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LONG-TERM EXPOSURE OF $^{238}\text{PuO}_2$ TO A TERRESTRIAL ENVIRONMENT

by

R. C. Heaton, J. H. Patterson,
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ABSTRACT

A plutonium oxide source consisting of a single piece of 83% $^{238}\text{PuO}_2$ and weighing 38 g was exposed for 2.9 yr to a humid, temperate terrestrial environment in an environmental simulation chamber. The soil tray of the chamber was divided into four compartments so that different soil types could be studied under identical conditions. Soils examined in this experiment included loam, silt loam, sand, and humus. Plutonium released into the soils, the soil drainages, and the condensates from the dehumidifier was monitored throughout the experiment. The total plutonium release rate from the PuO_2 source was approximately $2 \text{ ng/m}^2/\text{s}$. The generation of short-ranged airborne plutonium, able to travel from a few centimeters to half a meter, was one of the most significant release pathways. The amount of plutonium released in this way was 10 times that washed directly off the source by rainwater and 20 times that from the fully airborne (longer ranged) release. Of the 200 μg of plutonium deposited in the soils, less than 0.1 μg was released into the soil percolates. In fact, the soil percolates constituted the least significant release pathway. Within the uncertainties in deriving the plutonium inventories of the soil compartments, we found no discernible differences among the behaviors of the four soil types towards plutonium. There was little or no seasonal effect on the release of plutonium from the soil.

INTRODUCTION

Radioisotope sources provide heat for electric power generators capable of supplying stable power levels for many years. Because of their longevity and simplicity, these generators are used to provide electric power for instruments and data transmission on many space missions. The isotope used almost exclusively for the space program is ^{238}Pu , usually as PuO_2 . The heat source container is designed to withstand both reentry from orbit and impact with the earth so that the source will be safely contained until recovery. Existing designs have proved to be more than adequately safe; however, to improve the safety of the heat sources and to provide

data for risk assessment studies, the Department of Energy continually seeks more information about potential plutonium release modes and the possible effects of released plutonium.

As part of this program, the Los Alamos National Laboratory has been studying the interactions of $^{238}\text{PuO}_2$ fuel materials with various environmental systems. The results of experiments with iridium-clad fuel,¹ with a complete fueled sphere assembly with iridium cladding and graphite impact shell,² and with unclad fragments of pressed plutonium oxide (PPO),^{3,4} all in humid terrestrial environments, were reported previously. Also reported were the results of a long-term study of PuO_2 fragments exposed to an arid, temperate climate.⁵ This paper describes an experiment

in which airborne plutonium derived from an intact $^{238}\text{PuO}_2$ fuel pellet was allowed to settle on four soils in a simulated humid, temperate environment.

OBJECTIVE

The purpose of this experiment was twofold. The first part was to determine the importance of the airborne or "spalled" plutonium released from the source, compared with that washed directly off the source by rainwater. The second part was to compare the four soil types after each had received doses of the same type of plutonium under the same environmental conditions. To accomplish these objectives, we divided the soil tray of the environmental test chamber into four compartments (Fig. 1) and placed the source on a stand above the center of the tray at the intersection of the four compartments. Water flowing over the source was directed into a drain under the stand so plutonium that washed directly off the source was not allowed to contact the soils. Only plutonium released into the air and transported for at least several centimeters could be deposited on the soils.

EXPERIMENTAL WORK

Equipment

This experiment was conducted in an environmental test chamber manufactured by Standard Environmental Systems, Inc., of Totowa, New Jersey, Model SLHH/64 (see Fig. 1). Spray heads were included to provide rainfalls as needed. The soil tray, 0.9 m square by 0.3 m deep, was divided into four equal compartments. Each compartment was drained separately to collectors located outside the chamber (Fig. 1). The four compartments were filled to about 3 cm from the top of the compartment wall with loam, silt loam, sand, or humus soil (see Table A-1 in the Appendix). The PuO_2 source was placed on a screen located above the juncture of the compartments. Rainwater running off the source and through the screen drained separately from the soil percolates and was combined with the dehumidifier condensates in a common sample container.

Fig. 1. Environmental simulation chamber.

Chamber Operation

The air temperature and humidity were cycled diurnally over 20 to 40°C and 85 to 97% RH. This humid summer regime was alternated every 6 months with a humid winter one of 0 to 17°C and 60 to 100% RH. Water from the spray head was distributed evenly over the soil in the trays weekly, simulating a weekly rainfall in each chamber. The amount of water used in each case was equivalent to a 32-mm (1.3-in.) rainfall. The chamber functioned in a trouble-free manner throughout the experiment.

PuO₂ Source

The source was a right circular cylinder of PuO₂ manufactured at Los Alamos in March 1981. It was 83% ²³⁸Pu with a specific activity of 14.2 Ci/g (Table A-II). The pellet, which was pressed from a mixture of PuO₂ particle types (GROG), was 16.9 mm in diameter by 16.7 mm long and had a mass of 38.16 g.

Samples

Aqueous Effluents. The waters that percolated through the soil in each compartment after each rain were collected and analyzed by liquid scintillation counting to determine their plutonium contents. Condensates from the refrigeration-type dehumidifiers of the chamber climate control systems were collected as needed and also analyzed for plutonium by liquid scintillation counting. Included in the condensates were the direct washings from the PuO₂ source. The plutonium contents of the soil percolates revealed the groundwater contents, whereas the condensate data indicated trends of the plutonium contents in the air and the amount of plutonium washed directly off the source by the rainwater.

Soil Cores. At the end of the experiment, two soil cores were taken from each soil compartment for plutonium analysis. We obtained the cores by pushing sections of 1/2-in. copper tubing into the soil to the full depth of the soil tray. In each compartment, one core was taken 6 in. from the juncture of the four compartments and another was taken 3 in. from the far side. Each core was divided into five equal sections that were individually analyzed to determine the plutonium content as a function of depth. Analyses were performed by dissolving the individual sections in nitric and

hydrofluoric acids and then mixing the resulting solutions with a scintillation cocktail before counting.

RESULTS AND DISCUSSION

Soil Percolates

The results of the plutonium analyses on the soil percolates are shown in Figs. 2 to 5 and listed in Table A-III. These are displayed as cumulative plutonium releases to best illustrate the trends in the data. Thus the slope of the curve indicates the release rate of plutonium into the soil drainage. The overall plutonium release curves can be reasonably well described by straight lines. Such lines were fitted to each curve and are shown in Figs. 2 to 5. In performing the curve fits, the earliest data points were assigned low weights when they suggested a release rate lower than the remainder of the data. This was done because one would expect the earliest release rates to be low until the soil equilibrates with the plutonium in the percolating water. The slopes and x-intercepts of the lines are shown in Table I. The slope indicates the average release rate observed after the induction period. The intercept suggests the length of the induction period, that is, the time required for the soil to equilibrate with the plutonium in the percolating water. The release rates (slopes) fall between 10 and 40 pg/day. These by themselves do not mean very much until they are related to the rates of input to the soils, which are discussed below. The induction periods ranged from 0 to 190 days. Because many variables affected these times, the numbers may be significant only in indicating a possible delay between deposition of plutonium on the soil and the appearance of plutonium at the bottom of the soil column.

The slopes of the curves do vary somewhat during the experiment. This variability may be caused by a number of factors, including changes in the flow rate of the water through the soil, changes in the mechanical properties of the soil (for example, channeling), changes in temperature or relative humidity, and variations in the rate of plutonium input into the soil. In past experiments¹⁻⁵ essentially no seasonal dependencies were observed for the release rate of plutonium. That appears to be the case in the present work as well. Table II shows the percolate release rates by seasons. There is a significant amount of variation in these data, but it is difficult to find any seasonal trends. Furthermore, changes in the slopes of the curves in Figs. 2 to 5 do not occur at the same time as changes in seasons. Thus we conclude that seasonal factors are not important in

Fig. 2. Plutonium in the soil percolates from the north sector of the soil tray, which contained a loam soil.

Fig. 3. Plutonium in the soil percolates from the east sector of the soil tray, which contained a silt loam soil.

