12 ± 0.008	6.9 ± 0.5	7.5	
		0.14 ± 0.009	8.0 ± 0.5		
	2-7"	0.009 ± 0.002	3.3 ± 0.9	2.8	10.3
		0.006 ± 0.002	2.2 ± 0.7		

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TABLE 1 (Contd.)

	Sampling Site	Depth	d/m/gm soil	mc/mi²	mc/mi² Ave.	mc/mi² Total
10.	Memphis, Tenn.	0-2"	0.27 ± 0.006	15 ± 0.4	15	
			0.26 ± 0.006	15 ± 0.4		
		2-6"	0.028 ± 0.003	6.5 ± 0.7	6.6	21.6
			0.029 ± 0.003	6.6 ± 0.7		
11.	New Orleans, La.	0-2"	0.24 ± 0.006	8.8 ± 0.2	8.6	
			0.22 ± 0.006	8.3 ± 0.2		
		2-6"	0.009 ± 0.002	3.3 ± 0.9	2.8	11.4
			0.006 ± 0.002	2.2 ± 0.7		
12.	New York, N. Y.	0-2"	0.21 ± 0.006	10 ± 0.3	12	
			0.29 ± 0.007	14 ± 0.3		
		2-6"	0.072 ± 0.004	14 ± 0.8	14	26.0
			0.068 ± 0.004	14 ± 0.8		
13.	Philadelphia, Pa.	0-2"	0.17 ± 0.005	12 ± 0.4	12	
			0.16 ± 0.005	11 ± 0.4		
		2-6"	0.029 ± 0.003	7.3 ± 0.8	6.8	18.8
			0.026 ± 0.003	6.4 ± 0.7		
14.	Rapid City, S.D.	0-2"	0.29 ± 0.006	20 ± 0.4	22	
			0.34 ± 0.006	23 ± 0.4		
		2-6"	0.053 ± 0.004	12 ± 1.0	11	33.
			0.045 ± 0.003	10 ± 0.7		
15.	Rochester, N.Y.	0-2"	0.22 ± 0.006	16 ± 0.4	16	
			not reported			
		2-6"	0.013 ± 0.002	2.5 ± 0.4	2.5	18.5
			0.013 ± 0.002	2.5 ± 0.4		
16.	Salt Lake City, Ut.	0-2"	0.32 ± 0.007	22 ± 0.5	22	
			0.33 ± 0.007	23 ± 0.5		
			0.31 ± 0.007	22 ± 0.5		
		2-8"	0.016 ± 0.002	5.7 ± 0.7	5.8	27.8
			0.016 ± 0.002	5.9 ± 0.8		
17.	Seattle, Wash.	0-2"	0.46 ± 0.011	17 ± 0.4	17	
			0.44 ± 0.010	16 ± 0.4		
		2-6"	0.051 ± 0.007	9.4 ± 1.2	9.5	26.5
			0.052 ± 0.004	9.6 ± 0.7		

* Air dried

** Alternative procedure used.

Each error term represents one standard deviation due to counting error.

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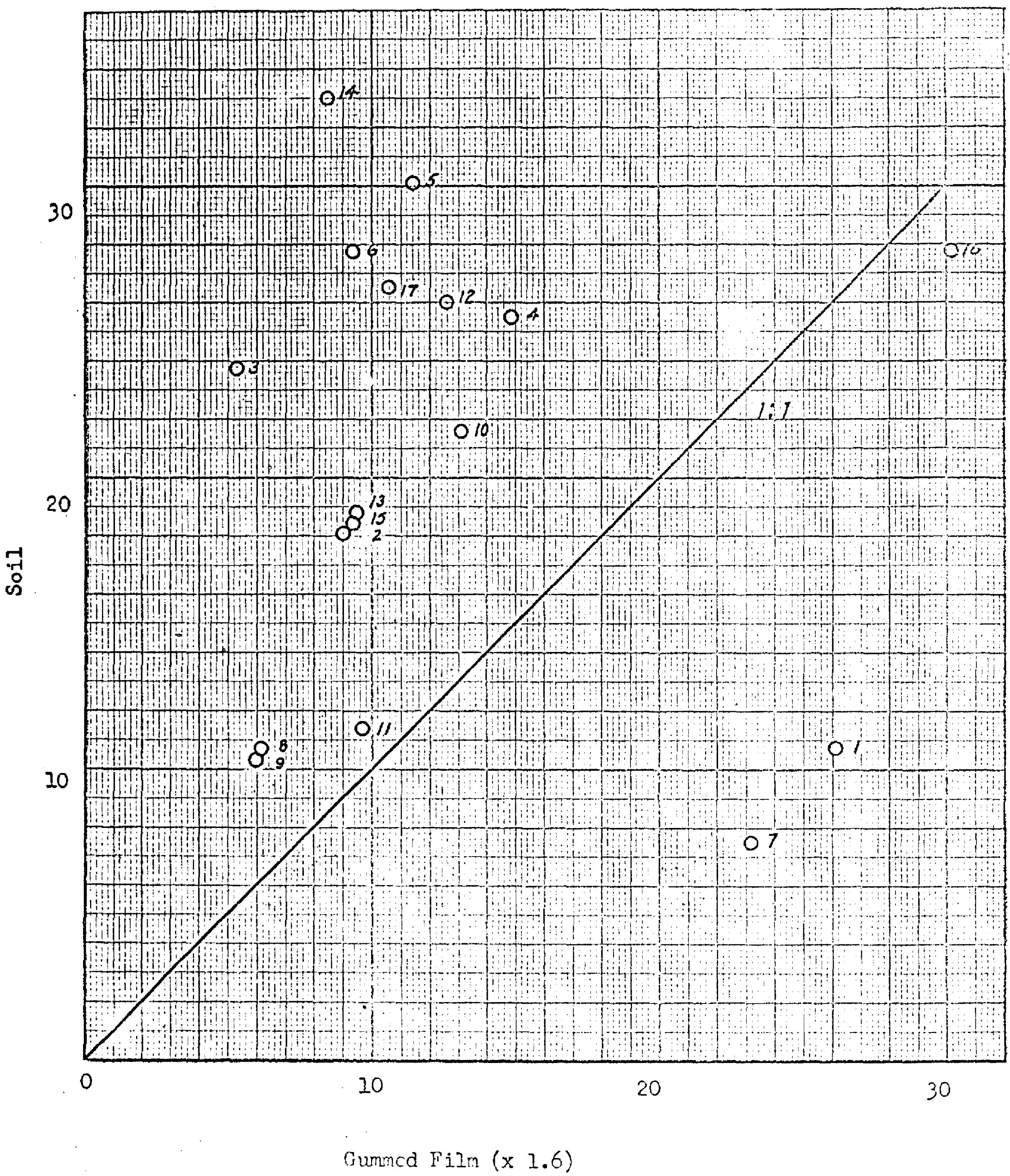

Fig. 3

Soil - Gummed Film Relationship for Sr-90 (mc/mi^2)

Further investigations are in progress on the reasons for the deviations shown by the three stations mentioned above. In addition, analysis of foreign soils will be made where available to extend the comparison.

