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LOS ALAMOS • NEW MEXICO

**Plutonium and Strontium in
Soil Near Technical Area 21,
Los Alamos Scientific Laboratory,
Los Alamos, New Mexico**

by

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PLUTONIUM AND STRONTIUM IN SOIL NEAR
TECHNICAL AREA 21, LOS ALAMOS SCIENTIFIC LABORATORY,
LOS ALAMOS, NEW MEXICO

by

William R. Kennedy
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ABSTRACT

A study was made of plutonium in soil around TA-21 to determine amounts of plutonium deposited from laboratory ventilation stack emission. In general the plutonium concentrations decrease with increased distance from the stacks.

Results are similar insofar as locations of maximum concentrations to those found by Jordan and Black in 1956. Calculations as to total amounts deposited within a radius of approximately 1 mile give approximately 2% of the total released from the stacks in the 24 year period of operation.

Strontium analyses were made to possibly distinguish fallout from atmospheric tests from stack emission material by use of the $^{239}\text{Pu}/^{90}\text{Sr}$ ratio method. The method proved invalid due to trace deposition of ^{90}Sr in the soil from past activities in the area.

1. INTRODUCTION

Soil samples were collected and analyzed for plutonium and strontium in an area in and adjacent to Technical Area 21 (DP-West Plant) of the Los Alamos Scientific Laboratory (LASL). Two sets of samples were taken from the same locations in 1970. One set was collected in January-February and the other set in November to determine the isotope levels in the top soil, possibly from stack emissions. Plutonium isotopes are among the materials processed at TA-21. After filtration, the plant and process exhaust air released from the stack contains traces of plutonium. Analyses were made for ^{239}Pu and ^{241}Pu . ^{90}Sr analyses were done on soils taken in January-February.

Jordan and Black (1956),¹ evaluated the

air pollution problem relative to the emission of plutonium from the stacks at TA-21. Their study of air and soil in the area indicated that air concentrations of plutonium did not exceed permissible values.

TA-21 is located on a long narrow mesa that is a part of the Pajarito Plateau. The plateau is formed by a series of ash-flow and ashfalls or rhyolite tuff. The soil is derived from the tuff. The fine-to-coarse sand-size fraction is composed of quartz, sanidine crystals and crystal fragments, and of minor amounts of rock fragments of rhyolite, latite, tuff and pumice. The silt and clay size fraction is composed of the clay minerals of montmorillonite and illite.² The silt and clays constitute between 20 and 30 wt% of

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the soil in the samples collected.

The precipitation on the mesa averages about 18 in./yr, the greater part occurring in July, August, and September. The predominate winds are southerly and carry the fine particles from the stacks toward the north.

II. RADIOCHEMICAL ANALYSES

Referenced soil samples were collected and analyzed from the Los Alamos, Espanola, and Santa Fe areas to establish background of ^{238}Pu , ^{239}Pu , and ^{90}Sr in soil from world-wide fallout as the result of atmospheric nuclear tests.³ The following table presents the range and average concentrations of ^{238}Pu , ^{239}Pu , ^{90}Sr , and $^{238}\text{Pu}/^{90}\text{Sr}$ activity ratio in referenced soils that could be attributed to world-wide fallout in the area.

Isotope or Activity Ratio	Number of Samples	Concentrations dpm/g	
		Range	Average
^{238}Pu	19	0.001-0.008	0.003
^{239}Pu	20	0.001-0.051	0.021
^{90}Sr	18	0.152-1.921	0.711
$^{238}\text{Pu}/^{90}\text{Sr}$	18	0.003-0.138	0.038

The referenced soils were compared to the results obtained from soils collected near TA-21.

A. January-February Analytical Results

Soil samples were collected from locations 1 through 12 in January-February 1970 (Fig. 1). The samples were taken from flat undisturbed areas to avoid concentration or dilution by wash from storm runoff, or contribution by past LASL activities. The samples were collected from a 4 by 4 in. area to a depth of 2 in. The preparation and analyses of the soil samples were done as outlined in Ref. 4 (1970). The major difference in the preparation for analysis to the method found in Ref. 5 (1970) is that hot 6N hydrochloric acid was used to leach the soil rather than hydrofluoric and nitric or perchloric acids.

The analytical results of soils for ^{238}Pu indicated that samples from locations 3, 4, 5, 8, and 11 contained concentrations

of ^{238}Pu in excess of that expected from world-wide fallout (Table I). The locations of these sampling stations show that the source of the ^{238}Pu may be from stack emissions at TA-21.

The analytical results of soils for ^{239}Pu indicated that samples from locations 1, 2, 3, 5, 8, 9, 12, and perhaps 7, contained concentrations of ^{239}Pu in excess of that expected from world-wide fallout. The location of the sampling stations in relation to the concentrations indicates that stack emissions are the source of the ^{239}Pu . The concentrations decrease with increased distance from the stacks.

