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Results of the
Radiological Survey at
the Former Ore Storage Site,
Palmerton, Pennsylvania (PP001)

W. D. Cottrell
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HEALTH AND SAFETY RESEARCH DIVISION

Environmental Restoration and Waste Management Non-Defense Programs
(Activity No. EX 20 20 01 0; ADS3170000)

RESULTS OF THE RADIOLOGICAL SURVEY
AT THE FORMER ORE STORAGE SITE,
PALMERTON, PENNSYLVANIA (PP001)

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ABSTRACT

As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites that were used by the department's predecessor agencies. The radiological survey discussed in this report for the former ore storage site in Palmerton, Pennsylvania, is part of the FUSRAP effort and was conducted at the request of DOE by members of the Measurement Applications and Development group of Oak Ridge National Laboratory (ORNL) in 1988.

In 1953 and 1954 the Atomic Energy Commission (AEC) established an ore stockpile on the property of the New Jersey Zinc Corporation in Palmerton, Pennsylvania. Approximately 57 truckloads of ore (about 360 tons) were stored at this site and remained there until 1973, when the AEC initiated a clean-up program. The 1988 ORNL radiological survey included a gamma scan at the ground surface, gamma measurements at discrete locations at the surface and at 1 m above the surface, gamma logging of 80 auger holes, and collection of 161 surface and subsurface soil samples. Of these 161 soil samples, 98% were below DOE guidelines for ^{226}Ra concentration in soil. Interpretation of the data suggests small, isolated spots of residual ore. The data indicate that it is highly unlikely that an individual living or working on this site could receive a radiation dose approaching the 100 mrem annual limit. However, it is suggested that DOE evaluate potential exposures at this site to ensure compliance with their policy that all exposures to radiation are reduced to levels that are as low as reasonably achievable.

RESULTS OF THE RADIOLOGICAL SURVEY AT THE FORMER ORE STORAGE SITE, PALMERTON, PENNSYLVANIA (PP001)*

INTRODUCTION

During the early 1950s the Atomic Energy Commission (AEC) implemented a program to identify potential sources of domestic uranium. Several sites in eastern Pennsylvania underwent exploratory mining. To support the development of eastern uranium mines and to meet the AEC's goals for procurement and stockpiling of uranium ore, in 1953 and 1954 the AEC established an ore stockpile on the property of the New Jersey Zinc Corporation in Palmerton, Pennsylvania. Approximately 57 truckloads of ore (about 360 tons), with an average uranium oxide content of 0.21%, were stored at this site. The ore remained there until 1973 when, as an indirect result of the Grand Junction mill tailings legislation, the AEC initiated a program to evaluate and clean up its ore storage or stockpile locations.¹

The AEC cleanup plan for the Palmerton site called for the removal of the ore and the first 15 cm (6 in.) of soil. The ore and soil were transported to the AEC Feed Materials Center in Fernald, Ohio, for disposal in the plant's raffinate pits. During removal operations, some chunks of ore were inadvertently buried, necessitating additional soil excavation. The area at the east end of the stockpile was excavated an additional 61 to 76 cm (2 to 2.5 ft) to ensure removal of all the ore, and this material was disposed of in the New Jersey Zinc slag dump.¹

The AEC arbitrarily set the maximum acceptable residual radioactivity level at 40 μ R/h above background. The post-removal survey, completed in July 1973, found all areas to be within acceptable limits. One air sample taken prior to backfilling contained a radon concentration of 6.4 pCi/L, or 20 times background, which was in excess of the radon guideline in effect at that time (2 times background). Additional samples and measurements were taken later in the year (September 1973) at both background locations and the ore storage site. Radon samples indicated that levels at the site (0.5 pCi/L) were actually lower than those at background locations (1.6 pCi/L). External gamma measurements in the areas excavated and backfilled and around the railroad tracks averaged 8 μ R/h, with a maximum measurement of 11 μ R/h. Based on this second set of measurements, and because all the gamma measurements were within the applicable guideline, the site was considered acceptable and was released to the owner.¹

*The survey was performed by members of the Measurement Applications and Development group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

As part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) is implementing a radiological survey program to determine the radiological conditions at sites that were used by the department's predecessor agencies. Although the final Palmerton site report indicated that the site met the criteria as defined at the time of cleanup, DOE determined that supporting radiological data were not sufficient to demonstrate that contemporary standards were met everywhere on the site. Subsequent radiological criteria and guidelines have become more stringent for the release of such sites for unrestricted use. Thus, the data were insufficient to demonstrate that current FUSRAP standards are met.

A preliminary radiological scoping survey was conducted at the request of DOE by members of the Measurement Applications and Development group of Oak Ridge National Laboratory (ORNL) on May 10, 1988, at the Palmerton site. The results of this survey indicated the possibility of residual contamination. In order to determine the extent of contamination, a comprehensive survey was performed by ORNL in July and August of 1988.

The former ore storage site at Palmerton consists of $\sim 9500 \text{ m}^2$ (~ 5 acres) of relatively flat land northwest of Allentown, Pennsylvania. It is bounded on the north by a chain link fence and is traversed by two sets of railroad tracks, running west to east and intersecting in the approximate center of the site (Fig. 1). There were no habitable structures on the site at the time of this survey.

SURVEY METHODS

The radiological survey included (1) a gamma scan at the surface and measurement of gamma radiation levels at discrete locations at the surface and at 1 m above the surface, throughout the site, (2) collection of surface and subsurface soil samples, and (3) gamma logging of auger holes. The radiological survey followed a plan developed at ORNL for this site.² For convenience and in order to arrive at meaningful estimates of the average concentration levels, the area to be surveyed was divided into a grid of 15-m (50-ft) squares (Fig. 1). Photographs showing the site at the time of the survey (August 1988) are provided in Figs. 2-6.

To define the extent of possible subsurface soil contamination, auger holes were drilled to varying depths. A plastic pipe was placed in each hole, and a NaI scintillation probe was lowered inside the pipe. The probe was encased in a lead shield with a horizontal row of collimating slits on the side. This collimation allows measurements of gamma ray intensities to be taken within small increments of the hole depth. Increases in the count rate above those associated with natural background are used to identify potential regions of subsurface contamination. Measurements were made at 15-to-46-cm (6-to-18-in.) intervals. If the gamma readings in the hole were elevated, a soil sample was scraped from the wall of the auger hole at the point showing the highest gamma radiation level. The auger hole loggings were used to select locations where further soil sampling would be useful. A split-spoon sampler was used to collect subsurface samples at known depths. In some auger holes, a combination of split-spoon sampling and side-wall scraping was used

to collect samples. These survey methods followed the plan outlined in Reference 2. A comprehensive description of the survey methods and instrumentation has been presented in another report.³

SURVEY RESULTS

Applicable DOE guidelines are summarized in Table 1. Normal background radiation levels for the Palmerton, Pennsylvania, area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in soil samples.

Gamma Radiation Levels

Gamma radiation levels measured at the surface, at 1 m from the surface, and the range of gamma exposure rates for individual grid blocks are given in Table 3. Gamma exposure rates over the major portion of the site ranged from 5 to 25 $\mu\text{R}/\text{h}$ and are shown in Fig. 7. Small areas of elevated gamma measurements (hot spots) were noted during the scan of the grid blocks. Areas with exposure rates $\geq 25 \mu\text{R}/\text{h}$ occurred in eight grid blocks: 4+50, BL; 5+00, BL; 6+00, BL; 4+50, 50R; 5+00, 50R; 5+50, 50R; 3+00, 100R; and 3+50, 100R. (See Fig. 7.)

Systematic and Biased Soil Samples

Thirteen systematic soil samples were taken from five locations, and eight biased soil samples were taken from three locations. These samples were taken at varying depths and were analyzed for radionuclide concentrations. The results of analysis for ^{226}Ra , ^{232}Th , and ^{238}U are shown in Table 4. Locations of the systematic (S) and biased (B) samples are shown in Fig. 7. Concentrations of ^{226}Ra , ^{232}Th , and ^{238}U in the systematic soil samples ranged from 0.85 to 1.9 pCi/g, 0.34 to 2.3 pCi/g, and 0.82 to 1.7 pCi/g, respectively. In the biased soil samples, concentrations of ^{226}Ra , ^{232}Th , and ^{238}U ranged from 1.3 to 750 pCi/g, 1.2 to 1.9 pCi/g, and <3.0 to 670, respectively.

Because of past usage of this site for uranium ore storage, it seemed likely that if any elevated radiation levels existed, they would result from natural uranium. Therefore, a comparison was made of the ^{226}Ra and ^{238}U concentrations listed in Table 4. This comparison verified that, generally, the two radionuclides are in secular equilibrium, which supports the case for the presence of uranium ore. The applicable DOE guidelines for sites containing uranium ore residuals in soil are the ^{226}Ra guidelines for surface and subsurface soils given in Table 1. All the systematic soil samples are well within these guidelines. DOE guidelines for ^{226}Ra are exceeded in three biased soil samples: B2, B3A, and B3B. The high concentrations of ^{226}Ra and ^{238}U in these samples (maximum concentrations occurring in sample B2: 750 pCi/g of ^{226}Ra and 670 pCi/g of ^{238}U) appear to result from small, residual chunks of ore that were buried during the 1973 soil excavation or from "fines" (i.e., small particles of ore) that have become mixed with soil.

Auger Hole Soil Samples and Gamma Logging

To determine if subsurface contamination existed and, if so, to define its extent, 140 soil samples were taken from 80 auger holes drilled to varying depths on the site. Varying thicknesses of subsurface soil were sampled from depths of 0 to 198 cm (0 to 6.5 ft) in auger holes (A) drilled at locations indicated in Fig. 8. The results of analyses of these samples are given in Table 4. Concentrations of ^{226}Ra , ^{232}Th , and ^{238}U ranged from 0.46 to 260 pCi/g, 0.26 to 2.4 pCi/g, and 0.70 to 280 pCi/g, respectively. The maximum concentrations of ^{226}Ra (260 pCi/g) and ^{238}U (280 pCi/g) were found in soil sample A58C at a depth of 15 to 31 cm. The other 139 soil samples were slightly elevated above background concentrations of radionuclides but were below DOE guidelines.

Gamma logging was performed in each of the auger holes to characterize and further define the extent of possible contamination. The logging technique used here is not radionuclide specific. However, logging data, in conjunction with soil sample analyses data, may be used to estimate regions of elevated radionuclide concentration in auger holes when compared with background levels for the area. A shielded gamma scintillation reading of 1000 cpm (counts per minute) or greater generally indicates the presence of above-background concentrations of gamma-emitting radionuclides. At this site, the correlation of hole logging data with soil sample analyses data is generally good. However, in some cases the correlation is rather poor. Because of this, the two sets of data must be considered individually to estimate regions of above-background contamination on this site. Gamma measurements from the 80 auger holes are graphically presented in Figs. 9-88. To summarize that data, a frequency distribution is given below. The gamma levels (in counts per minute) measured in the 80 auger holes are grouped in six ranges, and the number of holes having measurements falling within each range is given.

<u>No. of holes</u>	<u>Maximum counts per minute</u>
58	1,000 or less
14	1,001 to 1,200
5	1,201 to 2,000
2	2,001 to 3,000
0	3,001 to 12,000
1 (A58)	12,001 or more

Readings recorded between the surface and 2.1 m (0 to 7 ft) in 72 (90%) of the 80 auger holes were ≤ 1200 cpm, a value near the background level. The maximum gamma level occurred in auger hole A58 at a depth of 30 cm (1 ft) and corresponds to a soil concentration of 260 pCi/g of ^{226}Ra . In auger hole A56 a large chunk of ore was removed after gamma logging. Following removal of the ore, the hole was relogged, and gamma readings and radionuclide concentrations were near background levels (Fig. 64 and Table 4). Other soil samples revealed slight elevations above background radionuclide concentrations but were within DOE guidelines.

SIGNIFICANCE OF FINDINGS

Gamma exposure rates and concentrations of radionuclides in soil samples from the former ore storage site in Palmerton, Pennsylvania, indicate small, isolated areas of residual radioactive material. To further define the contamination, extensive gamma measurements were taken, and 161 soil samples were analyzed for radionuclide concentrations. Comparison of the ^{226}Ra and ^{238}U concentrations in these soil samples verified that the two radionuclides are, generally, in secular equilibrium, which supports the case for the presence of uranium ore. Thus, DOE guidelines for concentrations of ^{226}Ra in surface and subsurface soil are applicable. These ^{226}Ra guidelines were exceeded in four soil samples taken at three soil sample locations: B2 (750 pCi/g), B3 (33 pCi/g in sample B3A and 30 pCi/g in sample B3B), and A58 (260 pCi/g in sample A58C).

Of the 161 soil samples taken, 157 (98%) were below DOE guidelines for ^{226}Ra concentrations in soil. Of the 80 gamma logs performed in auger holes, 72 (90%) were below or slightly elevated above background. Interpretation of the data suggests small, isolated pieces of residual ore or small areas of soil that has become mixed with particles of uranium ore. The data indicate that it is highly unlikely that an individual living or working on this site could receive an exposure approaching the 100-mrem annual limit. However, it is suggested that DOE evaluate potential exposures on this site to ensure that all exposures to radiation have been reduced to levels as low as reasonably achievable (ALARA).

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4. *U. S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987.

Table 1. Applicable guidelines for protection against radiation^a

Mode of exposure	Exposure conditions	Guideline
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100 m ² area ²²⁶ Ra ²³² Th ²³⁸ U	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface Derived (site specific)
Guidelines for non-homogeneous contamination (used in addition to the 100 m ² guideline) ^b	Applicable to locations with an area ≤25 m ² , with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i (100/A)^{1/2}$ where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m ² area

^aSource: Adapted from *U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987.

^bDOE guidelines specify that every reasonable effort shall be made to identify and to remove any source which has a concentration exceeding 30 times the guideline value, irrespective of area.

Table 2. Average background radiation levels for the
Palmerton, Pennsylvania, area

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure rate at 1 m ($\mu\text{R/h}$) ^a	9
Concentration of radionuclides in soil (pCi/g) ^b	
²²⁶ Ra	0.81
²³² Th	0.69
²³⁸ U	0.63

^aExposure rate determined from pressurized ionization chamber measurements taken at eight locations near the former Palmerton ore storage site.

^bSource: T. E. Myrick, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975–1979*, Oak Ridge National Laboratory, ORNL/TM-7343 (November 1981).

Table 3. Gamma exposure rate measurements at the former ore storage site, Palmerton, Pennsylvania (PP001)

Grid location ^a	Grid point measurements ^b ($\mu\text{R/h}$)		Range of gamma exposure rates during scan of grid block ^c ($\mu\text{R/h}$)
	Gamma exposure rate at 1 m	Gamma exposure rate at the surface	
0+00, BL	7.5	7.5	5-10
0+50, BL	6.3	5.8	4.5-8
1+00, BL	7.5	8.3	5-13
1+50, BL	7	7.5	5-7.5
2+00, BL	6.8	6.8	5-8.8
2+50, BL	6.3	6.8	3.8-7.5
3+00, BL	7.5	7	5-8.8
3+50, BL	7.5	7	5-10
4+00, BL	7.5	7	5-10
4+50, BL	7.5	7	5-25
5+00, BL	8	8	5-75
5+50, BL	8	7	5-10
6+00, BL	7.5	7.5	5-35
6+50, BL	8	8.8	5.8-9.5
7+00, BL	9.3	9.3	5-11
7+50, BL	8.8	9.3	5-8.8
8+00, BL	8.8	8.8	5-8
8+32, BL	8	8	<i>d</i>
0+00, 50R	6.5	5.8	3.8-6.3
0+50, 50R	7.5	8.8	4.5-8.8
1+00, 50R	7.3	6.5	5-11
1+50, 50R	9.3	10	3.8-7.5
2+00, 50R	6.8	6.8	4.5-6.3
2+50, 50R	6.3	6.3	5-7.5
3+00, 50R	6.3	5.8	3.8-6.3
3+50, 50R	5.8	5.8	4.5-6.3

Table 3 (continued)

Grid location ^a	Grid point measurements ^b ($\mu\text{R/h}$)		Range of gamma exposure rates during scan of grid block ^c ($\mu\text{R/h}$)
	Gamma exposure rate at 1 m	Gamma exposure rate at the surface	
4+00, 50R	6.5	6.5	5-7.5
4+50, 50R	6.3	6.8	6.3-125
5+00, 50R	6.3	6.3	5-150
5+50, 50R	6.3	6.3	7-100
6+00, 50R	7.5	7	3.8-6.3
0+00, 100R	6.3	6.3	4.8-5.8
0+50, 100R	5.5	5.5	3.8-6.3
1+00, 100R	4.5	4.3	3.8-5
1+50, 100R	5.8	5.8	3.8-6.3
2+00, 100R	5.8	5.8	3.8-5.5
2+50, 100R	6.3	6.8	3.8-7.5
3+00, 100R	6.8	6.8	3.8-25
3+50, 100R	6.8	6.3	5-25
4+00, 100R	5.8	6.3	4.5-8.8
4+50, 100R	7	5.5	<i>d</i>
0+00, 150R	5.5	5.5	5-7.5
0+50, 150R	3.8	4.3	5-7.5
1+00, 150R	5	4.5	3.8-6.3
1+50, 150R	4.5	4.5	5-7.5
2+00, 150R	4.5	5	3.8-7
2+50, 150R	5	5	3.8-6.3
3+00, 150R	5	4.5	<i>d</i>
3+50, 150R	6.3	5.5	<i>d</i>
0+00, 200R	5.5	5.5	3.8-7.5
0+50, 200R	4.5	4	3.8-5
1+00, 200R	3.8	3.8	3.8-6.3

Table 3 (continued)

Grid location ^a	Grid point measurements ^b ($\mu\text{R/h}$)		Range of gamma exposure rates during scan of grid block ^c ($\mu\text{R/h}$)
	Gamma exposure rate at 1 m	Gamma exposure rate at the surface	
1+50, 200R	3.8	3.8	<i>d</i>
0+00, 225R	5.8	6.3	<i>d</i>
0+50, 225R	3.8	3.8	<i>d</i>

^aGrid locations are shown on Fig. 1.

^bGrid point measurements are discrete measurements taken at grid points.

^cGrid block measurements are obtained from a gamma scan of the entire grid block.

^dScan of total grid block was not performed.

Table 4. Concentration of radionuclides in soil samples taken from the former ore storage site, Palmerton, Pennsylvania (PP001)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
<i>Systematic samples^c</i>				
S1A	0-15	1.5 ± 0.04	1.5 ± 0.06	<2.7
S1B	15-31	1.7 ± 0.1	1.8 ± 0.1	<6.5
S1C	46-61	1.9 ± 0.1	2.3 ± 0.2	<8.2
S1D	76-84	1.2 ± 0.04	1.4 ± 0.08	<4.2
S2A	0-15	1.0 ± 0.02	0.34 ± 0.04	0.82 ± 0.4
S2B	15-25	1.1 ± 0.06	0.42 ± 0.8	<3.4
S2C	25-31	1.0 ± 0.06	0.44 ± 0.08	<3.9
S3A	0-15	0.85 ± 0.04	0.76 ± 0.06	<3.5
S3B	15-31	1.3 ± 0.06	1.2 ± 0.09	<1.7
S3C	46-61	1.2 ± 0.1	1.4 ± 0.2	<8.9
S6 ^d	76-81	1.3 ± 0.04	1.3 ± 0.06	1.7 ± 0.8
S7A	31-46	1.5 ± 0.04	1.2 ± 0.04	1.7 ± 0.6
S7B	76-84	1.2 ± 0.04	1.4 ± 0.06	<2.9
<i>Biased samples^e</i>				
B1A	0-15	5.0 ± 0.1	1.6 ± 0.1	<7.5
B1B	15-31	2.0 ± 0.08	1.9 ± 0.08	<3.5
B1C	31-46	2.1 ± 0.04	1.9 ± 0.08	3.5 ± 1
B1D	61-76	1.3 ± 0.04	1.4 ± 0.06	<3.0
B1E	91-107	1.4 ± 0.08	1.3 ± 0.1	<5.3
B2	25-28	750 ± 5	<1.6	670 ± 60
B3A	0-3	33 ± 0.3	1.4 ± 0.3	43 ± 10
B3B	3-15	30 ± 0.3	1.2 ± 0.3	73 ± 10
<i>Auger samples^f</i>				
A1	122-137	0.98 ± 0.01	1.1 ± 0.01	1.4 ± 0.2
A2	76-91	1.2 ± 0.01	1.2 ± 0.03	1.2 ± 0.5
A3	76-91	1.3 ± 0.03	1.4 ± 0.05	<4.7

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A4	76-91	1.2 ± 0.01	1.3 ± 0.02	1.3 ± 0.4
A5	137-152	1.1 ± 0.01	1.2 ± 0.02	1.6 ± 0.2
A6	46-61	1.3 ± 0.03	1.4 ± 0.05	1.5 ± 0.7
A7	61-76	1.3 ± 0.01	1.1 ± 0.02	<1.3
A8	76-91	1.1 ± 0.02	1.1 ± 0.04	1.3 ± 0.6
A9	46-61	1.0 ± 0.01	1.2 ± 0.02	1.2 ± 0.3
A10	46-61	1.1 ± 0.01	1.1 ± 0.02	1.3 ± 0.2
A11	46-61	1.1 ± 0.02	1.1 ± 0.03	<2.6
A12	15-31	2.2 ± 0.04	1.2 ± 0.05	8.9 ± 0.8
A13A	0-5	1.2 ± 0.02	0.46 ± 0.02	<0.71
A13B	31-46	1.5 ± 0.01	1.3 ± 0.02	1.8 ± 0.4
A14	76-91	1.1 ± 0.01	1.2 ± 0.02	<1.4
A15A	0-5	1.3 ± 0.01	0.48 ± 0.01	1.4 ± 0.3
A15B	46-61	1.3 ± 0.03	1.4 ± 0.05	<4.2
A16	31-46	1.2 ± 0.02	1.2 ± 0.04	3.1 ± 0.8
A17	0-0	1.5 ± 0.01	1.3 ± 0.02	2.6 ± 0.5
A18A	0-5	1.1 ± 0.02	0.32 ± 0.02	1.4 ± 0.4
A18B	76-91	1.3 ± 0.01	1.4 ± 0.02	2.3 ± 0.4
A19	91-107	1.1 ± 0.01	1.2 ± 0.02	1.6 ± 0.2
A20A	0-5	1.9 ± 0.02	1.0 ± 0.03	<2.9
A20B	76-91	1.2 ± 0.02	1.4 ± 0.04	<3.3
A21	76-91	1.2 ± 0.02	1.4 ± 0.05	<1.5
A22A	0-5	1.2 ± 0.01	0.97 ± 0.02	1.7 ± 0.3
A22B	31-46	1.2 ± 0.03	1.4 ± 0.05	<4.1
A23	76-91	1.3 ± 0.01	1.4 ± 0.02	1.8 ± 0.2
A24A	0-5	0.61 ± 0.01	0.31 ± 0.02	<1.9
A24B	61-76	1.1 ± 0.03	1.2 ± 0.05	<1.7

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A25	46-61	1.1 ± 0.01	0.42 ± 0.01	0.97 ± 0.2
A26A	0-5	1.4 ± 0.02	0.87 ± 0.02	<2.5
A26B	31-46	1.6 ± 0.02	1.1 ± 0.04	<3.2
A27	15-31	1.7 ± 0.02	1.2 ± 0.03	<2.4
A28A	0-5	1.2 ± 0.02	0.45 ± 0.02	<2.3
A28B	61-76	1.7 ± 0.02	0.97 ± 0.03	<3.0
A29	61-76	1.3 ± 0.03	1.4 ± 0.04	2.6 ± 0.8
A30A	0-5	0.86 ± 0.01	0.50 ± 0.01	<0.90
A30B	46-61	1.3 ± 0.01	1.3 ± 0.04	1.2 ± 0.2
A31	91-107	1.2 ± 0.02	1.4 ± 0.04	<3.1
A32A	0-5	0.90 ± 0.01	0.64 ± 0.01	1.0 ± 0.3
A32B	152-168	1.2 ± 0.02	1.3 ± 0.05	<1.6
A33	107-122	1.4 ± 0.03	1.5 ± 0.05	3.5 ± 0.8
A34A	0-5	1.0 ± 0.01	0.44 ± 0.01	0.81 ± 0.2
A34B	107-122	1.1 ± 0.03	1.3 ± 0.04	4.6 ± 1
A35	91-107	1.2 ± 0.02	1.3 ± 0.05	<4.0
A36A	0-5	1.7 ± 0.04	1.3 ± 0.05	<4.5
A36B	46-61	1.4 ± 0.01	1.3 ± 0.03	<2.2
A37	61-76	1.4 ± 0.01	1.1 ± 0.01	1.6 ± 0.3
A38A	0-5	0.86 ± 0.01	0.66 ± 0.01	0.80 ± 0.1
A38B	61-76	1.2 ± 0.02	1.3 ± 0.04	<3.4
A39	46-61	2.2 ± 0.05	2.4 ± 0.1	2.9 ± 2
A40A	0-5	0.56 ± 0.01	0.50 ± 0.02	1.2 ± 0.3
A40B	91-107	1.1 ± 0.02	1.1 ± 0.03	2.3 ± 0.6
A41	91-107	1.1 ± 0.01	1.3 ± 0.02	1.2 ± 0.2
A42A	0-5	0.46 ± 0.01	0.41 ± 0.02	<1.3
A42B	61-76	1.2 ± 0.01	1.4 ± 0.02	1.3 ± 0.3

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A43	137-152	1.2 ± 0.01	1.2 ± 0.04	1.5 ± 0.2
A44A	0-5	0.76 ± 0.01	0.26 ± 0.01	0.70 ± 0.1
A44B	46-61	1.7 ± 0.04	1.8 ± 0.07	<2.4
A45	91-107	1.1 ± 0.01	1.3 ± 0.01	1.7 ± 0.2
A46A	0-5	0.48 ± 0.01	0.40 ± 0.02	<1.8
A46B	91-107	1.2 ± 0.01	1.2 ± 0.02	1.3 ± 0.2
A47A	0-15	2.0 ± 0.04	2.2 ± 0.07	<5.9
A47B	31-61	1.3 ± 0.01	1.4 ± 0.02	<1.5
A47C	61-91	1.2 ± 0.02	1.4 ± 0.04	<2.9
A47D	91-107	1.1 ± 0.02	1.2 ± 0.03	1.0 ± 0.4
A48A	0-15	1.2 ± 0.02	0.56 ± 0.02	1.1 ± 0.4
A48B	46-61	1.3 ± 0.02	1.3 ± 0.04	2.5 ± 0.6
A48C	61-76	1.3 ± 0.01	1.3 ± 0.02	2.2 ± 0.3
A48D	76-91	1.2 ± 0.01	1.5 ± 0.02	2.1 ± 0.2
A48E	91-107	1.4 ± 0.01	1.6 ± 0.02	<1.6
A48F	107-122	1.3 ± 0.02	1.6 ± 0.04	<3.7
A48G	122-137	1.3 ± 0.01	1.5 ± 0.02	1.8 ± 0.4
A48H	137-168	1.0 ± 0.02	1.2 ± 0.04	1.3 ± 0.5
A49A	0-15	1.1 ± 0.01	0.56 ± 0.01	1.1 ± 0.2
A49B	31-61	1.4 ± 0.02	1.4 ± 0.03	<2.7
A49C	61-76	1.3 ± 0.03	1.3 ± 0.04	2.6 ± 0.5
A49D	76-91	1.3 ± 0.01	1.4 ± 0.02	1.9 ± 0.5
A50A	31-46	1.9 ± 0.01	1.3 ± 0.02	1.8 ± 0.3
A50B	46-61	2.7 ± 0.02	1.5 ± 0.04	3.0 ± 0.6
A50C	61-91	2.4 ± 0.02	1.5 ± 0.03	2.5 ± 0.4
A50D	122-152	1.4 ± 0.03	1.3 ± 0.05	<1.6
A50E	152-168	1.3 ± 0.01	1.4 ± 0.02	1.8 ± 0.4

