MSS Box 7

Environmental Reports 1951-1980

UCLA School of Medicine
Atomic Energy Project

Report UCLA 108

"Alpha Activity Due to The 1945
Atomic Bomb Detonation at Trinity, Almagordo,
New Mexico" : An Interim Report
by K. H. Larson et. al.
Submitted Jan 5, 1951

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He was part of The Almogordo Section,
AEC Project of UCLA

- job - coll data
which would furnish a basis for estim. present +
long range hazards arising from residual radioactivity
Data may have medico-legal implications

5
7 got 7 anim. within fenced area
8 + 27 rodents nearby outside (28)
9
10 Set up a trap line
11 got wood rats on Chupadera mesa
13
14 40
17 4
18 45
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ABSTRACT

Plutonium has been found in soil and plants collected from various locations along the line of Fall-out for at least a distance of eighty-five miles from the Fenced Area, Trinity, Alamogordo, New Mexico. The plutonium concentration in soil outside the Fenced Area increased with distance from the Crater; the maximum is at twenty-eight miles from Zero on the Chupadera Mesa.

Alpha activity was not found in rodents collected in and around the Fenced Area. However, alpha activity was found in bone, liver, and muscle and connective tissue of all rodents collected twenty-eight miles from the Crater.

The alpha activity (assumed to be plutonium) in air-borne material around the Fenced Area in August, 1949 varied from a minimum of background to a maximum of 29.95×10^{-9} micrograms plutonium per cubic foot of air. In August, 1950 in Area 21 on the Chupadera Mesa, twenty-eight miles from the Crater, the alpha activity varied from background to 3.29×10^{-9} micrograms plutonium per cubic foot. The maximum in Area 21 was obtained after a two-inch, seven hour rain during the night when there was very little wind and the surface for miles around was so soft as to prevent vehicular transportation.

ALPHA ACTIVITY DUE TO THE 1945 ATOMIC BOMB DETONATION AT TRINITY, ALAMOGORDO, NEW MEXICO

An Interim Report

INTRODUCTION

Assignments of the Alamogordo Section, Atomic Energy Project of the University of California at Los Angeles, included the collection of data which would furnish a basis for estimating present and long range hazards to man arising out of the residual radioactivity laid down from the 1945 bomb test. Data have accumulated to date which may have medico-legal implications.

For certain periods and locations samples of air-borne material indicate levels of alpha activity that are substantially higher than the maximum permissible amount established at the Chalk River Conference(1). This activity is presumed to be largely due to plutonium.

The data also demonstrate the presence of plutonium in the surface soil and in plant tissue. Alpha activity has been found in the rodents collected from Area 21 on the Chupadera Mesa.

It is the air-borne material, however, which, because of its particle size and level of alpha activity appears, at this time, to be of greatest concern.

It is for these reasons that this brief interim report is prepared for the information of the Atomic Energy Commission.

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(1) Minutes of the Permissible Doses Conferences held at Chalk River, Canada. Sept. 29-30, 1949.

Each soil sample was collected from the surface to a depth of one inch over an area of about two square feet (Fig. 1). The total sample was dried at 105° C for 16 hours. A quartered sample of 100 grams was fractionated by sieving with the portion made up of particles of 250 microns and less in size used for assay. All samples were run in duplicate using the TTA extraction procedure. The final extract was mounted in stainless steel dishes and counted for 1000 counts by the scintillation type alpha counter. The results reported are the averages of the duplicate samples.

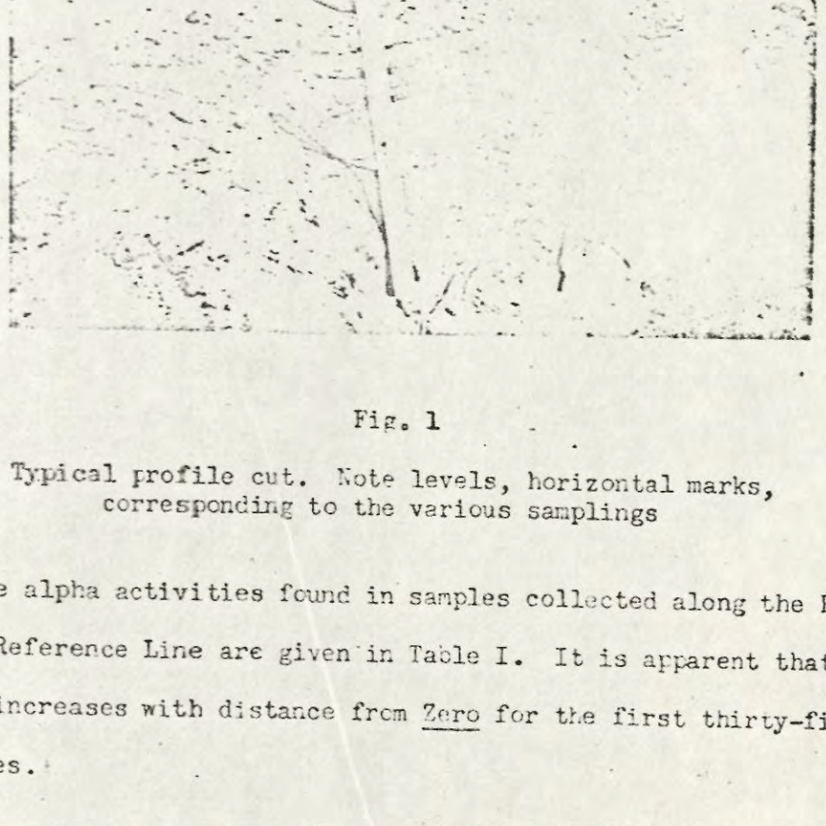

Fig. 1

Typical profile cut. Note levels, horizontal marks, corresponding to the various samplings

The alpha activities found in samples collected along the Primary Transect Reference Line are given in Table I. It is apparent that the activity increases with distance from Zero for the first thirty-five to forty miles.

