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Strontium-90, Cesium-137, and Radioactive Rare Earths in Environmental Rain and Air at Los Alamos, New Mexico 1963-1964

by

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ABSTRACT

The report is a continuation of work reported in LAMS-2878. The study was a determination of the strontium-90, cesium-137, and the radioactive rare earths in environmental rain and air at Los Alamos, New Mexico.

The results of the study show the activity of the strontium-90 to be the highest during the summer months. The activity then decreases slowly reaching the lowest level during December and January.

The observed results of the environmental concentration of cesium-137 and rare earth radioactivity were similar to those for strontium-90. The results of the activity measured in the air and that in the rain followed the same monthly distribution. The results of the study would indicate that the rain-held activity is just a wash out of the activity present in the Los Alamos air.

INTRODUCTION

As a part of the Environmental Health Program at the Los Alamos Scientific Laboratory, samples of rain and samples of airborne radioactive particles are collected at regular intervals to determine the gross beta-gamma radioactivity. The rain samples are collected with an oversized rain gauge; the airborne particles are collected in air filters. To arrive at the concentration of long-life fission products in the rain and the air samples, a study was made of the methods suitable for sample preparation and the determination of the activity of strontium-90, cesium-137, and the radioactive rare earths. Since the samples were collected over a period of several years, the changes in contamination of the air of the Los Alamos area by fallout and, possibly, industrial waste fission products may be ascertained. This information, along with future studies, will allow for an evaluation of the environmental air radionuclide contamination of the Los Alamos area.

It was the objective of this study to determine the

amount of strontium-90, cesium-137, and radioactive rare earths in the rain and air samples collected by the Health Division at Los Alamos.

PROCEDURE

Rain Samples

The rain samples were collected in an oversized rain collector with a cross section of approximately 0.4 square meter. This area was such that a rainfall of 0.1 inch would deliver 1 liter of rain water. During dry periods, the rain gauge was washed down with a liter of distilled water daily. The wash samples as well as the rain samples were reduced in volume and plated dry on 1-inch-diameter, stainless steel planchets to determine the beta-gamma activity. The gross beta-gamma activity results have been reported in LAMS reports numbers 2397, 2499, 2702, 2870, 3071, and 3245.

The planchets prepared during one month were composited for a sample and placed in a liter beaker, and 200 milliliters of concentrated HNO_3 was added. The beaker containing the sample was placed on a hot plate and the acid brought to boiling for 1 minute. The resulting supernatant liquid and a distilled water wash of the planchets was transferred to a large platinum evaporating dish and the contents reduced to dryness. The residue was digested with nitric-perchloric

acid until clear, then dried again. The silicon was removed from the residue by treating with a mixture of one part of concentrated hydrofluoric acid and one part of concentrated perchloric acid. After the removal of the silicon, the resulting residue was soluble in dilute nitric acid. The soluble sample was transferred to a volumetric flask and set aside for future analysis.

Air Filter Samples

Airborne radioactive particles were collected by filtration through 4-inch-diameter filters (MSA catalog number CR-17651). The sampling rate was 46 cubic meters per hour. Air samples were collected for 24-hour intervals during the work week; the week-end samples were for a 72-hour period. The gross beta-gamma activity was determined by counting in a thin-window proportional counter. The results have been reported in LAMS reports numbers 2397, 2499, 2702, 2870, 3071, and 3245. A collection of samples for one month* was placed in a liter beaker and digested with concentrated nitric acid, which required 48 hours or more. After this period 72 per cent perchloric acid was added and the digestion continued until the samples were clear. The

*One month's sample would equal approximately 33,120 cubic meters of filtered air.

sample was then transferred to large platinum dishes and reduced to dryness. A mixture of concentrated nitric and hydrofluoric acid was added, and the silicon was removed by two treatments of the nitric-hydrofluoric acid mixture. After the removal of the silicon, the sample was soluble. It was then transferred to a volumetric flask and set aside for analysis.

Aliquots of the dissolved samples were analyzed for strontium-90, cesium-137, and radioactive rare earths by the methods outlined by Geiger[1] and Boni.[2]

RESULTS AND DISCUSSION

The results of the strontium-90, cesium-137, and rare earth radioactivity analyses of the monthly composite of rain-collected and filter-collected air samples at Los Alamos are presented in Tables 1 through 6.