Fig. 4. Plutonium in the soil percolates from the south sector of the soil tray, which contained a sand soil.

Fig. 5. Plutonium in the soil percolates from the west sector of the soil tray, which contained a humus soil.

TABLE I. Percolate Release Rates

Soil	Release Rate (Slope of Graph) ($\mu\text{g/day}$)	Delay Time (Intercept) (days)
Loam (North)	3.34×10^{-5}	0
Silt loam (East)	1.96×10^{-5}	151
Sand (South)	1.42×10^{-5}	124
Humus (West)	1.70×10^{-5}	187

determining plutonium release into the soil percolates. The flow rate of water through the soil was virtually constant, and the changes in plutonium release rates for the four soil compartments all occurred at the same times. These observations suggest that the variable release rates may be caused by a variable input rate, so the amount of plutonium coming off the source is not necessarily constant over time.

Soil Cores

Two soil cores were taken from each of the four soil compartments. Each of these was divided into five equal sections, which were then dissolved and analyzed for plutonium. Results of these analyses are shown in Figs. 6 and 7 and in Tables A-IV and A-V.

One reason for examining soil cores is to determine the depth profile of the plutonium in the soil. In Figs. 6 and 7, the graphs are normalized to 100% so the bars show the relative plutonium contents of the sections within each core. Because the cores were nominally 12.5 cm long, each section represents approximately 2.5 cm in depth. Cores from the humus soil are excep-

tions, since the inner core contained only 3.5 cm of soil and the outer contained only 5 cm. The depth profiles shown suggest a nearly random distribution of plutonium through the depth of the soil. This finding contradicts our expectations that most of the plutonium would be retained on the top of the soil and that only very small amounts would appear lower in the soil column until after the top layers were saturated. The observed behavior cannot be satisfactorily explained unless the soil is essentially saturated with plutonium; we will show later in this discussion that this is not the case. The only remaining alternatives are that the percolating water did not flow uniformly down the soil column or that cross contamination of the cores occurred during the sampling or analysis process.

The second reason for obtaining core samples is to estimate the plutonium contents of the soils. Based on the dubious assumption that the two cores from each soil compartment are representative of the whole compartment, we can calculate the plutonium inventory of the soil by multiplying the average plutonium content of the cores by the ratio of the cross-sectional areas of the soil compartment to the core. Because the outer core represents a larger soil area than the inner core, a weighted average was used, with the inner core carrying 0.516 the weight of the outer core. Because of the assumptions and uncertainties involved in this calculation, we do not have a great deal of confidence in the accuracy of the resulting values. However, they are useful for order of magnitude comparisons. Results are shown in Table III.

One of the more interesting facets of Table III is that the amount of plutonium in the soil is 3 orders of magnitude greater than the total amount of plutonium released into the soil percolates. Consequently, virtually all the plutonium deposited on the soil is retained

TABLE II. Seasonal Release Rates

Season	Time (days)	North Loam (pg/day)	East Silt Loam (pg/day)	South Sand (pg/day)	West Humus (pg/day)
Summer	111	16.3	2.80	2.87	2.19
Winter	183	57.7	15.0	12.4	8.59
Summer	179	21.1	12.6	11.2	11.0
Winter	188	35.3	18.8	11.5	25.6
Summer	179	35.7	39.0	23.0	21.1
Winter	179	24.5	5.51	7.16	13.1
Summer	27	14.4	5.16	2.82	6.60

Fig. 6. Plots showing the distribution of plutonium over depth for soil cores taken from two sectors of the soil tray.

Fig. 7. Plots showing the distribution of plutonium over depth for soil cores taken from two sectors of the soil tray.

TABLE III. Soil Plutonium Contents

Soil	Pu Inner Core (ng)	Pu Outer Core (ng)	Pu/Core Wgt. Avg. (ng)	Total Pu in Soil (μg)	Total Pu in Percolates (ng)	Pu Retained (%)
Loam (North)	10.4	44.3	32.8	54.0	32.9	99.9
Silt loam (East)	47.9	37.2	40.8	67.2	16.3	100
Sand (South)	84.6	20.0	42.0	69.2	12.0	100
Humus (West)	10.7	1.61	4.70	7.75	14.0	99.8
Total				198.2	75.2	

there. Because the release rates of plutonium to the soil percolates remained essentially constant throughout the experiment, we conclude that the soil never approached saturation. Further evidence can be obtained from past experiments. Soil column studies indicated that soil capacities for plutonium range from 9 to 13 $\mu\text{g/g}$.⁶ In the present case, the soil loadings are approximately 2 ng/g—3 orders of magnitude lower. This strongly suggests that much more plutonium would be required to approach saturation of the soils in this experiment.

The ratios of the release rates into the percolates to the soil loadings are approximately the same for the four soils, ranging from 0.8 to $2.0 \times 10^{-4}/\text{yr}$, except for the humus soil, which had a ratio of $8.0 \times 10^{-4}/\text{yr}$. The difference stems entirely from the anomalously low soil loading for the humus soil. This same quadrant of the soil tray yielded unusually short soil cores, which suggests that there may have been a sampling problem in this quadrant. Based on this evidence, probably no differences in soil behaviors can be discerned from this experiment.

Dehumidifier Condensates

The plutonium released into the dehumidifier condensates is shown in Fig. 8 and listed in Table A-VI. This curve (Fig. 8) is nearly a straight line, indicating a constant release rate. The release rate itself is given by the slope of the line, which is 28.3 ng/day. When normalized to the surface area of the source, this translates to a release rate of 0.245 ng/m²/s (Table IV). This

release consisted of two components, plutonium released from the source into the air and plutonium washed off the source directly by rainwater. This latter component exists because the source was placed on a screen over a drain that emptied into the same container as the dehumidifier condensates. Thus any plutonium washed off the source by rainwater was collected with the condensates, whereas only plutonium released into the air would have any chance of being deposited on the soil. The two-component nature of the condensates makes it difficult to determine how much is due to wash-off and how much is due to airborne plutonium. However, some information can be obtained by considering condensate samples collected during periods with no rainfalls. Such condensates would contain only the airborne component of the plutonium release.

The cumulative plutonium contents of the rain-free condensate samples are shown in Fig. 9. The slope of this curve is 8.30 ng/day or 0.072 ng/m²/s (Table IV), which represents the rate of airborne plutonium release in the absence of rain. Evidence from past experiments suggests that the airborne release rate can be substantially larger during a rainfall, but we cannot separate this from the direct wash-off with the information available. The difference between the release rate for all the condensates and that for the rain-free condensates is the amount caused by wash-off and is 20.0 ng/day or 0.173 ng/m²/s (Table IV). This value is significant only to the extent that the frequency of rainfall used is typical of terrestrial environments. A more meaningful way to express the rate of wash-off would be as nanograms per rain. However, this would preclude comparisons with the other modes of release.

Fig. 8. Plutonium in the dehumidifier condensates, including the direct wash-off from the source.

TABLE IV. Condensate Release Rates

Sample	Release Rate ($\mu\text{g}/\text{day}$)	Release Rate ($\text{ng}/\text{m}^2/\text{s}$)
Total condensate	2.83×10^{-2}	0.245
Rain-free condensate	8.30×10^{-3}	0.072
Wash-off (difference)	2.00×10^{-2}	0.173

Total Plutonium Releases

Table V summarizes the total amounts of plutonium released from the source over the course of the experiment. Consider first the total release. We cannot compare this to past terrestrial experiments because fragmented sources with unknown surface areas were always used. However, the currently observed release rate of $2 \text{ ng}/\text{m}^2/\text{s}$ compares favorably with the 0.3 to $11 \text{ ng}/\text{m}^2/\text{s}$ found in cold sea water⁷ and the 0.73 to $9.5 \text{ ng}/\text{m}^2/\text{s}$ in 1M (Ref. 8) but is lower than the 3.3 to $13 \text{ ng}/\text{m}^2/\text{s}$ in normal saline⁹ and the 10 to $40 \text{ ng}/\text{m}^2/\text{s}$ in cold fresh water.⁷ It is interesting that these values compare as well as they do, since air and water are such different media. Perhaps the release mechanisms in air and water may be related and the presence of water (or air) may have only secondary effects on the release rate.