Table I

PLUTONIUM IN SOILS AT THE PRIMARY TRANSECT REFERENCE POINTS AND SOME FALL-OUT BOUNDARY SAMPLES

Sample Location	At Left Boundary	At Reference Point	At Right Boundary
	Micrograms plutonium per gram soil		
Lateral # 4*	---	10.3×10^{-6}	---
# 7	---	25.7×10^{-6}	---
# 9	---	40.3×10^{-6}	---
#12	---	52.8×10^{-6}	---
#16	15.4×10^{-6}	29.3×10^{-6}	4.32×10^{-6}
#18	---	74.8×10^{-6}	---
#20	---	162.0×10^{-6}	---
#21	27.1×10^{-6}	190.0×10^{-6}	11.0×10^{-6}
#22	12.5×10^{-6}	194.0×10^{-6}	3.15×10^{-6}
#23	20.5×10^{-6}	100.0×10^{-6}	20.7×10^{-6}

* For lateral location, see Detailed Lateral Radiological Survey Map inside back cover UCLA-32, "The 1948 Radiological and Biological Survey of Areas in New Mexico Affected by the First Atomic Bomb Detonation."

Table II gives the amount of plutonium found in samples of soil and plants collected on the Chupadera Mesa in 1947 and 1950. See Figure 2 for locations.

Since the half life of plutonium is very long (24,100 years) it is assumed that any differences between the samples collected in 1947 and 1950 can be attributed to such factors as weathering, diffusion, erosion, etc.

Samples of fresh cow feces were collected in 1947 on the Chupadera Mesa, east of Cooper Wells (see Alamogordo Report of 1947 Survey, Soil Section, p. 11, Table 6 for beta-gamma values). The plutonium content of these same samples is given in Table III.

Table II

PLUTONIUM IN SOIL AND PLANT TISSUE
FROM THE CHUPADERA MESA

Sample Location	Year Sample Collected	Surface Soil	Plants (Tops)* Dry Material
		Micrograms plutonium per gram	
From Area 21, along Trap Line on Ridge in Juniper			
# 1	1950	175.0×10^{-6}	14.7×10^{-6}
# 4	1950	183.0×10^{-6}	7.33×10^{-6}
# 7	1950	198.0×10^{-6}	5.72×10^{-6}
#13	1950	249.0×10^{-6}	3.51×10^{-6}
From Area 21 - Profile Series on Bottom of Valley			
21-A	1950	191.0×10^{-6}	---
21-B	1950	352.0×10^{-6}	1.47×10^{-6}
21-C	1950	198.0×10^{-6}	3.81×10^{-6}
From AE Series on Mesa			
AE 1	1950	55.7×10^{-6}	---
AE 2	1950	169.0×10^{-6}	---
AE 3	1950	80.6×10^{-6}	---
AE 3-A	1947	586.0×10^{-6}	297.0×10^{-6}
AE 3-B	1947	---	89.4×10^{-6}
From Profile at Lateral #20			
20-A	1950	161.0×10^{-6}	4.32×10^{-6}
From Harvey Gate Series			
H.G. C	1950	308.0×10^{-6}	4.76×10^{-6}
H.G. 0.2 E	1948	117.0×10^{-6}	---
H.G. 0.9 E	1948	117.0×10^{-6}	---
H.G. 0.3 W	1948	198.0×10^{-6}	---
From "Alpha" Series Collection			
A.S. #1	1950	117.0×10^{-6}	---
A.S. #2	1950	169.0×10^{-6}	---
A.S. #3	1950	102.0×10^{-6}	---
A.S. #5	1950	49.8×10^{-6}	In a cultivated field
A.S. #23	1950	33.7×10^{-6}	In grassland, approx. 65 miles from Zero.
From R Series			
R 1	1947	425.0×10^{-6}	212.0×10^{-6}
R 2	1947	---	87.9×10^{-6}

*Approximately six weeks of growth.