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A51A	76-91	1.7 ± 0.02	1.2 ± 0.04	<3.3
A51B	91-107	1.4 ± 0.01	1.4 ± 0.02	1.7 ± 0.4
A52A	46-76	1.3 ± 0.01	1.4 ± 0.02	1.1 ± 0.3
A53A	76-107	1.4 ± 0.03	1.4 ± 0.05	<3.9
A54A	31-46	1.4 ± 0.03	1.4 ± 0.05	<5.2
A54B	46-61	1.4 ± 0.02	1.4 ± 0.04	<3.1
A54C	61-76	4.4 ± 0.05	1.5 ± 0.06	<6.6
A54D	76-91	1.5 ± 0.01	1.4 ± 0.02	1.4 ± 0.4
A54E	91-107	3.2 ± 0.03	1.3 ± 0.04	2.9 ± 0.6
A54F	107-122	1.4 ± 0.02	1.3 ± 0.04	2.1 ± 0.6
A54G	122-152	1.7 ± 0.01	1.3 ± 0.02	2.0 ± 0.3
A54H	152-167	1.1 ± 0.01	1.1 ± 0.02	1.9 ± 0.3
A55A	61-76	1.3 ± 0.01	0.81 ± 0.01	1.3 ± 0.2
A55B	76-91	1.2 ± 0.03	1.3 ± 0.05	<1.6
A56A	0-15	1.2 ± 0.02	0.37 ± 0.02	1.1 ± 0.4
A56B	31-61	0.99 ± 0.01	1.1 ± 0.02	1.6 ± 0.4
A57A	31-46	1.3 ± 0.01	1.4 ± 0.02	1.5 ± 0.3
A57B	46-61	1.3 ± 0.02	1.4 ± 0.03	<2.9
A57C	61-76	1.4 ± 0.03	1.5 ± 0.06	<4.7
A57D	76-91	1.4 ± 0.02	1.3 ± 0.04	2.0 ± 0.6
A57E	91-107	1.3 ± 0.01	0.93 ± 0.02	1.6 ± 0.3
A58A	31-61	2.0 ± 0.03	1.5 ± 0.05	<4.7
A58B	61-76	4.6 ± 0.05	1.4 ± 0.07	7.6 ± 2
A58C	15-31	260 ± 0.9	<2.0	280 ± 30
A59A	31-46	1.4 ± 0.03	1.5 ± 0.05	3.6 ± 2
A59B	46-61	1.2 ± 0.02	1.4 ± 0.04	<3.2
A59C	61-76	1.3 ± 0.01	1.4 ± 0.02	1.9 ± 0.4

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A59D	76-91	1.3 ± 0.03	1.5 ± 0.05	<4.6
A59E	107-122	1.3 ± 0.01	1.4 ± 0.05	1.6 ± 0.2
A59F	122-137	1.4 ± 0.03	1.5 ± 0.05	<4.1
A59G	137-152	1.4 ± 0.01	1.5 ± 0.02	2.1 ± 0.5
A59H	152-168	1.3 ± 0.01	1.5 ± 0.02	1.9 ± 0.2
A59I	168-183	1.2 ± 0.02	1.4 ± 0.05	2.4 ± 0.7
A59J	183-198	1.1 ± 0.01	1.3 ± 0.02	1.5 ± 0.3
A60	31-46	1.6 ± 0.03	1.3 ± 0.05	2.3 ± 0.8
A61	31-46	2.1 ± 0.03	1.2 ± 0.04	3.2 ± 0.6
A62	15-31	2.1 ± 0.02	1.2 ± 0.04	2.9 ± 0.7
A63	31-46	2.3 ± 0.03	1.1 ± 0.03	1.9 ± 0.6
A64	15-31	2.6 ± 0.01	1.4 ± 0.02	2.2 ± 0.5
A65A	31-46	3.0 ± 0.04	1.4 ± 0.05	9.9 ± 1
A65B	61-76	6.3 ± 0.04	1.5 ± 0.06	22 ± 2
A65C	91-107	1.3 ± 0.02	1.4 ± 0.05	3.0 ± 0.8
A66	76-91	1.3 ± 0.01	1.5 ± 0.02	1.8 ± 0.4
A67	0-15	5.2 ± 0.03	1.8 ± 0.04	8.2 ± 1
A68	76-91	1.3 ± 0.03	1.5 ± 0.05	<4.1
A69	31-46	4.6 ± 0.05	1.2 ± 0.06	11 ± 2
A70	46-61	1.2 ± 0.01	1.2 ± 0.02	1.7 ± 0.2
A71	46-61	1.3 ± 0.01	1.3 ± 0.02	1.8 ± 0.2
A72	46-61	1.4 ± 0.01	1.5 ± 0.02	2.0 ± 0.8
A73	31-46	1.5 ± 0.03	1.5 ± 0.05	<4.0
A74	31-46	1.2 ± 0.03	1.2 ± 0.05	<4.1
A75	46-61	1.1 ± 0.02	1.2 ± 0.04	1.3 ± 0.7
A76	31-46	1.1 ± 0.01	1.3 ± 0.02	<1.5
A78	91-107	1.2 ± 0.02	1.4 ± 0.04	1.7 ± 0.6

Table 4 (continued)

Sample No. ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
A79	61-76	1.4 ± 0.03	1.4 ± 0.05	<4.1
A80	46-61	1.7 ± 0.03	1.5 ± 0.04	4.8 ± 2

^aLocations of systematic and biased soil samples are shown on Fig. 7, and locations of auger samples are shown on Fig. 8.

^bIndicated counting error is at the 95% confidence level ($\pm 1\sigma$).

^cSystematic samples are taken at grid locations irrespective of gamma exposure.

^dNo samples were taken at systematic locations S4 and S5.

^eBiased samples are taken from areas shown to have elevated gamma exposure rates.

^fAuger samples are taken from holes drilled to further define the depth and extent of radioactive material.

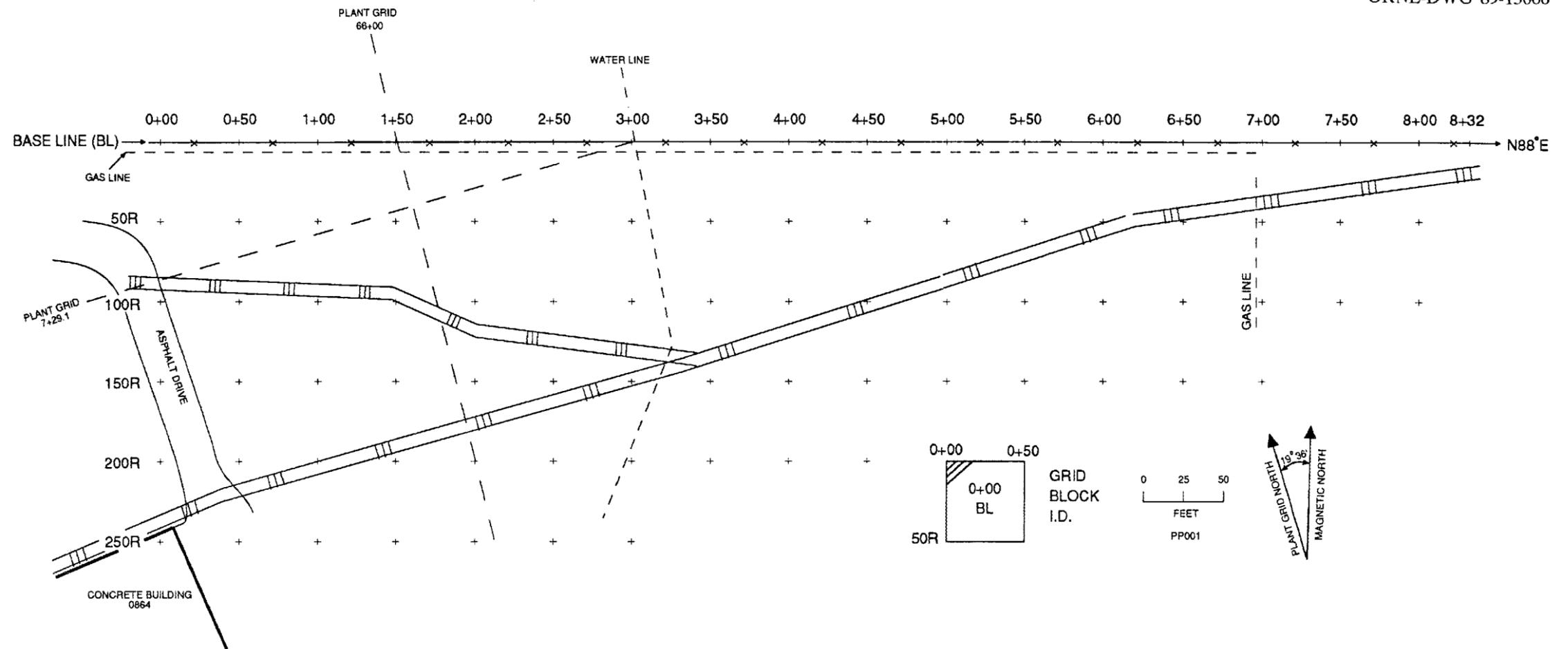


Fig. 1. Diagram showing the grid system used in the survey at the former ore storage site, Palmerton, Pennsylvania (PP001).

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Fig. 2. The former ore storage site, Palmerton, Pennsylvania (PP001), looking east (August 1988). The fence at the left forms the baseline for the grid system (Fig. 1).



Fig. 3. The former ore storage site, Palmerton, Pennsylvania (PP001), looking east (August 1988).



Fig. 4. Railroad tracks at the former ore storage site, Palmerton, Pennsylvania (PP001), looking east (August 1988). Piles of soil and debris were moved to allow access to the area around the tracks.



Fig. 5. Relocation of soil and debris to allow access to the area around the railroad tracks (Fig. 6) at the former ore storage site, Palmerton, Pennsylvania (PP001), looking northeast (August 1988).



Fig. 6. Railroad tracks following relocation of soil and debris (Fig. 5), former ore storage site, Palmerton, Pennsylvania (PP001), looking east (August 1988).

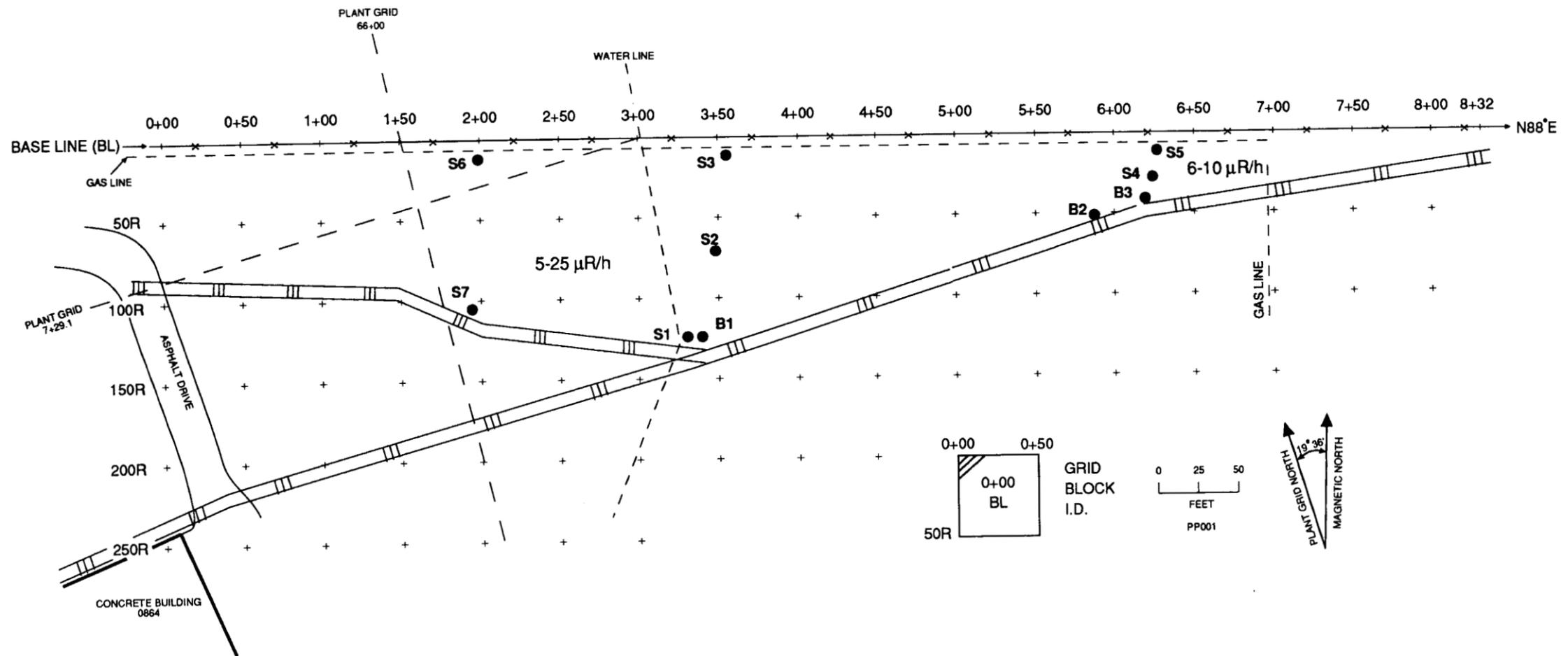


Fig. 7. Gamma radiation levels ($\mu\text{R/h}$) and systematic (S) and biased (B) soil sample locations at the former ore storage site, Palmerston, Pennsylvania (PP001).

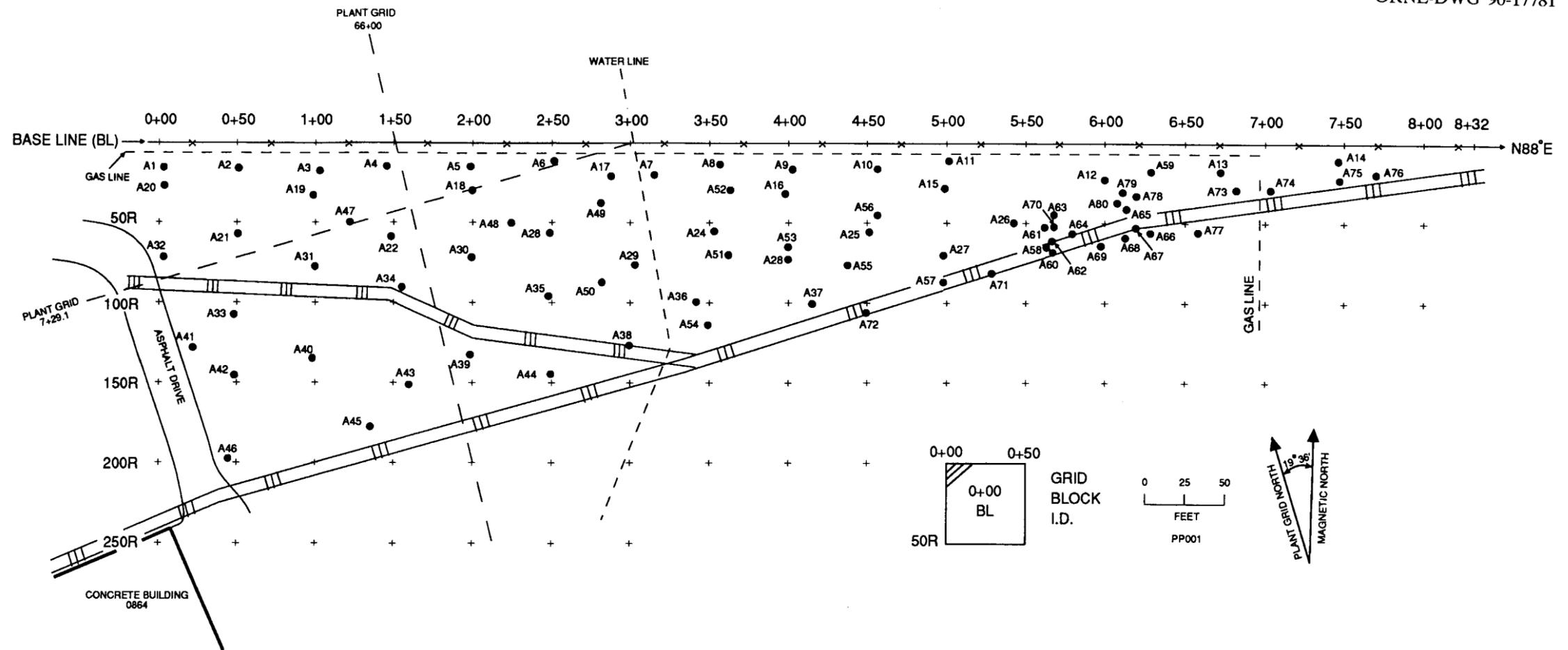


Fig. 8. Diagram showing auger hole locations at the former ore storage site, Palmerton, Pennsylvania (PP001).

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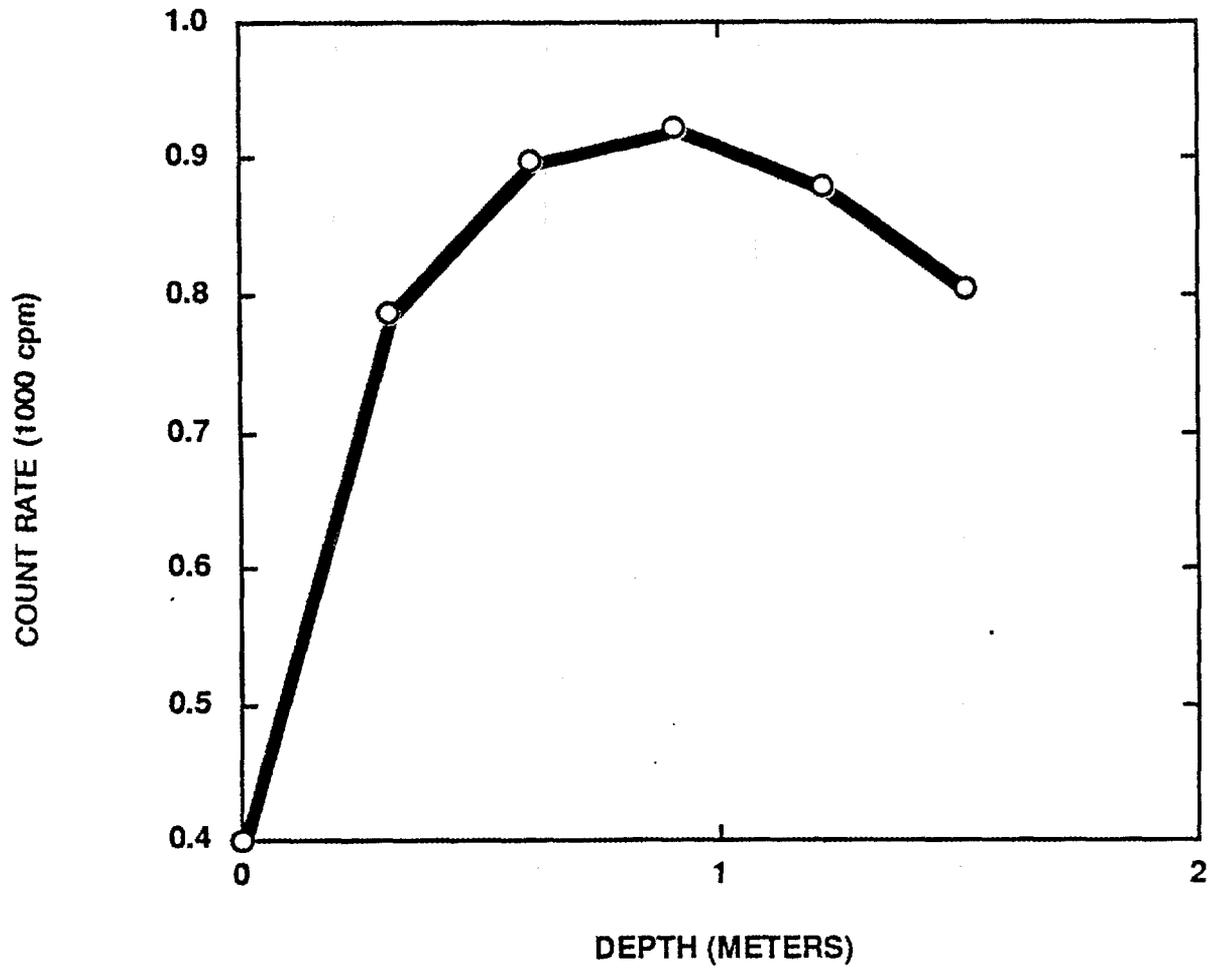


Fig. 9. Gamma profile for auger hole 1 (A1) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13074

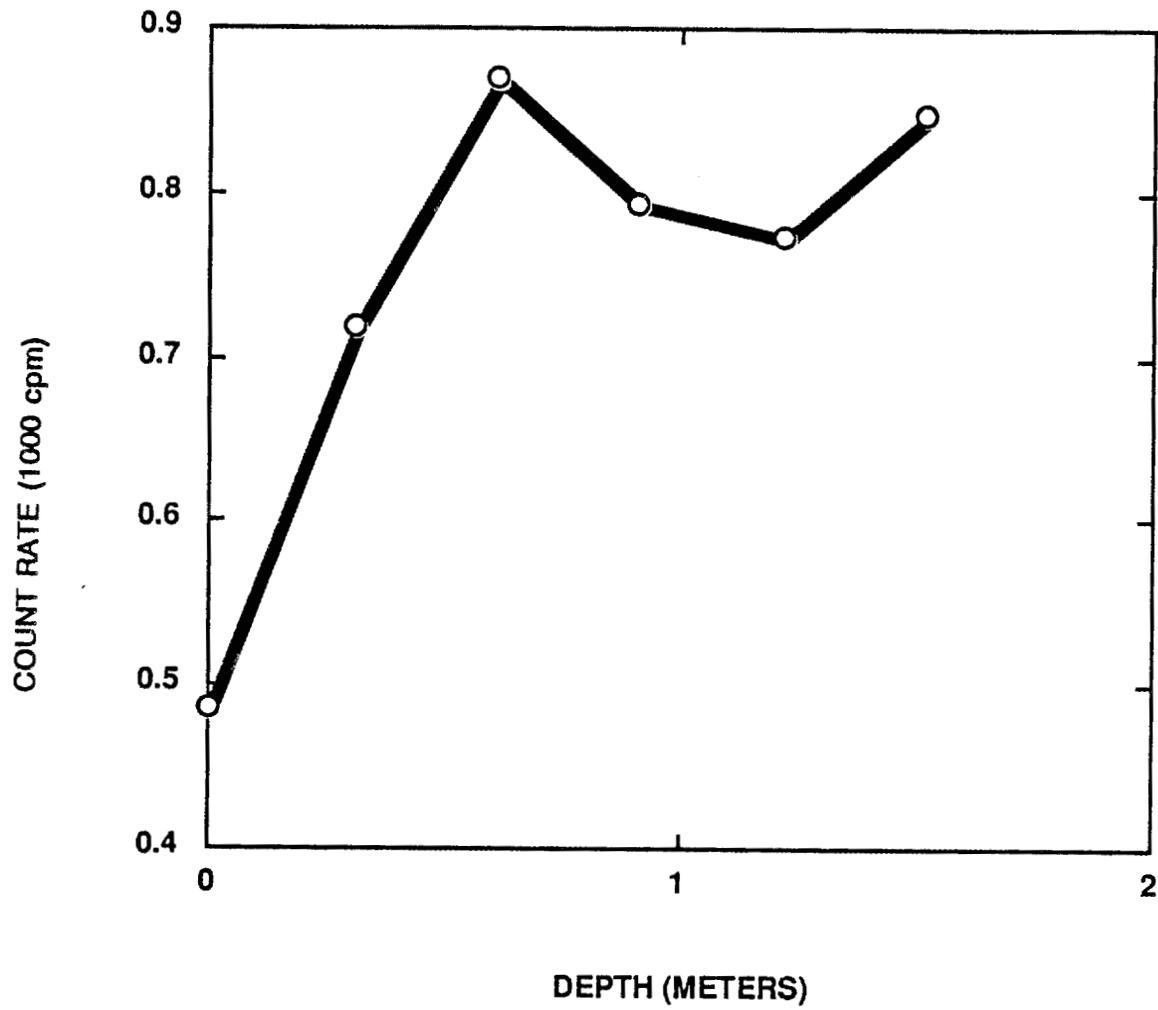


Fig. 10. Gamma profile for auger hole 2 (A2) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13115

