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LOS ALAMOS SCIENTIFIC LABORATORY

OF THE UNIVERSITY OF CALIFORNIA o LOS ALAMOS NEW MEXICO

A SURVEY OF SOME LOS ALAMOS COUNTY CANYONS FOR RADIOACTIVE CONTAMINATION, SPRING 1953 TO SPRING 1955

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HEALTH AND SAFETY

LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

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A SURVEY OF SOME LOS ALAMOS COUNTY CANYONS FOR RADIOACTIVE CONTAMINATION, SPRING 1953 TO SPRING 1955

by

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ABSTRACT

This document is a survey analysis of soil samples from Los Alamos, Pueblo, Bayo, and Mortandad canyons to determine the presence and activities of radioactive contaminants. Also included are the results of analyses of a few samples of grass and of surface water. This survey covers the period from spring 1953 to spring 1955.

1. INTRODUCTION

This environmental survey is a follow-up to similar work done in 1946 and 1947 and reported in documents LAMS-516, LAMS-516A, and LAMS-709.

During the period covered by this report, soil samples were collected three times in Los Alamos Canyon and Pueblo Canyon at intervals of six to nine months. Mortandad Canyon was surveyed twice and Bayo Canyon once. The small canyons on the north and southwest sides of DP Site (both drain into Los Alamos Canyon) were surveyed once. Though soil was the principal subject of analysis, a few surface-water samples and grass samples were collected at selected spots and analyzed.

Specific analyses for plutonium, polonium, and strontium, as well as gross alpha and beta-gamma emission determinations, were done in the H-6 laboratory. Analyses for uranium were done by personnel in Group H-5.

2. SUMMARY

The following results, in summary and in detail, show the qualitative and quantitative picture of radioactive contamination in the area surveyed.

2.1 Plutonium

The only significant plutonium concentrations were in the soil and grass samples from Acid Canyon (the small canyon directly west of the Industrial Waste Treatment Plant which joins Pueblo Canyon at the east end of Pueblo Mesa). Here soil samples showed contamination levels up to 10,000 disintegrations (alpha emission) per minute per gram of soil, and grass samples showed 2,000 disintegrations per minute per gram of grass (ash). See Tables II and IV.

2.2 Polonium

No polonium was detected in any of the samples taken in this survey.

2.3 Uranium

Uranium was detected in virtually all soil and grass samples in trace amounts (0.05 to 0.5 μg uranium per gram sample). It is from naturally occurring sources. Uranium contamination from plant operations was found only inside the fenced area of Acid Canyon. See Tables III and IV. Maximum levels were under 100 μg per gram of soil.

Some beta-gamma activity was found in the soil from the drain area immediately outside the east fence of Ten Site Laboratory, where the waste fluids are occasionally emptied into Mortandad Canyon. See Table VI. Here the beta activity was found to be approximately 16,000 disintegrations per minute per gram soil (specific analysis showed the principal contaminant to be strontium).

A small area alongside the old Bayo Laboratory (no longer in use) showed strontium contamination at approximately 5,000 disintegrations (beta emission) per minute per gram soil.

3. INTERPRETATION OF RESULTS

Results of the radioassays are expressed usually in disintegrations per minute (d/m). Uranium is given in micrograms (μg) per gram sample.

TABLE I LOS ALAMOS CANYON AND PUEBLO CANYON SURVEYS, SPRING 1953

Sample Location No.*	Type of Sample		Plutonium (d/m)		Uranium (μg)		Polonium
	Soil	Water	gm soil	liter water	gm soil	liter water	
Los Alamos Canyon							
1	Not sampled				Not analyzed for uranium		None detected on analysis.
2	Not sampled						
3	Not sampled						
4	X		1.5				
5	X		2.6				
6**	X		2.8				
7**	X		2.4				
8**	X		2.2				
9	X		2.4				
10	X		2.6				
11	X		2.8				
12	X		2.2				
13	X		2.0				
14	X		2.6				
Pueblo Canyon							
15**	Not sampled						None detected on analysis.
16**	Not sampled						
17**	Not sampled						
18**	X		124		0.10		
19**	X		172		0.032		
20**	X	X	62	13	0.27	Not analyzed	
21	X		48		0.18		
22	X		19.8		0.061		
23	X		14.2		0.05		
24	X		13.8		0.061		
25	X	X	17.4	1	0.12	Not analyzed	
26	X		6.2		0.083		
27	X		7.6		0.057		
28	X		5.4		0.072		
29	X		4.8		0.078		
30	X		3.0		0.064		
31	Not sampled						

* For sample locations, see Table VIII and map.
** Sample points inside fenced area designated "Contaminated Area."