Other Comparison Programs

Other sampling procedures for fallout documentation are by collection in a high-walled pot, or by collection of rainfall. These procedures may also be used for calibration of the gummed film. The first is represented by data from New York City by HASL, and the second by data from Pittsburgh by Nuclear Science and Engineering Corporation under AEC contracts. The detailed data will be presented later, but Table 2 indicates the cumulative results useful for calibration purposes. For comparison, the New York City (La Guardia Airport) soil and gummed film data are included.

The pot and rainfall samples show that the 1.6 correction factor is not sufficient for this period. It must be emphasized, however, that this is not necessarily a failure of the original pot to film calibration figure of 1.6. It is more likely a failure to attribute measured MFP activity correctly to earlier tests, with a corresponding error in Sr-90 estimation.

GUMMED FILM COMPARISONS

(Cumulative mc/mi^2)

	10/55	10/56	Δ	Ratio
LaGuardia Soil	13.0	26.0	13.0	
Gummed Film	2.6	7.9	5.3	2.45
HASL Pot	14.9	25.9	11.0	
Gummed Film	3.8	9.3	5.5	2.0
Pittsburgh Rain	6.5	16.2	9.7	
Gummed Film	2.6	8.5	5.9	1.65

Note: Gummed film values not corrected for efficiency.

New Haven Dustfall

The Bureau of Environmental Sanitation of the New Haven Department of Health collects monthly dust-fall samples at several stations in and around the city. The collectors are standard 1500 ml beakers, and duplicate samples are analyzed for dust content, one by evaporation of any rainfall and the other by filtration. The samples supplied to HASL were measured for total MFP activity and Sr-90, and the results are shown in Table 3.

While the data are not as complete as desired, there are several interesting points,

1. Filtration or evaporation are equally effective for dust-fall by weight.
2. Filtration loses both MFP and Sr-90 by solubility.
3. The agreement in activity values between stations is fairly good, and is independent of the dust-fall.

A comparison of the mean Sr-90 values from the evaporated samples and the corresponding gummed film estimates (New Haven Airport) is shown in Table 4. It appears that the gummed film activity should have been attributed to an early test series, rather than current tests, to give better agreement.

TABLE 3

NEW HAVEN DUST FALL EXPERIMENT

Sampling Station	March: Activity Total β* mc/mi²	March: Sr^{90} mc/mi²	March: gms. dust	April: Activity Total β* mc/mi²	April: Sr^{90} mc/mi²	April: gms. dust	May: Activity Total β* mc/mi²	May: Sr^{90} mc/mi²	May: gms. dust
Airport # 1									
evaporation				55.55 ± 1.37 [1]	2.1 ± 0.26	0.077	40.17 ± 1.28 [1]	0.49 ± 0.31	0.072
filtration	11.11 ± 0.85 [1]	0.20 ± 0.05	0.035	26.49 ± 1.11 [1]	0.14 ± 0.06	0.075	17.95 ± 0.94 [1]	0.38 ± 0.09	0.046
Airport # 2									
evaporation									
filtration	10.26 ± 0.85 [1]	0.09 ± 0.06	0.025						
St. Rose's Convent									
evaporation				48.71 ± 1.54 [1]	1.7 ± 0.32	0.167	43.58 ± 1.37 [1]	0.70 ± 0.32	0.128
filtration	14.53 ± 0.94 [1]	0.23 ± 0.05	0.110	29.05 ± 1.19 [1]	0.25 ± 0.1	0.159	15.38 ± 0.85 [1]	0.18 ± 0.07	0.112
Hall of Records									
evaporation				70.93 ± 1.54 [1]	1.4 ± 0.08	0.143			
filtration	15.38 ± 0.94 [1]	0.14 ± 0.06	0.096	Lost	0.14 ± 0.05	0.114	23.92 ± 1.11 [1]	0.34 ± 0.08	0.116
Edward Malley Co., Bldg.									
evaporation				69.22 ± 1.62 [1]	1.6 ± 0.12	0.130			
filtration	16.24 ± 0.94 [2]	0.37 ± 0.11	0.106	23.07 ± 1.11 [1]	±0.08	0.111	17.09 ± 0.85 [1]	0.34 ± 0.06	0.090
Brady Hospital Lab.									
evaporation									
filtration	12.82 ± 0.85 [2]	0.21 ± 0.07	0.206						
New Haven Hospital									
evaporation				63.24 ± 1.62 [1]	0.94 ± 0.29	0.109			
filtration	11.96 ± 0.85 [2]	0.14 ± 0.06	0.081	25.64 ± 1.03 [2]	0.09 ± 0.07	0.090	17.09 ± 0.94 [1]	0.71 ± 0.06	0.059
Grace -N.H. Memorial Bldg.									
evaporation				68.37 ± 1.71 [1]	6.0 ± 0.37	0.109			
filtration				27.35 ± 1.03 [2]	0.14 ± 0.05	0.100	15.38 ± 0.94 [1]	0.39 ± 0.07	0.068
Grace -N.H. Memorial Bldg.									
evaporation									
filtration									

Sampling Station	June: Activity Total β* mc/mi²	June: Sr^{90} mc/mi²	June: gms. dust	July: Activity Total β* mc/mi²	July: Sr^{90} mc/mi²	July: gms. dust	August: Activity Total β* mc/mi²	August: Sr^{90} mc/mi²	August: gms. dust
Airport # 1									
evaporation	25.64 ± 1.28 [2]	0.53 ± 0.06	0.054				Lost	0.51 ± 0.07	
filtration	12.82 ± 0.85 [2]	0.34 ± 0.06	0.046	23.07 ± 1.11 [3]	0.25 ± 0.06	0.028	7.61 ± 0.72 [4]	±0.10	0.015
Airport # 2									
evaporation									
filtration									
St. Rose's Convent									
evaporation	31.62 ± 1.19 [2]	0.66 ± 0.08	0.163				Lost	0.57 ± 0.07	
filtration	19.66 ± 1.03 [2]	0.53 ± 0.06	0.157	30.77 ± 1.20 [3]	0.17 ± 0.06	0.095	8.30 ± 0.77 [4]	0.17 ± 0.06	0.122
Hall of Records									
evaporation	26.49 ± 1.11 [2]	0.69 ± 0.09	0.110						
filtration	16.24 ± 1.03 [2]	0.50 ± 0.12	0.112	32.47 ± 1.20 [3]	0.26 ± 0.1	0.080	9.40 ± 0.77 [4]	0.18 ± 0.10	0.075
Edward Malley Co., Bldg.									
evaporation	30.76 ± 1.20 [2]	0.60 ± 0.06	0.098						
filtration	16.24 ± 0.85 [2]	0.42 ± 0.06	0.096	22.22 ± 1.03 [3]	0.15 ± 0.06	0.067	[illegible] [4]	[illegible]	[illegible]
Brady Hospital Lab.									
evaporation									
filtration									
New Haven Hospital									
evaporation									
filtration									
Grace -N.H. Memorial Bldg.									
evaporation	26.49 ± 1.20 [2]	0.36 ± 0.06	0.104				Lost	0.51 ± [illegible]	
filtration	17.09 ± 0.94 [2]	0.49 ± 0.08	0.079	26.49 ± 1.03 [3]	0.25 ± 0.05	0.069	8.30 ± 0.60 [4]	0.40 ± [illegible]	[illegible]
Grace -N.H. Memorial Bldg.									
evaporation	24.78 ± 0.94 [2]	0.54 ± 0.11	0.062						
filtration	15.38 ± 0.94 [2]	0.37 ± 0.08	0.064	37.60 ± 1.37 [3]	0.22 ± 0.05	0.046	6.24 ± 0.44 [4]	0.19 ± [illegible]	[illegible]

* See counting date reference

Ref.	c-date
1	7-17-56
2	7-24-56
3	8-24-56
4	11-7-56

TABLE 4

NEW HAVEN DUST-FALL EXPERIMENT

Month	Sr^{90} Activity in mc/mi^2 Mean Dust-Fall	Gummed Film
March, 1956	--	0.38
April	1.55 *	0.59
May	0.60	0.12
June	0.56	0.01
July	--	0.01
August	0.53	0.02

* Memorial Building sample omitted.