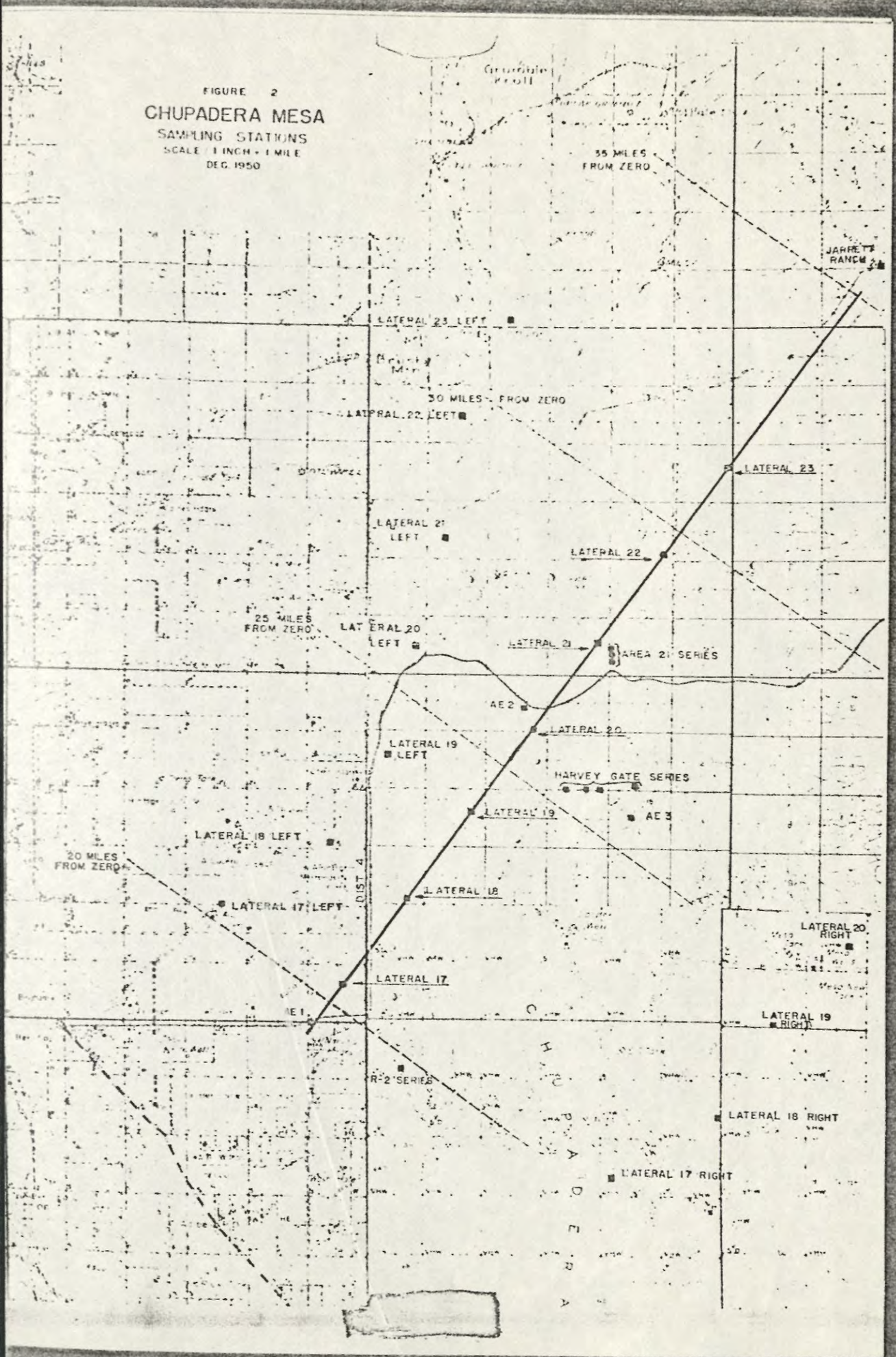
FIGURE 2
CHUPADERA MESA
SAMPLING STATIONS
SCALE 1 INCH = 1 MILE
DEC. 1950
35 MILES FROM ZERO
JARRETT RANCH
LATERAL 23 LEFT
30 MILES FROM ZERO
LATERAL 22 LEFT
LATERAL 23
LATERAL 21 LEFT
LATERAL 22
25 MILES FROM ZERO
LATERAL 20 LEFT
LATERAL 21
AREA 21 SERIES
AE 2
LATERAL 20
LATERAL 19 LEFT
HARVEY GATE SERIES
LATERAL 19
AE 3
LATERAL 18 LEFT
20 MILES FROM ZERO
LATERAL 18
LATERAL 17 LEFT
LATERAL 20 RIGHT
LATERAL 17
AE 1
LATERAL 19 RIGHT
R-2 SERIES
LATERAL 18 RIGHT
LATERAL 17 RIGHT
CHUPADERA MESA

Table III

PLUTONIUM CONTENT OF COW FECES
COLLECTED IN 1947

Sample and Location	Micrograms Plutonium Per Gram Dried Material
Calf feces - 1 mile N E of Mesa Water Tanks*	5.79×10^{-5}
Cow feces - 1 mile N E of Mesa Water Tanks	6.30×10^{-5}
Bull feces - In meadow by Mesa Water Tanks	9.97×10^{-5}
Cow feces - 100 yards S W of Mesa Water Tanks	11.9×10^{-5}

* Mesa Water Tanks are four miles east of Cooper Wells and are the property now of the largest land owner on the Chupadera Mesa - Mr. Harvey, El Paso, Texas. There are an estimated 1000 head of cattle in this general area grazing every summer. Owners permission could not be obtained for subsequent surveys.

b - Air-borne Material

During each of the Field Surveys, one to several dust storms have been observed in the valley where the Crater is located. These storms transported large amounts of fine soil great distances from one place to another. Fig. 3 illustrates one of the smaller rain-dust squalls approaching the Crater from the westward. Dust preceding the rain shower is carried to elevations of several hundred feet. This particular squall covered a path six to ten miles wide. It passed over and northward of the Crater, disappearing over the Oscuro Escarpment (10 miles from the Crater). During the four weeks of August, 1950, seven similar dust storms passed over or near the Crater. The direction of the winds varied at random (see letter from Dr. Bellamy to Dr. Warren dated August 22, 1950, Appendix).

Air-borne material was collected with special continuous type air samplers. These instruments, previously described in UCLA-13, are a modification of the jet impaction method of air sampling. (Fig. 4).