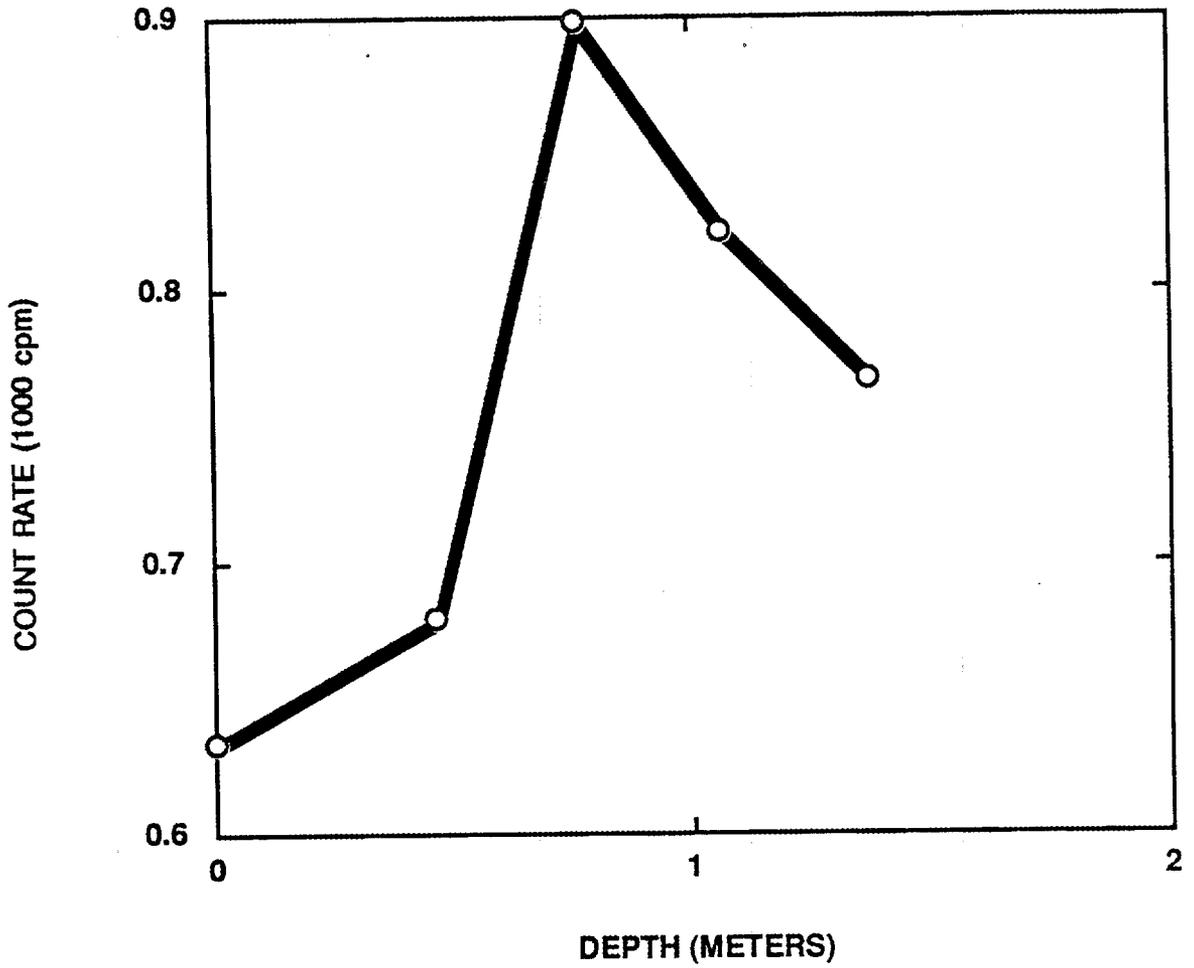


Fig. 11. Gamma profile for auger hole 3 (A3) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13075

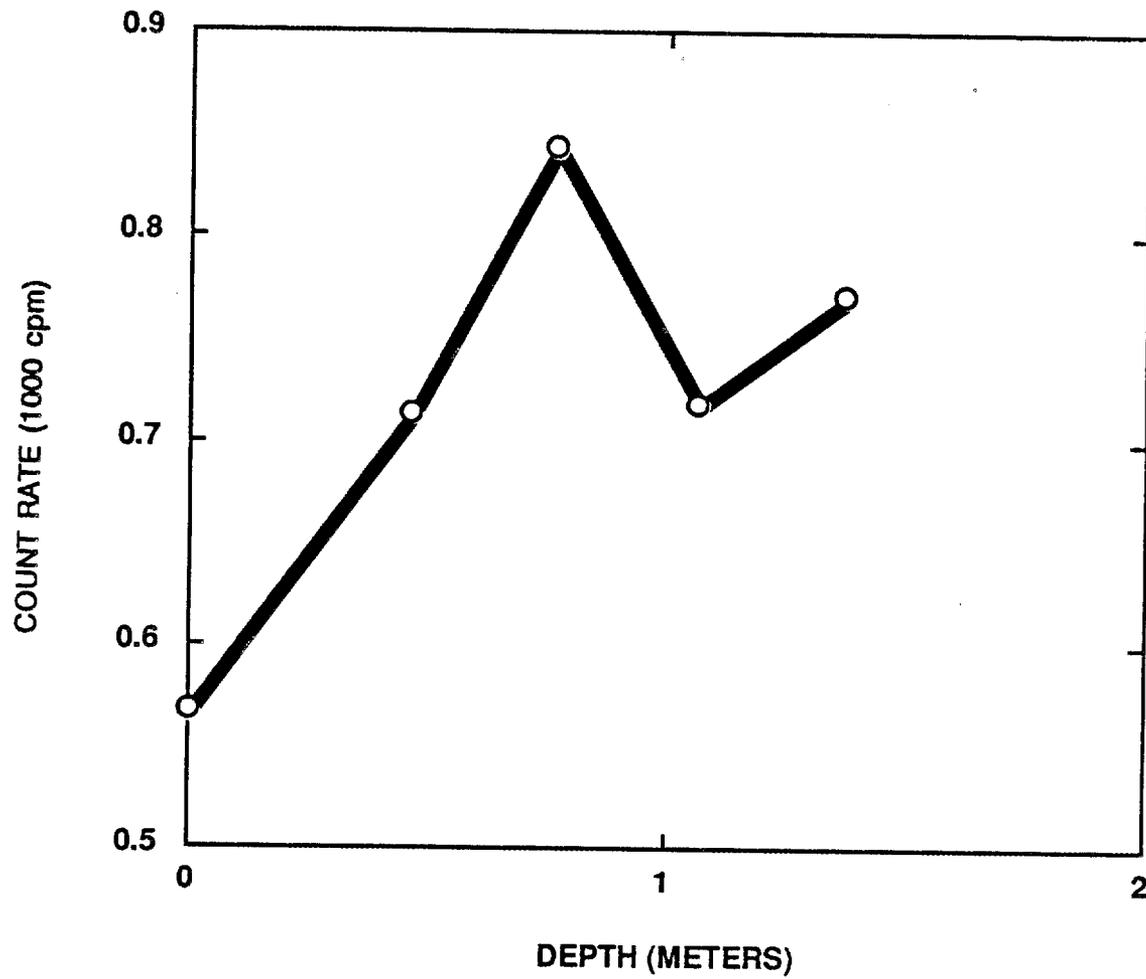


Fig. 12. Gamma profile for auger hole 4 (A4) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13076

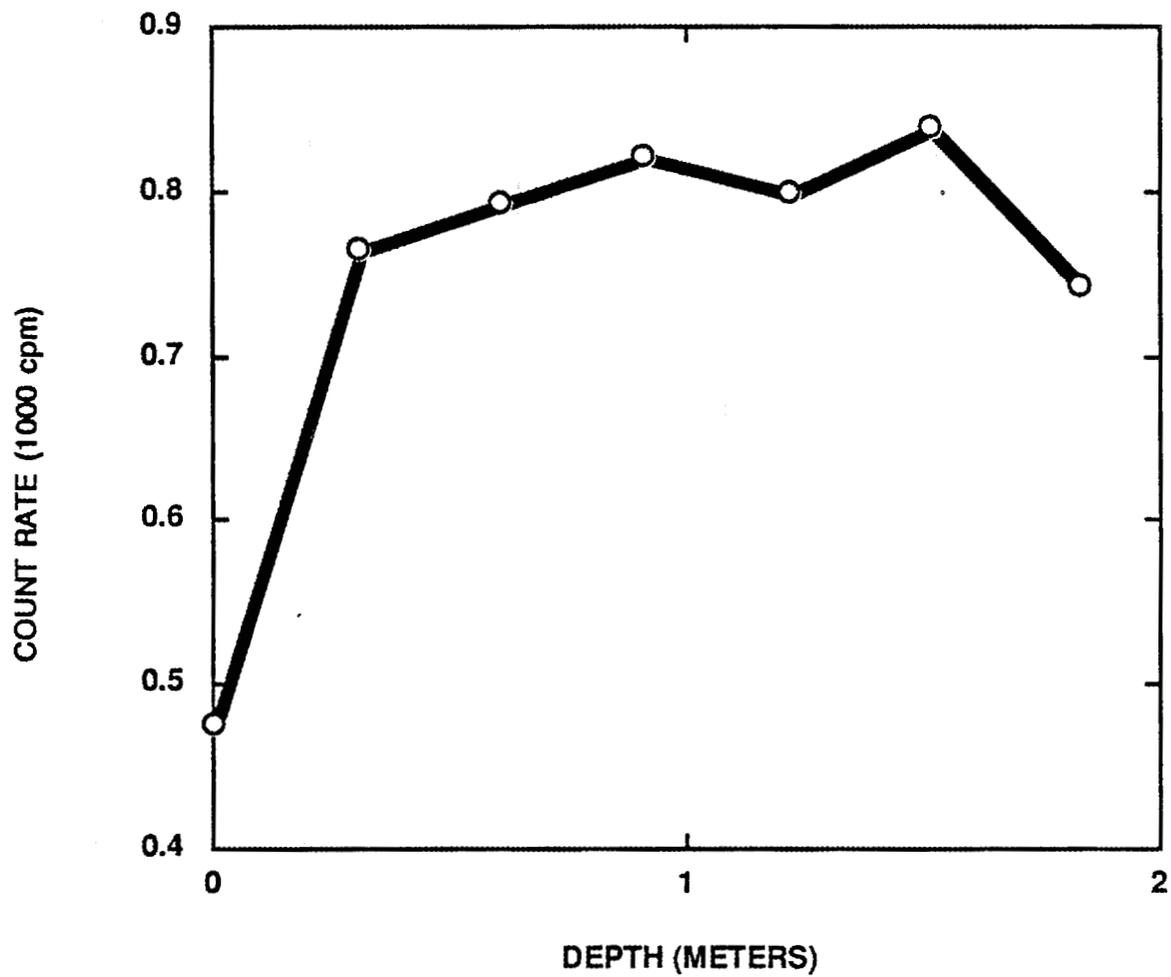


Fig. 13. Gamma profile for auger hole 5 (A5) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13077

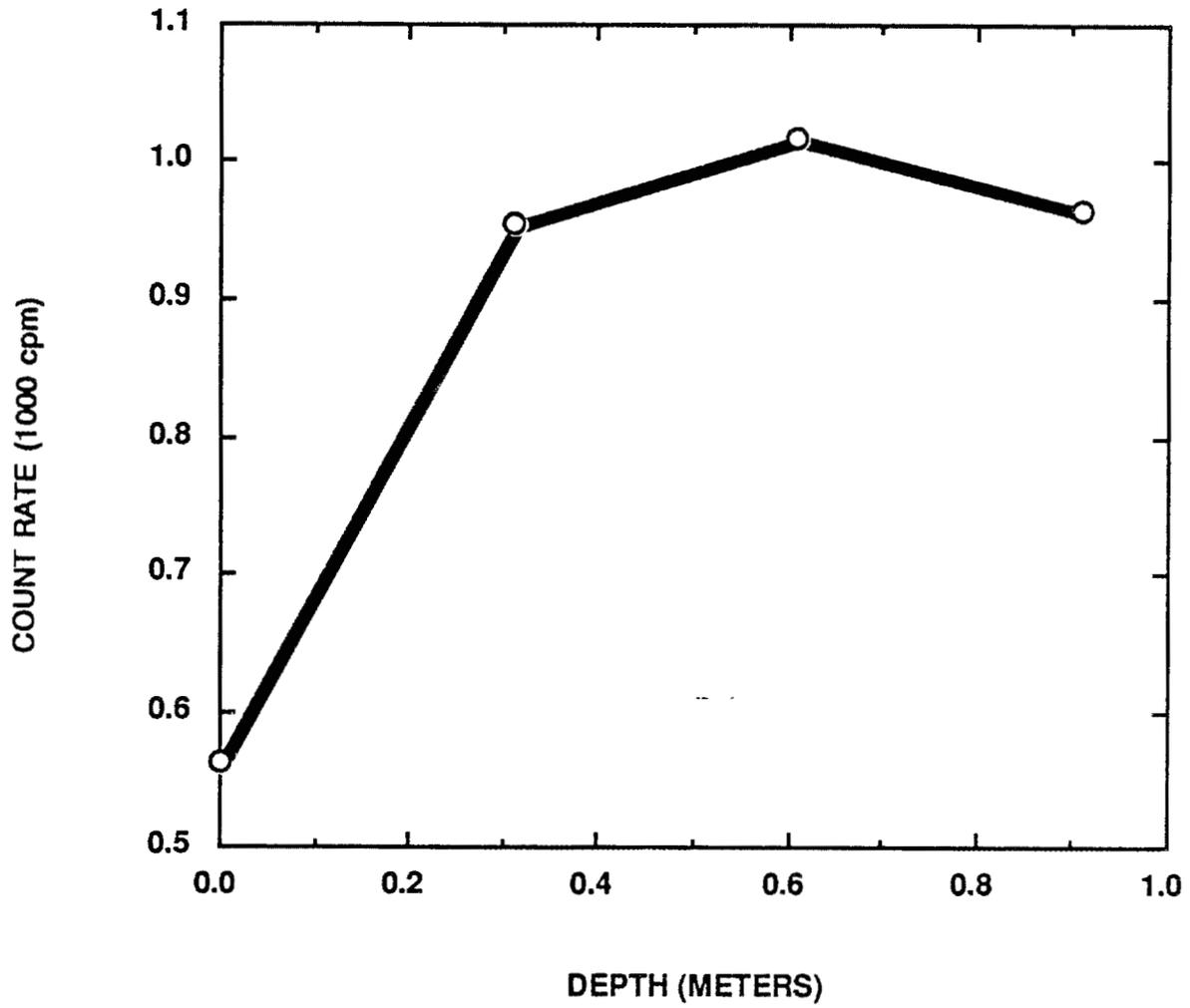


Fig. 14. Gamma profile for auger hole 6 (A6) at the former ore storage site, Palmerton, Pennsylvania (PP001).

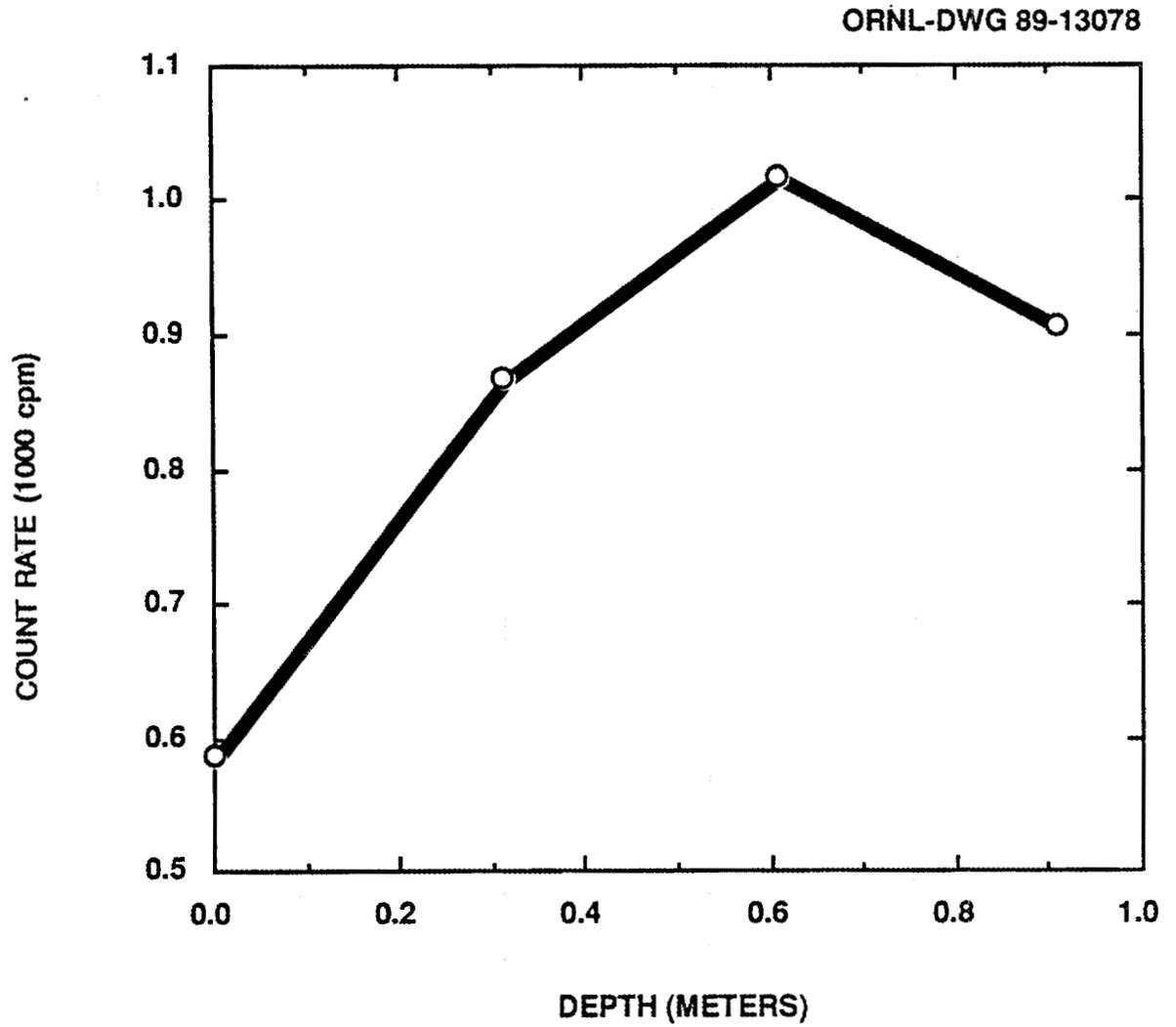


Fig. 15. Gamma profile for auger hole 7 (A7) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13079

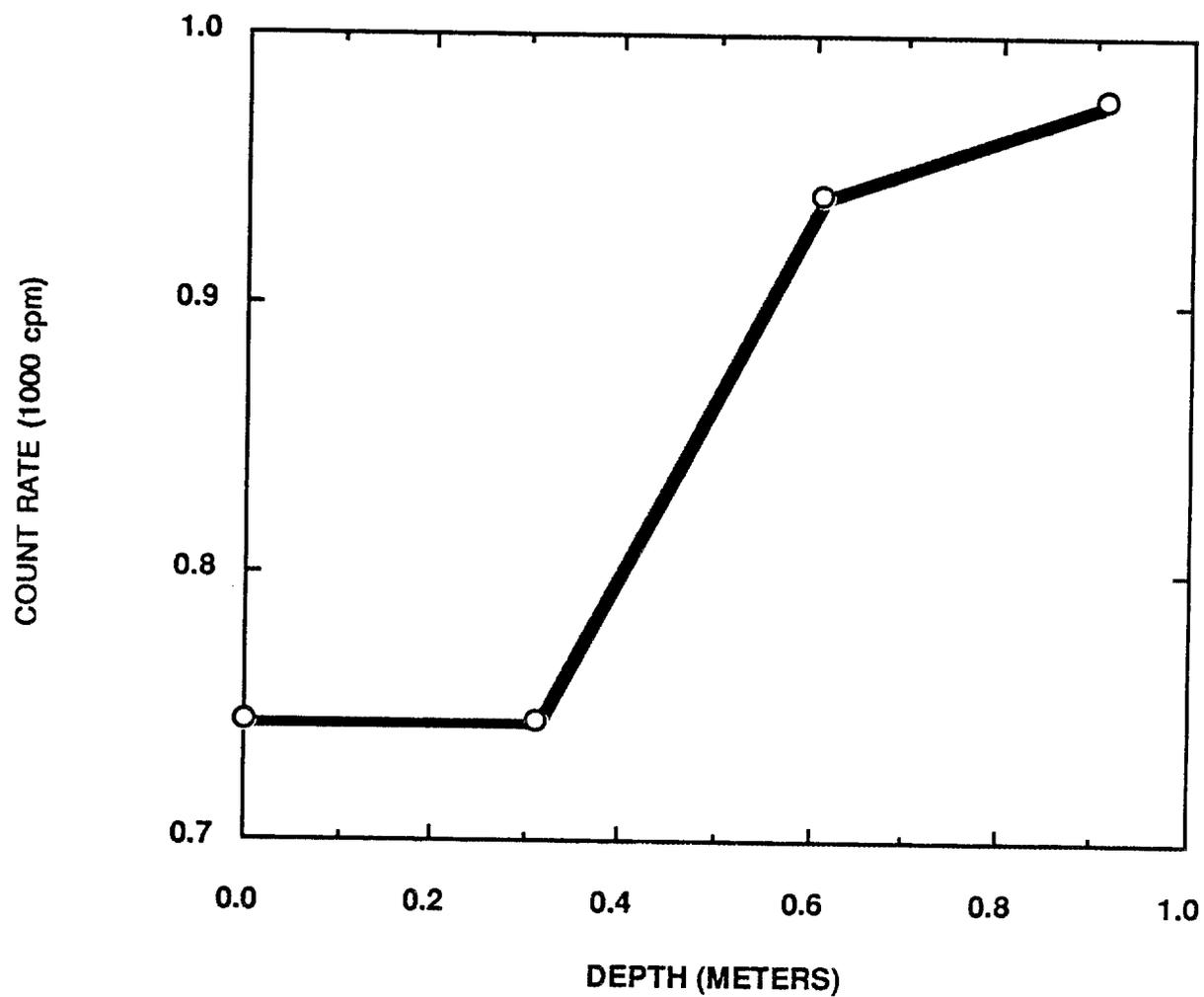


Fig. 16. Gamma profile for auger hole 8 (A8) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13080

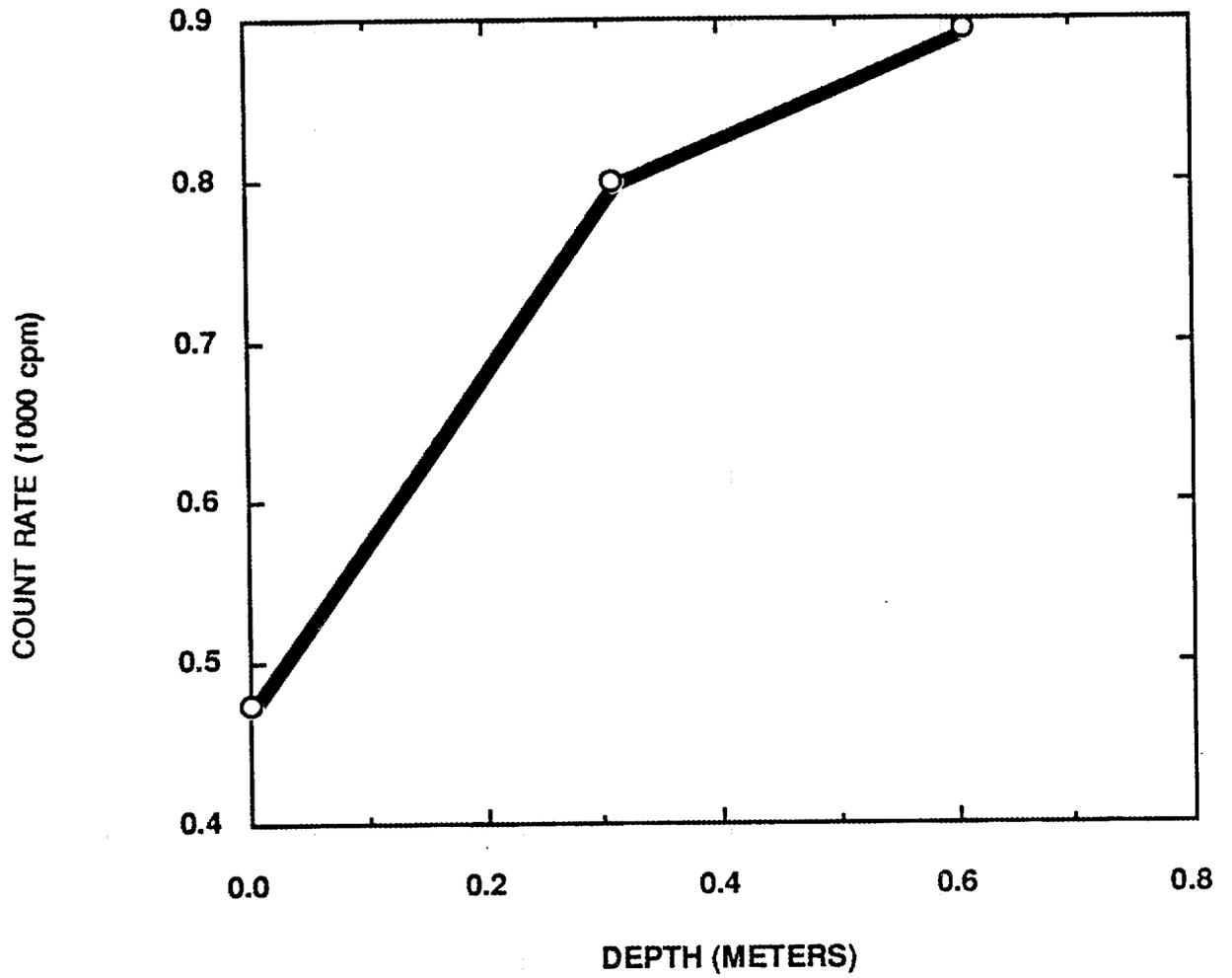


Fig. 17. Gamma profile for auger hole 9 (A9) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13081

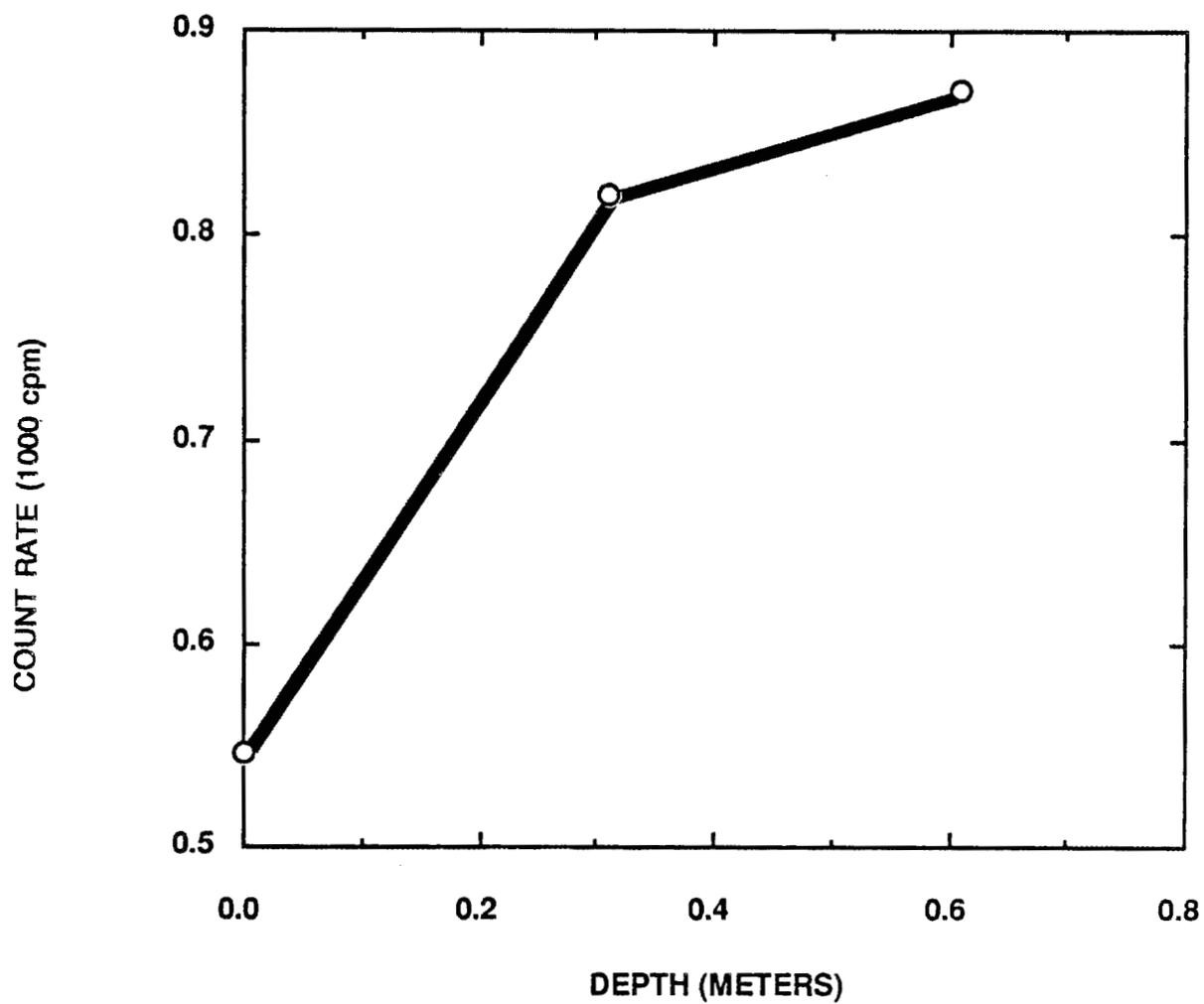


Fig. 18. Gamma profile for auger hole 10 (A10) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13082