The most striking aspect of Table V is the large amount of plutonium in the soil—10 times the amount washed directly off the source, which is the next most significant component. It is surprising that so much more plutonium finds its way into the soil than into the wash-off. Even if our estimate of the plutonium content of the soil is an order of magnitude too high, the results are still surprising. To get into the soil, plutonium must travel through the air for at least several centimeters and may travel more than half a meter. Released plutonium that remains airborne for longer periods of time would appear in the rain-free condensates. Therefore, generation of short-ranged airborne plutonium may be one of the most important release pathways for sources exposed to terrestrial environments.

Table V also shows that plutonium release into the soil percolates is negligible compared with the total release. This attests to the efficiency of the soil for retaining the deposited plutonium and suggests that contamination of groundwater in the event of a terrestrial deposition of plutonium is less significant than the potential contamination of top soil and surface runoff.

CONCLUSIONS

The observed total plutonium release rate from the PuO_2 source of approximately $2 \text{ ng}/\text{m}^2/\text{s}$ compares

Fig. 9. Plutonium in the rain-free dehumidifier condensates.

TABLE V. Total Plutonium Inventories

	Pu (μg)	Pu Rate ($\text{ng}/\text{m}^2/\text{s}$)
Percolates	0.0752	0.00062 ^a
Soil	198	1.64 ^a
Condensate—wash-off	20.9 ^b	0.173
Condensate—air	8.69 ^b	0.072
Total	228	1.89

^aDerived from total release assuming 1046 days and 1335.2-mm² source area.

^bDerived from release rate assuming 1046 days and 1335.2-mm² source area.

favorably with release rates observed in aqueous systems in past experiments. The absence of surface area data on the fragmented sources used in other terrestrial experiments prevents comparisons with these more closely related systems. The similarity in release rates observed in aqueous systems and the present terrestrial experiment may be coincidental, or it may indicate that the different media have only secondary influence on the rate of plutonium release from the source. The

generation of short-ranged airborne plutonium (able to travel from a few centimeters to half a meter and thereby be deposited on the soil within the chamber) may be one of the most significant release pathways. The amount of plutonium released in this way was 10 times that found in the direct wash-off and 20 times that found in the dehumidifier condensate (longer ranged airborne material).

Virtually all the plutonium deposited in the soil was retained there. Of the 200 μg deposited in the soil, less than 0.1 μg was released into the soil percolates. In fact, the soil percolates constituted the least significant release pathway, amounting to less than one-tenth of the release into the dehumidifier condensates and less than one-twentieth of the direct wash-off. There was a considerable degree of uncertainty in deriving the plutonium inventory of the four soil compartments. Within the limits of that uncertainty, we found no discernible differences among the four soil types in their behavior towards plutonium. The rate of plutonium release into the soil percolates did vary somewhat over time, but because this did not correlate with any changes in seasonal parameters, we conclude that there is little or no seasonal effect on plutonium release from the soil.

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APPENDIX. SUMMARY OF EXPERIMENTAL DATA

TABLE A-I. Soil Data^{a,b}

	Loam (North)	Silt Loam (East)	Sand (South)	Humus (West)
Total sand	49.7	31.4	95.7	28.8
Total silt	38.6	58.3	2.6	51.9
Clay	11.7	10.3	1.7	19.3
Total organic carbon	0.87	0.09	0.10	4.45
Particle size analysis				
>2 mm	3	tr	tr	20
>0.1 mm	30	2	89	35
1 mm < sand < 2 mm	6.9	0.2	0.2	3.8
0.5 mm < sand < 1.0 mm	7.7	0.2	1.3	5.2
0.25 mm < sand < 0.5 mm	5.2	0.2	30.1	5.1
0.1 mm < sand < 0.25 mm	7.9	1.1	57.1	4.9
0.05 mm < sand < 0.1 mm	22.0	29.7	7.0	9.8
0.02 mm < silt < 0.05 mm	25.7	42.2	1.2	22.6
0.002 < silt < 0.02	12.9	16.1	1.4	29.3
clay < 0.0002 mm	6.6	2.8	1.2	7.2
Free iron (Dith-Cit extractable)	0.5	0.5	0.3	1.1
Aluminum (Dith-Cit extractable)	0.1	0.1	tr	0.1
NH ₄ OAc extractable Mg (meq/100 g)	1.9	3.3	0.6	2.2
NH ₄ OAc extractable Na	0.1	2.8	---	---
NH ₄ OAc extractable K (meq/100 g)	0.5	0.4	0.1	1.1
Cation exchange capacity (ph 7)(meq/100 g)	10.3	12.7	3.5	24.0
Calcium carbonate equivalent	tr	10	1	tr
pH (1:2 0.01M CaCl ₂)	6.8	8.3	7.9	5.1
pH (1:1 H ₂ O)	7.5	8.3	8.4	5.3
Surface area (EGME) (m ² /g)	63	84	24	147
Moisture content at 15 bar	5.5	6.1	1.7	17.2

^aAll values are in weight percent unless otherwise noted.

^bAnalyses were performed by the US Department of Agriculture Soil Conservation Service Laboratory, Lincoln, NE 68508.

TABLE A-II. Source Data

Physical Specifications		Isotopic Abundances (%) ^a	
Length	16.706 mm	238	82.84
Diameter	16.896 mm	239	14.54
Mass	38.161 g	240	2.10
Fabrication date	March 1981	241	0.37
Identification	ET1-1	242	0.15

^aAs of July 31, 1984.