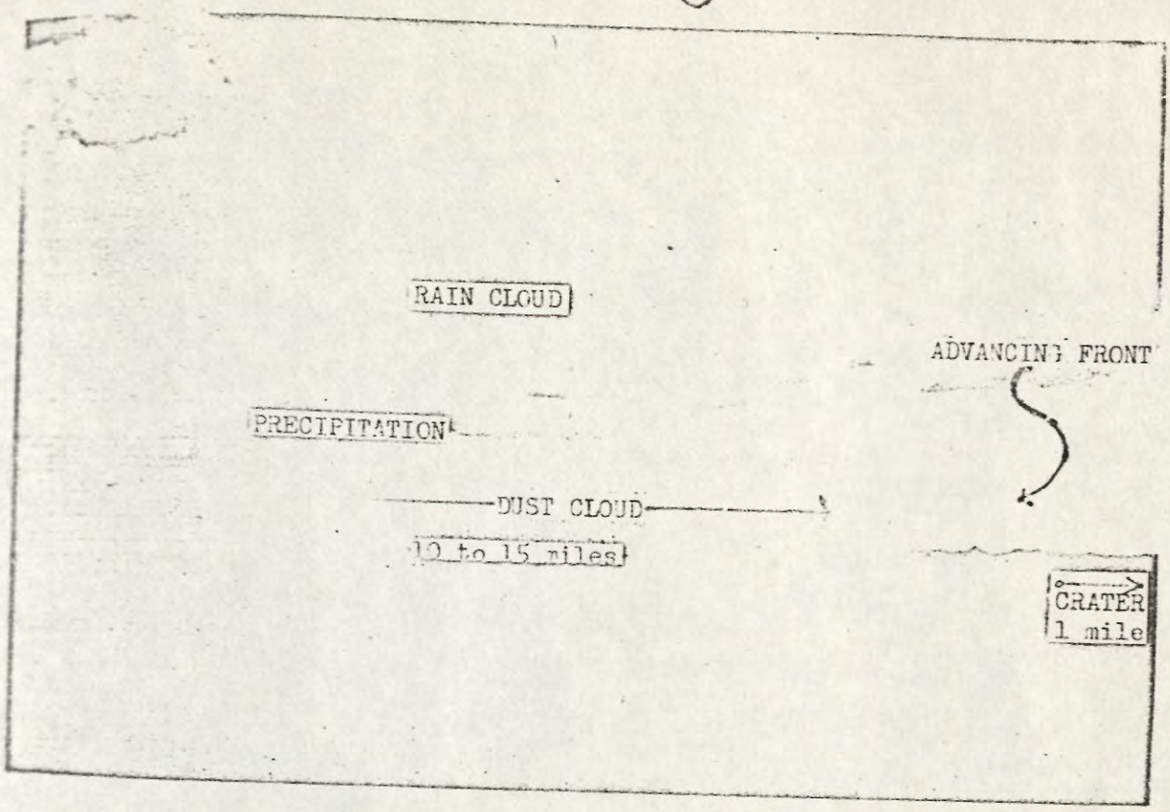

Fig. 3

Dust and rain storm in the vicinity
of the Crater - August, 1950

The amount of air-borne material varies with such factors as wind direction, velocity and duration, time of day, vegetative cover, type of soil, location, amount and duration of rain and doubtless with the complex interrelationships of these factors as time affects the immediate and more remote history of the area. In these units a circular glass plate is rotated, at a selected constant speed at a distance of 0.020 inches from the jet opening. The opening in the jet is 0.5 inches by 0.025 inches yielding high efficiency at small particle sizes. A speed of one revolution per day was selected in order that the material collected would be spread over a relatively large area to allow assay of alpha activity and microscopic particle size determination.

The counting of the glass plates was done on a modification of the alpha scintillation counter originally reported in UCLA-14. The glass disc is located so that the air-borne material deposit is 0.0625 inches from the screen and separated from it by an aluminum shield, with a slit exposing 1/32 of the circular deposit (Fig. 5). This permits alpha determinations for separate periods of sampling. The instrument has an average geometry of 27% and a background ranging from 0.7 to 1.0 counts per hour. The counting data have a maximum standard error of 40%. In samples having higher activity the error is much less (9 per cent for the 1950 collections).

After the alpha determination of the air-borne material of each selected sampling period, particle sizes were microscopically determined directly on the impacted sample. The weights of the deposited material were determined on a semi-micro balance to an accuracy of one per cent.

In 1949 sampling stations were selected so that areas of varying activities could be better represented in the final results and information could be obtained as to whether or not the air-borne material originated from trinitite deposits. Three stations were 100 feet outside the Fenced Area. Another station was located inside the Fenced Area, 100 feet west of Zero, Fig. 6. The fifth station was located 0.6 miles west of the Primary Transect Reference Line, along Lateral 2, Left, 2 miles north of the Crater (Fig. 7).

The alpha activity found in air-borne material in the Crater Region, expressed as the equivalent of plutonium, is given in Table IV, Figs. 8 - 14 inclusive, and Appendix Tables 1, 2, 3, 4 and 5.

A maximum of thirty-six hours was available for air-borne material sampling on the Chupadera Mesa in 1950 because of a seven hour rain during the limited period scheduled for collections. The results presented

in Figs. 15, 16, Table V, and Appendix Tables 6 and 7, give the alpha activity found in air-borne material collected in Areas 20 and 21 on the Chupadera Mesa. If the data obtained from the soil from which the dust originates is applicable the activity in the dust may be presumed to be alpha activity from plutonium.

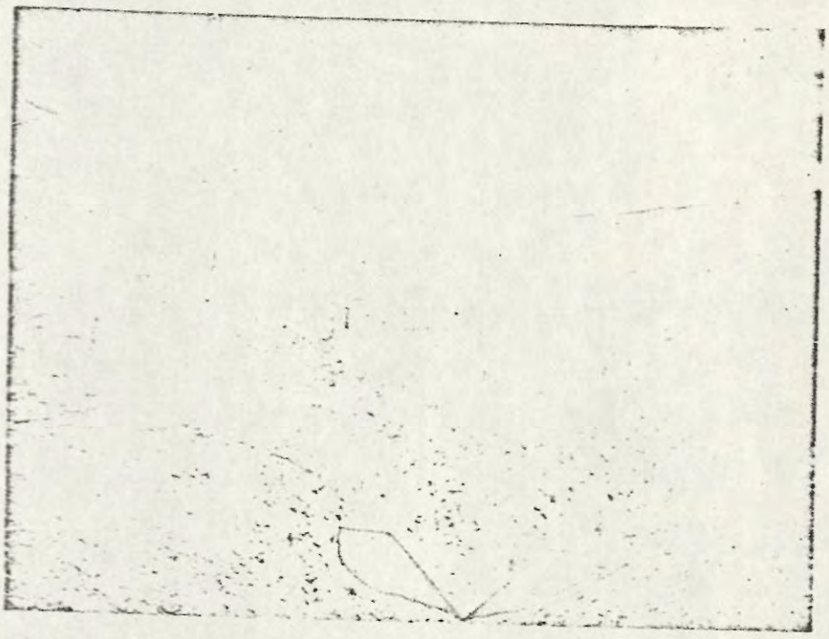

Fig. 7

The Weir Area, located 0.6 to 0.8 miles west of the Primary Transect Reference Line, along Lateral 2, Left, 2 miles north of Crater. This area was established in 1949 to determine micro-erosional effects