Note: Gummed film values have not been corrected for efficiency.

Current Pot Program

The uncertainty as to the source of current fallout requires more extensive calibration than in the past. The simplicity of gummed film for daily network operation makes it necessary that it be retained for routine sampling. The possible errors in attributing activity to a given source is expected to be overcome by a broader network of pot sampling stations. The operating and projected stations in the HASL program are shown in Fig. 4. These samples will be collected monthly and analyzed for MFP and Sr-90 and probably for Cs-137.

Cooperative tests will start in April 1957 on a fallout collector designed by Dr. Bo Aler of Sweden. Fallout collects in a plastic funnel and is passed through a filter and ion exchange column to collect the activity. Such a collector would be simple to maintain and to ship to a central laboratory for processing.

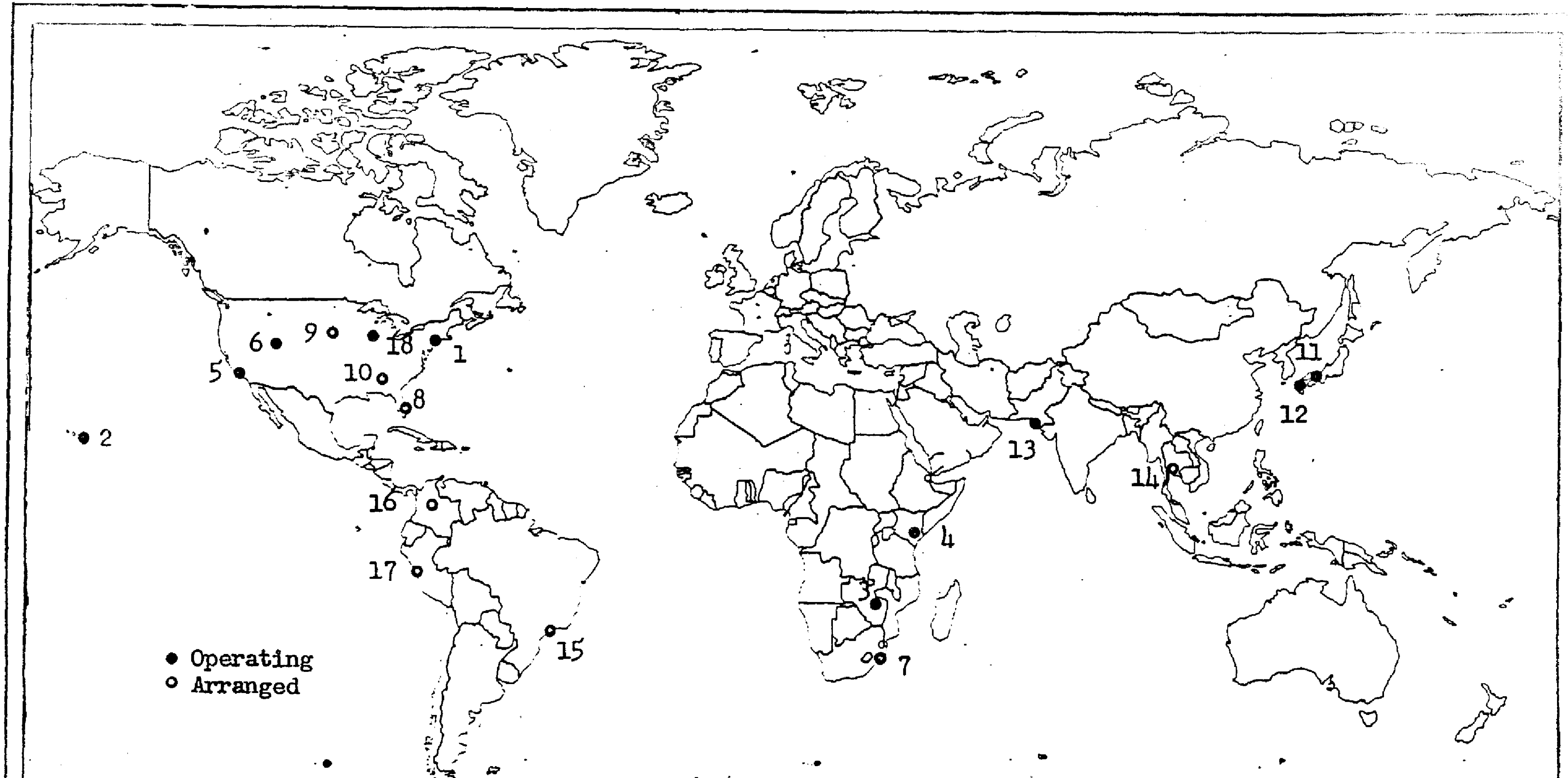

Fig. 4. Pot Sampling Stations

1. New York, N.Y.
2. Honolulu, Hawaii
3. Causway, Southern Rhodesia
4. Kikuyu, Kenya
5. West Los Angeles, Cal.
6. Salt Lake City, Utah
7. Durban, South Africa
8. Coral Gables, Fla.
9. Vermillion, S. D.
10. Birmingham, Ala
11. Hiroshima, Japan
12. Nagasaki, Japan
13. Karachi, Pakistan
14. Bangkok, Thailand
15. Rio de Janeiro, Brazil
16. Bogota, Colombia
17. Lima, Peru
18. Chicago, Ill.

Summary

The sets of data on fallout from the U. S. soils, the New Haven dust-fall and the pot and rainfall from New York City and Pittsburgh all indicate that the current gummed film estimates of Sr-90 deposition are in error. This is particularly true for activity attributed to tests in the summer of 1956. The actual Sr-90 measurements show the debris to be much older, and the gummed film data must be recalculated on this basis.

It was not possible to recalculate the mass of data involved for this report, but this will be done. In the meantime, the gummed film estimates of Sr-90 must be considered as minimum values, subject to correction.

Further samples and analyses on pot and soil samples are required before conclusions can be drawn as to the extent and uniformity of fallout outside the United States. Such work is in progress and will be reported when the results are completed.

PASTURE PROGRAM

Not all of the 1956 samples for the HASL pasture program have been received, and no Sr-90 data will be reported until all analyses are complete.

There have been several improvements in analytical techniques since the 1953 and 1954 pasture samples were run originally. Therefore, all samples still available will be reanalyzed in the coming months. When complete, the four years data will be reported as a unit.