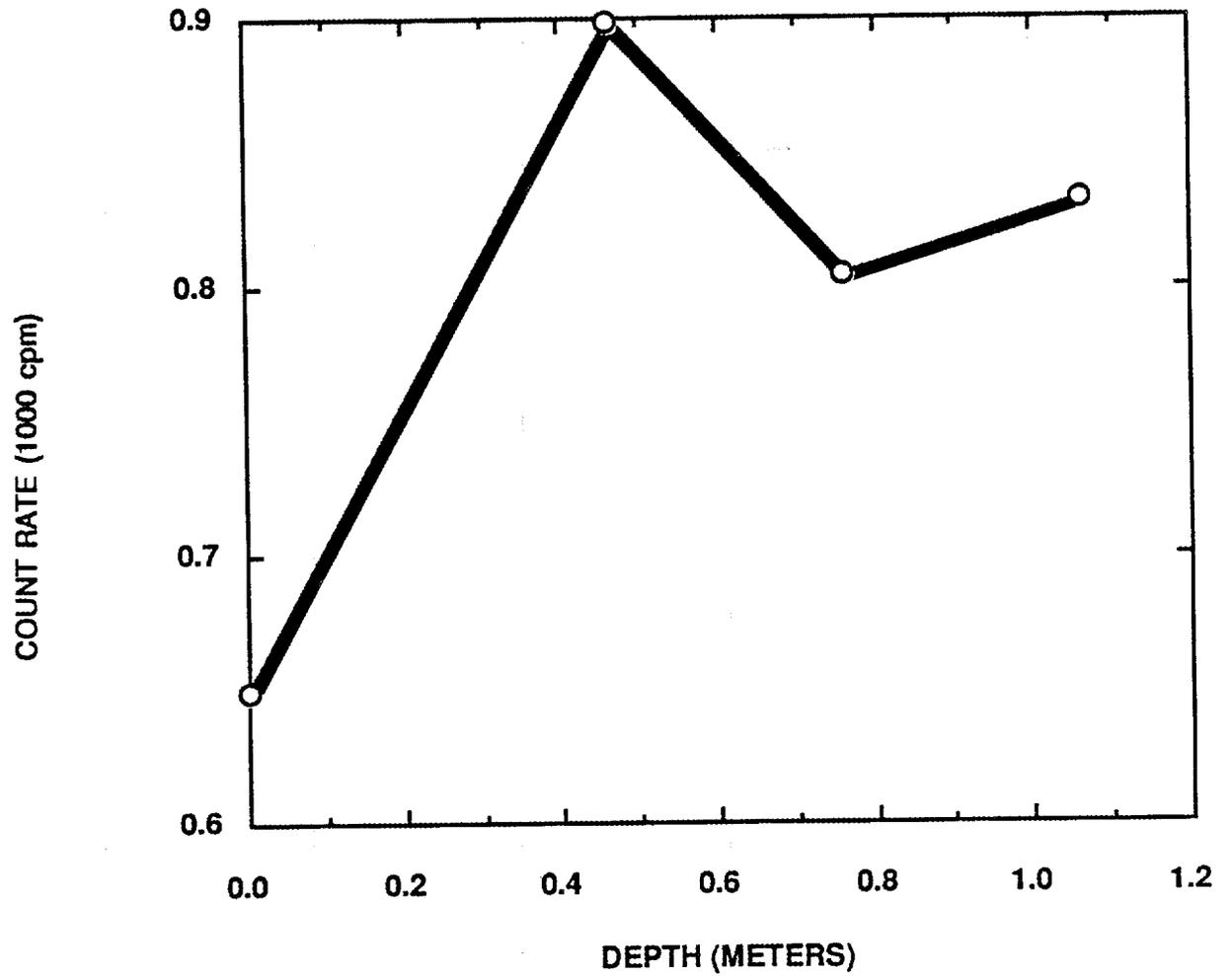


Fig. 19. Gamma profile for auger hole 11 (A11) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13083

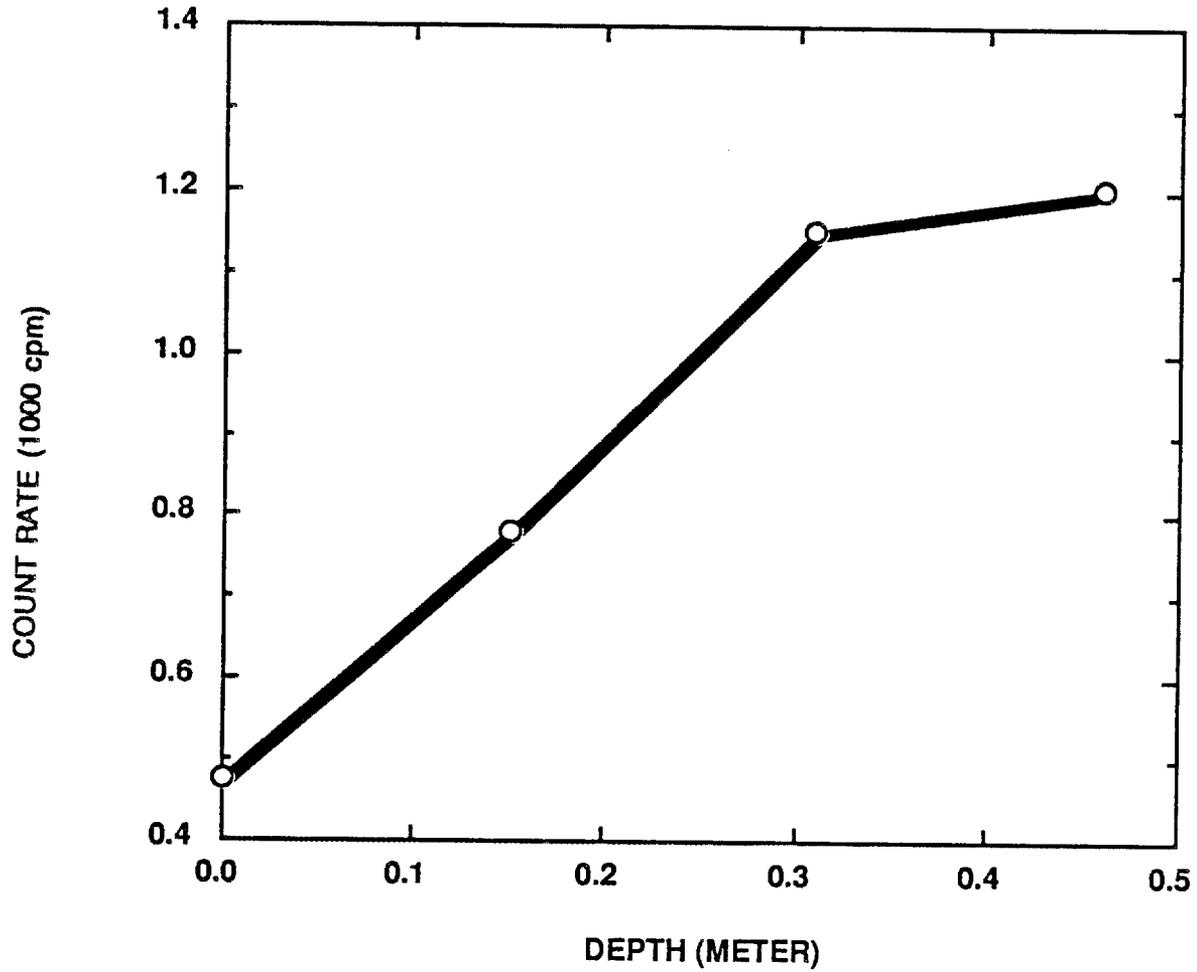


Fig. 20. Gamma profile for auger hole 12 (A12) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13084

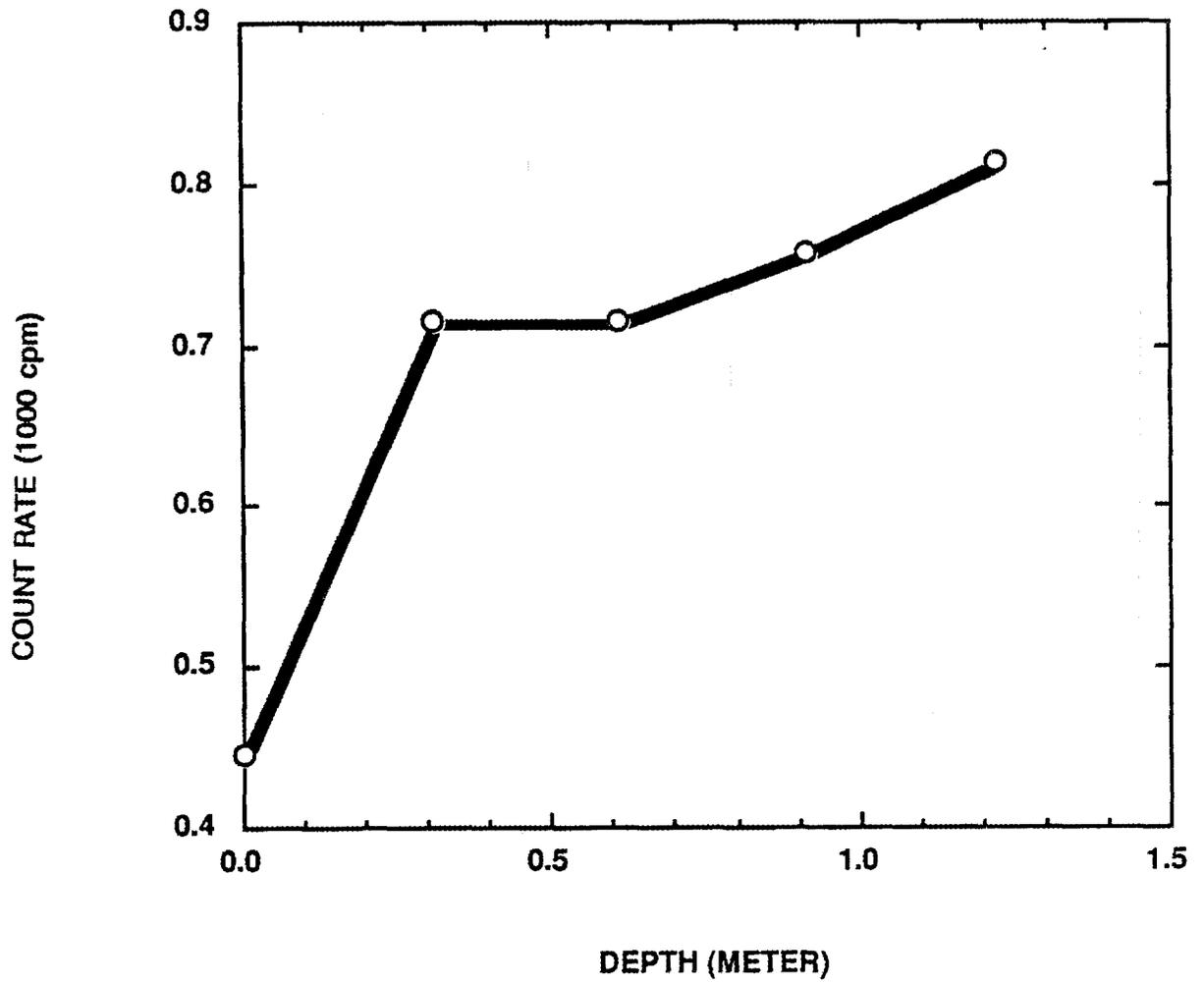


Fig. 21. Gamma profile for auger hole 13 (A13) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13085

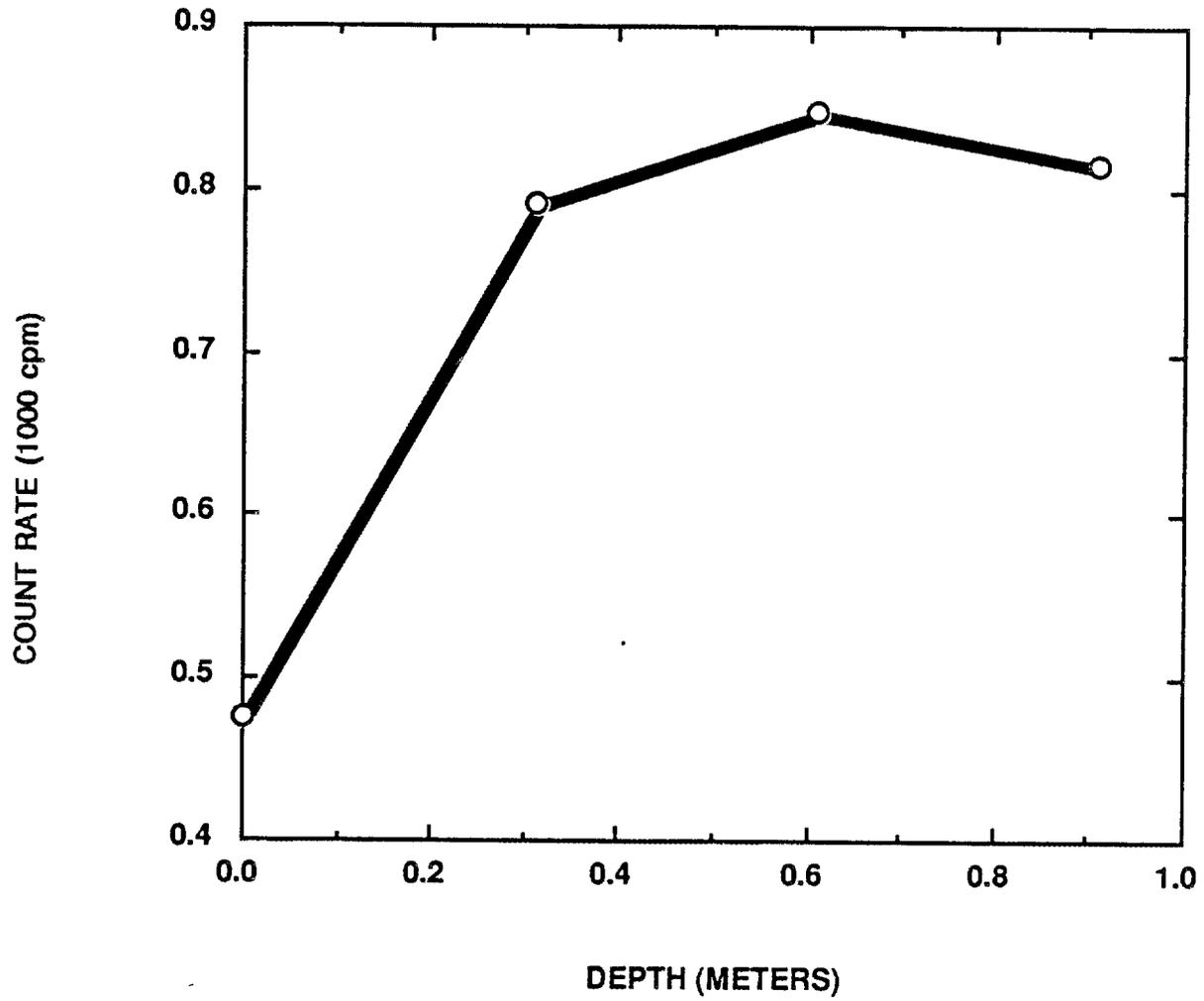


Fig. 22. Gamma profile for auger hole 14 (A14) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13086

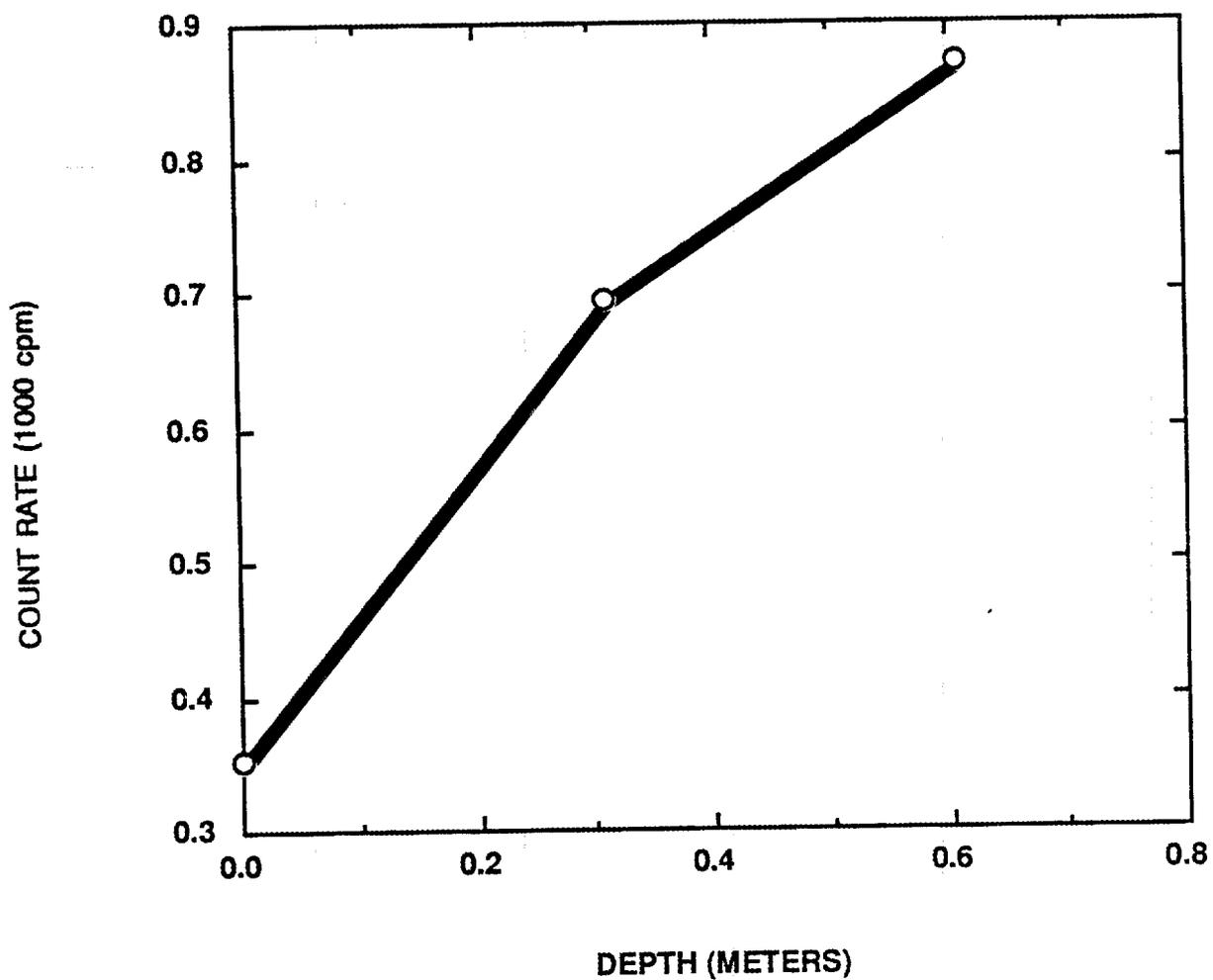


Fig. 23. Gamma profile for auger hole 15 (A15) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13087

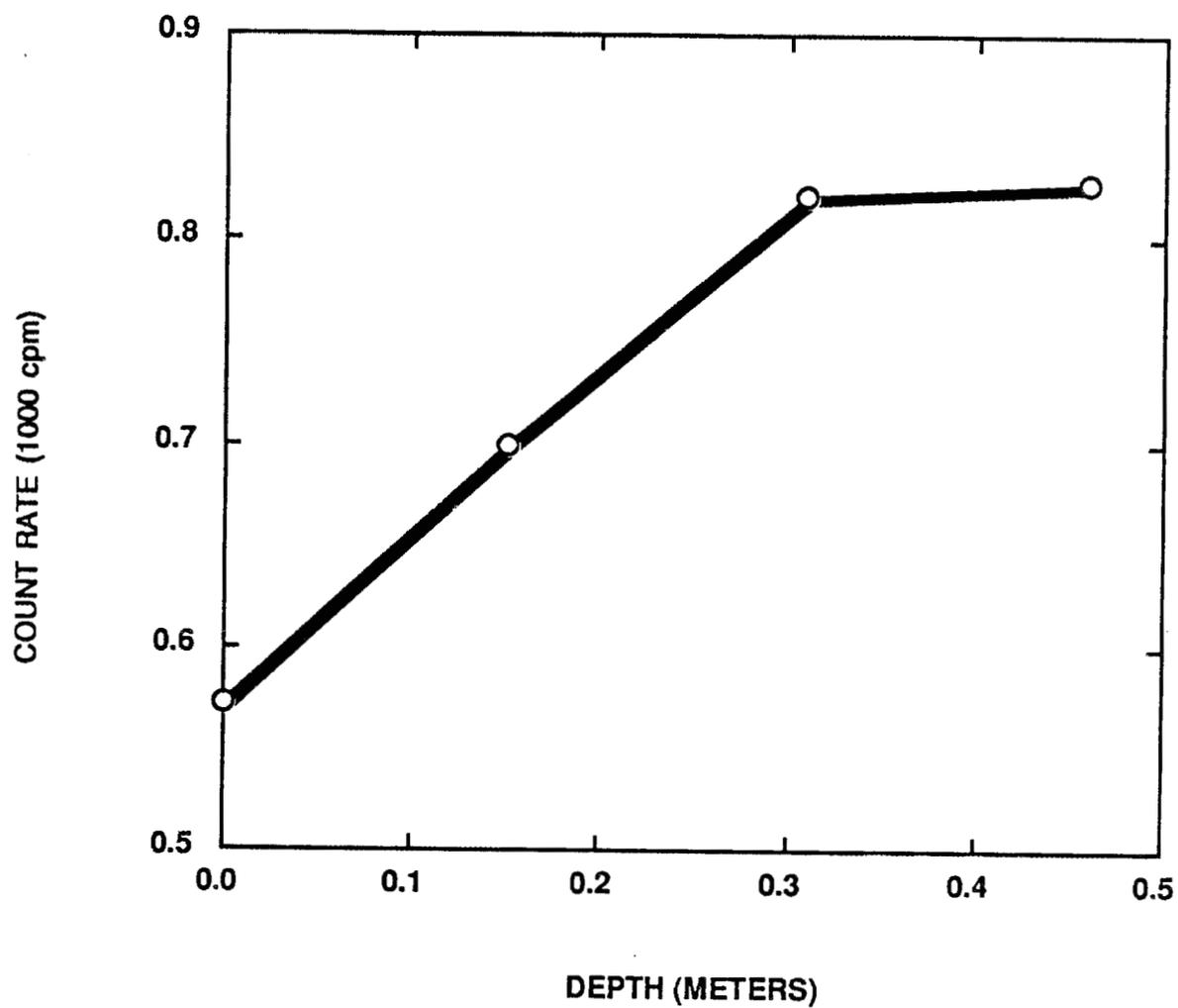


Fig. 24. Gamma profile for auger hole 16 (A16) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13088

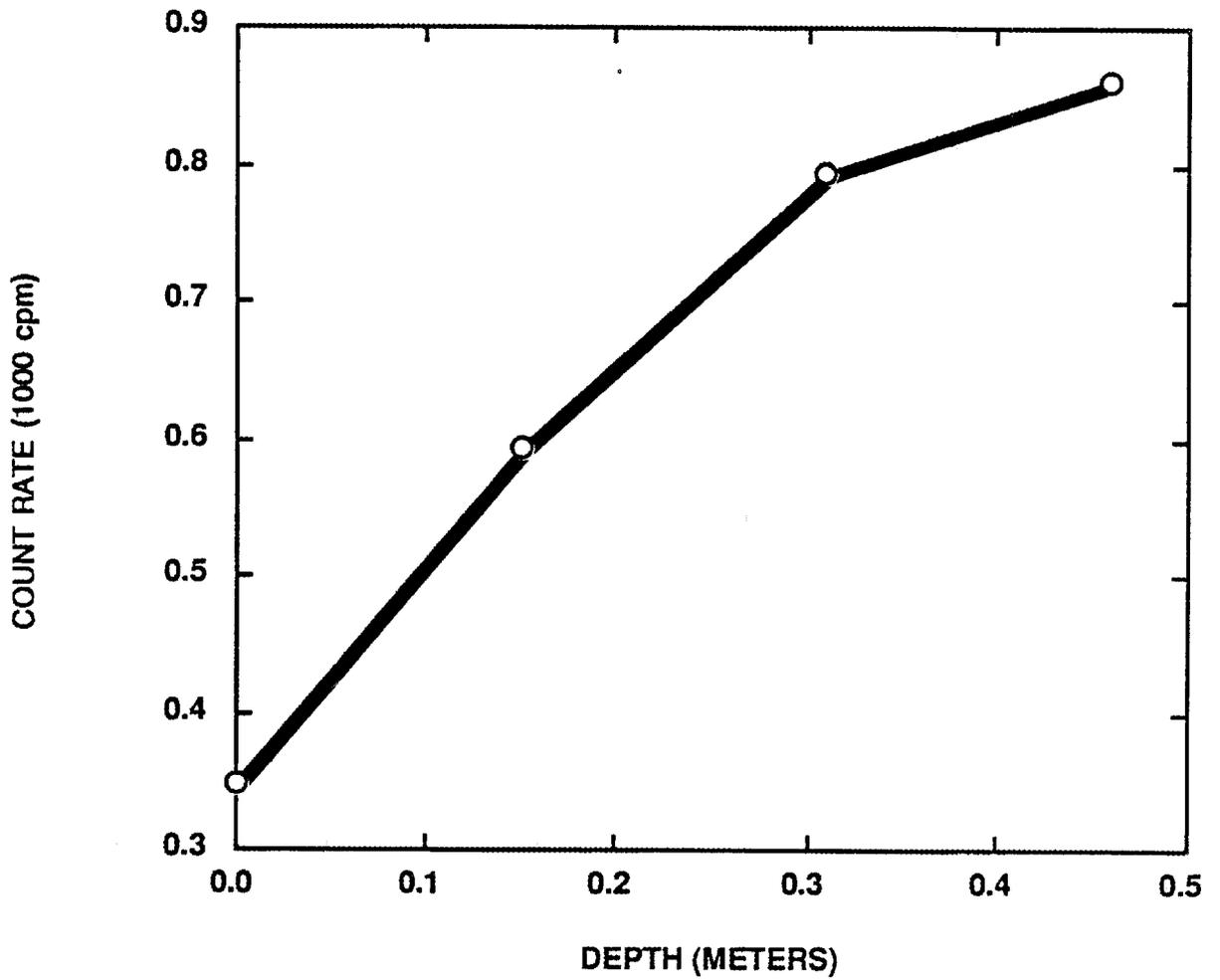


Fig. 25. Gamma profile for auger hole 17 (A17) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13089