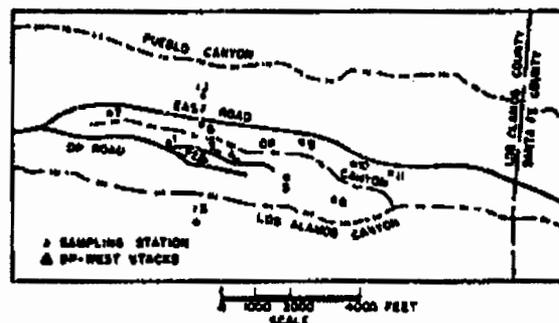


Fig. 1. Soil sampling stations near DP-West stacks.

Initially, the ^{90}Sr analyses were performed to distinguish world-wide fallout from local material by activity ratio $^{238}\text{Pu}/^{90}\text{Sr}$. The ratio method proved invalid for this area because of traces of ^{90}Sr added to the soils by activities in the area many years ago. Short-lived gamma emitting isotopes were used as tracers in atmospheric release experiments done before 1962. These were separated from mixed fission products and contained a trace of ^{90}Sr that was carried over into the experiment. This same ^{90}Sr was also released to the atmosphere along with the gamma tracer. Any ^{90}Sr found locally is under suspicion of originating from other than world-wide fallout. Samples from locations 4 and 5 contain concentrations of ^{90}Sr that cannot be attributed to world-wide fallout or stack emissions from TA-50.

TABLE I
ANALYTICAL RESULTS OF SOIL SAMPLES COLLECTED IN JANUARY-FEBRUARY 1970

Sample Loca- tion Number	Date Col- lected	Radiochemical Analysis						Activity	
		dpm/g (Top 2 in.)			$\mu\text{Ci}/\text{m}^2$ (Top 2 in.)			Ratio	
		^{239}Pu	^{240}Pu	^{90}Sr	^{239}Pu	^{240}Pu	^{90}Sr	$^{239}\text{Pu}/$ ^{90}Sr	$^{240}\text{Pu}/$ ^{90}Sr
1	1-27-70	0.006 ± 0.002	1.092 ± 0.068	0.754 ± 0.101	0.0002	0.0298	0.0208	1.448	
2	2-4-70	0.008 ± 0.002	1.200 ± 0.054	0.878 ± 0.112	0.0002	0.0211	0.0155	1.370	
3	2-4-70	0.052 ± 0.006	1.815 ± 0.122	0.783 ± 0.116	0.0015	0.0518	0.0225	2.318	
4	2-4-70	0.025 ± 0.003	0.017 ± 0.004	4.356 ± 0.220	0.0007	0.0006	0.1420	0.004	
5	2-4-70	0.016 ± 0.003	1.595 ± 0.078	2.459 ± 0.213	0.0003	0.0312	0.0485	0.649	
6	2-4-70	0.004 ± 0.002	0.055 ± 0.009	1.172 ± 0.114	0.0002	0.0021	0.0440	0.047	
7	2-4-70	0.003 ± 0.001	0.094 ± 0.008	1.016 ± 0.110	0.0001	0.0024	0.0285	0.092	
8	2-4-70	0.035 ± 0.004	2.911 ± 0.135	1.742 ± 0.136	0.0011	0.0871	0.0526	1.671	
9	2-4-70	0.010 ± 0.002	0.138 ± 0.008	0.734 ± 0.106	0.0003	0.0041	0.0218	0.188	
10	2-4-70	0.003 ± 0.001	0.064 ± 0.005	0.730 ± 0.086	0.0001	0.0018	0.0354	0.088	
11	2-4-70	0.038 ± 0.004	0.041 ± 0.005	1.225 ± 0.132	0.0011	0.0012	0.0368	0.033	
12	2-4-70	0.006 ± 0.002	0.242 ± 0.016	0.744 ± 0.099	0.0002	0.0083	0.0256	0.325	

The $^{239}\text{Pu}/^{90}\text{Sr}$ activity ratios in samples from locations 6, 7, 9, 10, and 11 are generally equivalent to ratios found by other laboratories in world-wide fallout.⁷ The activity ratios in samples from locations 1, 2, 3, 8, and 12 reflect the ^{239}Pu omissions from stacks at TA-21. The ratio from the samples from locations 4 and 5 are anomalous due to excessive ^{90}Sr .