One approach to estimating the eventual equilibrium state of Sr-90 in the biological cycle is through measurement of stable strontium and calcium. Some of the original pasture samples have been run for stable strontium and are reported in preliminary form in Table 5. No attempt at interpretation will be made until further analyses are completed. (See also section on milk analyses.)

TABLE 5

NORMAL STRONTIUM - PASTURE SAMPLES

(Atoms Sr/1000 atoms Ca)

	Tifton	Ithaca
1953 Soil (Avail. Ca)	69	5.6
(Total Ca)	1.9	0.8
1955 Plant	0.73	1.1
1953 Bone	0.21	0.22
1955 Bone	0.35	0.26

NEW YORK CITY MONITORING PROGRAM

Pot Sampling

A high-walled stainless steel pot is maintained on the roof of HASL for fallout sampling. The results of weekly collections are given in Table 6 and the cumulative curve is shown in Fig. 5.

It was found that agreement between duplicate pots is not good. This is mostly caused by the low activity levels. Such deviations are expected to be reduced by exposure for one month periods and by counting on lower background equipment. The latter is shown partially by the data after 9/24/56, but further improvement will be possible as more counting equipment will allow longer counting times.

Tap Water

New York City tap water has been analyzed since August 1954. The results obtained since issuance of NYO-4751 are given in Table 7. The weighted average value for the six months period is 0.19 $\mu\mu c$/liter.

TABLE 6

POT AND GUMMED FILM RESULTS FROM HASL

Date	Pot mc/mi²		Film mc/mi²
1-3-56	.104	2.7	0.8
1-9-56	.289		
1-16-56	2.01		
1-23-56	.301		
1-30-56	.188	1.0	1.5
2-6-56	.308		
2-13-56	.226		
2-20-56	.276		
2-27-56	.251	1.9	1.3
3-5-56	.509		
3-12-56	.729		
3-19-56	.302		
3-26-56	0.073		
4-2-56	.295	0.8	1.1
4-9-56	.176		
4-16-56	.201		
4-23-56	.099		
4-30-56	.377	1.0	0.11
5-7-56	.068		
5-14-56	.214		
5-21-56	.377		
5-28-56	.176	0.8	0.01
6-4-56	.070		
6-11-56	.141		
6-18-56	.276		
6-25-56	.141		

Date	Pot mc/mi²		Film mc/mi²
7-2-56	.264	0.6	0.03
7-9-56	.080		
7-16-56	.062		
7-23-56	.120		
7-30-56	.119	0.5	0.05
8-6-56	0.068		
8-13-56	.301		
8-20-56	0.068		
8-27-56	0.095		
9-3-56	.085	0.3	0.04
9-10-56	.194		
9-17-56	.019		
9-24-56	.018		
10-1-56	.157	0.3	[illegible]
10-8-56	.030		
10-15-56	.050		
10-22-56	.086		
10-29-56	.383	0.9	0.03
11-5-56	.078		
11-12-56	.142		
11-19-56	.244		
11-26-56	.047		
12-3-56	.092	0.6	--
12-10-56	.25		
12-17-56	.18		
12-26-56	.035		

Note: Gummed film results are not corrected for efficiency.

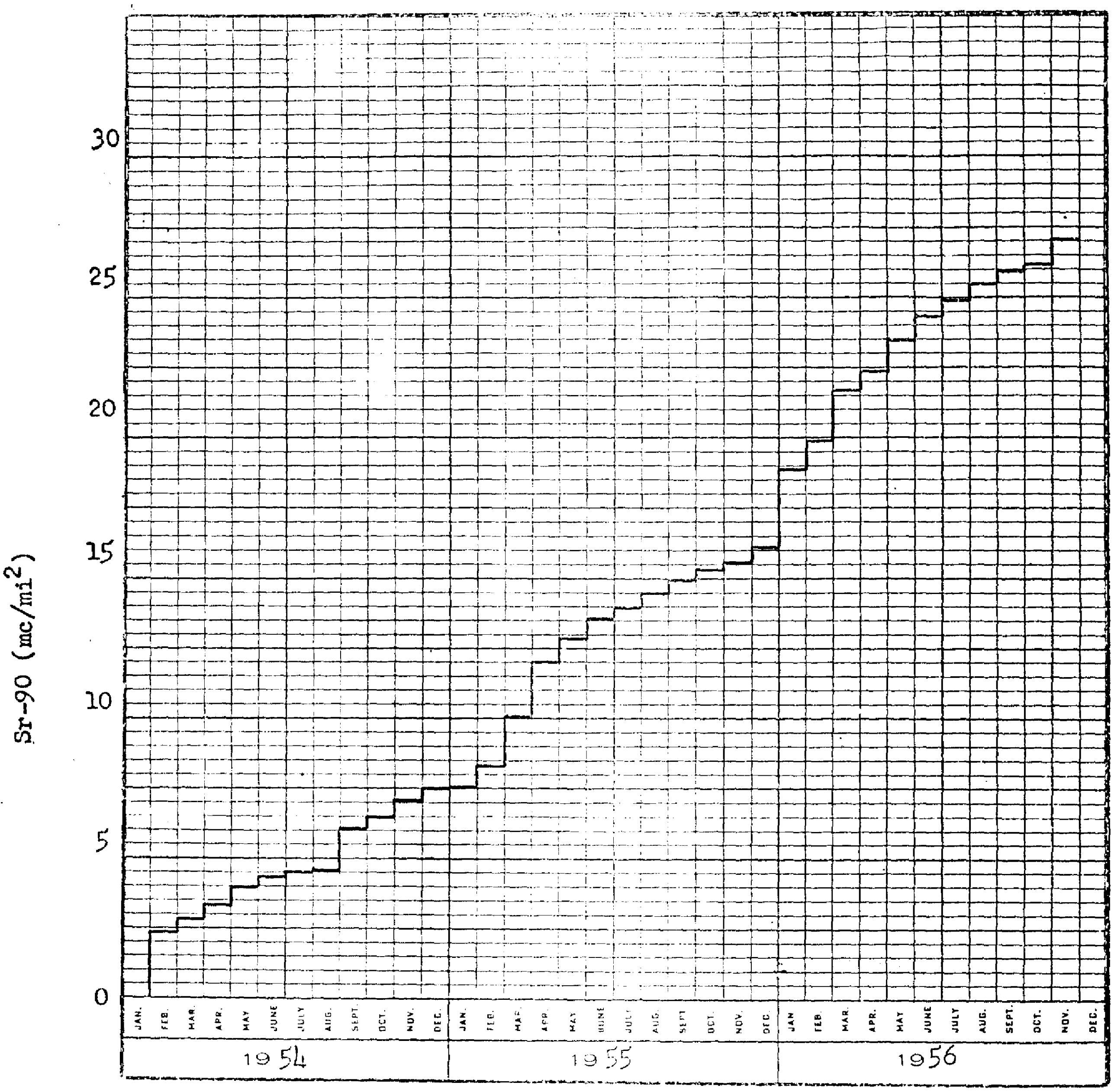

Fig. 5

Cumulative Sr-90 from Pot Collections at HASL

TABLE 7

NEW YORK CITY TAP WATER

HASL #	Sampling Period From	Sampling Period To	Total Activity c-date	Total Activity d/m/l	Sr^{90} d/m/l
3785	6/27/56	7/17/56	8-30-56	4.1 ± 0.2	0.50 ± 0.08
4216	8/27/56	9/12/56	9-19-56	3.9 ± 0.2	0.28 ± 0.06
4286	9/12/56	9/22/56		2.6 ± 0.3	0.03 ± 0.02
4299	9/22/56	10/5/56	10-19-56	8.4 ± 0.3	0.57 ± 0.03
4404	10/5/56	10/17/56	10-19-56	7.5 ± 0.3	0.44 ± 0.03
4585	10/16/56	10/30/56	10-19-56	4.2 ± 0.2	Lost
4699	10/30/56	11/13/56	11-19-56	5.0 ± 0.3	0.56 ± 0.04
4850	11/14/56	11/27/56	11-30-56	5.4 ± 0.2	0.49 ± 0.03

Milk

The results of milk analyses performed since the issuance of NYO-4751 are given in Table 8 and the continuous curve for dried milk is shown in Fig. 6.