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TABLE II LOS ALAMOS CANYON AND PUEBLO CANYON SURVEYS, FALL 1953

Sample Location No.*	Type of Sample Soil	Grass	Plutonium (d/m) gm soil	gm grass (ash)	Uranium (μg) gm soil	gm grass (ash)
			Los Alamos Canyon			
1	X		2.6		0.08	
2	X		1.4		0.2	
3	X		1.0		0.1	
4	X		0.7		0.07	
5	X		0.9		0.17	
6**	X		1.4		0.17	
7**	X		1.2		0.12	
8**	X		2.4		0.5	
9	X		1.8		0.14	
10	X		2.4		0.14	
11	X		2.0		0.17	
12	X		1.8		0.16	
13	X		2.6		0.10	
14	X		1.4		0.13	
			Pueblo Canyon			
15**	Not sampled					
16**	Not sampled					
17**	X	X	320	2300	0.51	0.053
18**	X	X	120	460	0.54	0.084
19**	X	X	106	Sample destroyed	0.19	1.71
20**	X	X	24.3	Sample destroyed	0.22	0.46
21	X	X	26.0	310	0.066	Sample destroyed
22	X	X	28.8	760	0.11	0.24
23	X	X	24.0	195	0.11	0.33
24	X	X	17.0	90	0.19	0.09
25	X	X	7.6	82.8	0.046	0.17
26	X	X	6.8	45.4	0.07	0.07
27	X	X	6.5	15.2	0.02	0.07
28	X	X	6.2	5.2	0.11	0.068
29	X	X	5.8	24.0	0.024	0.015
30	X	X	4.0	4.4	0.09	2.4
31	X	X	6.4		2.3	0.16

* For sample locations, see Table VIII and map.
**Sample points inside fenced area designated "Contaminated Area."

TABLE III LOS ALAMOS CANYON AND PUEBLO CANYON SURVEYS. SUMMER AND FALL 1954

Sample Location No.*	Type of Sample Soil (only)	Plutonium (d/m/gm soil)	Uranium (μg/gm soil)	Gross Alpha Count (d/m/gm soil)
		Los Alamos Canyon		
1	X	1.3	Not analyzed for uranium	4.0
2	X	1.7		3.8
3	X	0.9		6.2
4	X	1.3		4.4
5	X	1.9		17.2
6**	X	2.0		4.0
7**	X	0.8		3.6
8**	X	1.8		5.8
9	X	1.6		4.8
10	X	2.2		4.0
11	X	1.8		4.0
12	X	1.4		2.8
13	X	2.8		3.6
14	X	1.6		4.6
		Pueblo Canyon		
15**	X	1.6	0.10	Gross alpha count not taken
16**	X	38.0	39.4	
17**	X	528	81.2	
18**	X	576	0.28	
19**	X	438	0.17	
20**	X	144	0.11	
21	X	34	0.08	
22	X	41	0.13	
23	X	32.8	0.28	
24	X	50.4	0.31	
25	X	23.4	0.14	
26	X	19.2	0.09	
27	X	9.2	0.09	
28	X	17.2	0.20	
29	X	3.2	0.13	
30	X	3.8	0.21	
31	X	3.4	0.37	

* For sample locations, see Table VIII and map.
** Sample points inside fenced area designated "Contaminated Area."

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TABLE IV ACID CANYON FORK OF PUEBLO CANYON, SPECIAL SURVEY (SUBSURFACE SAMPLES), SUMMER 1954

	Gross Alpha (d/m/gm)					Uranium (μg/gm)				
Sample Location No.*	1 ft depth	2 ft depth	3 ft depth	4 ft depth	5 ft depth	1 ft depth	2 ft depth	3 ft depth	4 ft depth	5 ft depth
15	6	4	6	6	4	0.09	0.03	0.02	0.05	0.04
16	370	9,660	5,258	1,940		1.42	7.80	11.0	5.20	
17	7,736	4,130	5,968			16.0	10.8	11.2		
18	248					0.48				

*For sample locations see Table VIII and map.