TABLE A-III. Percolate Data

No.	Date (Mo/Dy/Yr)	Loam (North)		Silt/Loam (East)		Sand (South)		Humus (West)		Smp1
		Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	
2	030381	0.2750e+01	0.1000e-13	0.4000e+01	0.1000e-13	0.3400e+01	0.1000e-13	0.2900e+01	0.1000e-13	br1
3	031081	0.2800e+01	0.9714e-10	0.3500e+01	0.1000e-13	0.1700e+01	0.1000e-13	0.2000e+01	0.1000e-13	ar2
4	031881	0.2700e+01	0.1852e-10	0.3500e+01	0.1000e-13	0.1500e+01	0.1000e-13	0.1900e+01	0.1000e-13	br3
5	032481	0.2500e+01	0.6120e-10	0.3500e+01	0.7000e-11	0.1600e+01	0.1550e-10	0.2000e+01	0.6200e-11	ar4
6	033181	0.2700e+01	0.1070e-10	0.4000e+01	0.6000e-11	0.2000e+01	0.1030e-10	0.2300e+01	0.8957e-12	br5
7	040881	0.2400e+01	0.6875e-11	0.4000e+01	0.8000e-11	0.2000e+01	0.6600e-11	0.2100e+01	0.1571e-11	ar6
8	041481	0.2700e+01	0.2489e-10	0.4000e+01	0.1000e-11	0.2000e+01	0.7200e-11	0.2300e+01	0.8957e-12	br7
9	042181	0.3300e+01	0.3424e-10	0.4500e+01	0.2000e-11	0.1500e+01	0.1787e-10	0.2200e+01	0.7500e-11	ar8
10	043081	0.3300e+01	0.4303e-10	0.5000e+01	0.2000e-11	0.2500e+01	0.1896e-10	0.3400e+01	0.1576e-10	br9
11	050681	0.3300e+01	0.5515e-10	0.4500e+01	0.6000e-11	0.1700e+01	0.1818e-10	0.2500e+01	0.6600e-11	ar10
12	051381	0.3000e+01	0.1183e-09	0.4000e+01	0.1400e-10	0.1200e+01	0.1717e-10	0.2000e+01	0.7200e-11	br11
13	052081	0.3000e+01	0.4600e-10	0.4000e+01	0.7000e-11	0.1200e+01	0.3267e-10	0.2000e+01	0.1650e-10	ar12
14	052881	0.2750e+01	0.3451e-10	0.3500e+01	0.9000e-11	0.5000e+00	0.7000e-10	0.1250e+01	0.6080e-11	br13
15	060281	0.2200e+01	0.2214e-10	0.4000e+01	0.7000e-11	0.1000e+01	0.2100e-10	0.1800e+01	0.2300e-10	ar14
16	061081	0.2800e+01	0.2093e-10	0.4000e+01	0.2000e-11	0.1000e+01	0.1570e-10	0.1750e+01	0.5657e-11	br15
17	061781	0.3250e+01	0.2794e-10	0.4000e+01	0.7100e-11	0.1000e+01	0.9080e-11	0.2000e+01	0.1525e-10	ar16
18	062481	0.3700e+01	0.3568e-10	0.4500e+01	0.5200e-11	0.1250e+01	0.5216e-10	0.2400e+01	0.6208e-11	br17
19	070181	0.3300e+01	0.2074e-10	0.5000e+01	0.9000e-12	0.2100e+01	0.2081e-10	0.3000e+01	0.1457e-10	ar18
20	070781	0.3400e+01	0.8353e-10	0.5000e+01	0.1000e-11	0.1950e+01	0.1697e-10	0.2950e+01	0.3627e-10	br19
21	071481	0.3750e+01	0.1616e-09	0.5750e+01	0.8700e-11	0.2300e+01	0.7174e-11	0.3400e+01	0.1091e-10	ar20
22	072181	0.4000e+01	0.9700e-10	0.5750e+01	0.3300e-11	0.2250e+01	0.8267e-11	0.3400e+01	0.5941e-11	br21
23	072881	0.3750e+01	0.7387e-10	0.5750e+01	0.7300e-11	0.2200e+01	0.1768e-11	0.3400e+01	0.5294e-11	ar22
24	080481	0.4000e+01	0.7325e-10	0.6000e+01	0.7000e-11	0.2400e+01	0.2388e-10	0.3500e+01	0.4114e-11	br23
25	081181	0.4000e+01	0.1145e-09	0.6000e+01	0.2400e-11	0.2500e+01	0.6520e-10	0.4000e+01	0.1013e-10	ar24
26	081881	0.4000e+01	0.1123e-09	0.6000e+01	0.2620e-10	0.2500e+01	0.3796e-11	0.4000e+01	0.1003e-10	br25
27	082581	0.4000e+01	0.8900e-10	0.5000e+01	0.5800e-11	0.2300e+01	0.8609e-11	0.3500e+01	0.4000e-11	ar26
28	090181	0.4000e+01	0.5725e-10	0.5750e+01	0.1000e-11	0.2300e+01	0.7174e-12	0.3500e+01	0.3771e-11	br27
29	090981	0.4000e+01	0.1168e-09	0.5750e+01	0.3000e-11	0.2200e+01	0.9773e-11	0.3500e+01	0.2123e-11	ar28
30	091581	0.4250e+01	0.9294e-10	0.6000e+01	0.3900e-10	0.2600e+01	0.2188e-10	0.4250e+01	0.1320e-10	br29
31	092281	0.4000e+01	0.1215e-09	0.6000e+01	0.1900e-10	0.2400e+01	0.1171e-09	0.3700e+01	0.1886e-10	br30
32	092981	0.4000e+01	0.6175e-10	0.6000e+01	0.5300e-11	0.2400e+01	0.1667e-10	0.3700e+01	0.6459e-11	br31
33	100681	0.4000e+01	0.3275e-10	0.6000e+01	0.7270e-10	0.2200e+01	0.4164e-10	0.4000e+01	0.3425e-11	ar32
34	102081	0.3700e+01	0.1919e-10	0.5000e+01	0.1200e-10	0.2000e+01	0.1000e-10	0.3400e+01	0.2379e-10	br33
35	102281	0.3800e+01	0.1161e-09	0.6000e+01	0.4700e-11	0.2300e+01	0.8957e-11	0.3900e+01	0.1797e-10	ar34
36	102781	0.4000e+01	0.1163e-09	0.6000e+01	0.1700e-10	0.2600e+01	0.1112e-10	0.4000e+01	0.5425e-11	br35
37	110381	0.4000e+01	0.1375e-09	0.6000e+01	0.4400e-10	0.2400e+01	0.8250e-10	0.3700e+01	0.1249e-10	ar36
38	111081	0.4000e+01	0.3625e-09	0.6000e+01	0.7800e-11	0.2300e+01	0.1830e-10	0.3500e+01	0.1791e-10	br37
39	111781	0.4000e+01	0.7575e-10	0.6000e+01	0.2900e-10	0.2500e+01	0.3632e-11	0.3600e+01	0.3667e-10	ar38
40	112481	0.4000e+01	0.3850e-10	0.5750e+01	0.6300e-10	0.2900e+01	0.5138e-10	0.3500e+01	0.3057e-11	br39
41	120181	0.4000e+01	0.1590e-09	0.6000e+01	0.1000e-10	0.2500e+01	0.1820e-09	0.4000e+01	0.5850e-10	ar40

TABLE A-III. (cont)