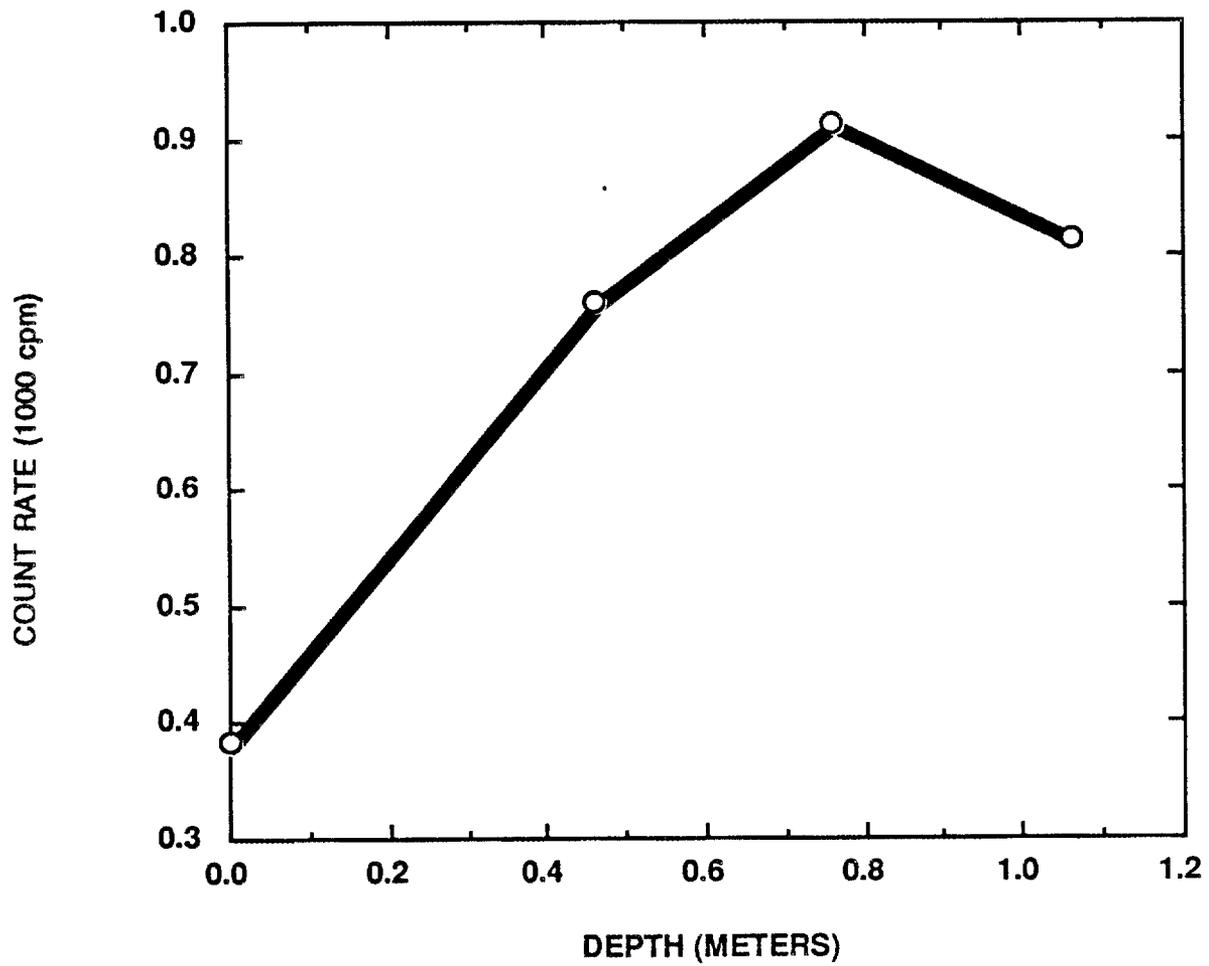


Fig. 26. Gamma profile for auger hole 18 (A18) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13090

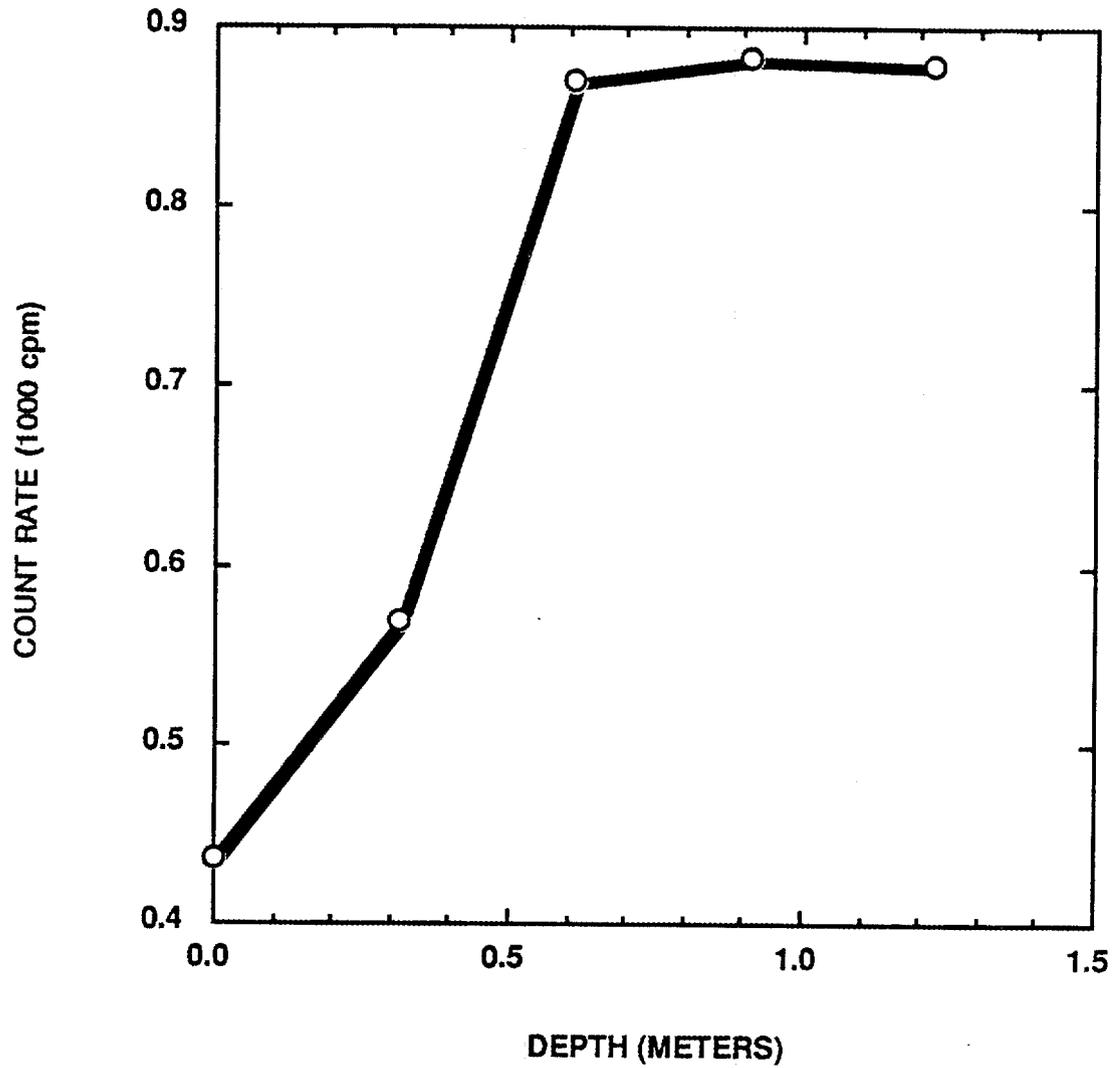


Fig. 27. Gamma profile for auger hole 19 (A19) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13091

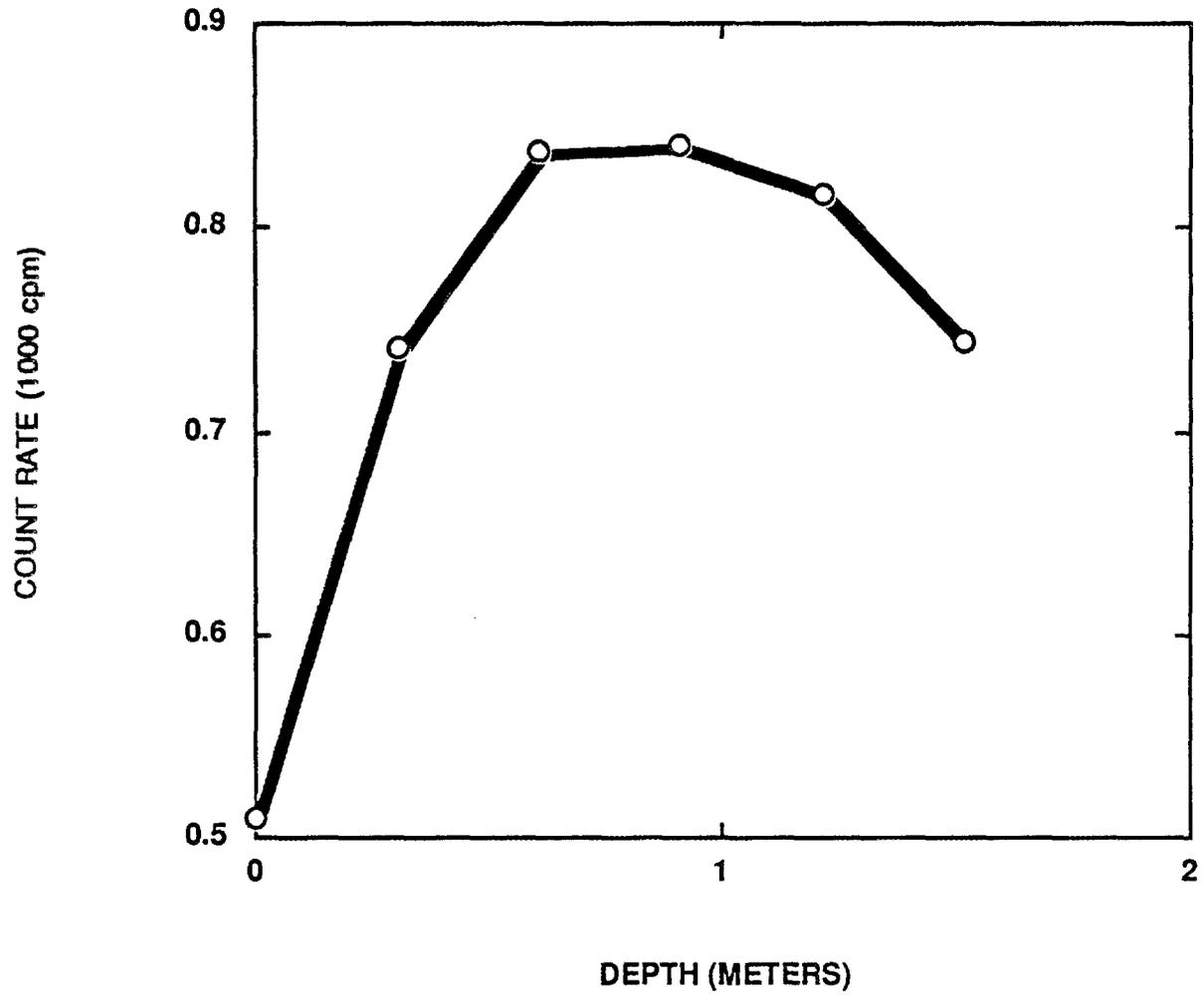


Fig. 28. Gamma profile for auger hole 20 (A20) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13092

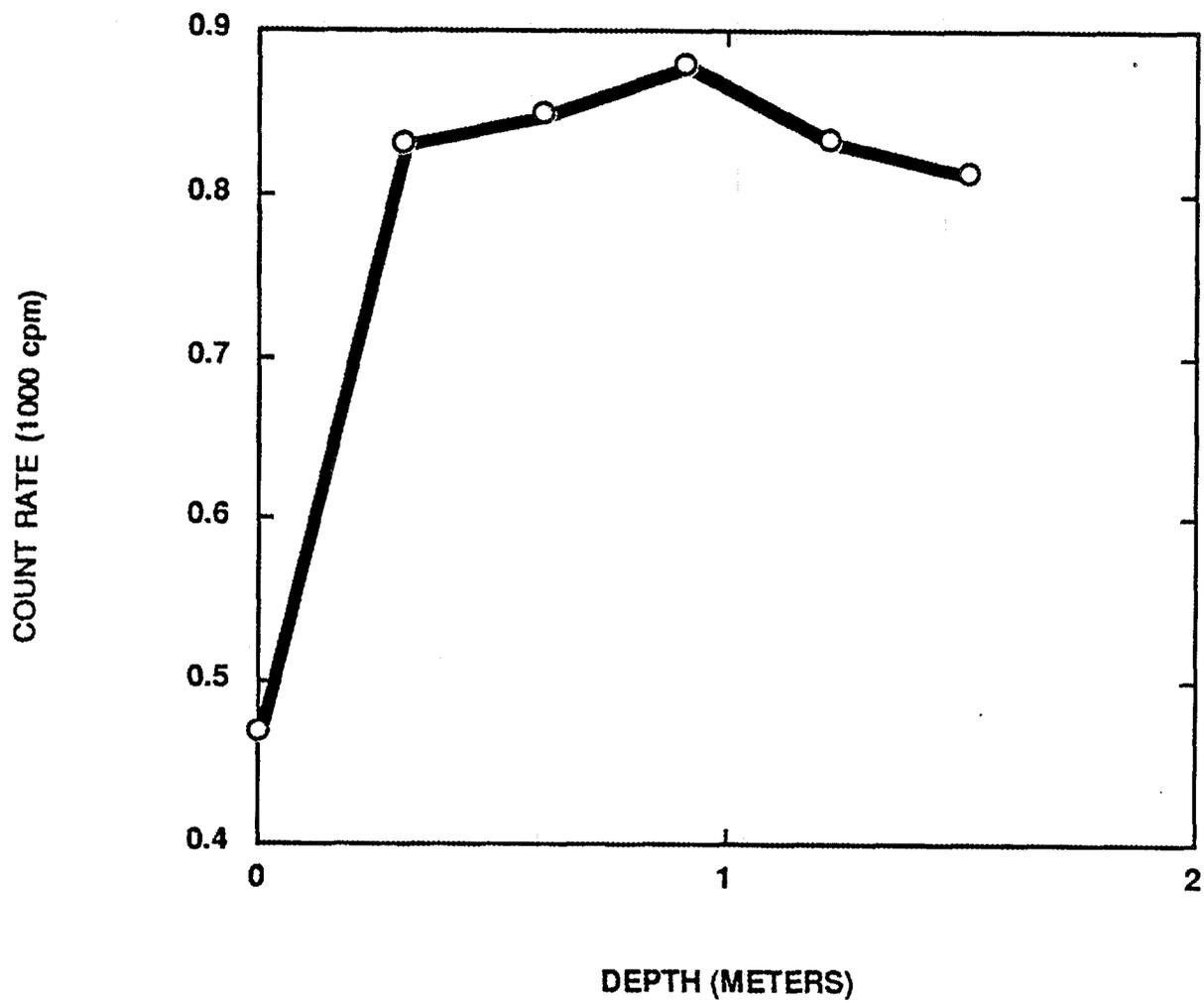


Fig. 29. Gamma profile for auger hole 21 (A21) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13093

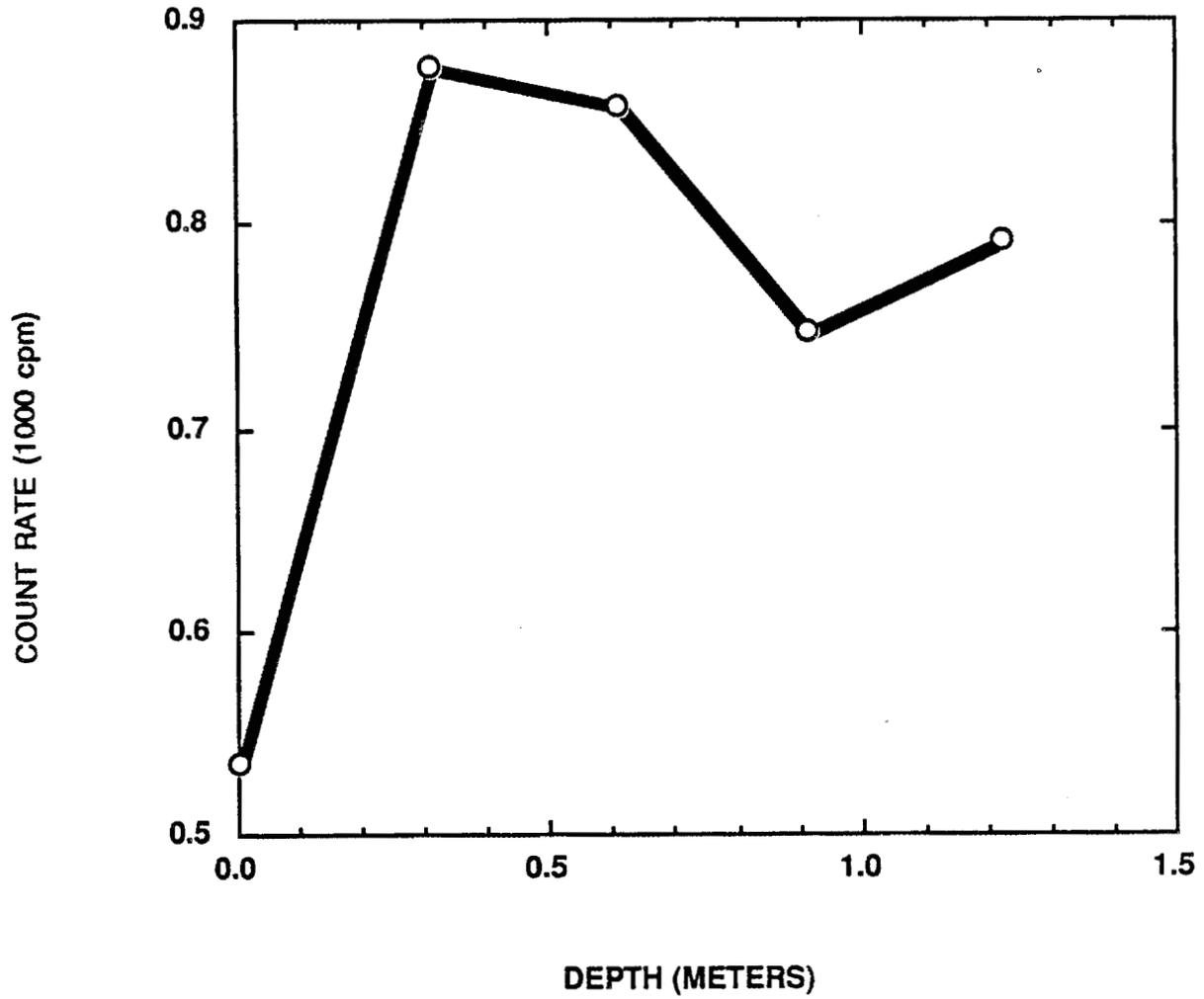


Fig. 30. Gamma profile for auger hole 22 (A22) at the former ore storage site, Palmerton, Pennsylvania (PP001).

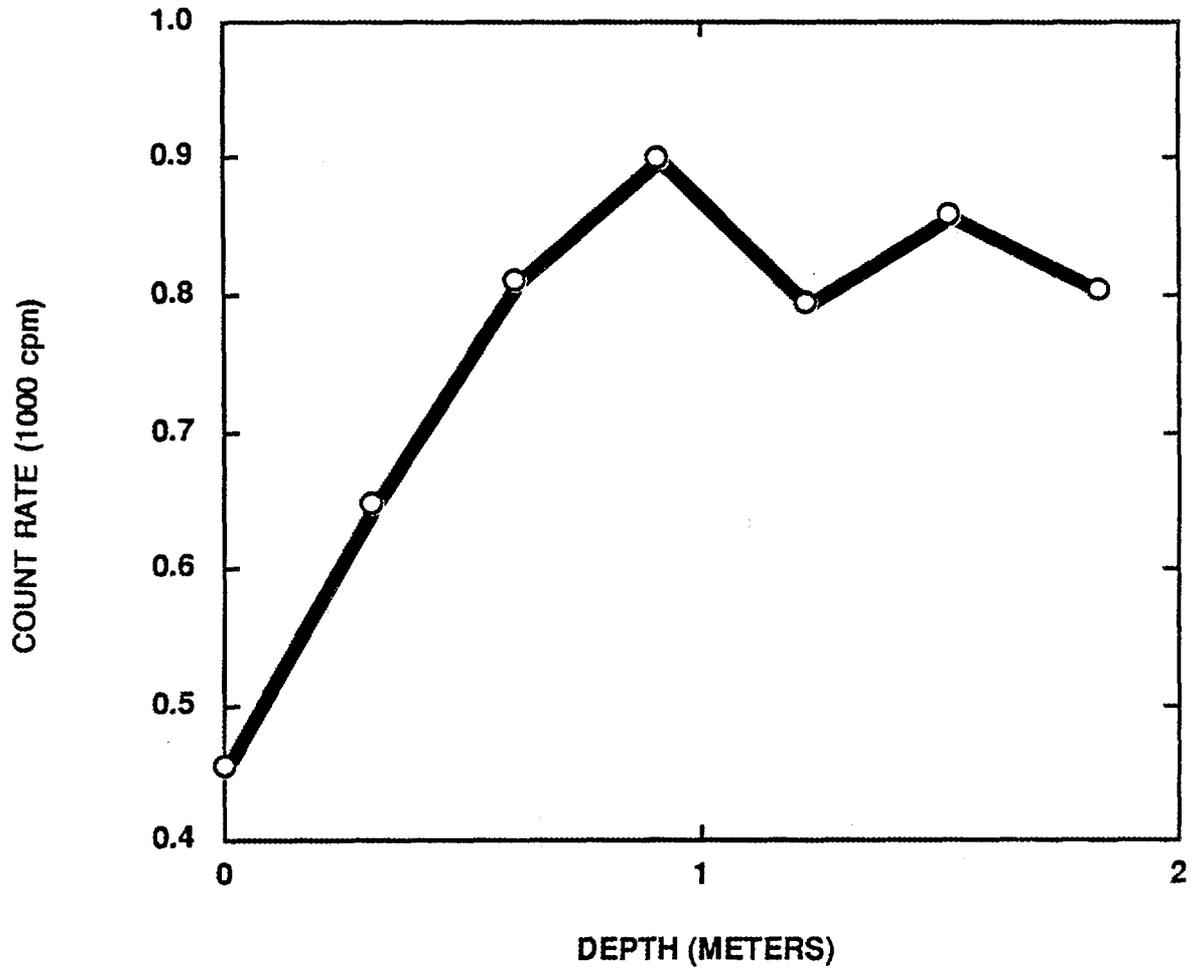


Fig. 31. Gamma profile for auger hole 23 (A23) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13095

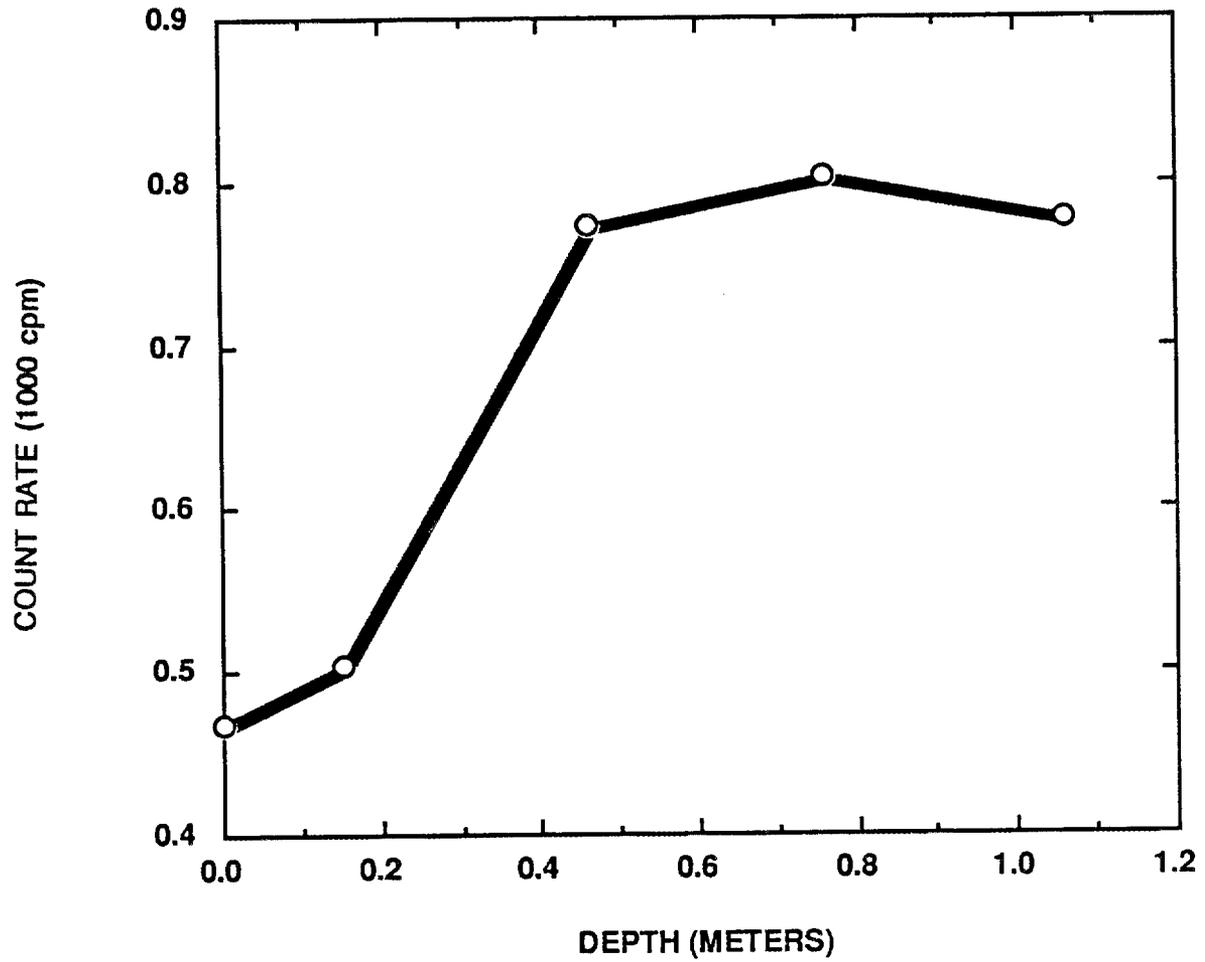


Fig. 32. Gamma profile for auger hole 24 (A24) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13096