The level increased during the summer of 1956 and has maintained its level after the normal pasture season. This probably indicates that the cows are feeding on vegetation exposed during the summer and will stay at the same level until the next pasture season.

In NYO-4751, some concern was shown that wet milk purchased in New York City showed higher levels than the dried milk being analyzed. This is apparently due to the difference in source area of the two supplies. As a check, however, Dr. Alexander obtained wet milk, dried milk, and the washings from the drier during a run at Columbus, Wisconsin. These samples are being analyzed to check possible loss of Sr-90 during processing and to test uniformity of run.

Wet milk samples were not run during this reporting period, but a more extensive sampling program for the city supply was started at the first of 1957.

Some of the dried milk samples have been analyzed for stable strontium. The preliminary data are given in Table 9.

Tests have shown that dry ashing of milk results in loss of Cs-137, even at low temperatures. No Cs-137 results on milk will be reported until improved techniques are available.

TABLE 8

DRIED MILK SAMPLES

Source: Perry, N. Y.

HASL No.	Analyzed by	Sample Date	Ca % Ash	S. U.	Sr^{89}/Sr^{90}	Sr^{89} o-date
3720	HASL	June 1956	14.01	3.0 ± 0.7	1	10-3-56
3832	HASL	July 1956	16.93	2.7 ± 0.7	5	10-3-56
3833	HASL	Aug. 1956	18.51	3.1 ± 0.7	7	10-3-56
4149 I	HASL	9-3-56	---	5.1 ± 0.7	11	10-3-56
4149 II	HASL	9-13-56	---	5.5 ± 0.5	8.5	11-13-56
4149 III	HASL	9-17-56	---	4.1 ± 0.7	11	11-13-56
4149 IV	HASL	9-24-56	---	4.8 ± 0.5	12	11-13-56
4301-1	(I)	10-4-56	17	5.05 ± 0.06	--	---
4301-2	(I)	10-11-56	15.6	5.37 ± 0.12	--	---
4301-3	(I)	10-18-56	18.7	5.68 ± 0.11	--	---
4301-4	(I)	10-26-56	20.0	5.52 ± 0.08	--	---
4698	(N)	Nov. 1955	16.0	5.6 ± 0.3	--	---

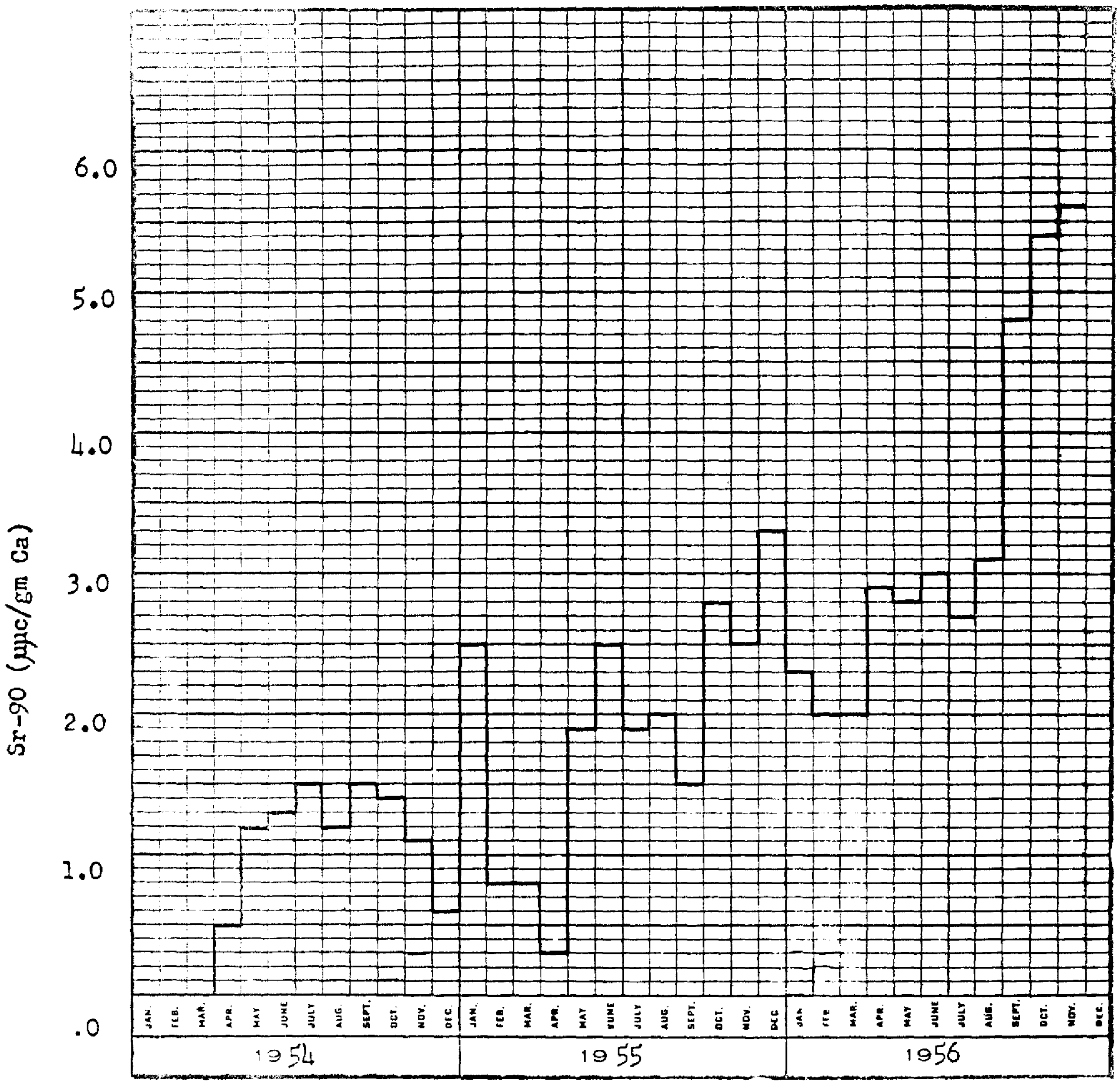

Fig. 6

Monthly Analyses of Dried Milk from Perry, New York.