Rain Collected Activity

The activity of strontium-90 expressed as picocuries per month was low during January of 1963, increased to a high in May, then decreased to a low in December. The activity recorded in 1964 was low during January and high in April. During the year of 1963 the strontium-90 activity averaged 1.85 per cent of the average gross beta activity for the year. During the first 6 months of 1964, the

strontium-90 activity averaged 4.23 per cent of the average gross beta activity for this period. A value of 4.23 per cent for the activity of strontium-90 as a part of the gross beta activity would be the approximate contribution to the activity of fission products which were 2 years old.[3-4]

The observed activity of cesium-137 found in the rain samples was low during January of 1963, increased to a high in May, then returned to a very low in December. The observations for 1964 showed a low in January with the high month being April. The contribution of the cesium-137 activity as a contribution of the total gross beta was 1.7 per cent in 1963 and 4.0 per cent for the first 6 months of 1964.

Filter Collected Air Samples

The activity collected in filters from air at Los Alamos shows almost the same pattern of monthly distribution as the activity collected in the rain collector. It is apparent that at Los Alamos the environmental air may be sampled either by collecting samples of rain or by filtering the air.

REFERENCES

1. Geiger, E. L., "Analysis of Fission Product Mixtures," Anal. Chem. 31, 806-09 (1959).

2. Boni, A. L., "Quantitative Analysis of Radionuclides in Process and Environmental Samples," Anal. Chem. 32, 599-604 (1960).

3. Blomeke, J. O., and Todd, Mary F., "Uranium-235 Fission-Product Production as a Function of Thermal Neutron Flux, Irradiation Time, and Decay Time," 1. Atomic Concentrations and Gross Totals, ORNL-2127, Pt. 1, 1, August 1957.

4. Bolles, R. C., and Ballou, N. E. "Calculated Activities and Abundances of U-235 Fission Products," NRDL-456, 1956.

TABLE 1

STRONTIUM-90 ACTIVITY OF MONTHLY RAIN-COLLECTOR SAMPLES
COLLECTED IN LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964	Contribution to Total Activity (%) 1963	1964
January	68	40	0.59	3.6
February	363	86	2.50	4.1
March	173	138	0.51	4.8
April	250	283	1.78	3.6
May	798	278	3.91	4.6
June	475	190	0.48	4.6
July	279	104	1.00	2.3
August	259	62	1.38	4.3
September	123	72	1.88	3.3
October	102	10	2.13	2.5
November	89	22	4.69	2.6
December	7	22	1.35	2.4

Rain-Collector = 0.4 square meter in cross section.

TABLE 2

CESIUM-137 ACTIVITY OF MONTHLY RAIN-COLLECTOR SAMPLES
COLLECTED IN LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964	Contribution to Total Activity (%) 1963	1964
January	152	31	1.32	2.8
February	115	50	0.80	2.4
March	198	199	0.58	7.0
April	213	327	1.52	4.1
May	797	213	3.91	3.5
June	377	170	0.38	4.1
July	384	68	1.37	1.5
August	270	40	1.44	2.7
September	116	63	1.78	2.9
October	89	45	1.86	11.3
November	29	11	1.48	1.3
December	21	23	4.03	2.5

Rain-Collector = 0.4 square meter in cross section.

TABLE 3

RARE EARTH RADIOACTIVITY OF MONTHLY RAIN-COLLECTOR SAMPLES COLLECTED AT LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964
January	1501	498
February	2345	914
March	4001	1370
April	4638	3552
May	7137	2857
June	44041	2993
July	204	764
August	3607	352
September	3293	564
October	1616	115
November	647	240
December	109	295

Rain-Collector = 0.4 square meter in cross section.

TABLE 4

STRONTIUM-90 IN RADIOACTIVE PARTICLES FILTER-COLLECTED FROM AIR AT LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964	Contribution to Total Activity (%) 1963	1964
January	618	496	0.33	1.9
February	2131	575	0.79	1.7
March	596	785	0.18	2.3
April	2804	1115	0.32	2.3
May	1378	837	0.39	2.1
June	1098	862	0.43	2.4
July	524	144	2.51	1.0
August	344	158	1.00	1.0
September	319	76	0.79	0.5
October	434	117	0.46	0.4
November	434	161	0.78	1.2
December	469	128	2.01	1.6

Filtered air/month = 33,120 cubic meters.