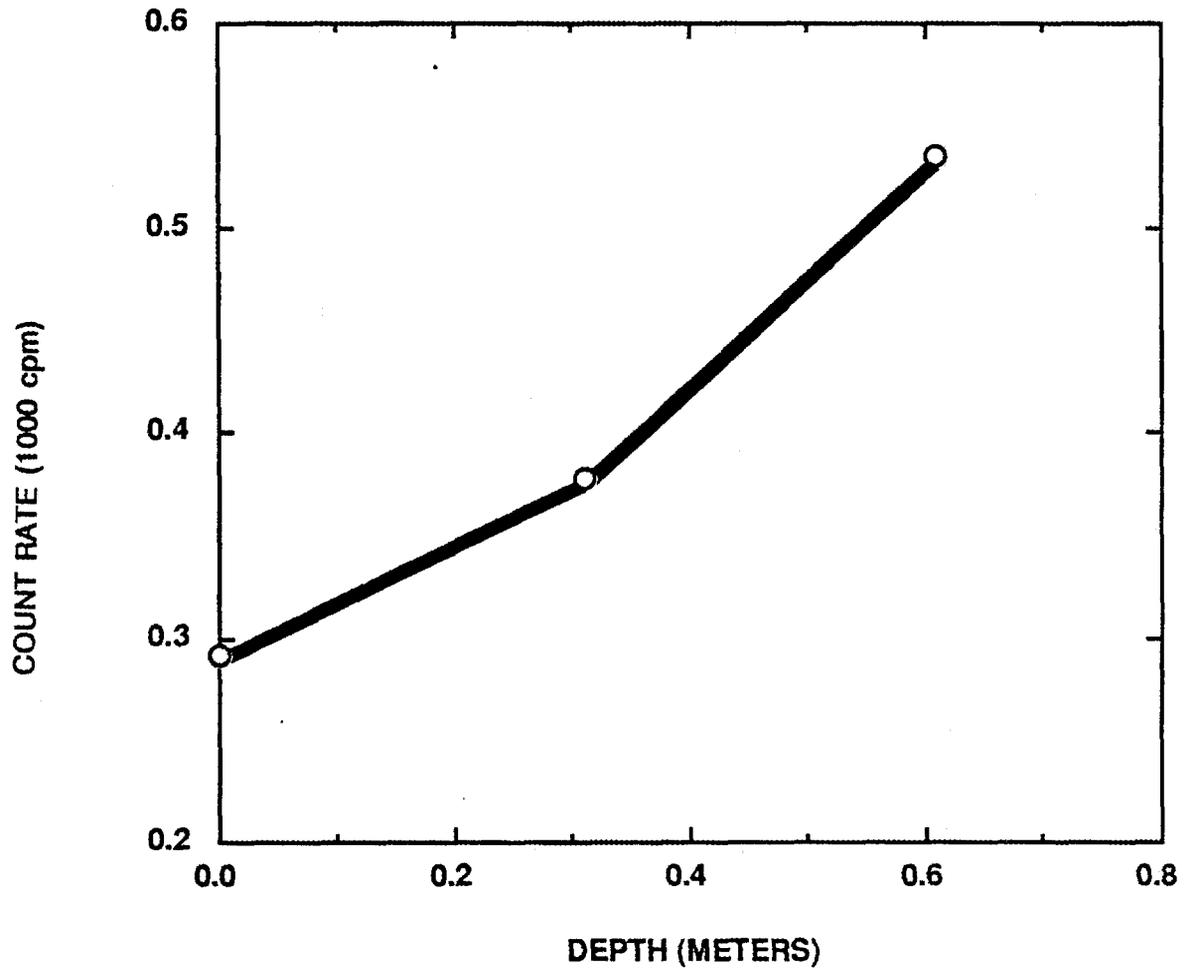


Fig. 33. Gamma profile for auger hole 25 (A25) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13097

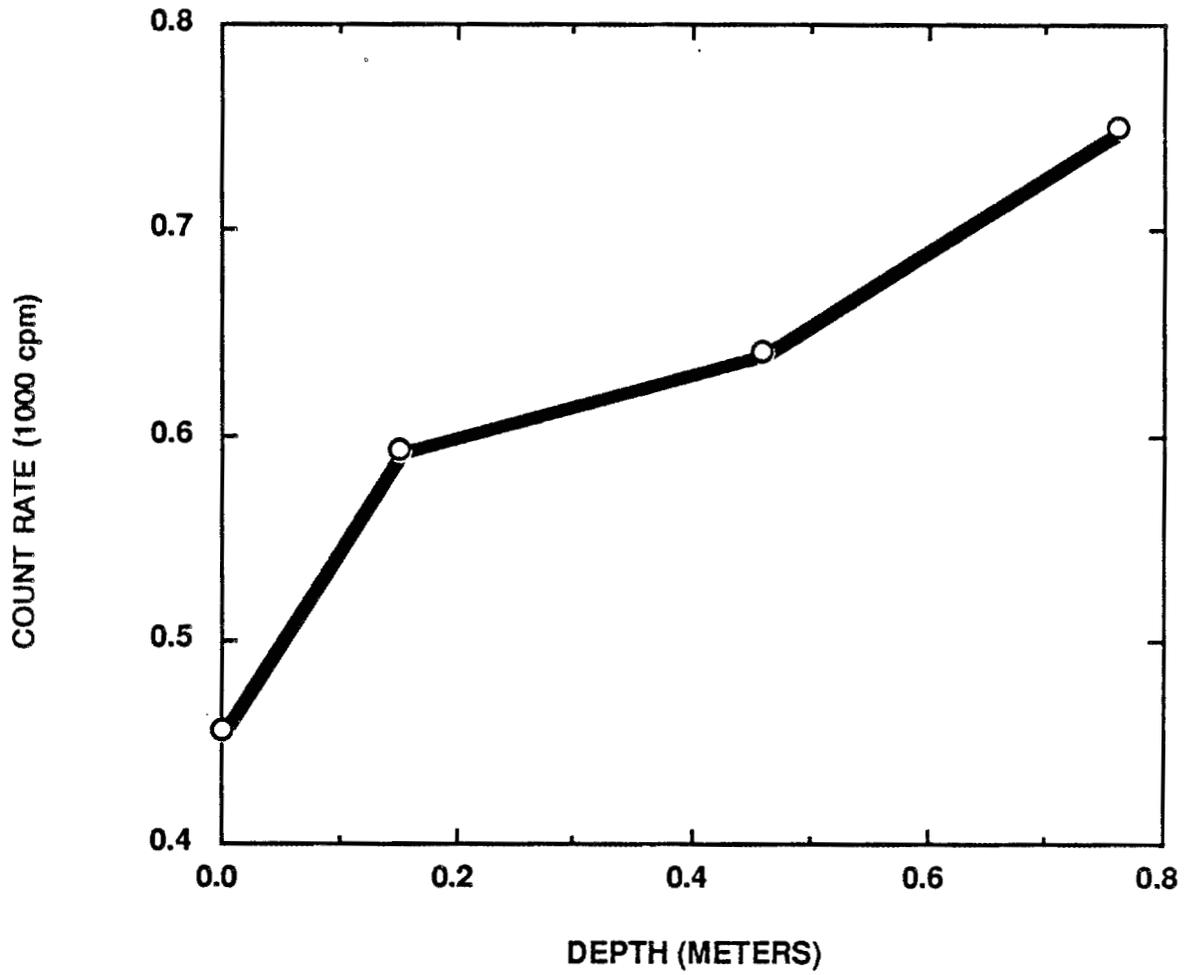


Fig. 34. Gamma profile for auger hole 26 (A26) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13098

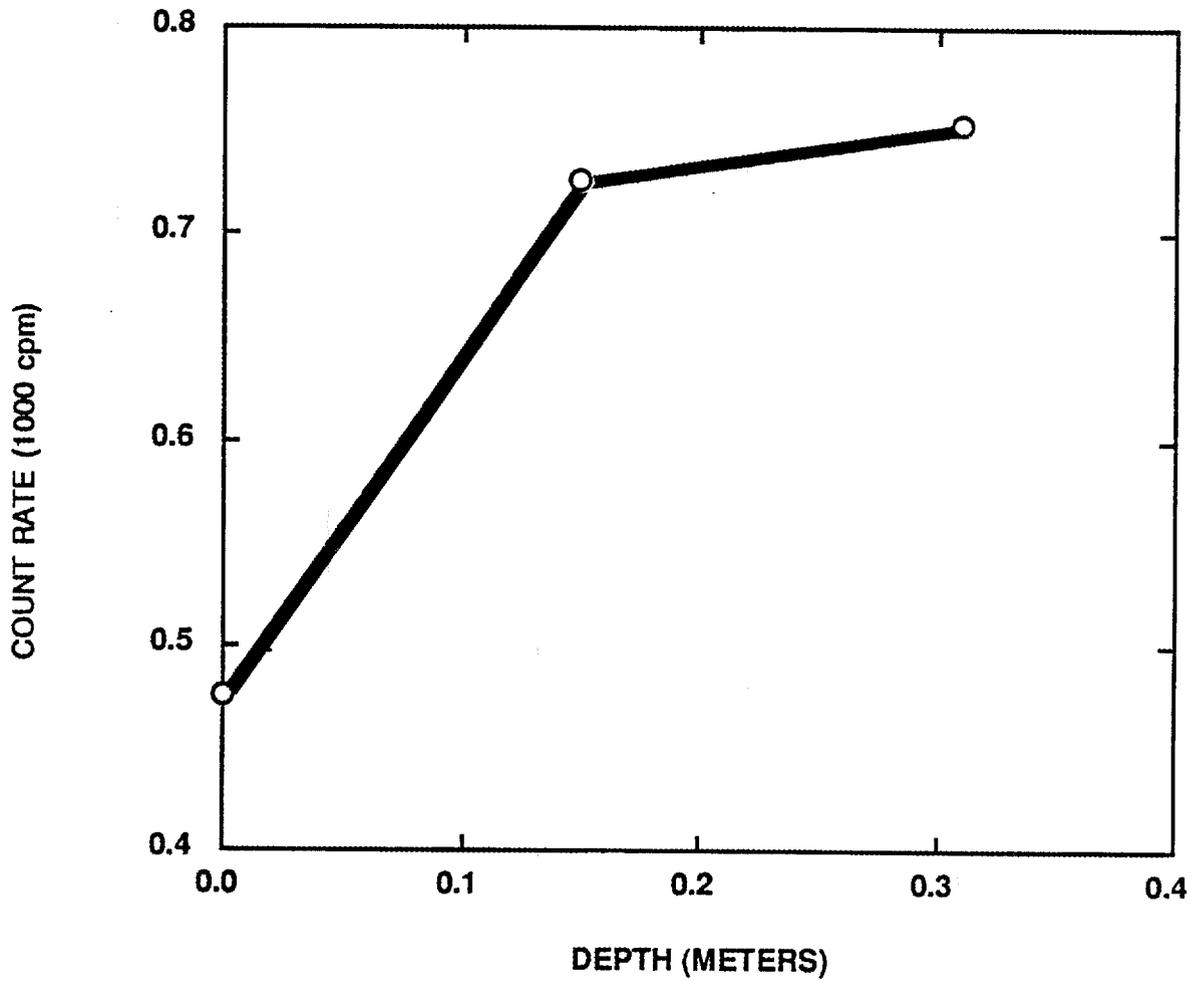


Fig. 35. Gamma profile for auger hole 27 (A27) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13099

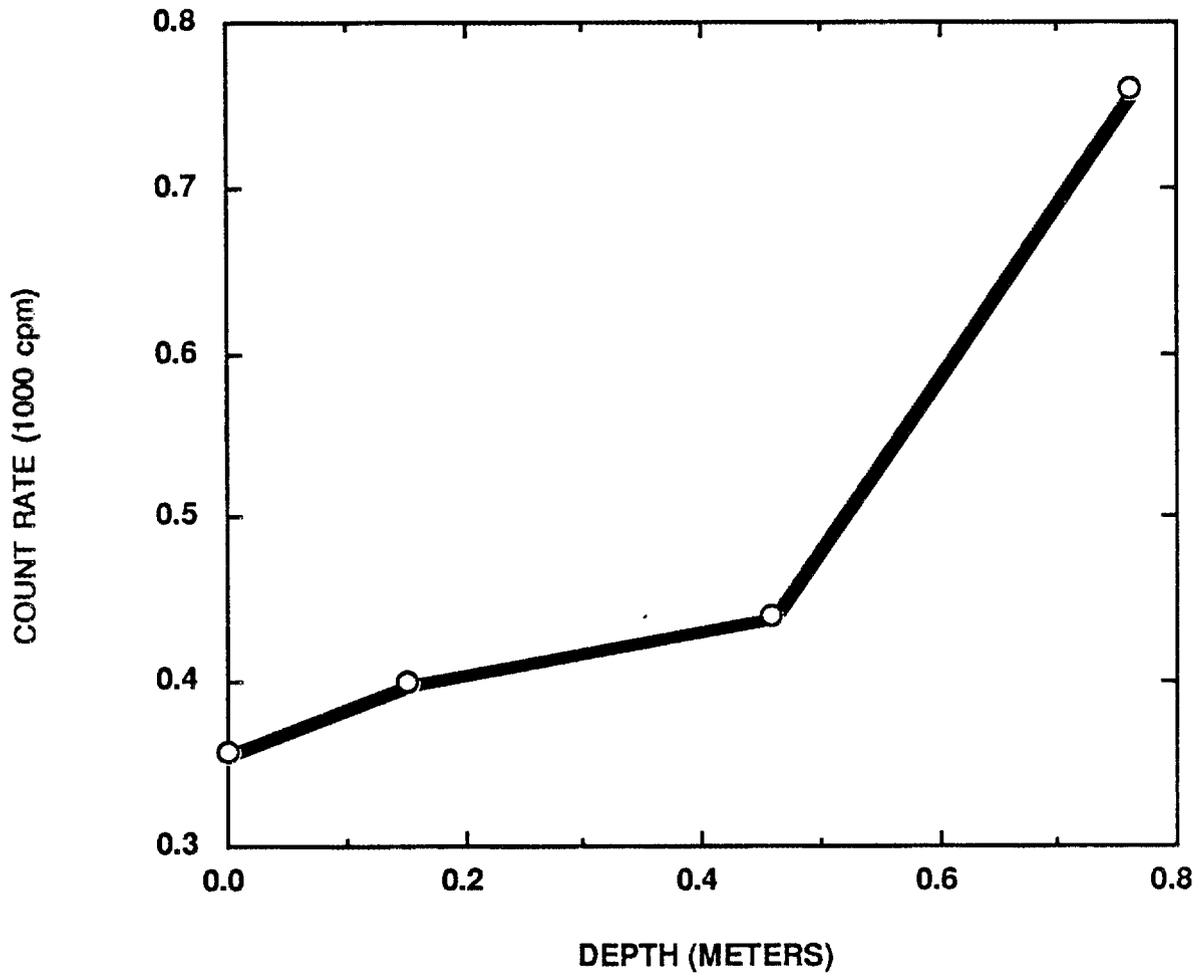


Fig. 36. Gamma profile for auger hole 28 (A28) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13100

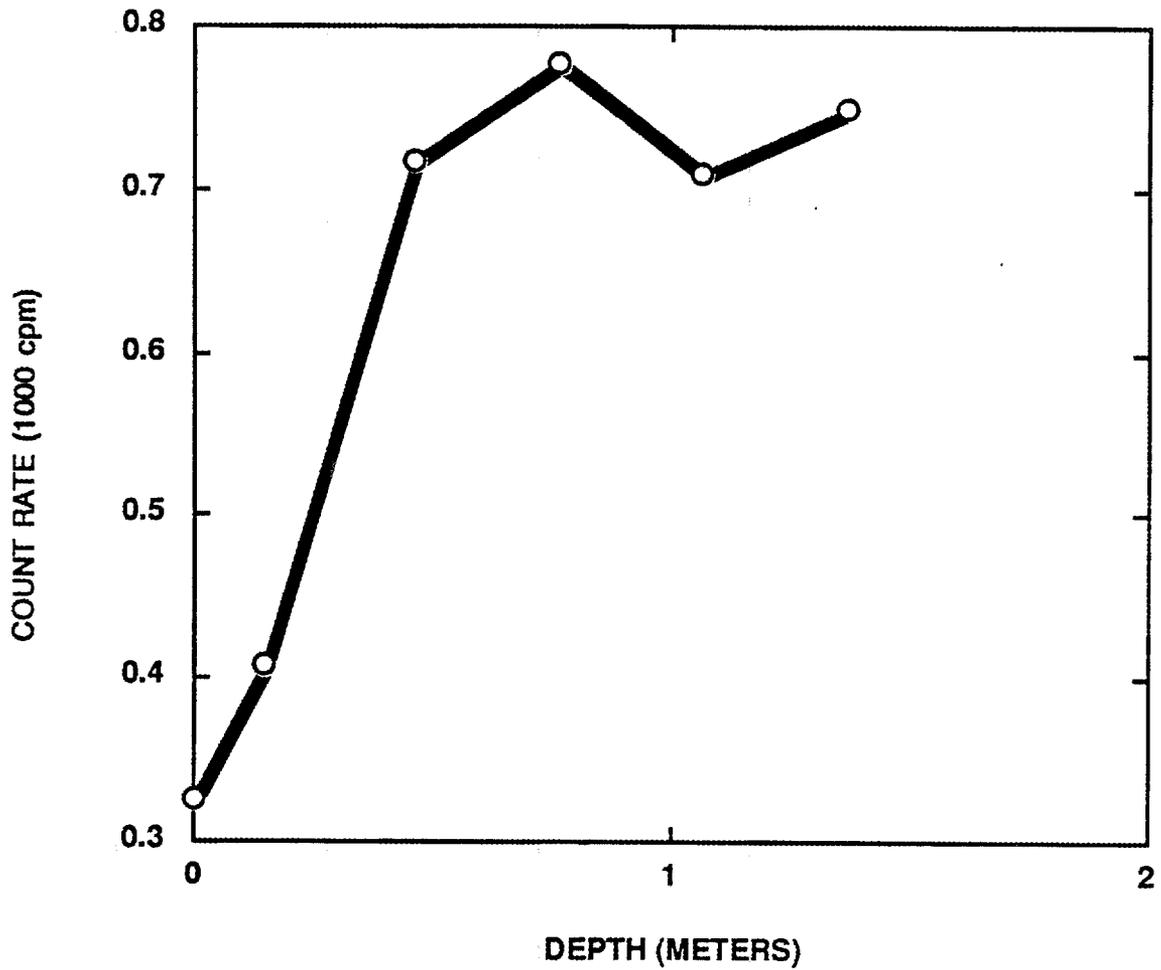


Fig. 37. Gamma profile for auger hole 29 (A29) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13101

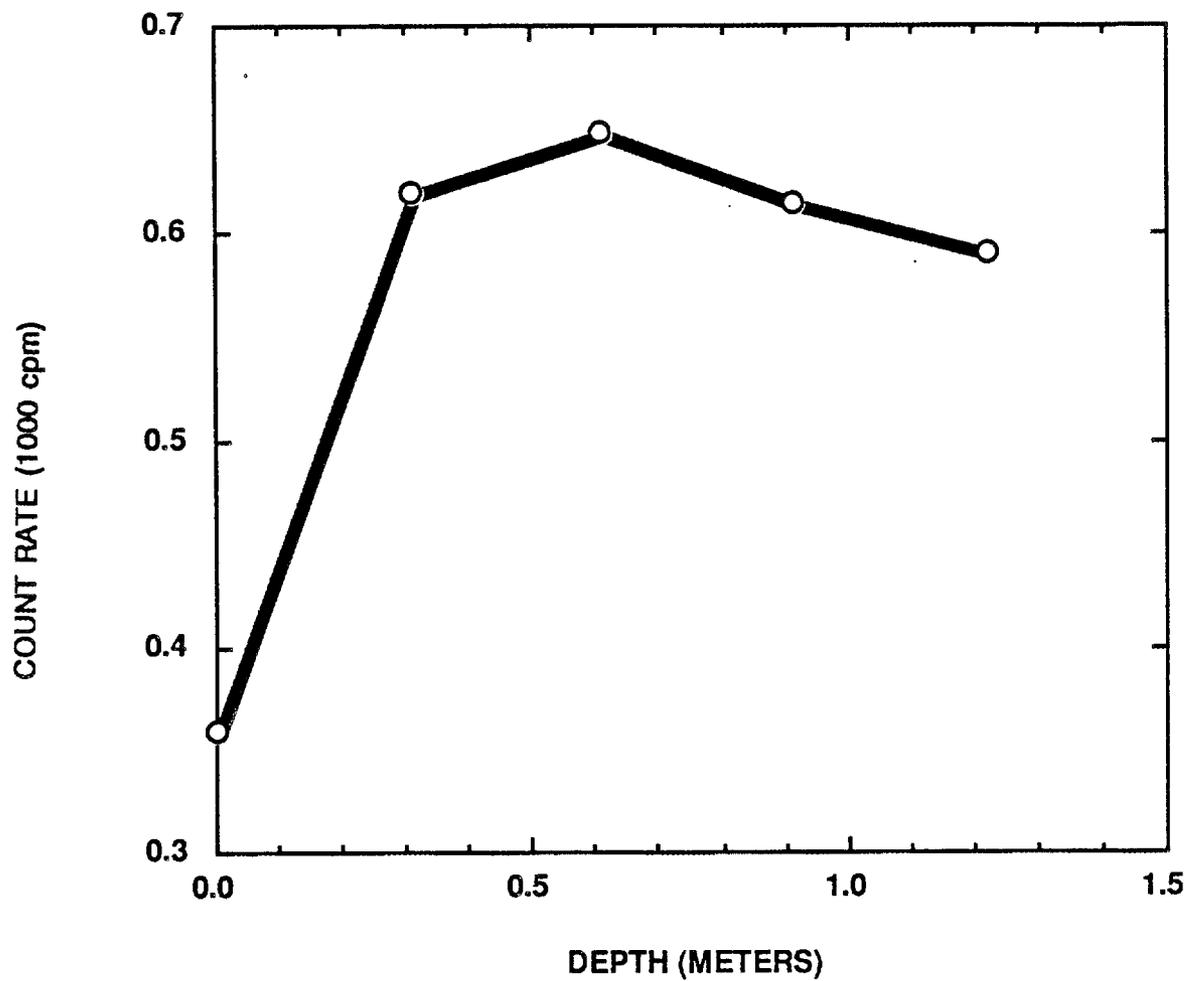


Fig. 38. Gamma profile for auger hole 30 (A30) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13102

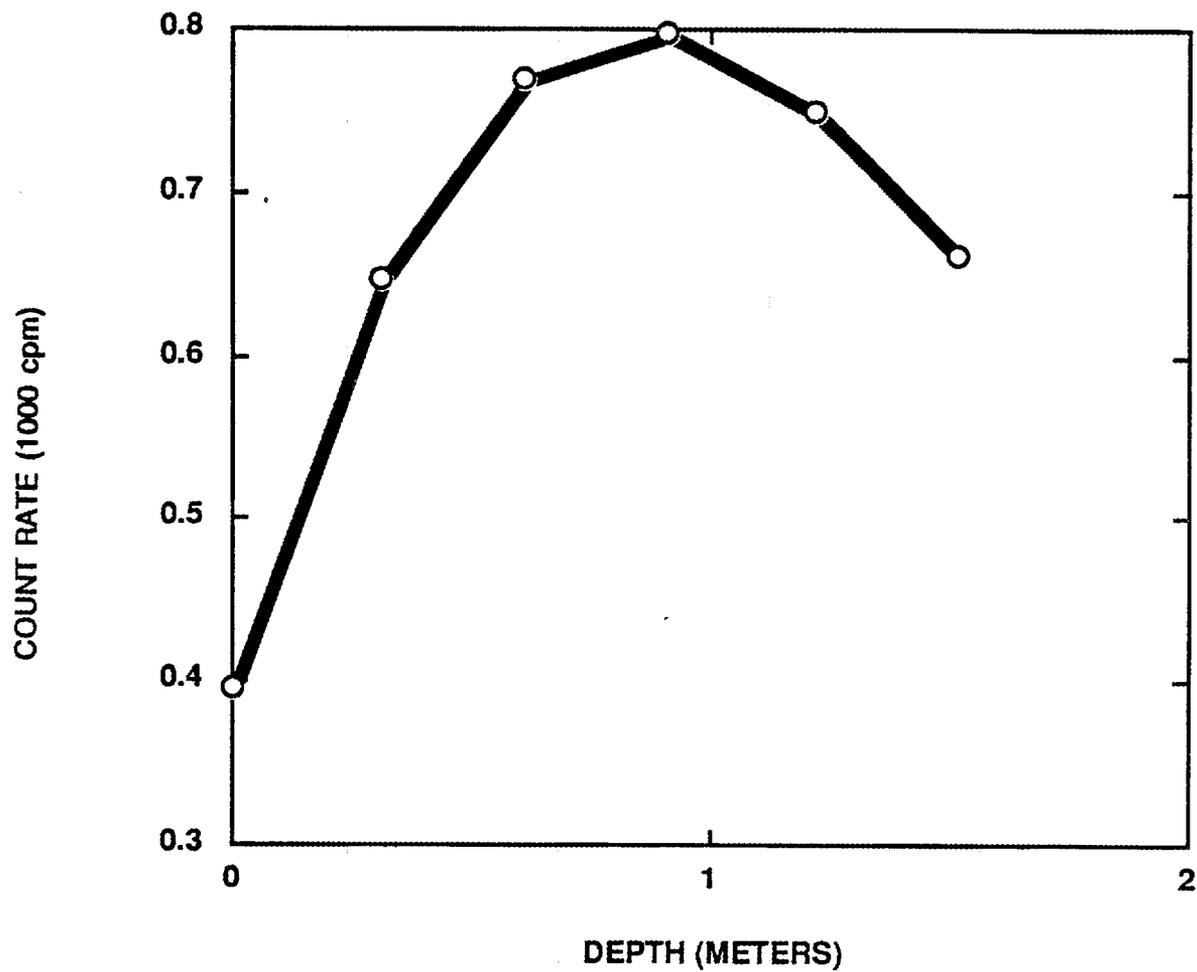


Fig. 39. Gamma profile for auger hole 31 (A31) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13103