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TABLE V MORTANDAD CANYON SURVEYS, 1954

Sample No.	Location of Soil Samples (see map also)	Gross Beta-Gamma Activity (d/m/gm soil) Spring 1954	Fall 1954
1	20 yds below Ten Site east fence	2,500,000	20,000
2	100 yds below Ten Site east fence	650,000	5,500
3	160 yds below Ten Site east fence	30,000	1,800
4	220 yds below Ten Site east fence	60,000	1,200
5	320 yds below Ten Site east fence	55,000	650
6	25 yds above drain junction with main canyon	Background	240
7	0.2 mile below drain junction with main canyon	1,100	52
8	0.3 mile below drain junction with main canyon	1,800	32
9	4 miles upstream from White Rock road crossing	38	Background
10	3 miles upstream from White Rock road crossing	Background	Background
11	2 miles upstream from White Rock road crossing	Background	Background
12*	1 mile upstream from White Rock road crossing	Background	Background
13*	Stream bed--White Rock road crossing	Background	Background

*Numbers 12 and 13, although inside the Los Alamos project fence, are on Sacred Land, and access to the area is still held by the Indians.

TABLE VI BAYO CANYON (SHOT SITE) SURVEY, SUMMER 1954

Sample No.	Location of Soil Samples (see map also)	Gross Beta-Gamma Activity (d/m/gm soil)
1	South pad	125
2	North pad	54
3	50 yds north of No. 2	62
4	50 yds north of No. 3	48
5	50 yds north of No. 4	50
6	50 yds north of No. 5	58
7	50 yds east of north pad	42
8	50 yds east of No. 7	36
9	50 yds east of No. 8	48
10	50 yds east of No. 9	46
11	50 yds west of north pad	48
12	50 yds west of No. 11	42
13	50 yds west of No. 12	48
14	50 yds west of No. 13	50
15	50 yds east of south pad	66
16	50 yds east of No. 15	44
17	50 yds east of No. 16	36
18	50 yds west of south pad	48
19	50 yds west of No. 18	46
20	50 yds west of No. 19	46
21	Area around main bunker	68
22	Asphalt paving between pads	72
23	100 yds south of south pad	62
24	Spot on ground on west side of old Bayo Laboratory	15,000

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TABLE VII DP SITE CANYONS (BOTH EMPTY INTO LOS ALAMOS CANYON), SPRING 1954

Sample No.	Sample Location (see map also)	Type Sample Soil	Type Sample Water	Gross Alpha
	Canyon on north side of DP sites			
1	Ditch between DP West and north road, N.E. corner	X		19.8 d/m/gm
2	Ditch as above, near mid-point of sump area	X		22.0 d/m/gm
3	25 yds downstream from DP West escape stairs	X		40.0 d/m/gm
4	50 yds below No. 3	X		11.5 d/m/gm
5	Pipeline crossing of stream bed	X		7.0 d/m/gm
6	Drainage ditch, N.E. corner DP West site, 30 ft north of road	X		514.0 d/m/gm
7	DP East escape stairs, bridge crossing	X		9.0 d/m/gm
8	100 yds below No. 7	X		7.0 d/m/gm
9	100 yds below No. 8	X		21.4 d/m/gm
10	300 yds below No. 9	X		19.0 d/m/gm
11	300 yds below No. 10	X		0.3 d/m/gm
12	600 yds below No. 11	X		3.5 d/m/gm
13	Near No. 3		X	480.0 d/m/liter
14	Near No. 10		X	200.0 d/m/liter
15	100 ft east of trailer area, between contaminated area fence and canyon	X		30.6 d/m/gm
	Canyon on south side of DP West laundry			
16	At head of canyon, parallel with playground park	X		48.0 d/m/gm
17	100 yds downstream from No. 16	X		28.0 d/m/gm
18	100 yds downstream from No. 17	X		44.0 d/m/gm
19	100 yds downstream from No. 18	X		75.0 d/m/gm
20	At fence below DP West contaminated laundry	X		53.6 d/m/gm
21	Near No. 16		X	480.0 d/m/liter
22	Near No. 20		X	320.0 d/m/liter