No.	Date (Mo/Dy/Yr)	Loam (North)		Silt/Loam (East)		Sand (South)		Humus (West)		Smp1
		Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	
42	120881	0.4000e+01	0.2133e-09	0.5750e+01	0.1970e-10	0.2800e+01	0.9714e-10	0.3500e+01	0.8257e-10	br41
43	121581	0.4000e+01	0.7025e-10	0.5750e+01	0.5000e-10	0.2500e+01	0.5760e-10	0.3500e+01	0.1734e-10	ar42
44	122281	0.4000e+01	0.7100e-10	0.5000e+01	0.1300e-10	0.4000e+01	0.5525e-10	0.4000e+01	0.8725e-11	br43
45	122981	0.3500e+01	0.3714e-10	0.5000e+01	0.2900e-10	0.3200e+01	0.3250e-10	0.4000e+01	0.2123e-11	ar44
46	010582	0.4000e+01	0.1170e-09	0.6000e+01	0.2600e-10	0.4000e+01	0.4250e-10	0.4000e+01	0.8350e-10	br45
47	011282	0.3500e+01	0.3886e-10	0.5000e+01	0.3200e-10	0.3250e+01	0.4369e-10	0.3500e+01	0.1086e-09	ar46
48	011982	0.3500e+01	0.4314e-10	0.5000e+01	0.6100e-11	0.3300e+01	0.2300e-10	0.3500e+01	0.5714e-11	br47
49	012682	0.3500e+01	0.3400e-10	0.4500e+01	0.1150e-09	0.3250e+01	0.9508e-10	0.3500e+01	0.1014e-10	ar48
50	020282	0.3500e+01	0.2146e-10	0.5000e+01	0.7800e-11	0.3200e+01	0.1625e-10	0.3500e+01	0.6143e-11	br49
51	021082	0.3500e+01	0.3571e-10	0.5000e+01	0.5420e-10	0.3500e+01	0.8371e-10	0.3500e+01	0.1403e-09	ar50
52	021882	0.3500e+01	0.9429e-11	0.4500e+01	0.5900e-11	0.3000e+01	0.2200e-11	0.3250e+01	0.6154e-11	br51
53	022382	0.4000e+01	0.1863e-10	0.4800e+01	0.7800e-11	0.3200e+01	0.6969e-11	0.4000e+01	0.4475e-11	ar52
54	030282	0.4000e+01	0.1603e-10	0.5000e+01	0.1000e-13	0.3200e+01	0.6250e-11	0.4000e+01	0.1415e-11	br53
55	030982	0.4000e+01	0.2075e-10	0.5000e+01	0.1000e-13	0.3000e+01	0.5500e-12	0.3500e+01	0.1414e-11	ar54
56	031682	0.4000e+01	0.9900e-11	0.5000e+01	0.3000e-11	0.3000e+01	0.7067e-12	0.4000e+01	0.1885e-11	br55
57	032382	0.4000e+01	0.1180e-09	0.5000e+01	0.1000e-13	0.3000e+01	0.6667e-11	0.4000e+01	0.9425e-12	ar56
58	033082	0.4400e+01	0.3045e-10	0.5000e+01	0.3000e-11	0.3300e+01	0.1085e-10	0.3900e+01	0.4231e-11	br57
59	040682	0.3500e+01	0.1746e-10	0.4000e+01	0.1000e-13	0.3000e+01	0.8500e-11	0.3250e+01	0.6154e-11	ar58
60	041382	0.3500e+01	0.2523e-10	0.4000e+01	0.5000e-12	0.3000e+01	0.7167e-11	0.3250e+01	0.1625e-10	br59
61	042082	0.3500e+01	0.9143e-11	0.4000e+01	0.1500e-10	0.3000e+01	0.2750e-11	0.3500e+01	0.4714e-11	ar60
62	042782	0.4000e+01	0.2575e-10	0.4000e+01	0.1100e-10	0.3000e+01	0.6667e-11	0.3500e+01	0.8714e-11	br61
63	050482	0.4000e+01	0.1368e-10	0.4000e+01	0.5200e-11	0.2750e+01	0.7491e-11	0.3400e+01	0.3147e-11	ar62
64	051182	0.4000e+01	0.2550e-10	0.4500e+01	0.6600e-11	0.3200e+01	0.2838e-11	0.3500e+01	0.1086e-10	br63
65	051882	0.4000e+01	0.2800e-10	0.4000e+01	0.4000e-11	0.2700e+01	0.6741e-11	0.3300e+01	0.5242e-11	ar64
66	052582	0.4000e+01	0.3100e-10	0.4000e+01	0.5370e-10	0.2800e+01	0.6000e-10	0.3000e+01	0.6600e-11	br65
67	060282	0.3500e+01	0.8143e-10	0.4000e+01	0.1600e-10	0.2500e+01	0.3432e-10	0.3000e+01	0.1103e-10	ar66
68	060882	0.3750e+01	0.3760e-10	0.4000e+01	0.1100e-10	0.2800e+01	0.6179e-11	0.3100e+01	0.8516e-10	br67
69	061782	0.3300e+01	0.1924e-10	0.4000e+01	0.8300e-11	0.3000e+01	0.1100e-10	0.3200e+01	0.1031e-10	ar68
70	062282	0.4500e+01	0.4222e-10	0.4800e+01	0.1500e-10	0.1500e+01	0.6600e-11	0.3000e+01	0.1047e-10	br69
71	062982	0.4400e+01	0.3364e-10	0.4700e+01	0.4000e-11	0.2400e+01	0.9958e-11	0.3300e+01	0.9121e-10	ar70
72	070782	0.4000e+01	0.5350e-10	0.4000e+01	0.9180e-10	0.2000e+01	0.2890e-10	0.2800e+01	0.2082e-09	br71
73	071382	0.4000e+01	0.2193e-10	0.4000e+01	0.1400e-10	0.2500e+01	0.8600e-11	0.3300e+01	0.1900e-10	ar72
74	072082	0.3200e+01	0.2941e-10	0.5000e+01	0.2000e-12	0.2500e+01	0.3960e-11	0.4500e+01	0.5667e-11	br73
75	072782	0.4000e+01	0.3250e-10	0.4500e+01	0.1100e-10	0.2400e+01	0.5167e-11	0.3200e+01	0.6438e-11	ar74
76	080382	0.4000e+01	0.7475e-10	0.5000e+01	0.8300e-11	0.2500e+01	0.1016e-09	0.3200e+01	0.5625e-10	br75
77	081182	0.4000e+01	0.4300e-10	0.5000e+01	0.3000e-11	0.2200e+01	0.8636e-11	0.3400e+01	0.4971e-10	ar76
78	081782	0.4500e+01	0.1771e-09	0.5500e+01	0.2000e-11	0.2800e+01	0.7607e-10	0.4000e+01	0.3925e-10	br77
79	082482	0.4000e+01	0.3675e-10	0.5000e+01	0.9400e-11	0.2500e+01	0.1056e-10	0.3500e+01	0.1557e-10	ar78
80	083182	0.4300e+01	0.1484e-09	0.4900e+01	0.4000e-11	0.2500e+01	0.1520e-09	0.3400e+01	0.6000e-10	br79
81	090882	0.4100e+01	0.8171e-10	0.4800e+01	0.1200e-10	0.2300e+01	0.5522e-10	0.3000e+01	0.2367e-10	ar80

TABLE A-III. (cont)

No.	Date (Mo/Dy/Yr)	Loam (North)		Silt/Loam (East)		Sand (South)		Humus (West)		Smp1
		Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	
82	091482	0.4500e+01	0.5733e-10	0.5300e+01	0.7300e-11	0.2800e+01	0.1357e-10	0.3700e+01	0.1941e-10	br81
83	092182	0.4000e+01	0.4150e-10	0.5000e+01	0.1200e-10	0.2500e+01	0.1124e-10	0.3400e+01	0.1215e-10	ar82
84	092882	0.5000e+01	0.3040e-10	0.6000e+01	0.8500e-11	0.2900e+01	0.4552e-11	0.4000e+01	0.1013e-10	br83
85	100682	0.4200e+01	0.2476e-10	0.5500e+01	0.4000e-10	0.2700e+01	0.8741e-10	0.3800e+01	0.9184e-11	ar84
86	101882	0.4100e+01	0.4341e-10	0.5100e+01	0.6270e-10	0.2100e+01	0.1886e-10	0.3300e+01	0.8000e-11	br85
87	101982	0.4000e+01	0.1768e-10	0.5000e+01	0.6400e-11	0.2500e+01	0.4640e-11	0.3600e+01	0.2383e-10	ar86
88	102782	0.4200e+01	0.1024e-09	0.5000e+01	0.1340e-09	0.2400e+01	0.1650e-10	0.3500e+01	0.5429e-10	br87
89	110282	0.4200e+01	0.2005e-10	0.5000e+01	0.3000e-11	0.2300e+01	0.7087e-10	0.3400e+01	0.1235e-09	ar88
90	110982	0.4000e+01	0.3150e-10	0.5000e+01	0.7000e-12	0.2500e+01	0.2840e-10	0.3200e+01	0.7875e-10	br89
91	111682	0.4000e+01	0.5100e-10	0.5000e+01	0.8300e-11	0.2300e+01	0.2187e-10	0.3200e+01	0.1728e-10	ar90
92	112382	0.4000e+01	0.1650e-10	0.5000e+01	0.1030e-09	0.2400e+01	0.1958e-10	0.3400e+01	0.1044e-10	br91
93	113082	0.4000e+01	0.1460e-09	0.5000e+01	0.1000e-10	0.2100e+01	0.1767e-10	0.3300e+01	0.2252e-09	ar92
94	120782	0.4500e+01	0.1011e-09	0.5500e+01	0.7190e-10	0.2500e+01	0.3728e-10	0.3500e+01	0.6000e-10	br93
95	121482	0.5000e+01	0.6080e-10	0.6000e+01	0.4700e-10	0.2800e+01	0.3360e-10	0.4000e+01	0.1100e-09	ar94
96	122182	0.3500e+01	0.1946e-09	0.4500e+01	0.2000e-09	0.3000e+01	0.9800e-10	0.3200e+01	0.7580e-10	br95
97	122882	0.3700e+01	0.1465e-10	0.4800e+01	0.4400e-10	0.3200e+01	0.3100e-10	0.3700e+01	0.9170e-10	ar96
98	010483	0.3500e+01	0.6314e-10	0.4500e+01	0.8500e-11	0.3100e+01	0.8000e-10	0.3400e+01	0.9180e-10	br97
99	011183	0.3750e+01	0.1533e-09	0.4200e+01	0.8000e-11	0.2800e+01	0.2100e-10	0.3400e+01	0.9100e-10	ar98
100	011883	0.3500e+01	0.2711e-10	0.4200e+01	0.1500e-10	0.2800e+01	0.1000e-10	0.3100e+01	0.3400e-10	br99
101	012583	0.3600e+01	0.3083e-10	0.4200e+01	0.1260e-09	0.3000e+01	0.1900e-10	0.3400e+01	0.9700e-11	ar100
102	020183	0.4000e+01	0.5950e-10	0.5000e+01	0.2000e-10	0.3000e+01	0.5000e-10	0.3500e+01	0.1070e-09	br101
103	020883	0.3800e+01	0.3737e-10	0.4500e+01	0.9900e-11	0.2900e+01	0.8200e-10	0.3800e+01	0.1300e-10	ar102
104	021583	0.4000e+01	0.1343e-10	0.5000e+01	0.1500e-10	0.3200e+01	0.7000e-11	0.4000e+01	0.1000e-11	br103
105	022483	0.4000e+01	0.9650e-10	0.4000e+01	0.4440e-10	0.2800e+01	0.1440e-09	0.3800e+01	0.1360e-10	ar104
106	030183	0.4000e+01	0.1703e-10	0.4500e+01	0.1370e-09	0.3100e+01	0.3100e-10	0.3600e+01	0.2200e-10	br105
107	030883	0.4000e+01	0.1323e-09	0.4200e+01	0.1320e-09	0.2800e+01	0.2430e-09	0.3500e+01	0.2000e-11	ar106
108	031583	0.4000e+01	0.1483e-09	0.4200e+01	0.2050e-09	0.2700e+01	0.1480e-09	0.3500e+01	0.1000e-13	br107
109	032283	0.4000e+01	0.4800e-10	0.4200e+01	0.9170e-10	0.3000e+01	0.1110e-09	0.3800e+01	0.1300e-10	ar108
110	032983	0.4100e+01	0.3854e-10	0.4300e+01	0.5780e-10	0.2900e+01	0.2400e-10	0.4100e+01	0.8500e-11	br109
111	040683	0.4000e+01	0.3975e-10	0.4200e+01	0.3050e-10	0.2600e+01	0.1900e-10	0.4000e+01	0.6890e-10	ar110
112	041283	0.4200e+01	0.1731e-09	0.5000e+01	0.3800e-10	0.3000e+01	0.1030e-09	0.4100e+01	0.3300e-10	br111
113	042083	0.4200e+01	0.4881e-10	0.5000e+01	0.4100e-10	0.3000e+01	0.3400e-10	0.4300e+01	0.2700e-10	ar112
114	042683	0.4260e+01	0.3615e-10	0.5500e+01	0.4700e-10	0.2700e+01	0.1400e-10	0.5000e+01	0.1700e-10	br113
115	050383	0.4500e+01	0.1627e-10	0.5000e+01	0.4500e-10	0.2300e+01	0.4100e-10	0.4500e+01	0.5330e-10	ar114
116	051183	0.4200e+01	0.3738e-10	0.5000e+01	0.2800e-10	0.2000e+01	0.1100e-10	0.4000e+01	0.1300e-10	br115
117	051883	0.3900e+01	0.5769e-10	0.4200e+01	0.5400e-11	0.5000e+00	0.7570e-10	0.3900e+01	0.7100e-11	ar116
118	052683	0.4000e+01	0.4675e-10	0.4200e+01	0.4100e-10	0.1000e+00	0.2470e-10	0.4000e+01	0.2600e-10	br117
119	060183	0.3750e+01	0.4000e-11	0.4000e+01	0.3100e-10	0.3250e+01	0.2200e-10	0.3500e+01	0.3600e-10	ar118
120	060983	0.4200e+01	0.1500e-10	0.4750e+01	0.7120e-10	0.3400e+01	0.3300e-10	0.4500e+01	0.3700e-10	br119
121	061683	0.4000e+01	0.6600e-11	0.4000e+01	0.1600e-10	0.9000e+00	0.2800e-10	0.4000e+01	0.4000e-11	ar120