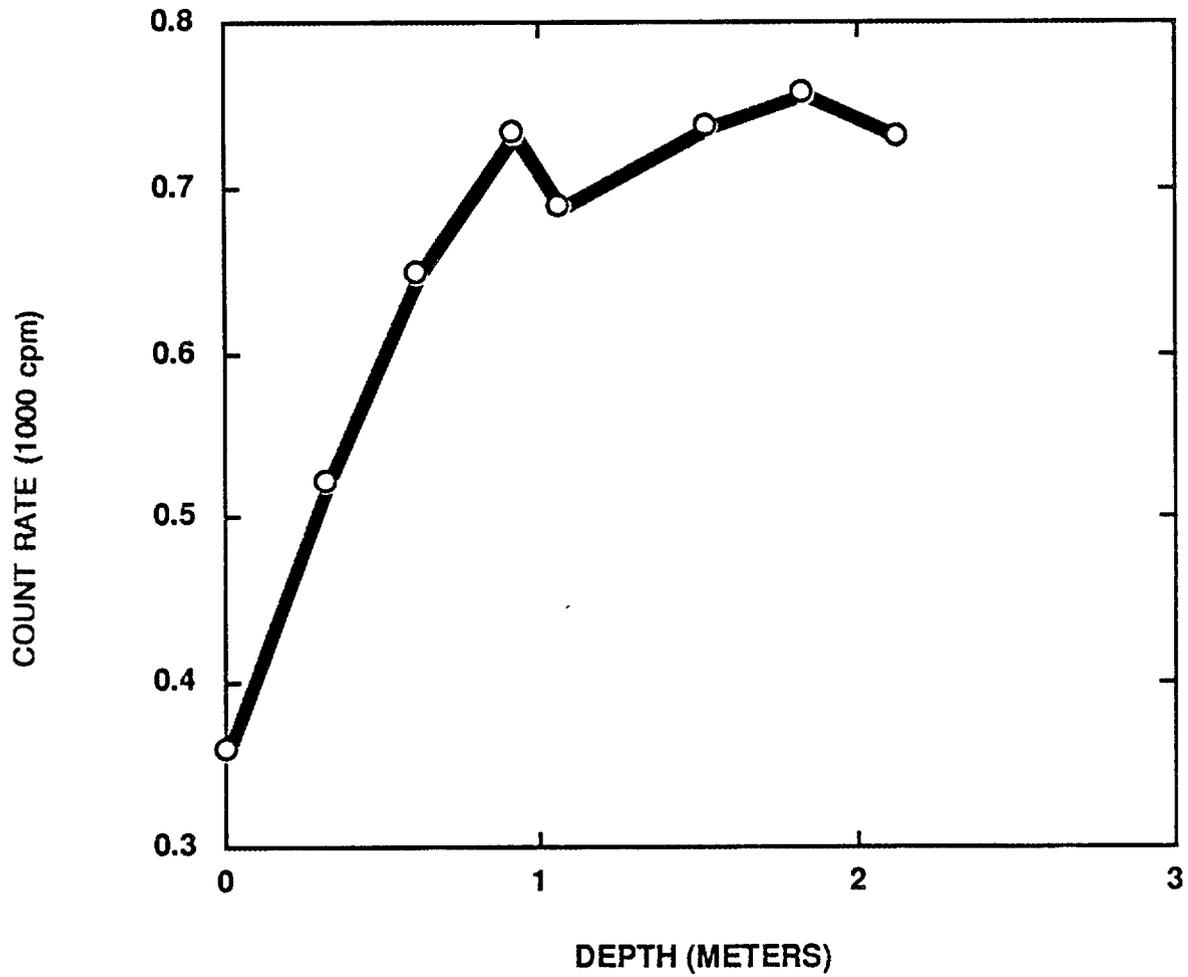


Fig. 40. Gamma profile for auger hole 32 (A32) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13104

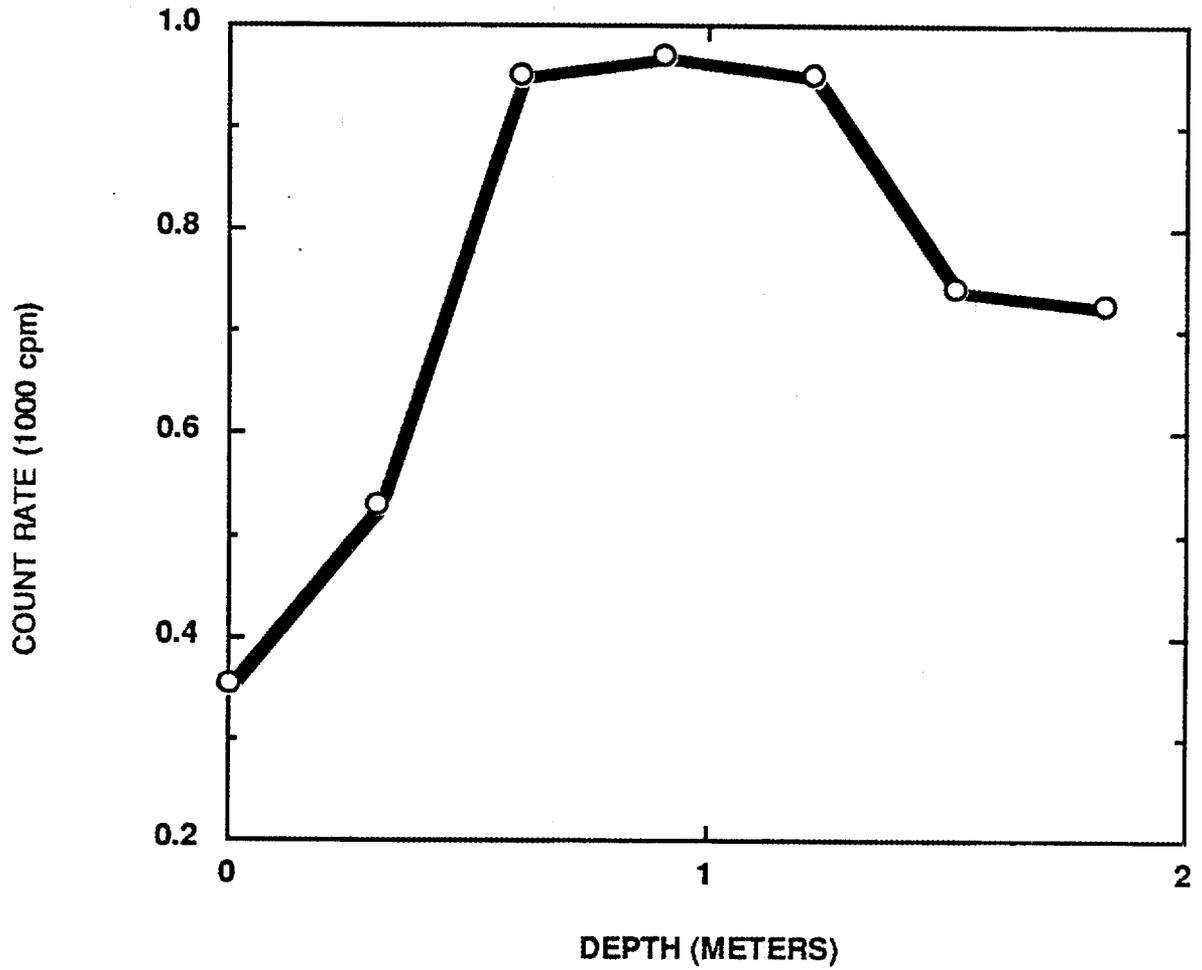


Fig. 41. Gamma profile for auger hole 33 (A33) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13105

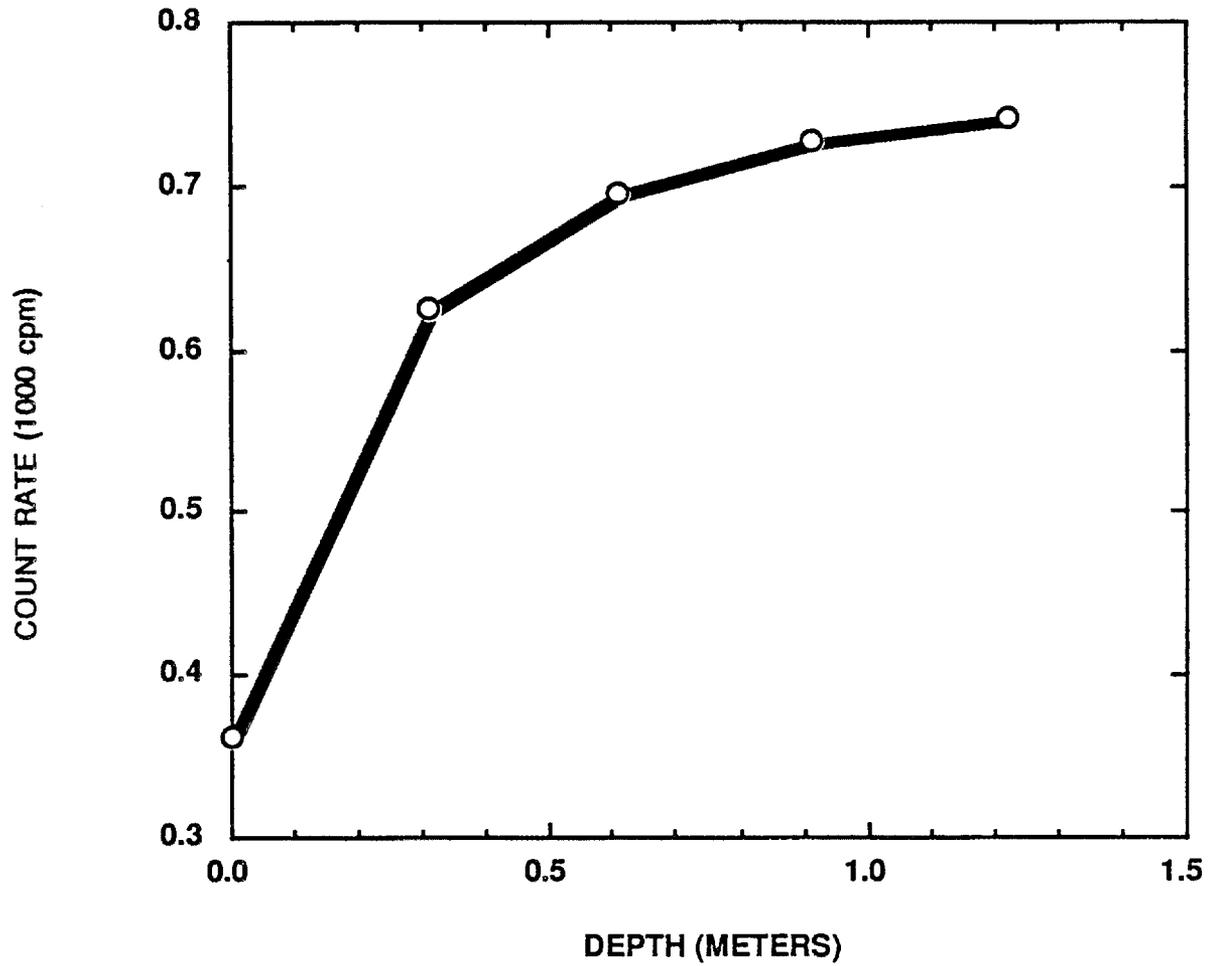


Fig. 42. Gamma profile for auger hole 34 (A34) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13106

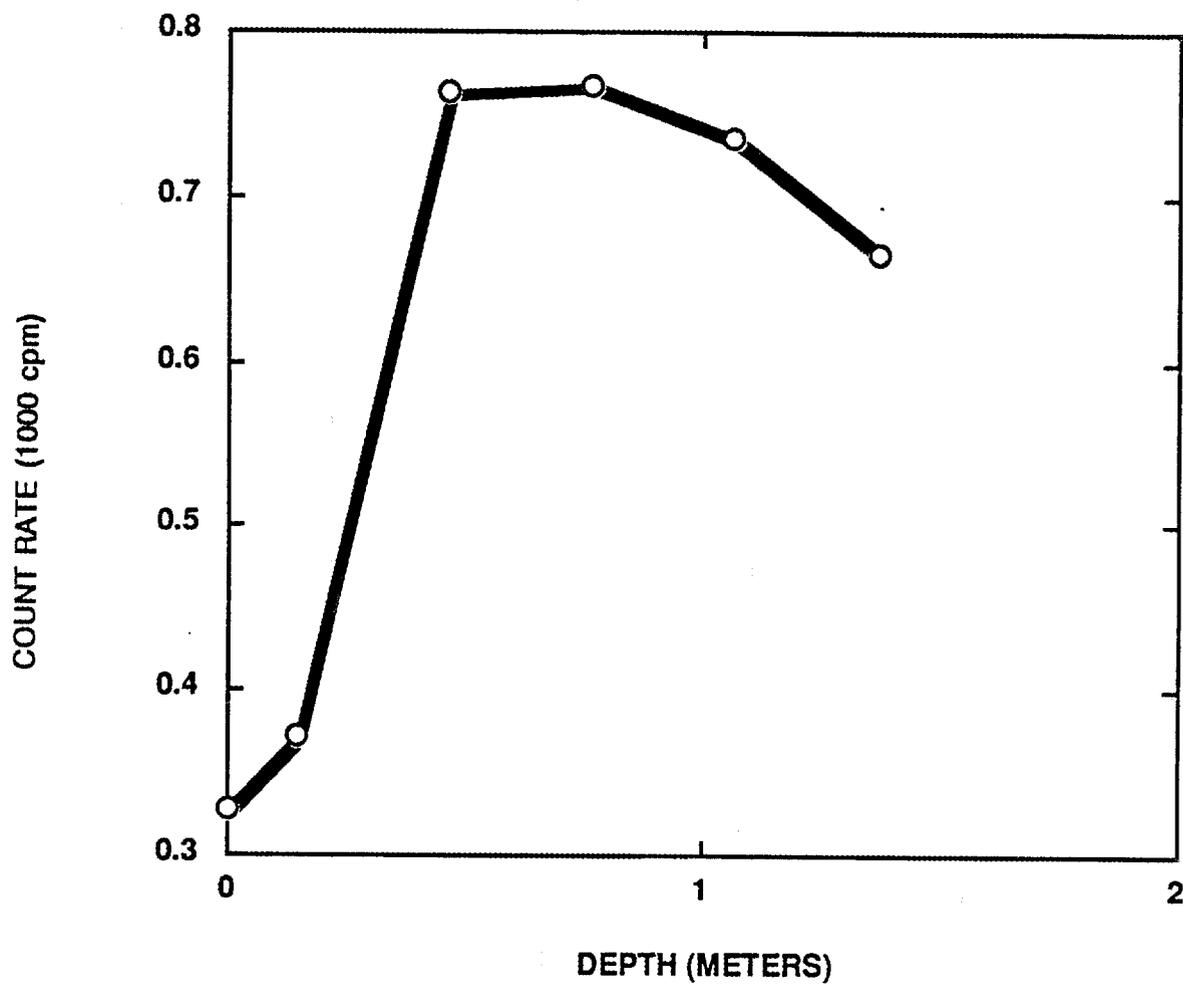


Fig. 43. Gamma profile for auger hole 35 (A35) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13107

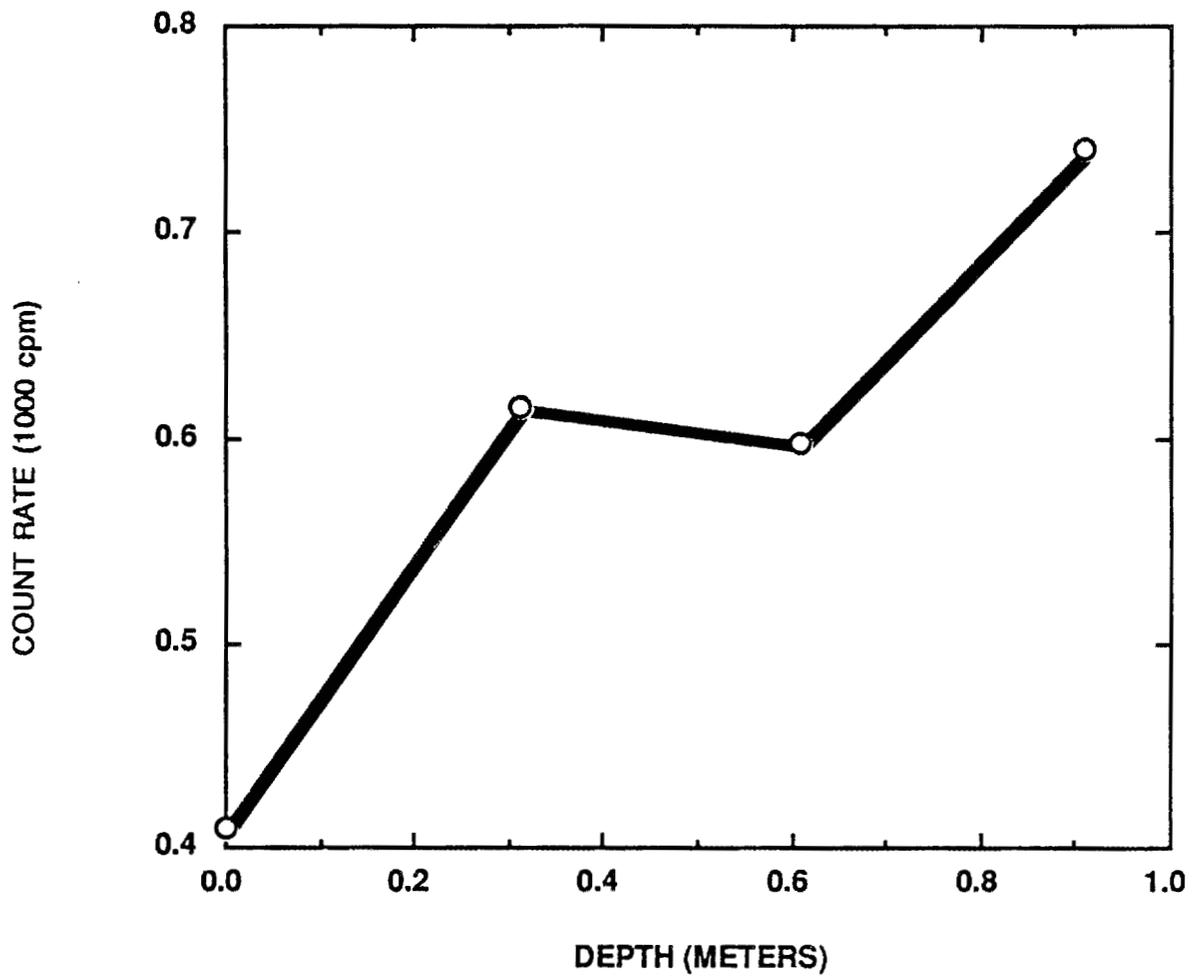


Fig. 44. Gamma profile for auger hole 36 (A36) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13108

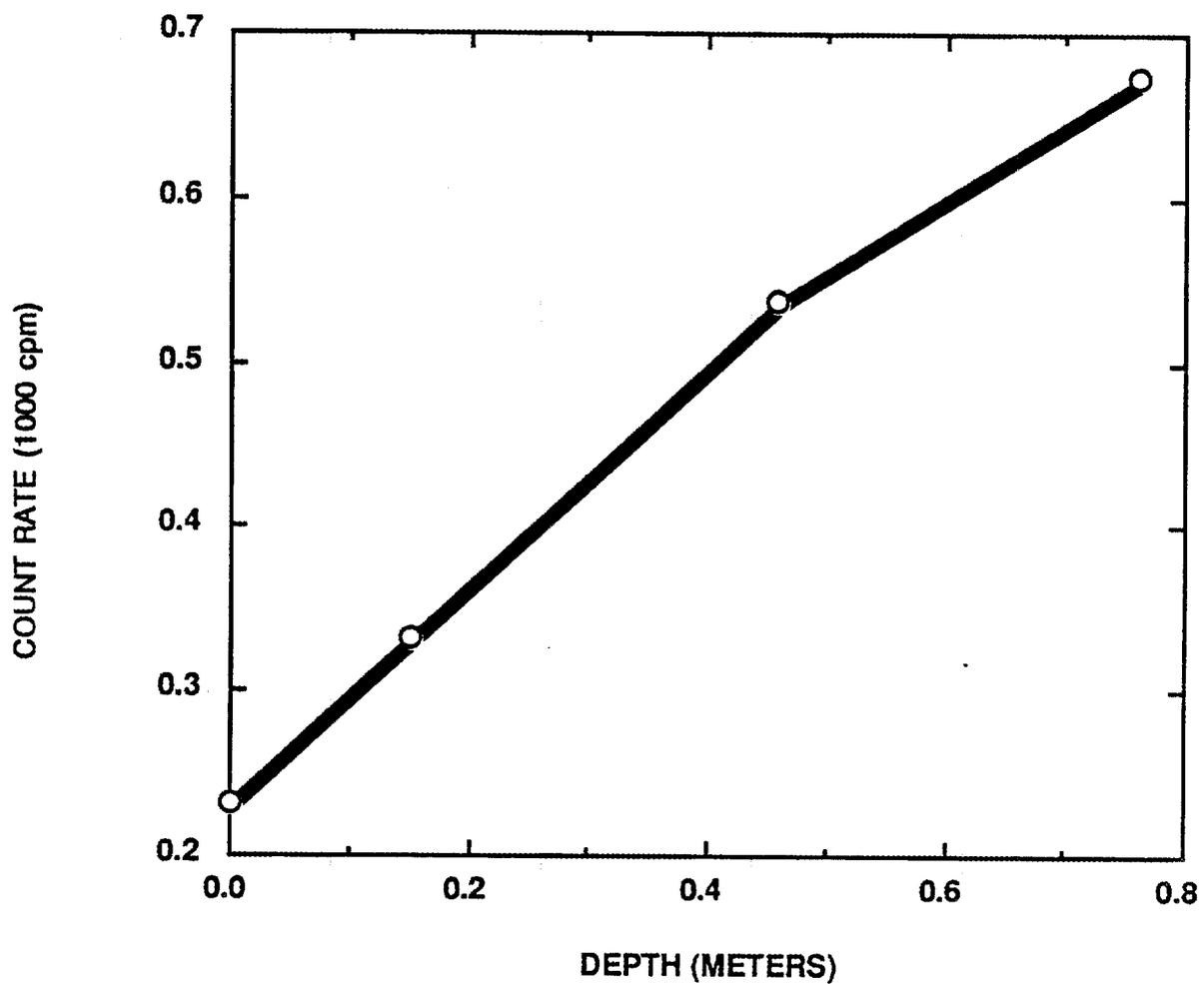


Fig. 45. Gamma profile for auger hole 37 (A37) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13109

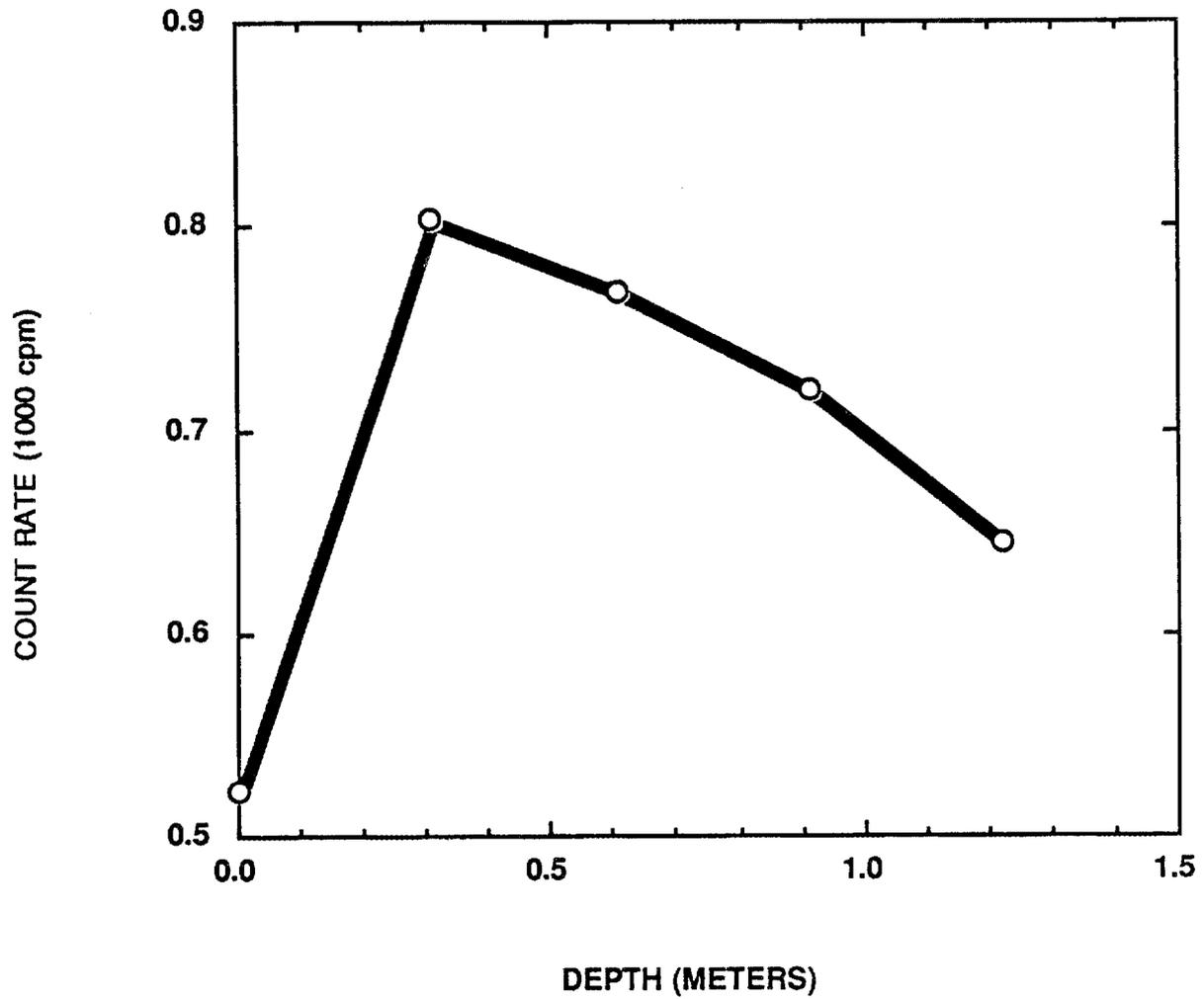


Fig. 46. Gamma profile for auger hole 38 (A38) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13110