TABLE 9

Normal Sr In Milk

HASL #	Location	Process Date	% ash	% Ca in ash	% Sr in ash	$\frac{\% Sr}{\% Ca} \times 10^3$	$\frac{atoms\ Sr}{atoms\ Ca} \times 10^3$
3558	N.Y.C. - wet	Mar. '56		15.1	0.0043 ± 0.0003	0.28	0.13
3719	N.Y.C. - wet	May '56		15.1	0.0046 ± 0.0002	0.30	0.14
3720	Perry, N. Y.	June '56	5.9	17.2	0.0034 ± 0.0002	0.20	0.092
3832	Perry, N. Y.	7-30-56	5.4	16.9	0.0045 ± 0.0006	0.27	0.12
3833	Perry, N. Y.	Aug. '56	5.7	18	0.0057 ± 0.0006	0.32	0.14
4352	Perry, N. Y.	8-28-56	4.9	17	0.0058 ± 0.0005	0.34	0.16
4698	Perry, N. Y.	Nov. '56	5.9	16	0.0059 ± 0.0006	0.37	0.17
3778	Columbus, Wisc.	May '56	5.8	16.0	0.0033 ± 0.0002	0.21	0.097
3800	Columbus, Wisc.	July '56	5.9	17.6	0.0024 ± 0.0001	0.14	0.064
3776	Mandan, N. D.	June '56	11.7	9.28	0.0039 ± 0.0008	0.42	0.19
4057	State College, Miss.	July '56	8.1	17.5	0.0077 ± 0.0006	0.44	0.20
3736	Portland, Ore.	May '56	8.2	16.4	0.0053 ± 0.0010	0.32	0.15
3737	Portland, Ore.	June '56	7.5	19.0	0.0057 ± 0.0010	0.30	0.14
4293	Hikurangi, New Zealand		7.9	13.5	0.0035 ± 0.0002	0.26	0.12

Urine

Urine samples from laboratory personnel and others in the city have been run at intervals. The values found for Sr-90 and Cs-137 are given in Table 10. The period of sampling is too short to indicate any trend.

TABLE 10

URINE ANALYSES

NEW YORK NAVAL SHIPYARD EMPLOYEES

HASL Number	Total Volume Liters	S-Date	Sr^{90} d/m/l	Cs^{137} d/m/l
3911	4	8-10-56	1.3 ± 0.25	
3912	4	8-10-56	1.1 ± 0.28	21 ± 1.5
3913	4	8-10-56	≤0.24	
3914	4	8-10-56	1.2 ± 0.25	
3915	4	8-10-56	2.3 ± 0.32	25 ± 1.6
3916	4	8-10-56	1.1 ± 0.30	16 ± 1.7
3917	4	8-10-56	≤0.20	
3918	3	Lost		30 ± 2.0
3919	2	Lost	1.2 ± 0.50	
3926	4	8-17-56	0.95 ± 0.28	26 ± 1.6
3927	4	8-17-56	0.82 ± 0.25	26 ± 1.9
3928	4	8-17-56	0.92 ± 0.28	21 ± 1.5

HASL EMPLOYEES

Type of Sample	Total Volume Liters	S-Date	Sr^{90} d/m/l
Pooled	5	6-56	1.4 ± 0.2
Pooled	5	6-56	1.9 ± 0.2
Pooled	2	6-56	1.0 ± 0.2
GH	5	9-56	0.6 ± 0.2
ST	5	9-56	1.0 ± 0.2
Pooled	5	9-56	1.3 ± 0.2

OTHER MONITORING

Milk Supplies

Dried milk from several sources in the United States and abroad has been analyzed. A complete summary of the data is given in Table 11.

The high value for Mandan led to analysis of soil and animal bone for this region. The bone ran 24 μμc/g Ca and the soil 6.4 μμc/g Ca with 10 mc/mi^2. Neither the fallout nor the activity relative to calcium is high for the soil, yet the bone value is what might be expected from the high level in the milk. The milk samples from other sites are reasonably close to the level found for New York.

Fish Samples

Canned tuna of known origin plus canned Alaska salmon and bonito are analyzed on a regular basis. The results of all analyses to data are given in Table 12. There are no apparent trends.

Pittsburgh Rain Collection

Rainfall has been collected since 2/25/55 at Pittsburgh. The collections are made by Nuclear Science and Engineering Corporation with a pair of tubs having a total area of 5.16 square feet. The collection periods are of irregular length and the analyses are performed at NSE. The cumulative data are shown in Fig. 7.

The accumulation of Sr-90 at Pittsburgh is in reasonable agreement with the results obtained at HASL. At the end of 1956, Pittsburgh showed 17 mc/mi^2, while HASL showed 18 for the same period.

TABLE 11

DRIED MILK ANALYSIS

	Sr^{90}, µµc/g Ca						
	1	2	3	4	5	6	7
January, 1955						3.0	
February						1.0	
March						2.0	1.8
April						1.8	2.9
May	2.6	4.1	1.0	7.3	1.7	1.9	
June	4.7	4.6	4.6	9.2	2.6	0.8	5.5
July	4.4	3.9	0.8	6.3			2.6
August	4.1		1.2	5.8		0.8	
September	3.2		3.3	4.7		2.0	
October			4.4	6.9		7.5	
November			3.7	7.4		2.5	
December			3.0	10.		3.5	
January, 1956			3.0	3.5		2.7	4.0
February			3.5	8.1			
March	6.3		3.4	11.		3.5	
April	6.7		3.4	9.6	5.2	3.0(N)	4.6
May	4.9		2.8	17.	6.4		4.5
June	4.4		3.4	8.7	5.0		5.0
July	6.1		4.2	6.6		2.3(N)	
August	3.8 (I)		4.7(I)	8.6			
September	4.8 (N)			10.7(N)			
October				8.9(N)			
November							
December							

Locations:

1 State College, Mississippi
2 St. Louis, Missouri
3 Columbus, Wisconsin
4 Mandan, North Dakota
5 Portland, Oregon
6 Japan
7 United Kingdom

TABLE 12

Sr^{90} IN CANNED FISH

HASL Number	Type		Date Received at HASL	Sr^{90} c/m/kg-wet*
3636	Alaska pink Salmon		5-26-56	$\leq$0.98
3739	Alaska pink Salmon		6-18-56	3.9 ± 1.5
3760	Alaska pink Salmon		7-3-56	2.9 ± 1.2
3762	Alaska pink Salmon		7-5-56	
3832	Alaska pink Salmon		8-6-56	1.5 ± 0.73
4146	Alaska pink Salmon		9-4-56	1.9 ± 1.2
4297	Alaska pink Salmon		10-3-56	4.6 ± 0.7
4790	Alaska pink Salmon		11-19-56	4.2 ± 0.6
3637	Bonito		5-26-56	5.3 ± 2.3
3638	Bonito		5-26-56	8.5 ± 3.7
3660	Bonito		6-2-56	2.2 ± 1.4
3761	Bonito		7-3-56	3.7 ± 1.3
3824	Bonito		8-6-56	0.77 ± 0.50
4147	Bonito		9-4-56	2.4 ± 0.93
4298	Bonito		10-3-56	1.2 ± 0.7
4791	Bonito		11-19-56	$\leq$0.7
3606	Yellowfin	N. E. Pacific Gulf of Tehauntepec	4-20-56	3.5 ± 1.2
3606	Yellowfin	Region of Marquesas Islands	4-20-56	$\leq$1.5
3608	Albacore	Western Pacific	4-20-56	5.9 ± 2.4
3721	Albacore	Western Pacific	6-19-56	2.5 ± 0.8
3722	Yellowfin	Caught off Cape San Lucas	6-19-56	1.8 ± 1.1
4055	Yellowfin	Lower California Eastern Pacific	8-1-56	$\leq$1.7
4056	Albacore	Western Pacific	8-1-56	3.8 ± 1.5
4152	Tuna	Cocos Is., Costa Rica, Nicaragua	9-7-56	1.4 ± 0.95
4153	Tuna	Western Pacific	9-7-56	2.2 ± 0.84
4792	Tuna	Eastern Pacific	11-19-56	3.2 ± 0.7
4793	Tuna	Western Pacific	11-19-56	4.0 ± 0.8