[redacted]

TABLE VIII SAMPLE NUMBERS AND CORRESPONDING LOCATIONS - LOS ALAMOS AND PUEBLO CANYONS

Sample No.	Location Where Collected
	Los Alamos Canyon, in stream bed
1	Below TA-1 drain area
2	100 yds west of W-1 Site
3	Between W-1 Site and Omega Site
4	Outside Omega Site east fence
5	300 yds below No. 4
6*	Below DP West laundry drain area
7*	100 yds below No. 6
8*	300 yds below No. 7
9	Opposite test well
10	At project east fence
11	At first road crossing east of fence
12	At third road crossing east of fence
13	At fifth road crossing east of fence
14	300 yds west of "Y" (White Rock turnoff)
	Pueblo Canyon
15*	Head of Acid Canyon (ravine below Industrial Waste Treatment Plant)
16*	50 yds above where plant effluent enters stream bed
17*	50 yds below where plant effluent enters stream bed
18*	Weir box at junction of Acid Canyon and main stream
19*	Point under gas-pipe line
20*	Fork of Acid and Pueblo canyons
21	Under pipeline to golf course
22	At Forest Service fence
23	100 yds downstream from No. 22
24	300 yds downstream from No. 22
25	At draw coming down from Hanford area
26	500 yds west of project boundary fence (along side of emergency air strip)
27	Bayo Road stream crossing
28	Opposite Pueblo Canyon cave ruins
29	Under Hill Road bridge crossing, just below "Y" (White Rock turnoff)
30	Stream bed at Totavi
31	Stream bed at Otowi

Note: Sample points 1 through 10, and 15 through 26 are all within the Los Alamos project fenced area.

* Sample points 6 through 8 and 15 through 20 are inside fenced areas designated "Contaminated Area."

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APPENDIX

RADIOANALYTICAL PROCEDURES

A.1 Plutonium

A.1.a Soil Samples

Oven dry the gross sample. Then weigh 25 grams into a beaker and boil in approximately 200 ml. conc. HNO_3 for one hour. Filter the supernatant through a medium frit Buchner filter and evaporate to 25 ml. volume (so that 1 ml. extract is equivalent to 1 gram soil). Fill a 50 ml. centrifuge cone with 30 ml. distilled water, add 2 ml. of above extract, 2 ml. sat. SO_2 water, and place cone in constant-temperature oil bath at 80 to 84°C. Add 1 ml. bismuth nitrate solution and 1.5 ml. conc. H_3PO_4. Stir for one hour. (If no precipitate appears on addition of bismuth nitrate solution, add sat. NaOH dropwise until permanent precipitate appears.) Remove from oil bath and centrifuge at 2000 RPM for five minutes. Discard supernatant. Break up the precipitate of bismuth phosphate with a fine stream of distilled water until the volume is about 30 ml. in the centrifuge cone. Centrifuge again and discard supernatant. Wash down centrifuge cone with 2 ml. conc. HCl and 2 ml. distilled water. If shaking cone does not dissolve precipitate, add conc. HCl dropwise until precipitate dissolves.

Now add 0.2 ml. lanthanum nitrate solution and 1 ml. conc. HF to the clear solution. Let stand five minutes for complete precipitation. Centrifuge and discard supernatant. Break up the fine clear precipitate of lanthanum fluoride (acts as a carrier for plutonium present) with approximately 1 ml. water and take up with 1 ml. pipette. Plate onto clean stainless steel disc. Rinse centrifuge cone with 1 ml. water, take up in pipette and add to disc. Evaporate under heat lamp to dryness and flame over gas burner to complete planchet preparation for alpha-counting.

[redacted]

This procedure is adapted from the method for determining plutonium in urine.[1]

A.1.b Water Samples

Evaporate to dryness a 1 liter sample, add 20 ml. conc. HNO_3, and evaporate the solution to a volume of 2 ml. From this stage, the procedure is the same as for soil samples.

A.1.c Grass Samples

Wash free of all soil particles a double handful of grass (roots as well as blades), cut up in a large porcelain evaporating dish, and ash in a furnace at high temperature. Weigh the dry ash (1/4 to 1/2 gram) and boil for one hour in 200 ml. conc. HNO_3. Then filter the sample and evaporate the filtrate to 2 ml. Treat thereafter as soil sample extract.