C - Alpha Activity in Rodents

All samples of animals were ashed at 600° C for eight hours and the dry powdered ash spread evenly on stainless steel dishes for counting without chemical separation of the alpha emitters. The counting was done on scintillation alpha counters. The activity reported, therefore, is total alpha activity. The alpha activity is reported as Background (Bkgd)

COLLECTED DURING AUGUST, 1949, AT VARIOUS STATIONS AROUND AND IN THE FENCED AREA

Location	Date	Equiv. Plutonium, μg/cu. ft. air Low	High	Average*	Duration of Collection in Hours	Total Micro-Grams Pu Collected	Median Particle Size in Microns
Fenced Area #1	8/22/49	0.0	9.75 x 10^{-9}	6.2 x 10^{-9}	3.5	9.9 x 10^{-7}	2.20
#1	8/25/49	0.0	29.74 x 10^{-9}	11.8 x 10^{-9}	11.25	71.1 x 10^{-7}	2.79
#1	8/26/49	0.0	0.0	0.0	6.75	Bkgd	3.44
#2	8/23/49	0.0	29.95 x 10^{-9}	8.0 x 10^{-9}	11.25	48.6 x 10^{-7}	1.84
#2	8/24/49	0.0	10.3 x 10^{-9}	2.5 x 10^{-9}	11.25	12.0 x 10^{-7}	1.75
#3	8/30/49	0.0	19.7 x 10^{-9}	6.6 x 10^{-9}	6.0	16.7 x 10^{-7}	1.60
#4	8/29/50	0.0	15.4 x 10^{-9}	1.9 x 10^{-9}	9.0	72.8 x 10^{-7}	2.10
#5	8/26/50	0.0	26.3 x 10^{-9}	9.8 x 10^{-9}	10.25	53.1 x 10^{-7}	1.62

*The average content of plutonium is determined by dividing the total activity for the sampling interval by the total volume of air sampled for the same period. Tables 1, 2, 3, 4 and 5 in the Appendix present the individual sampling intervals and their respective plutonium concentration.

Table V

CALCULATED DAILY AVERAGE ALPHA ACTIVITY IN AIR-BORNE MATERIAL
COLLECTED DURING AUGUST, 1950, IN AREAS 20 AND 21, CHUPADERA MESA, 25-28 MILES FROM THE CRATER

Location	Date	Equiv. Plutonium, μg/cu. ft. air Low	High	Average*	Duration of Collection in Hours	Total Micro-Grams Pu Collected	Median Particle Size in Microns
Area 20	8/15/50 8/16/50	0.0	3.04 x 10^{-9}	1.23 x 10^{-9}	31.2	18.7 x 10^{-7}	1.59
Area 21	8/16/50 8/18/50	0.0	3.29 x 10^{-9}	1.56 x 10^{-9}	36.4	23.8 x 10^{-7}	1.58

*The average content of plutonium is determined by dividing the total activity for the sampling interval by the total volume of air sampled for the same period. Tables 6 and 7 in the Appendix present the individual sampling intervals and their respective plutonium concentration.

ALPHA ACTIVITY FOUND IN VARIOUS ORGANS
FROM ANIMALS COLLECTED FROM WITHIN THE FENCED AREA

Animal Number	Alpha Activity in disintegrations/minute/gram of ash										
	Lung	Liver	Kidney	GI Tract	GI Contents	Lower Jaw	Femur	Innominate Bone	Skin	Carcass Bone	Carcass Tissue
Kangaroo Rat (Dipodomys ordii)											
79	Bkgd	Bkgd	Bkgd	135	24.6	Bkgd	Bkgd	Bkgd	5.77	Bkgd	Bkgd
82	Bkgd	Bkgd	Bkgd	311	16.1	Bkgd	Bkgd	Bkgd	4.11	Bkgd	Bkgd
104	Bkgd	Bkgd	Bkgd	Bkgd	26.3	Bkgd	Bkgd	Bkgd	6.85	Bkgd	Bkgd
Ground Squirrel (Citellus tereticaudus)											
103	Bkgd	Bkgd	Bkgd	Bkgd	17.1	Bkgd	Bkgd	Bkgd	1.42	Bkgd	Bkgd
Horned Lark (Eremophila alpestris)*											
87	Bkgd	69.7 74.3	---	115	1672.0 1605.0	8.57*	Bkgd	19.7**	12.3	---	---
88	Bkgd	Bkgd	---	Bkgd	1335.0 1296.0	Bkgd*	Bkgd Bkgd	Bkgd**	423.0	---	---
115	Bkgd	Bkgd	---	Bkgd	261.0	Bkgd*	Bkgd	Bkgd**	---	---	---

*These data are for the sternum instead of for the lower jaw.
**These data are for the synsacrum instead of for the innominate bone.