* Wet refers to weight as received

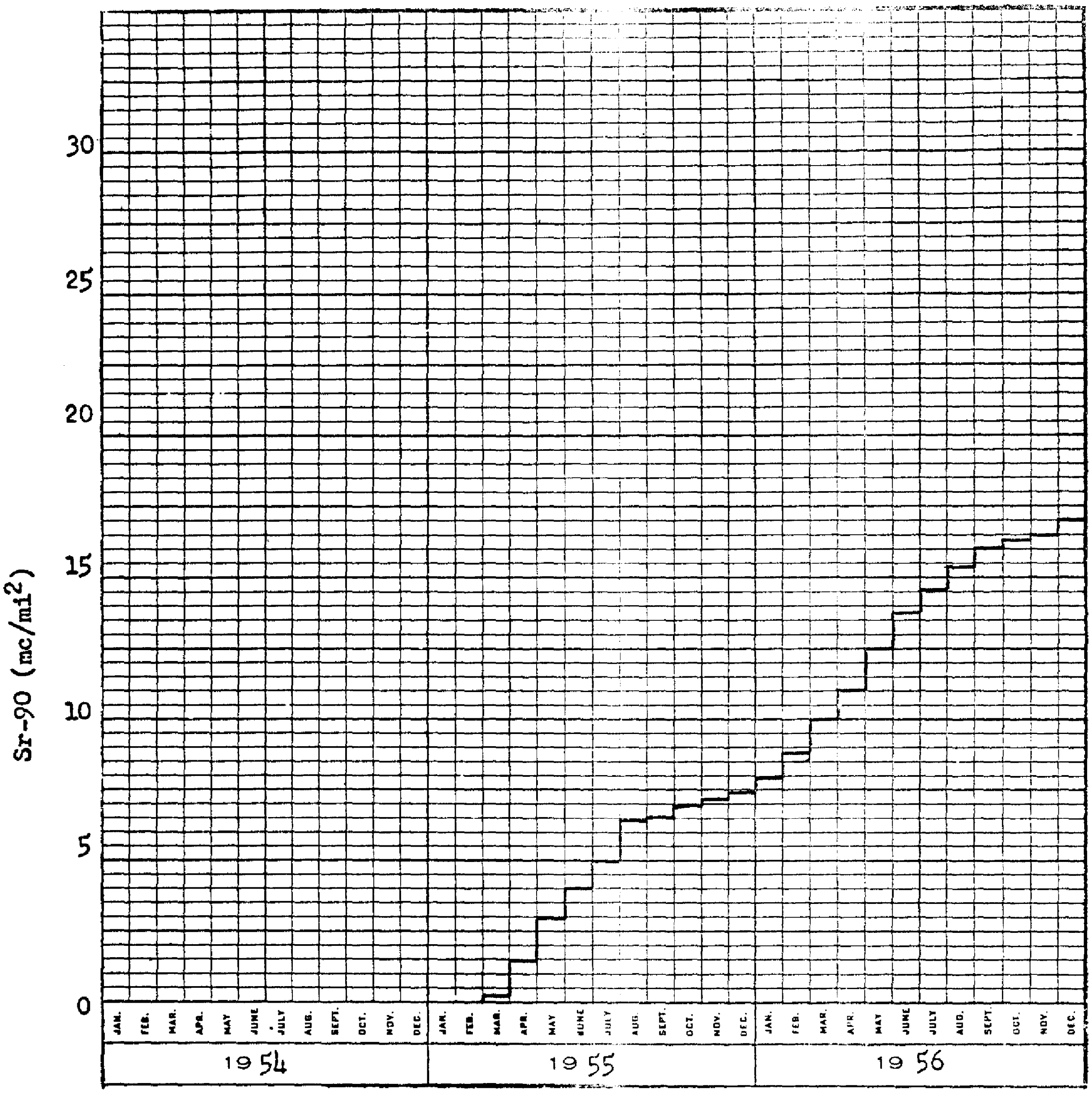

Fig. 7

Cumulative Sr-90 from Rainfall Collections at Pittsburgh.

BEAN EXPERIMENT

During the summer of 1956, three plants, snap beans, lima beans and black-eyed peas were grown at the Beltsville Laboratory of the U. S. Department of Agriculture. The leaf, stalk, pod and fruit of each were analyzed separately and the snap bean and black-eyed pea samples were run in duplicate. The results on the plants are given in Table 13, while the soil analysis is shown in Table 14.

Normalizing the data to stalk = 1, the mean Strontium Unit values for leaf, fruit and pod become 0.85, 0.52, and 0.54, respectively. The mean Sr-89/Sr-90 ratios are 1.9, 0.2, 0.7, and 1.4 for the leaf, fruit, stalk and pod. While such averaging may not be completely justified, it would lead to the following conclusions:

1. The high stalk activity may indicate uptake that is partially blocked from the rest of the plant.

2. The leaves show higher S.U. values than the pod and fruit, indicating some leaf retention

3. The Sr-89 values indicate that the leaf and pod activity is younger than the fruit activity.

It is also of interest to note that the Sr-89 values indicate that some of the top soil activity is younger than the bottom fraction.

TABLE 13

RADIOSTRONTIUM AND CALCIUM IN SELECTED TISSUES OF BEAN AND BLACK-EYED PEA PLANTS

Plant	Section	% Ash of dry wt.	% Ca in Ash	Average % Ca in Ash	d/m/g ash Sr^{90}	Sr Units	Average SU	Sr^{89}/Sr^{90} * Ratio
Snap Bean 1st Half Bag	Leaf	32	12 11	12	20 ± 0.5 19 ± 0.5	76 ± 1.7 80 ± 1.8	78	3.0 2.9
	Bean	4.2	1.4 1.4	1.4	2.0 ± 0.18 1.6 ± 0.26	65 ± 5.9 52 ± 8.6	58	0.87 0.79
	Stalk	11	14 15	14	25 ± 0.5 26 ± 0.5	82 ± 1.5 80 ± 1.4	81	1.2 1.1
	Pod	9.2	9.3 8.0	8.6	11 ± 0.4 11 ± 0.6	53 ± 1.7 61 ± 3.1	57	1.6 1.4
								* as of 10-15-56
2nd Half Bag	Leaf	52	3.8 4.2	4.0	3.9 ± 0.3 4.8 ± 0.3	45 ± 4 50 ± 3	48	2.0 1.4
	Bean	8.5	1.6 1.8	1.7	1.5 ± 0.3 1.2 ± 0.2	43 ± 9 30 ± 5	37	-- 0.60
	Stalk	12	15 16	16	23 ± 0.6 22 ± 0.6	68 ± 1.8 64 ± 1.8	66	0.39 0.44
	Pod	10	7.9 7.8	7.9	9.3 ± 0.4 9.4 ± 0.4	55 ± 2 55 ± 2	55	0.56 0.38
								* as of 1-21-57
Lima Bean	Leaf	27	15 14	15	11.5 ± 0.45 11.1 ± 0.41	35 ± 1.4 36 ± 0.9	36	0.99 0.98
	Bean	4.2	1.5 1.4	1.5	0.21 ± 0.19 0.48 ± 0.23	6.4 ± 5.9 15 ± 7.3	11	
	Stalk	9.0	14 15	15	13.9 ± 0.46 12.7 ± 0.47	45 ± 1.4 39 ± 1.4	42	0.20 0.16
	Pod	9.1	7.7 8.1	7.9	0.78 ± 0.33 0.53 ± 0.37	4.5 ± 1.8 3.0 ± 2.3	3.8	
								* as of 1-24-57