A.2 Polonium

A.2.a Soil Samples

Evaporate to dryness a 5 ml. portion of HNO_3 extract (see plutonium procedure) and then dissolve in 10 ml. 6 N HCl. Next add distilled water to a volume of 50 ml. and place under stirring rack. Hook a small nickel disc onto the end of a glass stirring rod and immerse in the solution. Stir for two hours, remove the disc, wash with distilled water and dry in air. Then count on both sides in an alpha counter.

This procedure is adapted from the method for the determination of polonium in urine.[2]

A.2.b Water Samples

Evaporate to dryness a 1 liter sample and take up in 10 ml. 6 N HCl. Thereafter follow the same procedure as for soil samples.

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[1]Jean McClelland, "Analytical Procedures of the Industrial Hygiene Group," Los Alamos Scientific Laboratory Report LA-1858, December 1954, Chap. 21.

[2]Ibid., Chap. 22.

A.3 Uranium

A.3.a Soil Samples

Evaporate to near dryness a measured volume (e.g., 5 ml.) of HNO_3 extract, as in the plutonium procedure, and then dissolve in 5 ml. 6 N HCl. Analyze by the method of fusing with sodium fluoride and examining in the fluorophotometer.[3]

A.3.b Water Samples

Evaporate to dryness a 1 liter sample, wet ash the residue with conc. HNO_3, and take up in 5 ml. 6 N HCl. Analyze the extract by the fluorophotometric method as in the case of the soil samples.

A.4 Strontium

A.4.a Soil Samples

Boil one hour in 200 ml. conc. HNO_3 a 25-gm. sample of dry soil and filter. Evaporate the filtrate to a 25 ml. volume. Add to 1 to 5 ml. of this extract, in a 50 ml. centrifuge cone, 2 ml. each of barium and strontium carrier and then 30 ml. of fuming HNO_3. Cool, stirring for one to two minutes, then centrifuge. Discard the supernatant and dissolve the precipitate in about 2 ml. H_2O. Reprecipitate with 15 ml. of fuming HNO_3, and centrifuge. For additional purity, dissolve the precipitate with about 5 ml. H_2O, add 5 mg. iron carrier and precipitate $Fe(OH)_3$ with about 2 ml. of 6 M NH_4OH. Centrifuge and discard the $Fe(OH)_3$.

To separate out any barium present, neutralize the supernatant with 6 M HNO_3 and add 1 ml. 6 M $HC_2H_3O_2$ and 2 ml. 6 M $NH_4C_2H_3O_2$. Heat the solution nearly to boiling and add 1 ml. 1.5 M Na_2CrO_4 drop by drop with stirring. Continue stirring for about one minute and centrifuge. Use the supernatant for strontium determination.

Now add 2 ml. of conc. NH_4OH to the clear supernatant, heat nearly to boiling, and add 5 ml. sat. $(NH_4)_2C_2O_4$ slowly with stirring. Stir for one to two minutes and filter with suction on a weighed paper (for yield determination) in a small Hirsch funnel. Wash three times with 5 ml. water, three times with 5 ml. 95 per cent ethanol, and three times with 5 ml. ether. Transfer the paper containing the $SrC_2O_4 \cdot H_2O$ to a small watch glass

[3] Ibid., Chap. 27.

and place in a vacuum dessicator. Evacuate for two minutes, release suction, and evacuate again for five minutes. Weigh the precipitate as $SrC_2O_4 \cdot H_2O$ and mount on stainless steel disc for counting.

For discussion of principles, preparation of carrier solutions, reagents, etc., see procedure by L. E. Glendenin.[4]

A.5 Gross Beta-Gamma Activity

When identification of specific elements is not desired, one can boil the soil sample in HNO_3, filter, evaporate the extract to a small measured volume, and plate an aliquot (e.g., 0.20 to 1 ml.) on a stainless steel disc and count in the Geiger-Mueller counter.

A.6 Gross Alpha Activity

When identification of specific elements is not desired, one can treat the sample as noted above for gross beta-gamma activity, and count for gross alpha activity in the methane proportional alpha counter.