TABLE A-III. (cont)

No.	Date (Mo/Dy/Yr)	Loam (North)		Silt/Loam (East)		Sand (South)		Humus (West)		Smp1
		Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	Volume (L)	Pu (g/L)	
122	062483	0.4750e+01	0.5280e-10	0.4200e+01	0.9000e-12	0.7000e+00	0.5400e-10	0.3500e+01	0.4900e-10	br121
123	070183	0.4200e+01	0.3100e-10	0.5000e+01	0.8000e-11	0.1700e+01	0.5000e-10	0.4000e+01	0.1700e-10	ar122
124	071183	0.4500e+01	0.4300e-10	0.5000e+01	0.9200e-11	0.2500e+01	0.1600e-10	0.4000e+01	0.2100e-10	br123
125	071883	0.4600e+01	0.6580e-10	0.5200e+01	0.1300e-10	0.2500e+01	0.1400e-10	0.4100e+01	0.1500e-10	ar124
126	072283	0.4500e+01	0.2800e-10	0.4750e+01	0.1000e-11	0.2500e+01	0.6000e-11	0.4000e+01	0.9400e-11	br125
127	072783	0.4800e+01	0.7200e-10	0.5200e+01	0.4000e-11	0.2400e+01	0.1300e-10	0.4300e+01	0.3700e-10	ar126
128	080483	0.4500e+01	0.2100e-10	0.5200e+01	0.4000e-11	0.8000e+00	0.4200e-10	0.4300e+01	0.5040e-10	br127
129	081083	0.4500e+01	0.3500e-10	0.5200e+01	0.4000e-11	0.1200e+01	0.1700e-10	0.4200e+01	0.1700e-10	ar128
130	081883	0.4300e+01	0.1700e-10	0.5000e+01	0.7000e-12	0.1200e+01	0.1000e-10	0.4100e+01	0.7300e-11	br129
131	082583	0.4200e+01	0.3800e-10	0.5000e+01	0.6100e-11	0.4000e+01	0.5400e-11	0.4200e+01	0.2900e-10	ar130
132	090283	0.4300e+01	0.6930e-10	0.5500e+01	0.7300e-11	0.3100e+01	0.8300e-11	0.4700e+01	0.3300e-10	br131
133	091283	0.4000e+01	0.1500e-10	0.4750e+01	0.2000e-11	0.1900e+01	0.5000e-11	0.4000e+01	0.1000e-10	ar132
134	091583	0.4700e+01	0.2700e-10	0.5800e+01	0.2000e-11	0.2300e+01	0.1800e-10	0.4700e+01	0.4000e-11	br133
135	092383	0.4000e+01	0.2300e-10	0.5000e+01	0.7000e-12	0.1500e+01	0.1000e-10	0.4000e+01	0.1300e-10	ar134
136	100383	0.5000e+01	0.2360e-10	0.5750e+01	0.1000e-11	0.3500e+01	0.3000e-11	0.5000e+01	0.1000e-10	br135
137	101183	0.5000e+01	0.3700e-10	0.5750e+01	0.6600e-11	0.3500e+01	0.7800e-11	0.4500e+01	0.5190e-10	ar136
138	101783	0.4500e+01	0.5450e-10	0.5750e+01	0.7100e-11	0.3500e+01	0.3000e-11	0.4500e+01	0.1100e-10	br137
139	102483	0.4750e+01	0.1160e-09	0.5750e+01	0.2100e-10	0.3200e+01	0.3200e-10	0.4500e+01	0.2200e-10	ar138
140	103183	0.4500e+01	0.6420e-10	0.5700e+01	0.4690e-11	0.3000e+01	0.1150e-09	0.4400e+01	0.5450e-11	br139
141	110783	0.4000e+01	0.2900e-10	0.4500e+01	0.9200e-11	0.2450e+01	0.9830e-10	0.3900e+01	0.1300e-10	ar140
142	111483	0.4600e+01	0.1000e-10	0.5000e+01	0.2000e-12	0.2300e+01	0.1600e-10	0.4000e+01	0.4000e-11	br141
143	112183	0.5000e+01	0.1900e-10	0.5500e+01	0.2000e-12	0.2700e+01	0.2000e-11	0.5000e+01	0.3500e-11	br142
144	112883	0.5000e+01	0.1600e-10	0.6000e+01	0.5700e-11	0.2700e+01	0.1000e-11	0.5000e+01	0.6400e-11	ar143
145	120583	0.5000e+01	0.1900e-10	0.6000e+01	0.4000e-11	0.2500e+01	0.7900e-11	0.5000e+01	0.7500e-11	ar144
146	121283	0.5000e+01	0.2500e-10	0.6000e+01	0.4000e-11	0.2900e+01	0.1100e-10	0.5000e+01	0.9400e-11	br145
147	121583	0.5000e+01	0.1600e-10	0.6000e+01	0.4000e-11	0.4000e+01	0.4700e-11	0.5000e+01	0.1700e-10	ar146
148	122783	0.5200e+01	0.1600e-10	0.6300e+01	0.1360e-10	0.3800e+01	0.1000e-11	0.5300e+01	0.4700e-11	br147
149	010384	0.4200e+01	0.2400e-10	0.1400e+01	0.4000e-11	0.3800e+01	0.5700e-11	0.4100e+01	0.5200e-11	ar148
150	011084	0.4000e+01	0.8300e-11	0.2500e+01	0.7000e-11	0.2900e+01	0.3000e-11	0.4000e+01	0.7800e-11	br149