TABLE 5

CESIUM-137 IN RADIOACTIVE PARTICLES FILTER-COLLECTED FROM AIR AT LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964	Contribution to Total Activity (%) 1963	1964
January	445	410	0.24	1.6
February	910	613	0.34	1.8
March	763	363	0.26	1.0
April	1458	716	0.17	1.5
May	1400	630	0.59	1.6
June	1861	932	0.71	2.6
July	335	176	0.68	2.2
August	295	256	0.71	2.9
September	381	34	0.85	0.4
October	323	176	0.86	0.9
November	323	159	1.24	2.0
December	358	170	0.91	3.7

Filtered air/month = 33,120 cubic meters.

TABLE 6

RARE EARTH RADIOACTIVE PARTICLES FILTER-COLLECTED FROM AIR AT LOS ALAMOS, NEW MEXICO

Month	pCi/month 1963	pCi/month 1964
January	23538	9657
February	31218	11217
March	36509	7022
April	56425	6267
May	54607	15280
June	60429	8591
July	8503	1347
August	5517	2321
September	5078	423
October	7178	1658
November	7178	1683
December	2280	1465

Filtered air/month = 33,120 cubic meters.

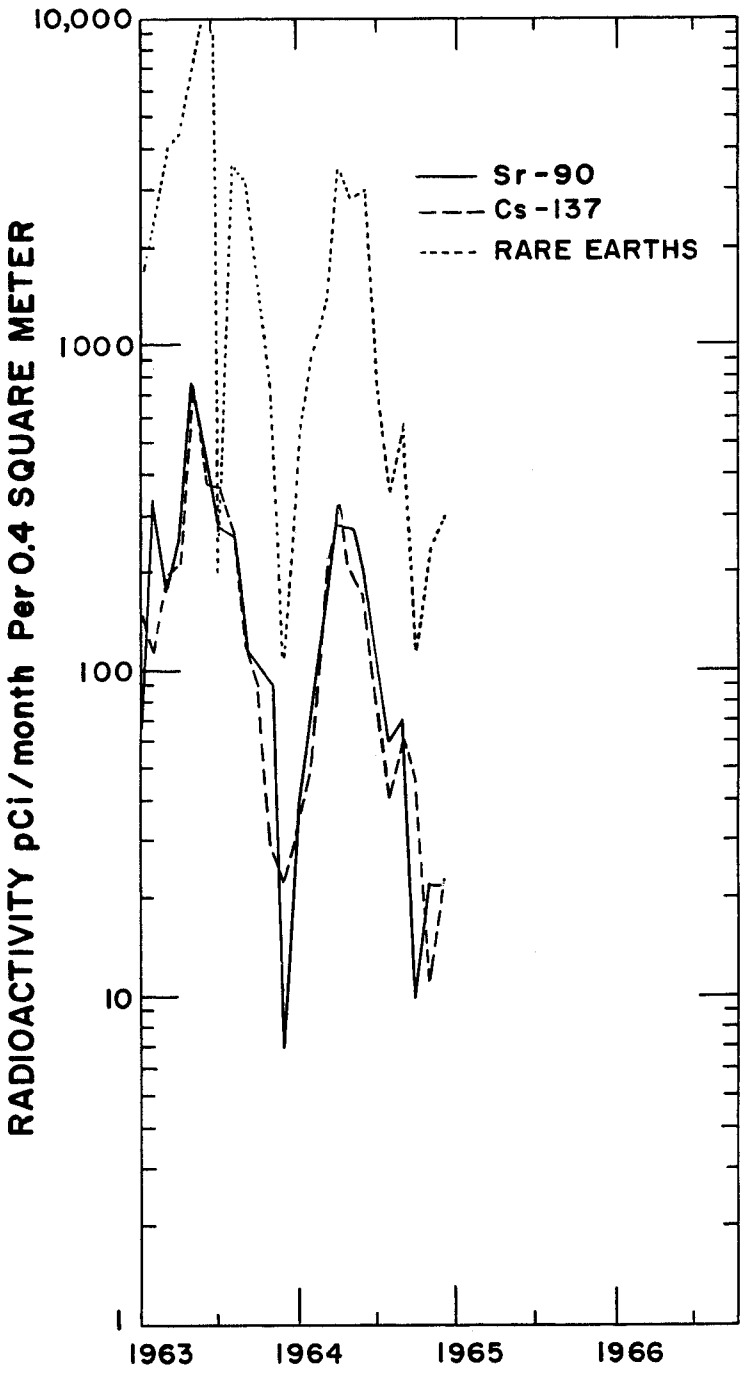

Figure 1

Radioactivity of Monthly Rain-Collector Samples Collected at Los Alamos, New Mexico