[4]Charles D. Coryell and Nathan Sugarman, Radiochemical Studies: The Fission Products (McGraw-Hill Book Co., New York, 1951), N.N.E.S. Div. IV, Vol. 9, Book 3, Paper 236.

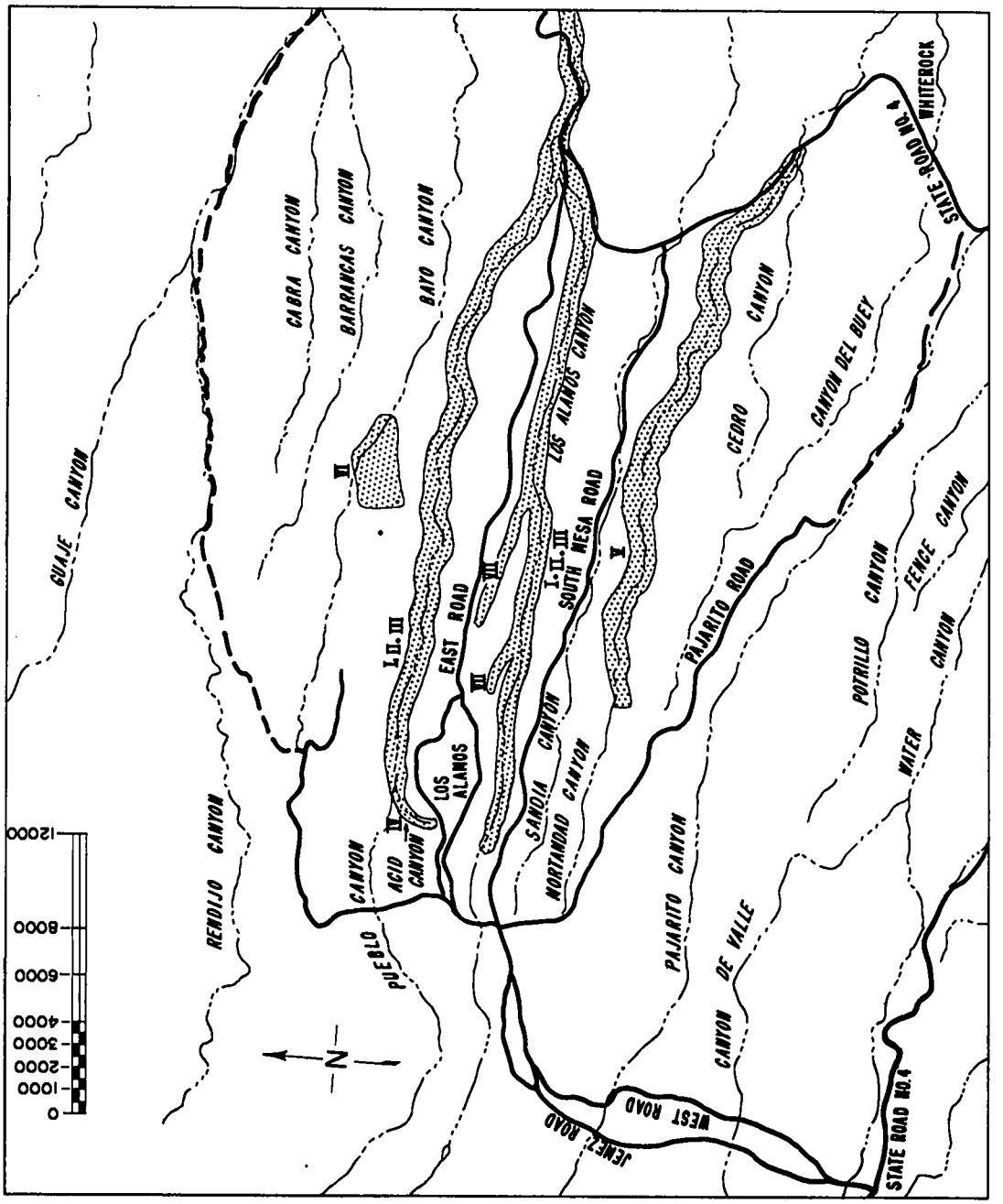

Fig. 1 Areas surveyed for radioactive contaminants. Roman numerals refer to tables of data of respective areas. Shaded portions indicate specific areas surveyed.