TABLE A-IV. Soil Core Data—Inside Cores

Section ^a	North Loam		East Silt Loam		South Sand		West Humus ^b	
	(ng Pu)	(%)	(ng Pu)	(%)	(ng Pu)	(%)	(ng Pu)	(%)
1 (top)	4.16	40.0	34.7	72.4	23.0	27.2	0.58	5.4
2	2.96	28.5	0.90	1.9	1.48	1.8	10.1	94.4
3	3.03	29.1	11.9	24.8	0.10	0.1	---	---
4	0.15	1.5	0.16	0.3	59.0	69.7	---	---
5 (bottom)	0.08	0.8	0.20	0.4	1.04	1.2	---	---
Total	10.4		47.9		84.6		10.7	

^aSections are nominally 2.5 cm in length.

^bThis core was only 3.5 cm long and was divided into two equal sections.

TABLE A-V. Soil Core Data—Outside Cores

Section ^a	North Loam		East Silt Loam		South Sand		West Humus	
	(ng Pu)	(%)	(ng Pu)	(%)	(ng Pu)	(%)	(ng Pu)	(%)
1 (top)	0.10	0.2	24.3	65.3	11.5	57.5	0.485	30.1
2	0.07	0.2	0.29	0.8	1.01	5.0	0.406	25.2
3	0.13	0.3	11.5	30.9	0.10	0.5	0.021	1.3
4	43.1	97.3	0.06	0.2	7.36	36.8	0.068	4.2
5 (bottom)	0.94	2.1	1.07	2.9	0.05	0.2	0.649	40.3
Total	44.3		37.2		20.0		1.61	

^aSections are nominally 2.5 cm in length.

TABLE A-VI. Condensate Data

No.	Date (Mo/Dy/Yr)	Volume (L)	Pu (g/L)	Smp1
1	022581	0.1800e+02	0.1000e-10	b1k
2	022781	0.1400e+02	0.1000e-10	b1
3	030281	0.1700e+02	0.4760e-07	a2
4	030681	0.1700e+02	0.1100e-07	b3 *
5	030981	0.1800e+02	0.2530e-08	a4
6	031181	0.1750e+02	0.2130e-07	b5
7	031681	0.2800e+02	0.3550e-09	a6 *
8	031881	0.1800e+02	0.4530e-07	b7
9	032081	0.1020e+02	0.5930e-09	a8 *
10	032381	0.1800e+02	0.2020e-08	b9
11	032681	0.2000e+02	0.1260e-09	a10
12	033081	0.2000e+02	0.5140e-09	b11 *
13	040181	0.1800e+02	0.1210e-07	a12
14	040381	0.1050e+02	0.7570e-09	b13
15	040681	0.1550e+02	0.3130e-09	a14
16	040881	0.1750e+02	0.1110e-07	b15
17	041381	0.2600e+02	0.3450e-09	b16 *
18	041581	0.1750e+02	0.1320e-07	a17
19	042081	0.1150e+02	0.5150e-09	b18 *
20	042081	0.1800e+02	0.2410e-08	a19
21	042381	0.1800e+02	0.9640e-08	c20
22	042981	0.1800e+02	0.7110e-08	a21
23	050481	0.2600e+02	0.1110e-08	b22 *
24	050681	0.1800e+02	0.9310e-08	c23
25	050881	0.1200e+02	0.7130e-09	a24 *
26	051181	0.1800e+02	0.3040e-09	b25
27	051481	0.2100e+02	0.1030e-07	c26
28	051881	0.2400e+02	0.5460e-09	a27 *
29	052081	0.1900e+02	0.9900e-08	b28
30	052281	0.1320e+02	0.4090e-09	c29 *
31	052681	0.2460e+02	0.4920e-09	a30
31	052881	0.2000e+02	0.9480e-08	b31
32	052981	0.6000e+01	0.1030e-08	c32
33	060181	0.2000e+02	0.3310e-09	a33
34	060381	0.2020e+02	0.1070e-07	b34
35	060581	0.1100e+02	0.3750e-09	c35 *
36	060881	0.1800e+02	0.3780e-09	a36
37	061081	0.1800e+02	0.9050e-08	b37
38	061581	0.2700e+02	0.7890e-09	c38 *
39	061781	0.2000e+02	0.9070e-08	a39
40	062381	0.1850e+02	0.8600e-08	b40
41	062981	0.1800e+02	0.4840e-08	c41
42	070681	0.1900e+02	0.7260e-08	a42
43	071381	0.1800e+02	0.7700e-08	b43
44	071781	0.1500e+02	0.1300e-07	c44
45	072381	0.1800e+02	0.1070e-07	a45
46	072981	0.1800e+02	0.9370e-08	b46
47	080381	0.1700e+02	0.7560e-08	a47
48	081081	0.1800e+02	0.7040e-08	b48
49	081781	0.2100e+02	0.1020e-07	a49
50	082481	0.1600e+02	0.5120e-08	b50 *
51	082881	0.1500e+02	0.1120e-07	a51
52	090381	0.1800e+02	0.9740e-08	b52
53	090981	0.1800e+02	0.8310e-08	a53
54	091581	0.1700e+02	0.8700e-08	b54

TABLE A-VI. (cont)

No.	Date (Mo/Dy/Yr)	Volume (L)	Pu (g/L)	Smp1
55	092181	0.1900e+02	0.9640e-08	a55
56	092881	0.1800e+02	0.8490e-08	b56
57	100581	0.1700e+02	0.8910e-08	a57
58	101381	0.1900e+02	0.8620e-08	b58
59	102081	0.1800e+02	0.1120e-07	a59
60	102781	0.1800e+02	0.1200e-07	b60
61	110381	0.1600e+02	0.9030e-08	a61
62	110981	0.1600e+02	0.8280e-08	b62
63	111681	0.1800e+02	0.1140e-07	a63
64	112381	0.1800e+02	0.9370e-08	b64
65	113081	0.1900e+02	0.9710e-08	a65
66	120781	0.2000e+02	0.1300e-07	b66
67	121481	0.2000e+02	0.7340e-08	a67
68	122181	0.1700e+02	0.9590e-08	b68
69	122481	0.1600e+02	0.1390e-07	a69
70	122981	0.1800e+02	0.1130e-07	b70
71	010482	0.2000e+02	0.8040e-08	a71
72	011182	0.2000e+02	0.2630e-07	c72
73	011582	0.1800e+02	0.1020e-07	a73
74	011982	0.1800e+02	0.1240e-07	b74
75	012582	0.2000e+02	0.1100e-07	a75
76	020182	0.1800e+02	0.6550e-08	b76 *
77	020582	0.1800e+02	0.1130e-07	a77
78	020982	0.1800e+02	0.1030e-07	b78
79	021682	0.1800e+02	0.2020e-08	a79 *
80	021982	0.1700e+02	0.9870e-08	b80
81	022382	0.1800e+02	0.9990e-08	a81
82	030182	0.1800e+02	0.3200e-08	b82
83	030582	0.1600e+02	0.1510e-07	a83
84	030982	0.1900e+02	0.8330e-08	b84
85	031582	0.1600e+02	0.2950e-08	a85 *
86	031982	0.1800e+02	0.9640e-08	b86
87	032282	0.1800e+02	0.1290e-07	a87
88	032982	0.1700e+02	0.7240e-08	b88 *
89	040282	0.2000e+02	0.7620e-08	a89
90	040682	0.2000e+02	0.6810e-08	b90
91	041282	0.1700e+02	0.2690e-08	a91 *
92	041682	0.2000e+02	0.7730e-08	b92
93	042082	0.2200e+02	0.7360e-08	a93
94	042682	0.1800e+02	0.9020e-09	c94 *
95	042982	0.1900e+02	0.1350e-07	a95
96	050382	0.2300e+02	0.5720e-08	b96
97	050782	0.1600e+02	0.3480e-08	a97
98	051082	0.2000e+02	0.5420e-08	b98
99	051482	0.1380e+02	0.4520e-08	a99 *
100	051782	0.1800e+02	0.8860e-08	b100
101	052182	0.1500e+02	0.2190e-08	a101 *
102	052482	0.1900e+02	0.9690e-08	b102
103	052882	0.1800e+02	0.3700e-08	a103
104	060182	0.1400e+02	0.9380e-09	b104
105	060482	0.1900e+02	0.7450e-08	b105
106	060882	0.2200e+02	0.5790e-08	b106
107	061482	0.2200e+02	0.1290e-08	a107 *
108	061682	0.1790e+02	0.7440e-08	b108
109	062182	0.1800e+02	0.7630e-08	a109