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Table VIII

ALPHA ACTIVITY FOUND IN VARIOUS ORGANS FROM WOOD-RATS (NEOTOMA SP.) COLLECTED FROM AREA 21, CHUPADERA MESA

28 Miles North of the Crater

Tissue	Range of Ash Weight of Samples Counted mg	Disintegrations/minute/gram of ash — Animal Number											
		90	91	92	93	94	95	96	97	98	99	100	101
Mandible	370 - 500	8.59	4.17	3.25	2.68	3.18	1.68	5.27	2.53	1.40	2.20	Bkgd*	2.79
Femur	149 - 334	25.2	8.23	4.54	5.12	6.89	6.32	10.8	5.29	2.95	4.22	2.97	3.66
Innominate Bone	86 - 218	32.7	15.4	10.6	6.00	9.72	7.48	18.4	10.3	3.73	9.77	Bkgd	4.93
GI Tract	8 - 73	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd
GI Contents	162 - 500	2.74	6.70	6.30	4.48	4.37	2.69	2.20	5.70	2.28	5.76	5.03	3.89
Liver	92 - 307	9.16	3.08	1.91	3.27	7h.8	Bkgd	1.63	6.52	Bkgd	Bkgd	Bkgd	Bkgd
Kidney	14 - 55	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	7.11	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd
Lung	10 - 29	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd	Bkgd
Skin	269 - 500	1.85	2.85	4.22	0.83	Bkgd	Bkgd	2.65	2.75	1.33	1.70	1.32	1.70
Carcass (Muscle and connective tissue)	100	15.6	Bkgd	5.25	5.20	9.10	5.20	11.5	9.31	6.29	8.09	10.9	Bkgd

*Background (Bkgd.) is equal to two times the instrument accumulated background (range 0.25 - 0.32 c/min)

DISCUSSION

Plutonium is present in the soils and plants (Table II). Alpha emitters, presumably plutonium, are present in air-borne material from the Crater Region and the Chupadera Mesa (Tables IV and V). Alpha activity has been clearly demonstrated twenty-eight to thirty miles away from the Crater in tissues of rodents collected from Area 21, Chupadera Mesa (Table VIII). No alpha activity was found in tissues of rodents collected from the Crater Region (Tables VI and VII).

The plutonium concentration in soil is variable. Maximum concentrations of plutonium outside the Fenced Area (beyond 1400 feet) are found approximately twenty-eight miles from Zero in the downwind trail of the Fall-out (Fig. 18). It is possible that a localized rain shower scrubbed a portion of the "cloud" or some other vagary of the weather conditions were responsible for depositing the contamination in the patterns found in 1948 UCLA-32).

Soil fixing properties have a direct bearing on the availability of plutonium. Experimentation is in progress at this laboratory to quantitatively establish the influence of such factors as clay type, degree of cation saturation, pH., cation exchange and content of organic matter. The importance of the valence state of plutonium has been demonstrated by Jacobson and Overstreet*. Using a calcium saturated bentonite, a common soil constituent, they found that PuO_2^{++} is fixed the least, 18.6%, while Pu^{+++} is fixed the most, 94.2%. This phenomenon alone could account for some of the anomalies present in the soil-plant interrelationships observed in the areas studied (Table II).

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*Jacobson, Louis and Overstreet, Roy. "The Uptake by Plants of Plutonium and some Products of Nuclear Fission Absorbed in Soil Colloids". Soil Science, 65. No. 2. February, 1948.

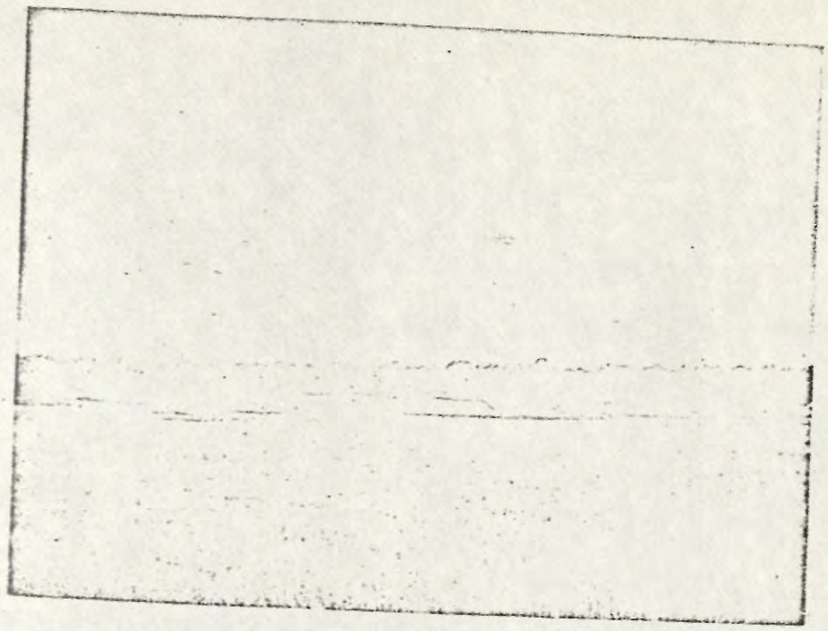

Fig. 18

Area 21, 28 miles from the Fenced Area, grazing valley in which the maximum plutonium concentration was found in 1950

Organic matter present in soil appears to be important. Based on d observations, the maximum concentrations of plutonium are associ- with the soil samples relatively high in organic matter. It is pos- e that this property of soil may be the most important characteristic he redistribution and accumulation of radioactivity in soil.

The extent and pattern of plutonium contamination differs consid- ly from the distribution of beta-gamma activity as outlined by the Survey (UCLA-32). The development of low-background instrumentation hemical separation techniques made possible the detection of the plu- m in these samples. The samples were originally collected on the of the readings obtained using the Victoreen Survey Instrument, 263A and presumably contained no beta-gamma emitters by this test field. The soil samples collected in 1948 as confirmatory back- or control samples, however, did contain measurable amounts of

plutonium (see Table I, right and left boundaries), as well as small amounts of beta-gamma activity when tested in the laboratory. A precise definition of the plutonium contaminated area is, therefore, dependent on additional and extensive sampling and assay. Redistribution of plutonium in the area occurs constantly from winds and storms, which could result in dispersal or concentration. The amount and variety of redistribution can only be determined by repeated surveys.