B. November Analytical Results

Soil samples were collected from locations 1 through 13 in November 1970 (Fig. 1). The samples were taken from near previous locations, except for location 13 that was added for control. The samples were taken with a sampler 3.5 in. in diameter to a depth of 2 in. Five samples at each location were collected in an area of about 30 sq ft. The five samples at each location represent a surface area of about 1/3 sq ft. The analyses were done as outlined in Ref. 4 (1970). A mixture of hot concentrated nitric and hydrochloric acids was used to leach the soil in sample preparation as described by Harley.⁸

Analytical results of soils for ^{239}Pu indicate that samples from locations 3 and 8 contained concentrations of ^{239}Pu in excess of that expected from world-wide fallout (Table II).

Samples from locations 1, 2, 3, 4, 5,

6, 7, 8, 9, 11, 12, and 13 contained concentrations of ^{239}Pu in excess of that expected in world-wide fallout. As in previous samples analyzed, the concentrations decreased with increased distance from the stacks.

A comparison of results of the soils collected in January-February to those collected in November show variations in concentrations. This is as expected from a nonuniform deposition of particles from the stacks.

III. DEPOSITION OF PLUTONIUM

Jordan and Black² in 1958 estimated that 13.1 g of plutonium had been released to the atmosphere from the stacks at TA-21 during the previous 9 years. They also estimated that of the 13 g only about 0.5% (or 0.065 g of plutonium) was retained in the soil within a 1-mile radius of the stacks.

An estimate of the ^{239}Pu deposition in soils was made by using average concentrations in $\mu\text{Ci}/\text{m}^2$ of the two sets of samples collected at each location during 1970. Isoplutonium contours were constructed at 0.005, 0.01, and 0.05 $\mu\text{Ci}/\text{m}^2$ (Fig. 2). The estimated deposition of ^{239}Pu within the 0.005 $\mu\text{Ci}/\text{m}^2$ contour was 0.026 Ci or about 0.42 g.

J. Healy⁹ used stack concentration

values to estimate the total release from the stacks through 1969 as 24 g. The total deposition of ^{239}Pu in soil within the $0.005 \mu\text{Ci}/\text{m}^2$ contour is about 2% of the total estimated release.

IV. CONCLUSIONS

This study indicates that plutonium is being deposited from stack emissions at TA-21. In general, the plutonium concentrations decrease with increased distance from the stacks. The deposition of ^{239}Pu in the area is estimated to be 0.42 g or about 2% of the total released from the stacks through 1969.

Traces of strontium above world-wide fallout values occurred in soils at some of the locations. The strontium is not from stack emission but is the result of past activities that have now been suspended.

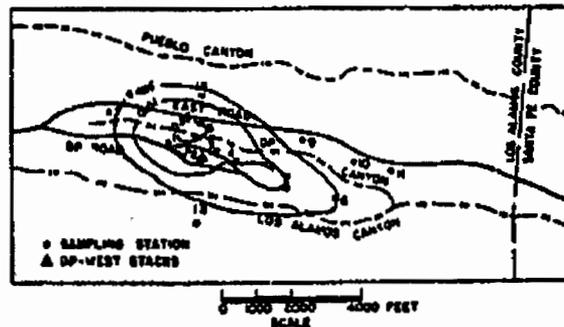


Fig. 2. Isoplutonium ^{239}Pu contours around DP-West stacks; contour values in $\mu\text{Ci}/\text{m}^2$.

TABLE II
ANALYTICAL RESULTS OF SOIL SAMPLES COLLECTED IN NOVEMBER 1970

Sample Location Numbers	Date Collected	Radiochemical Analyses			
		dpm/g (Top 2 in.)		$\mu\text{Ci}/\text{m}^2$ (Top 2 in.)	
		^{238}Pu	^{239}Pu	^{238}Pu	^{239}Pu
1	11-9-70	0.003 ± 0.000	0.475 ± 0.034	0.0001	0.0144
2	11-9-70	0.002 ± 0.002	1.115 ± 0.121	0.0001	0.0340
3	11-9-70	0.024 ± 0.005	0.879 ± 0.062	0.0006	0.0228
4	11-9-70	0.008 ± 0.003	1.041 ± 0.064	0.0002	0.0258
5	11-9-70	0.011 ± 0.003	0.121 ± 0.012	0.0003	0.0029
6	11-9-70	0.009 ± 0.003	0.254 ± 0.017	0.0002	0.0057
7	11-9-70	0.008 ± 0.003	0.178 ± 0.016	0.0002	0.0046
8	11-9-70	0.016 ± 0.004	1.017 ± 0.069	0.0004	0.0231
9	11-9-70	0.009 ± 0.003	0.135 ± 0.012	0.0002	0.0031
10	11-9-70	0.010 ± 0.003	0.048 ± 0.007	0.0002	0.0011
11	11-9-70	0.001 ± 0.003	0.079 ± 0.008	0.0001	0.0020
12	11-9-70	0.009 ± 0.004	0.215 ± 0.018	0.0002	0.0051
13	11-9-70	0.002 ± 0.003	0.194 ± 0.020	0.0001	0.0044

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