Plant	Section	% Ash of dry wt.	% Ca in ash	Average % Ca in Ash	d/m/g ash Sr^{90}	Sr Units	Average SU	Sr^{89} */Sr^{90} Ratio
Black Eye Pea Bag-1	Leaf	16	22	23	16 ± 0.5	33 ± 0.9	34	1.7
			23		17 ± 0.5	34 ± 0.9		1.8
	Bean	3.4	1.7	1.9	0.79 ± 0.25	21 ± 6.4	24	
			2.0		1.2 ± 0.25	27 ± 5.9		
	Stalk	8.3	8.4	8.0	6.3 ± 0.35	34 ± 1.8	37	0.64
			7.9		6.6 ± 0.35	38 ± 1.8		0.37
			7.9		6.0 ± 0.33	35 ± 1.8		0.70
			7.7		6.9 ± 0.35	41 ± 2.3		0.62
	Pod	6.2	8.1	8.2	3.7 ± 0.27	21 ± 1.4	22	2.3
			8.2		4.2 ± 0.35	23 ± 1.8		2.1
								* as of 1-23-57
Bag-2	Leaf	17	21	20	13 ± 0.5	28 ± 0.9	31	2.3
			19		14 ± 0.5	34 ± 1.4		2.0
	Bean	3.3	2.0	2.0	0.79 ± 0.21	18 ± 5.0	16	
			2.0		0.56 ± 0.19	13 ± 4.5		
	Stalk	6.6	6.2	8.1	6.5 ± 0.4	48 ± 2.7	39	1.1
			10		6.7 ± 0.4	30 ± 1.8		1.0
	Pod	5.8	7.2	7.3	3.1 ± 0.27	20 ± 1.8	19	2.9
			7.3		2.9 ± 0.31	18 ± 1.8		2.8
								* as of 1-22-57

TABLE 14

RADIOSTRONTIUM AND CALCIUM IN SOIL
FROM THE BEAN AND PEA PLANT PLOTS

Depth	gms Ca/gm Soil	Sr^{90} d/m/gm Soil	S. U.	Sr^{90} mc/mi^2	Sr^{89}/Sr^{90}	Sr^{89} c-date
0-2"	89×10^{-6}	0.080 ± 0.004	410 ± 2.0	6.0 ± 0.3		
	62×10^{-6}	0.083 ± 0.005	610 ± 3.7	6.2 ± 0.3		
	80×10^{-6}	0.077 ± 0.004	440 ± 2.3	5.8 ± 0.3		
		0.071 ± 0.006		5.3 ± 0.4	3.0	12-27-56
		0.090 ± 0.008		6.8 ± 0.6	2.3	12-27-56
2-6"		0.049 ± 0.003		10 ± 0.6	0.33	2-18-57
		0.051 ± 0.003		10 ± 0.6	0.21	
		0.051 ± 0.003		10 ± 0.6		
		0.039 ± 0.003		8.2 ± 0.6		

LABORATORY PROGRAM

Several phases of Analytical Branch operations other than direct analyses are related to the strontium program. Progress on these projects is reported here for completeness.

Wisconsin Milk Experiment

Dr. Alexander collected samples during a milk drying run at Columbus, Wisconsin on November 13, 1956. Dried milk was taken at the start of the 16 hour run, and every hour to the end. Whole milk from the start and end and caustic washes from the clean-up were also taken.

Since processing consumes about one tank per hour and one tank represents the largest blend made, the test should indicate the variability that might be expected in Sr-90 and Cs-137 for a normal run. Since our normal sampling is a 5 pound can selected weekly, this variability will be extremely important.

Cs-137 Analysis

Analysis of certain samples for Cs-137 will help in understanding parts of the strontium program, as well as having value in themselves.

The estimation of gamma dose from fallout will rely heavily on Cs-137 determinations for old debris. The gummed film is adequate for evaluating fresh activity, but analysis of pot samples for Cs-137 will assist in assigning an age to the material. The concentration of Cs-137 in foods and in human urine will be of direct interest.

The analytical methods are satisfactory for all types of sample except milk. There is considerable loss of cesium in the dry ashing process, even at 500°C. Still lower temperatures and a wet ashing process are being evaluated.

Laboratory Manual

The methods for analysis of Sr-90, Sr-89, Cs-137, calcium, strontium and mixed fission products are included in the Analytical Branch Laboratory manual, which is being issued in loose-leaf form as NYO-4700.

Standard Samples

Standard samples are being prepared to assist laboratories starting work on strontium analysis. These are:

1. Milk Ash
2. Bone Ash (Animal)
3. Bone Ash (Simulated Human)
4. Bone Ash (Blank $Ca_3(PO_4)_2$)
5. Vegetation Ash (Hay)
6. Mixed Fission Products (For Separation Studies)
7. Soil
8. Standard Sr^{90}-Y^{90} solution in ampoules (100 d/m)

Samples 1, 3 and 4 are being analyzed at three or four laboratories. Samples 2, 6 and 8 are in preparation. These samples will be forwarded to any laboratory, on request, with a statement of Sr-90 and calcium content. From 200 to 500 bottles of each sample will be available, each one adequate for duplicate or triplicate analyses.

Soil Comparison

Dr. Alexander of the Department of Agriculture is preparing large samples of soil for determination of Sr-90 and calcium by several methods. These will assist in evaluation and selection of the best available methods of analysis. Previous comparisons have been limited in scope, but have shown large deviations between methods, and one broad experiment is now required.

Intercomparison Report

A summary of all laboratory intercomparisons on all samples run to date has been completed, and will be issued as an NYO report. Agreement between laboratories is generally good, but there are enough major variations to warn against placing reliance on single results.

Control Milk

The Analytical Branch has been running an analysis monthly on large batches of dried milk. The first lot, run from June of 1954 through April of 1955 showed values of 0.91 ± 0.11 μμc/g Ca for 10 analyses. The second lot, run from August of 1956 through December of 1956 showed values of 4.6 ± 0.7 μμc/g Ca for 16 analyses. Although there are insufficient data for a complete statistical analysis, the results indicate some deviations greater than expected from counting error. Future control samples will be ashed and blended before use to remove the variation between cans in the same lot.

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