The biological significance of the data presented in this report cannot be evaluated at this time. It is not possible under the present circumstances of the Field Survey to assess the potential hazard of the plutonium found to the people and cattle living on the Chupadera Mesa. This area is not suitable for the collection of field data on food ordinarily consumed by humans and no good study has been possible with cattle in the area.

There are many variables affecting the transfer of plutonium from the soil to the plant. Rooting habit, for example, must be an important factor where the activity is mainly limited to the soil surface. In the area sampled, some grasses are characteristically shallow-lateral-rooted while others are deep rooted. The quantity of plutonium available to the root system of the plants sampled cannot be investigated in the field. However, under the desert conditions prevailing it appears that at least a fraction of one per cent of the plutonium available at the surface has been accumulated by the plants. This occurred during only a six week growth period. On July 9, 1950, there was no grass growing on the Mesa because of a spring and early summer drought. On August 16, 1950, the grass had grown only to a height of several inches (Fig. 18).

The chemical and physical states of the plutonium contamination determine biological availability. It is not unlikely that the plutonium

found is in the form of a silicate - probably similar to the "glass beads" found outside the Fenced Area but in particle sizes equivalent to "dust", smoke or fog. Due to the arid climate and alkaline soil (pH. 8-8.7) these microscopic silicate particles are, as yet, unable to become a part of the soil solution in significant quantities. Weathering and erosion are physical agents which eventually will assist in rendering the plutonium more soluble. This is the first phase in the breakup of any exposed silicate. Chemical reactions occur in the second phase, such as reactions with CO_2, exchange of cations on the clay, and development of organic matter. Therefore, more and more plutonium could become available to plants and subsequently to animals using these plants for food.

Plutonium is present in feces collected fresh from cattle grazing on the Chupadera Mesa near the Mesa Wells in 1947 (Table III). Alpha activity, presumably plutonium, is present in the tissues of wood-rats (Neotoma sp.) trapped in Area 21, Chupadera Mesa, in 1950 (Table VIII). No alpha activity was found in the tissues of twenty-six Kangaroo rats and ground squirrels trapped in and around the Fenced Area with few exceptions (Tables VI and VII). The reasons for the absence of plutonium in rats from the Crater Area are not clear, particularly when rats collected twenty-eight miles away show it in bones, muscle and liver in goodly amounts. Important factors probably are (1) the age of animals at the time of collection, (2) habits of animals with relation to exposure to type of food consumed and to dust (3) the physical and chemical state of the active materials as they affect absorption.

There are no data to indicate whether the alpha activity found is cumulative or has reached an equilibrium with respect to the animal's environment. It is possible that when more plutonium becomes available to the food plants, the plutonium content will increase in the animal.

The alpha activity reported in air-borne material is presumed to be plutonium. This assumption is based on the fact that air-borne material originates from the soil. A "standard man" living in the vicinity of the Fenced Area could inhale up to 29.95 x 10^{-9} micrograms of plutonium per cubic foot of air, based on measurements made in August, 1949. Even after a two inch rainfall, which should have scrubbed the air, a "standard man" could have inhaled up to 3.29 x 10^{-9} micrograms plutonium per cubic foot of air. This is based on the conditions present during the thirty six hour sampling period in Area 21. The sampling was done immediately after an estimated two inch rain lasting seven hours and in dense vegetative cover. However, during June and early July, 1950, there was no grass cover because of a spring and early summer drought. It is possible, therefore, the alpha activity in dust could be several magnitudes greater during that period in Area 21.

In the absence of better information, it would seem logical to suspect that conditions hazardous to man are not absent from the areas on Cheyenne Mesa, particularly if occupancy occurred over a considerable number of years. While in general the levels of plutonium activity found are within an order of magnitude or two of the present tolerances set for man, there are such large fluctuations in the observed data in respect to time and place that one can not conclude that the area is either safe or dangerous at any one time.

These data show that extensive controlled laboratory experiments with crops and further field surveys are essential to an understanding of these problems.

SUMMARY

Plutonium has been determined in a number of soil and plant samples collected from various locations along the line of Fall-out. In the soil the plutonium content increases with distance from a minimum 10.3 x 10^{-6} micrograms per gram of soil at Lateral #4 to a maximum of 352.0 x 10^{-6} micrograms per gram of soil near Lateral #21. This is based on the 1950 collection of samples.

Plutonium was found at higher concentrations in other "spot" checks made in previous years. AE-3-A located inside Harvey's Fence assayed 586.0 x 10^{-6} micrograms plutonium per gram of soil (1947 collection).

Plutonium content in plant dry material varies from 1.47 x 10^{-6} micrograms plutonium per gram to a maximum of 297.0 x 10^{-6} micrograms plutonium per gram.

Plutonium found in the feces of cattle collected in 1947 varies from a minimum of 57.9 x 10^{-6} micrograms plutonium per gram to a maximum of 119.0 x 10^{-6} micrograms plutonium per gram of dry fecal material.

The rodents collected around, as well as in, the Fenced Area do not show alpha activity in comparable tissues except for the ground squirrels. These show alpha activity only in the femur, an average of .33 dis/min/gram of ash.

On the other hand, alpha activity has been found in rodents collected on the Chupadera Mesa, Area 21, twenty-eight miles away. The average alpha dis/min/gram of ash in some of the samples are:

Sample	Dis/min/gm ash
Liver	14.3
Kidney	Bkgd
Lower jaw	3.89
Femur	8.46
Innominate bone	13.6
Lung	Bkgd
Muscle	6.34

The alpha activity (assumed to be plutonium) in air-borne material varies with such factors as climate, vegetative cover, type of soil. In August, 1949, the alpha activity varied from a minimum of background to a maximum of 29.95×10^{-9} micrograms plutonium per cubic foot of air around the Fenced Area.