TABLE A-VI. (cont)

No.	Date (Mo/Dy/Yr)	Volume (L)	Pu (g/L)	Smp1
110	062882	0.1770e+02	0.5440e-08	b110
111	070282	0.1300e+02	0.1180e-07	a111
112	070982	0.5000e+01	0.7160e-08	b112
113	071282	0.1500e+02	0.5220e-08	b113
114	071982	0.2000e+02	0.8080e-08	a114
115	072382	0.1700e+02	0.9750e-08	b115
116	072782	0.1700e+02	0.9950e-08	a116
117	080282	0.1800e+02	0.6890e-08	b117
118	080982	0.1800e+02	0.5840e-08	a118*
119	081382	0.1600e+02	0.9060e-08	b119
120	081882	0.1800e+02	0.1020e-07	a120
121	082382	0.1800e+02	0.5060e-08	b121
122	083082	0.1750e+02	0.4530e-08	a122
123	090382	0.1600e+02	0.9190e-08	b123
124	090882	0.1820e+02	0.1510e-07	a124
125	091482	0.1800e+02	0.7350e-08	b125
126	092082	0.1600e+02	0.3560e-08	a126*
127	092482	0.1600e+02	0.8550e-08	b127
128	092882	0.1700e+02	0.7880e-08	a128
129	100582	0.2160e+02	0.6180e-08	b129
130	101282	0.1700e+02	0.2190e-08	a130*
131	101882	0.2000e+02	0.7460e-08	c131
132	102282	0.1500e+02	0.7060e-08	a132
133	102882	0.1800e+02	0.6580e-08	b133
134	110382	0.1900e+02	0.8340e-08	a134
135	110982	0.2000e+02	0.6970e-08	b135
136	111582	0.2000e+02	0.5860e-08	a136
137	112282	0.1800e+02	0.5150e-08	b137*
138	112982	0.1900e+02	0.7530e-08	a138
139	120282	0.1600e+02	0.1120e-07	b139
140	120982	0.1900e+02	0.1150e-07	a140
141	121482	0.1800e+02	0.1220e-07	b141
142	122082	0.1750e+02	0.3260e-08	a142*
143	122782	0.2000e+02	0.6120e-08	a143
144	123082	0.1580e+02	0.7710e-08	a144
145	010483	0.2000e+02	0.8750e-08	c145
146	011083	0.1400e+02	0.2100e-08	a146*
147	011483	0.1650e+02	0.7880e-08	b147
148	011983	0.1775e+02	0.1100e-07	a148
149	012583	0.2000e+02	0.9320e-08	b149
150	013183	0.1600e+02	0.3200e-08	a150*
151	020783	0.2200e+02	0.8110e-08	a151
152	021183	0.1700e+02	0.8190e-08	a152
153	021683	0.2000e+02	0.7940e-08	b153
154	022283	0.1400e+02	0.1010e-08	a154*
155	022883	0.2500e+02	0.1620e-07	b155
156	030483	0.1800e+02	0.6040e-08	a156
157	030883	0.1800e+02	0.6460e-08	b157
158	031483	0.1800e+02	0.1710e-08	a158*
159	031883	0.1900e+02	0.8290e-08	b159
160	032283	0.1800e+02	0.9310e-08	a160
161	032883	0.1600e+02	0.2180e-08	b161*
162	040183	0.1800e+02	0.8730e-08	a162
163	040683	0.2000e+02	0.7030e-08	b163
164	041183	0.1400e+02	0.1380e-08	a164*

TABLE A-VI. (cont)

No.	Date (Mo/Dy/Yr)	Volume (L)	Pu (g/L)	Smp1
165	041583	0.2000e+02	0.9140e-08	b165
166	041983	0.1800e+02	0.8340e-08	a166
167	042583	0.2000e+02	0.1310e-08	b167*
168	042983	0.1800e+02	0.6660e-08	a168
169	050383	0.1800e+02	0.8070e-08	b169
170	050983	0.1700e+02	0.1640e-08	a170*
171	051383	0.2000e+02	0.6330e-08	b171
172	051683	0.1800e+02	0.9560e-08	a172
173	051983	0.2200e+02	0.3740e-08	b173
174	052383	0.2500e+02	0.1170e-08	a174
175	052683	0.2000e+02	0.5950e-08	a175
176	053183	0.1900e+02	0.9450e-09	b176*
177	060383	0.2000e+02	0.6770e-08	b177
178	060683	0.1700e+02	0.1120e-08	a178*
179	061383	0.2400e+02	0.2170e-08	b179
180	061783	0.1850e+02	0.5440e-08	a180
181	062283	0.1800e+02	0.9480e-08	b181
182	062983	0.1800e+02	0.9770e-08	a182
183	070583	0.1750e+02	0.9700e-08	b183
184	071183	0.1800e+02	0.2160e-07	a184
185	071883	0.1650e+02	0.9350e-08	b185*
186	072583	0.2000e+02	0.1360e-07	a186
187	080183	0.2000e+02	0.1320e-07	b187
188	080883	0.2000e+02	0.1220e-07	a188
189	081583	0.1900e+02	0.1300e-07	b189
190	082283	0.1900e+02	0.1450e-07	a190
191	082983	0.1900e+02	0.1050e-07	b191
192	090283	0.1400e+02	0.1730e-07	a192
193	090883	0.1700e+02	0.1580e-07	b193
194	091483	0.1800e+02	0.1500e-07	a194
195	092083	0.1500e+02	0.4090e-08	b195*
196	092683	0.2000e+02	0.1450e-07	a196
197	093083	0.1600e+02	0.1430e-07	b197
198	100583	0.1850e+02	0.2090e-08	a198
199	101183	0.1450e+02	0.3880e-08	b199*
200	101783	0.1800e+02	0.1530e-07	a200
201	102483	0.2000e+02	0.1570e-07	b201
202	102883	0.1400e+02	0.2060e-07	a202
203	110383	0.1800e+02	0.1640e-07	b203
204	110983	0.1880e+02	0.1150e-07	a204
205	111583	0.1820e+02	0.1740e-07	b205
206	112183	0.1700e+02	0.1200e-07	a206
207	112883	0.1570e+02	0.9600e-08	b207*
208	120583	0.2000e+02	0.1280e-07	a208
209	121283	0.2000e+02	0.1190e-07	b209
210	121683	0.1700e+02	0.1430e-07	a210
211	122083	0.1750e+02	0.9220e-08	b211
212	122283	0.5500e+01	0.2680e-08	a212*
213	122783	0.1400e+02	0.1620e-08	b213
214	122983	0.1450e+02	0.1140e-07	a214
215	010384	0.1600e+02	0.1200e-08	b215*
216	010684	0.1600e+02	0.9810e-08	a216

* indicates a rain-free condensate.