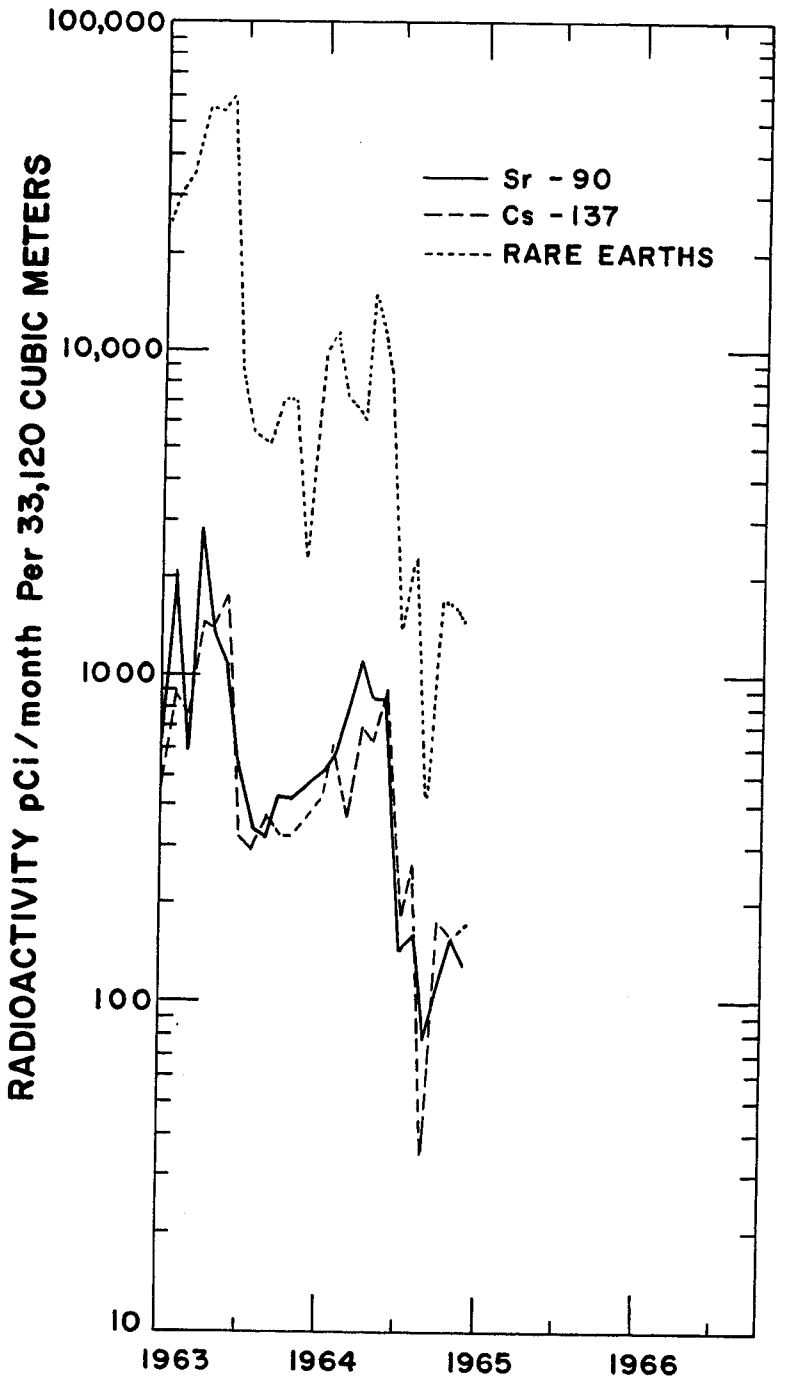

Figure 2

Radioactive Particles Filter-Collected From Air at Los Alamos, New Mexico