In August, 1950, on the Chupadera Mesa (Area 21) twenty-eight miles away, alpha activity varied from background to a maximum of 3.29×10^{-9} micrograms plutonium per cubic foot during a thirty-six hour sampling period. The maximum was obtained after a two inch, seven hour rain during the night when there was very little wind and the surface for miles around was so soft as to prevent vehicular transportation.

LETTER FROM DR. BELLAMY TO DR. WARREN, AUGUST 22, 1950

Observations made in 1950 on wind directions and velocities have a ect bearing on the serious problems involved. Some of the observa- s bear also on subsequent sections of this report and were recorded letter (Bellamy to Warren, August 22, 1950) written while at Trinity d Survey Headquarters.

"We, or some of us, have been worshiping too much the laboratory tion of 'controls'. In the unique and rapidly changing conditions d around the Crater Region, there can be no control. One has only perience the five heavy dust storms (so far)(1); the one rain of ourst proportions and two other heavy rains and numerous showers, to e that controls can exist, for the area, only in the imagination. tire valley - some 3,000,000 acres - is on the move. Five times we een all or much of it filled with dust to a height of from fifty to l hundred feet, moving at from thirty-five to fifty-five miles an one direction one time, another direction at another time. No the storms have been from the same direction.

The sampling of soil and plants from the site of mammal collec- an only present us with uninterpretable data on the immediate of any contamination in animal tissues. Trapping this year re- the recapture of marked animals as far as 200 feet(2) from their r from the place where they were taken previously. In the space y-four hours we have seen areas as large as this denuded of much rface soil one day and covered with an inch or so of new silt , or vice versa."

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(1) There were seven such dust storms recorded up to August 26.

(2) The maximum range recorded for a Kangaroo Rat in a three week period was 675 feet.

Table 1

ALPHA ACTIVITY IN AIR-BORNE MATERIAL
FOUND DURING A CONTINUOUS SAMPLING PERIOD
AT STATION #1 DURING AUGUST, 1949

(100 Feet Outside of Fence along T-330)

Sampling Volume = 31 Cubic Feet of Air for All Samples

Time	At of Dust mg	Activity		Particle Diameters*	
		α dis/min/ gram	μg Pu/cu ft Air	Range Microns	Median Microns
8/22/49					
4:10- 4:55 pm	0.11	268	7.08×10^{-9}	1.0- 6.0	1.9
4:55- 5:40 pm	0.03	1350	9.75×10^{-9}	1.0-10.0	2.6
5:40- 6:25 pm	0.03	1128	8.13×10^{-9}	1.0- 8.0	2.1
6:25- 7:10 pm	0.02	Bkgd	---	1.0- 5.5	2.0
7:10- 7:55 pm	0.04	716	6.90×10^{-9}	1.0- 9.0	2.4
8/25/49					
11:25-12:10 pm	0.28	262	16.88×10^{-9}	1.5-11.5	3.2
12:10-12:55 pm	0.69	40	6.69×10^{-9}	1.5- 9.0	3.4
12:55- 1:40 pm	0.45	Bkgd	---	2.0-13.5	3.9
1:40- 2:25 pm	0.20	206	9.92×10^{-9}	1.5- 9.0	3.2
2:25- 3:10 pm	0.20	401	19.32×10^{-9}	1.0- 6.0	2.8
3:10- 3:55 pm	0.04	2133	20.60×10^{-9}	1.0- 7.0	2.9
3:55- 4:40 pm	0.07	1220	20.60×10^{-9}	1.5- 8.5	3.1
4:40- 5:25 pm	0.10	450	10.82×10^{-9}	1.5-11.0	2.8
5:25- 6:10 pm	0.07	Bkgd	---	1.0- 9.0	2.9
6:10- 6:55 pm	0.06	666	9.55×10^{-9}	1.0- 7.5	2.4
6:55- 7:40 pm	0.12	273	7.90×10^{-9}	1.0- 7.0	2.9
7:40- 8:25 pm	0.04	1060	10.15×10^{-9}	1.0- 7.5	2.7
8:25- 9:10 pm	0.94	46	10.38×10^{-9}	1.0- 9.0	2.3
9:10- 9:55 pm	1.02	60	16.71×10^{-9}	1.0- 7.0	2.6
9:55-10:40 pm	1.01	78	17.76×10^{-9}	1.0-12.0	1.9
10:40-11:25 pm	1.55	80	29.74×10^{-9}	1.0-13.0	2.4
11:25-12:10 am	1.31	39	12.40×10^{-9}	1.0-13.5	2.6
8/26/49					
12:10-12:55 am	1.30	31	9.92×10^{-9}	1.0-12.5	2.4
12:55- 1:40 am	1.11	Bkgd	---	1.0-11.5	2.7
8/26/49					
11:20-11:05 am	0.93	Bkgd	---	1.5-11.5	4.1
11:05-11:50 am	0.76	Bkgd	---	1.0-10.5	4.6
11:50-12:35 pm	0.94	Bkgd	---	1.5-13.5	4.0
12:35- 1:20 pm	0.56	Bkgd	---	1.5-10.0	3.5
1:20- 2:05 pm	0.42	Bkgd	---	1.0- 9.0	3.0
2:05- 2:50 pm	1.01	Bkgd	---	1.5-10.5	3.5
2:50- 3:35 pm	0.94	Bkgd	---	1.5- 6.5	2.8
3:35- 4:20 pm	0.81	Bkgd	---	1.0-11.0	3.1
4:20- 5:05 pm	0.62	Bkgd	---	1.0- 7.0	2.4

*Size measurements do not go below 1 micron with optical method used so data only refer to particles of 1 micron or larger.