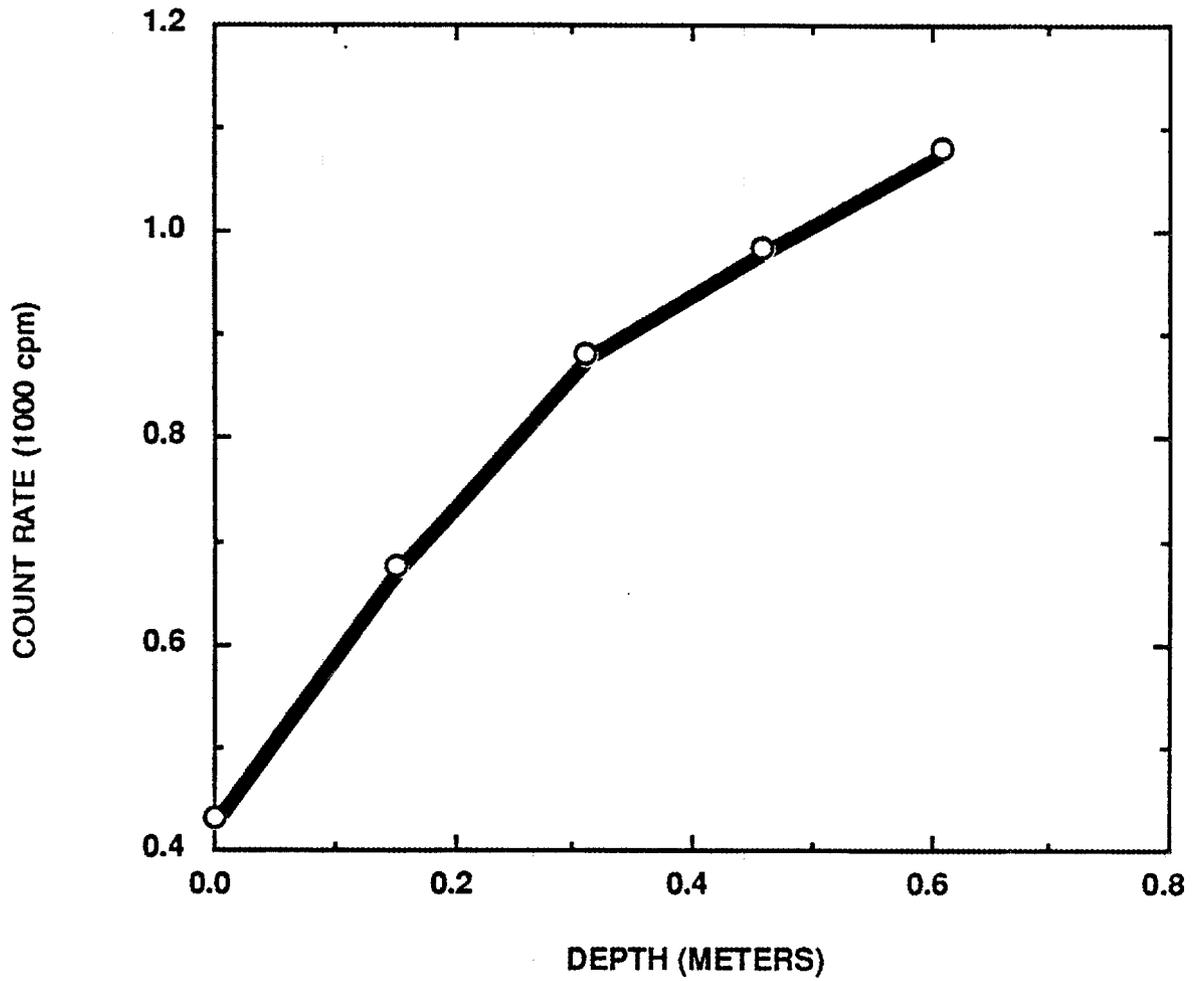


Fig. 47. Gamma profile for auger hole 39 (A39) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13111

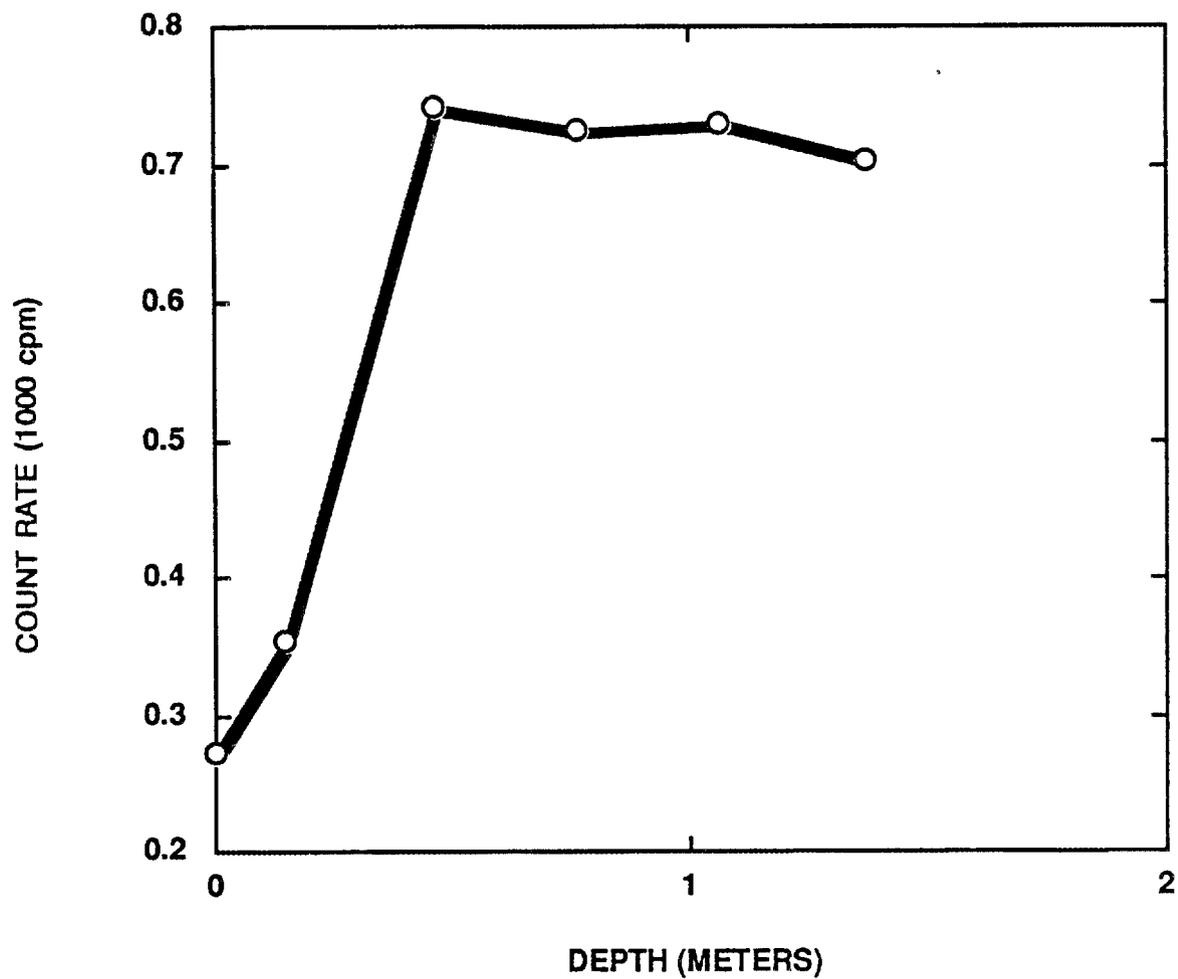


Fig. 48. Gamma profile for auger hole 40 (A40) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13112

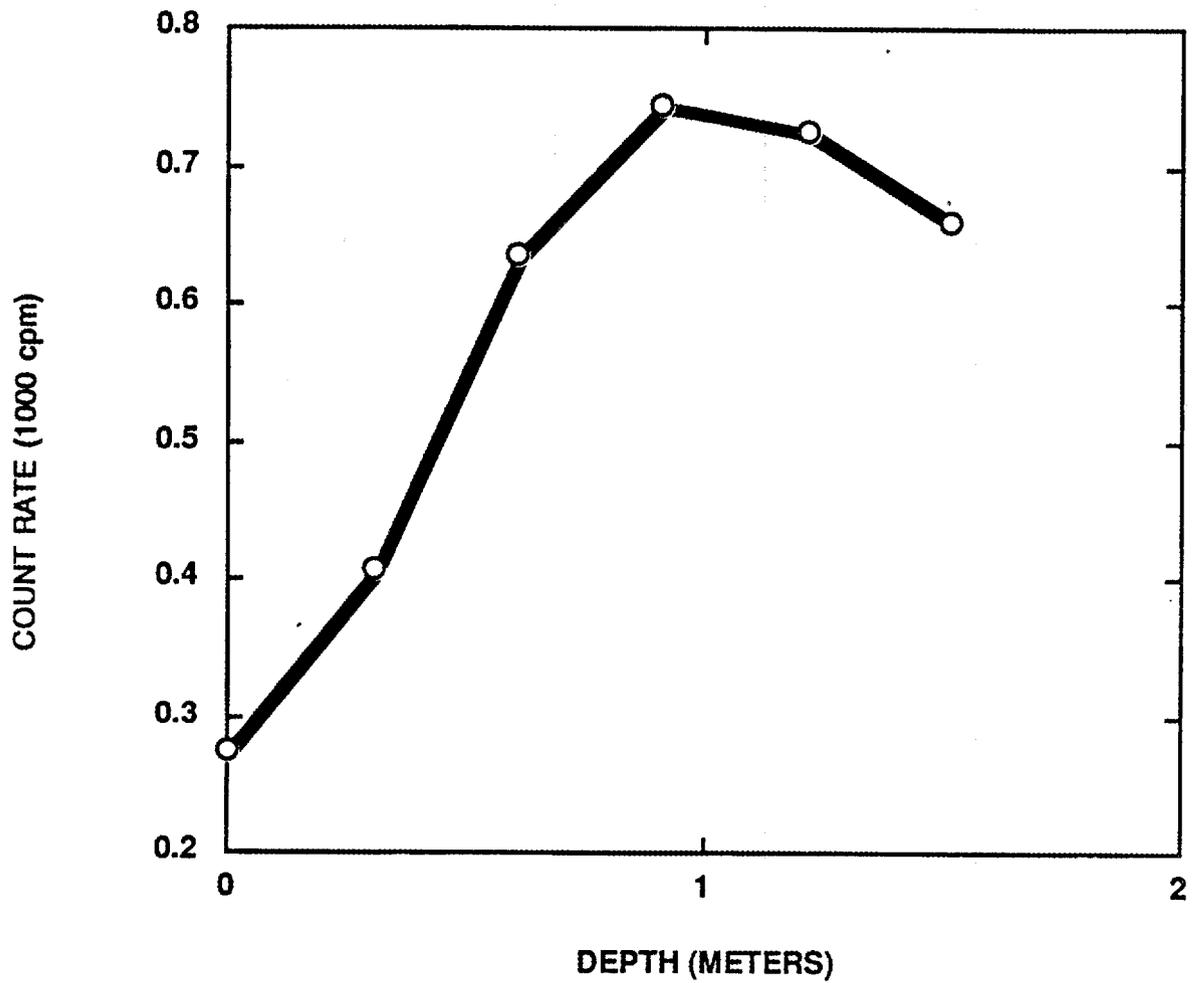


Fig. 49. Gamma profile for auger hole 41 (A41) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13113

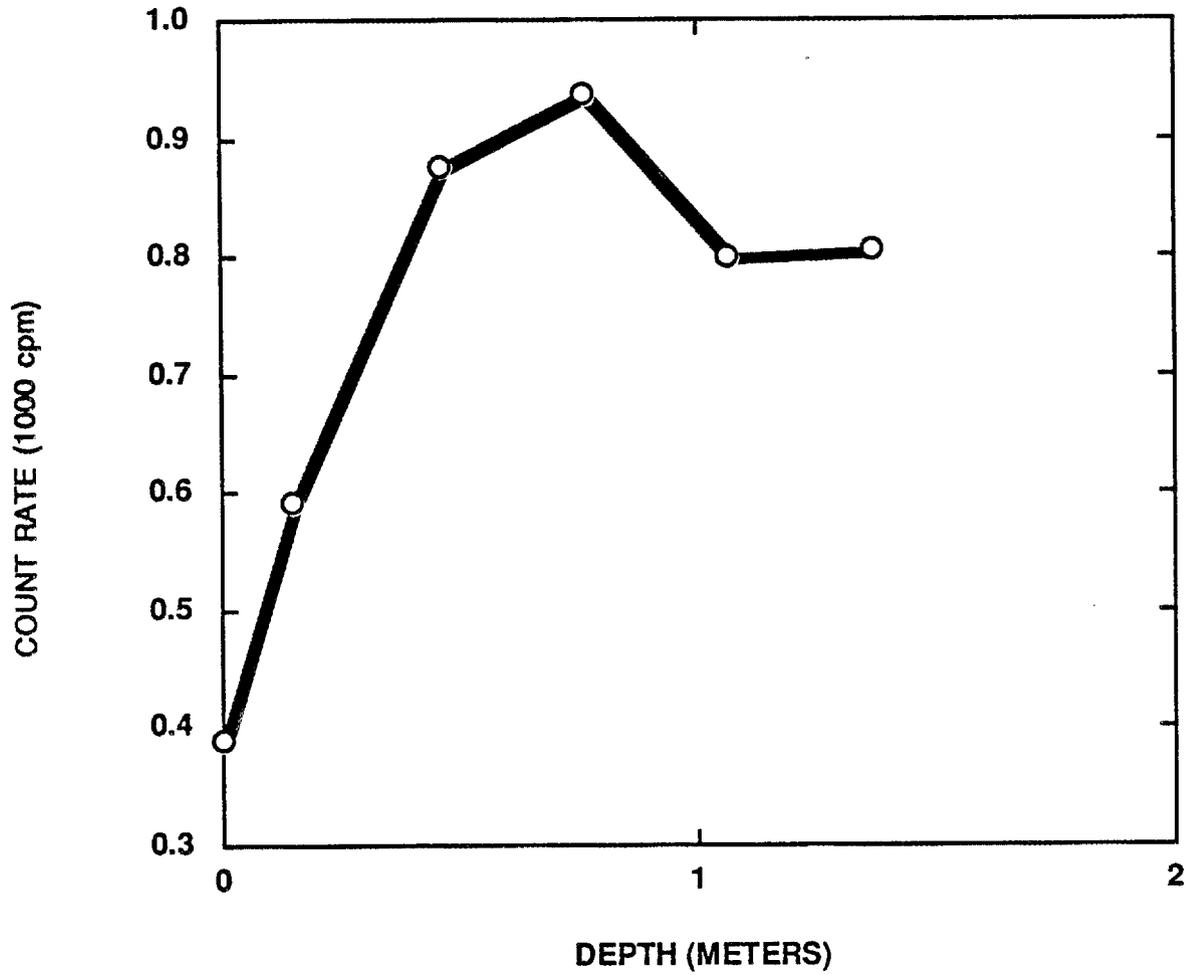


Fig. 50. Gamma profile for auger hole 42 (A42) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13114

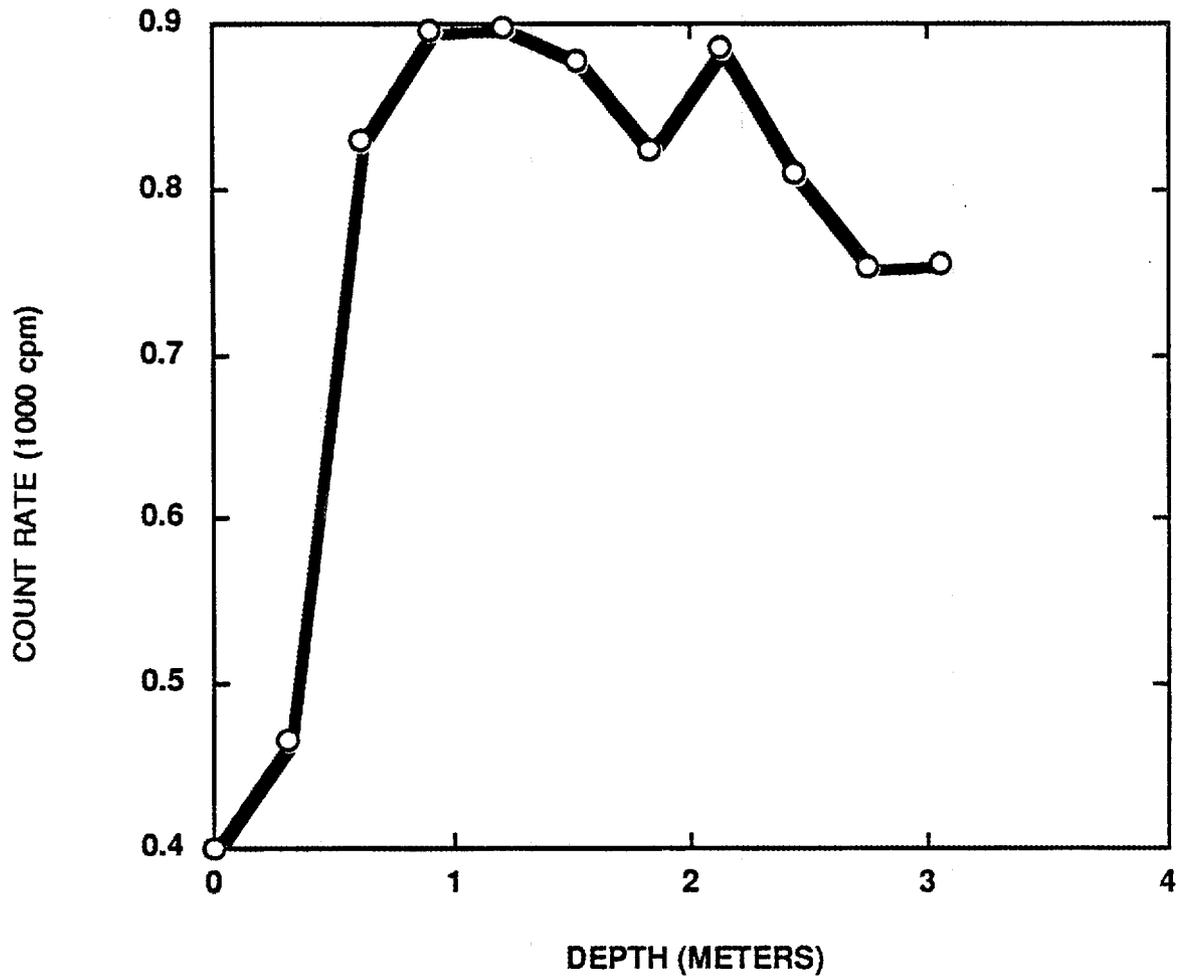


Fig. 51. Gamma profile for auger hole 43 (A43) at the former ore storage site, Palmerton, Pennsylvania (PP001).

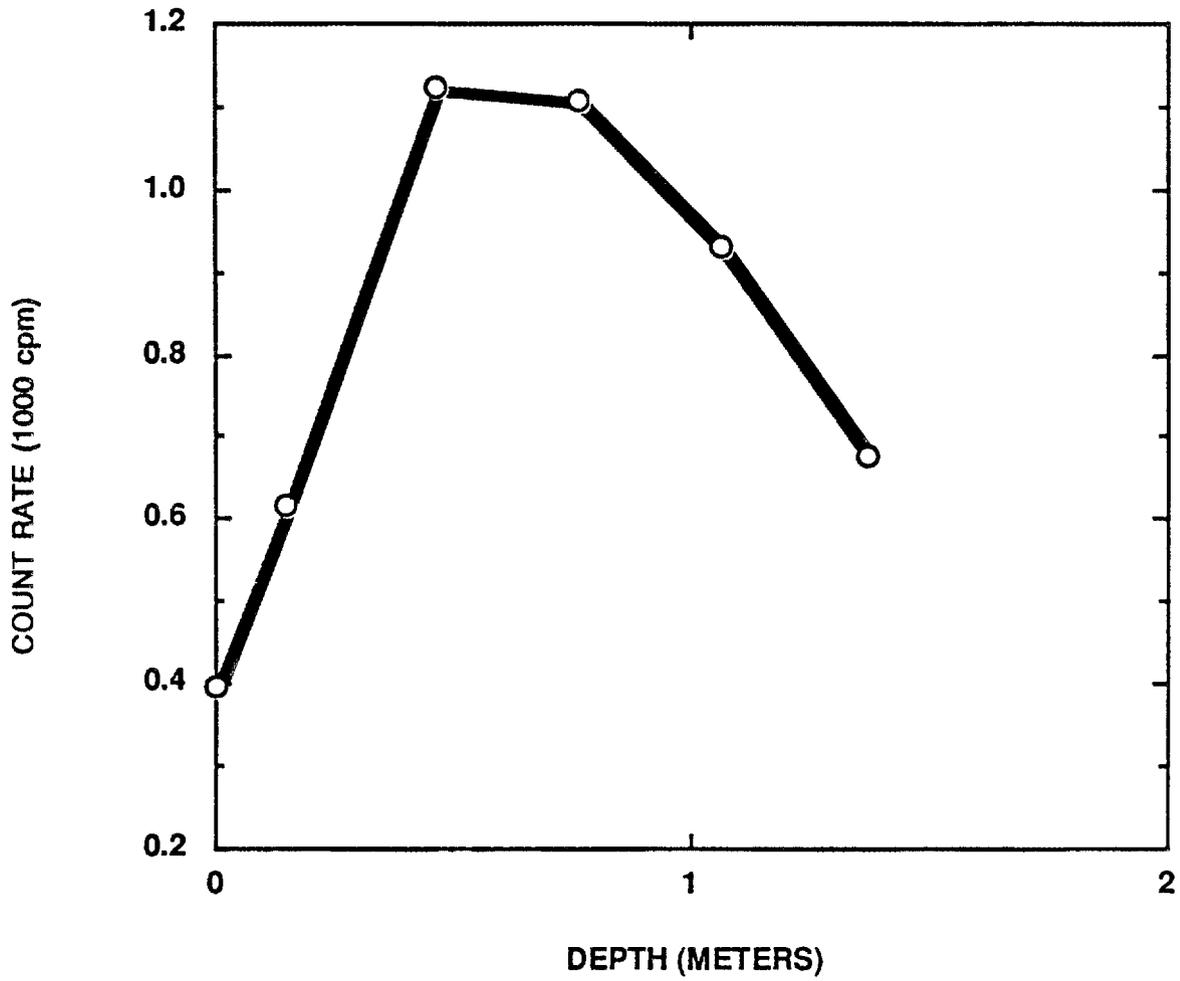


Fig. 52. Gamma profile for auger hole 44 (A44) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13117

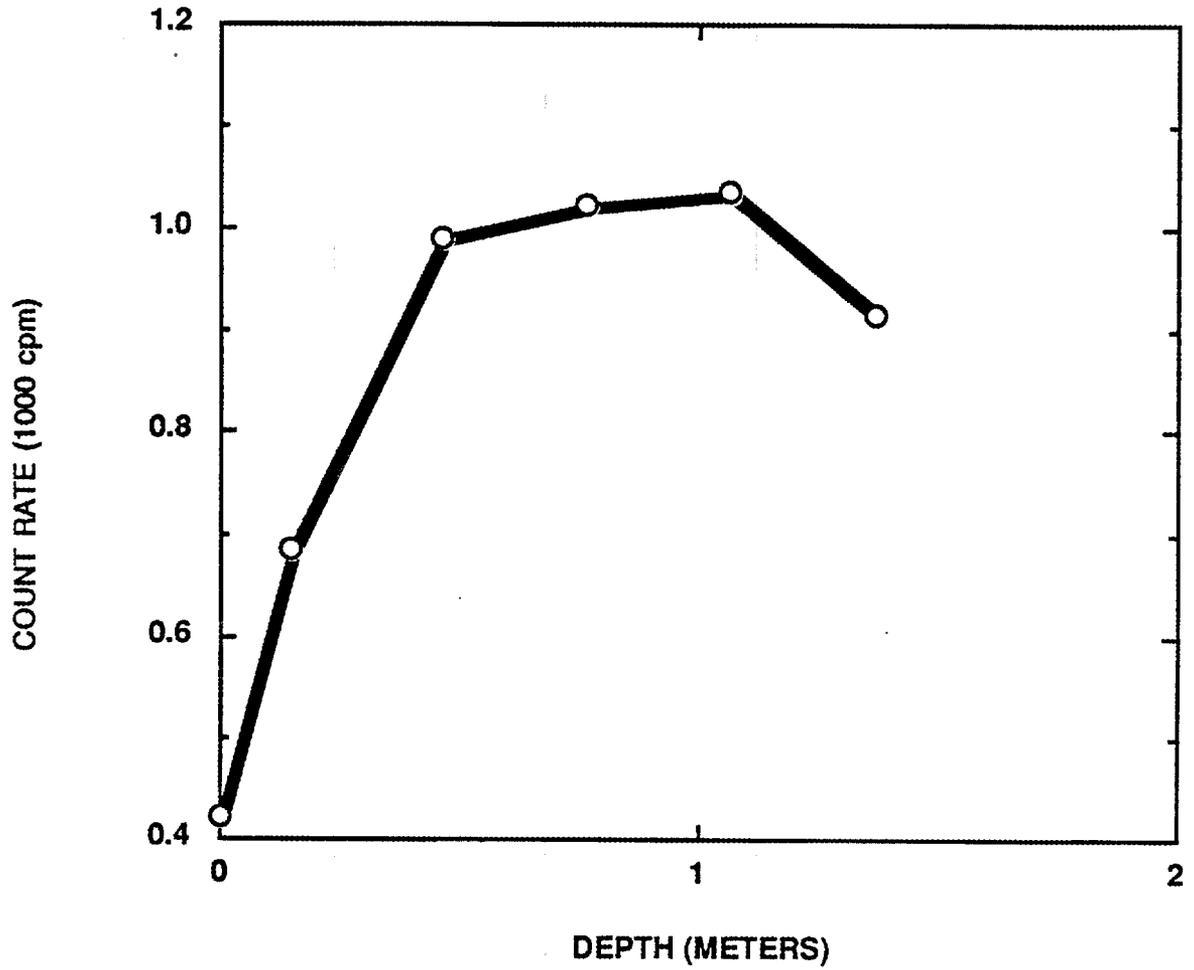


Fig. 53. Gamma profile for auger hole 45 (A45) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13118

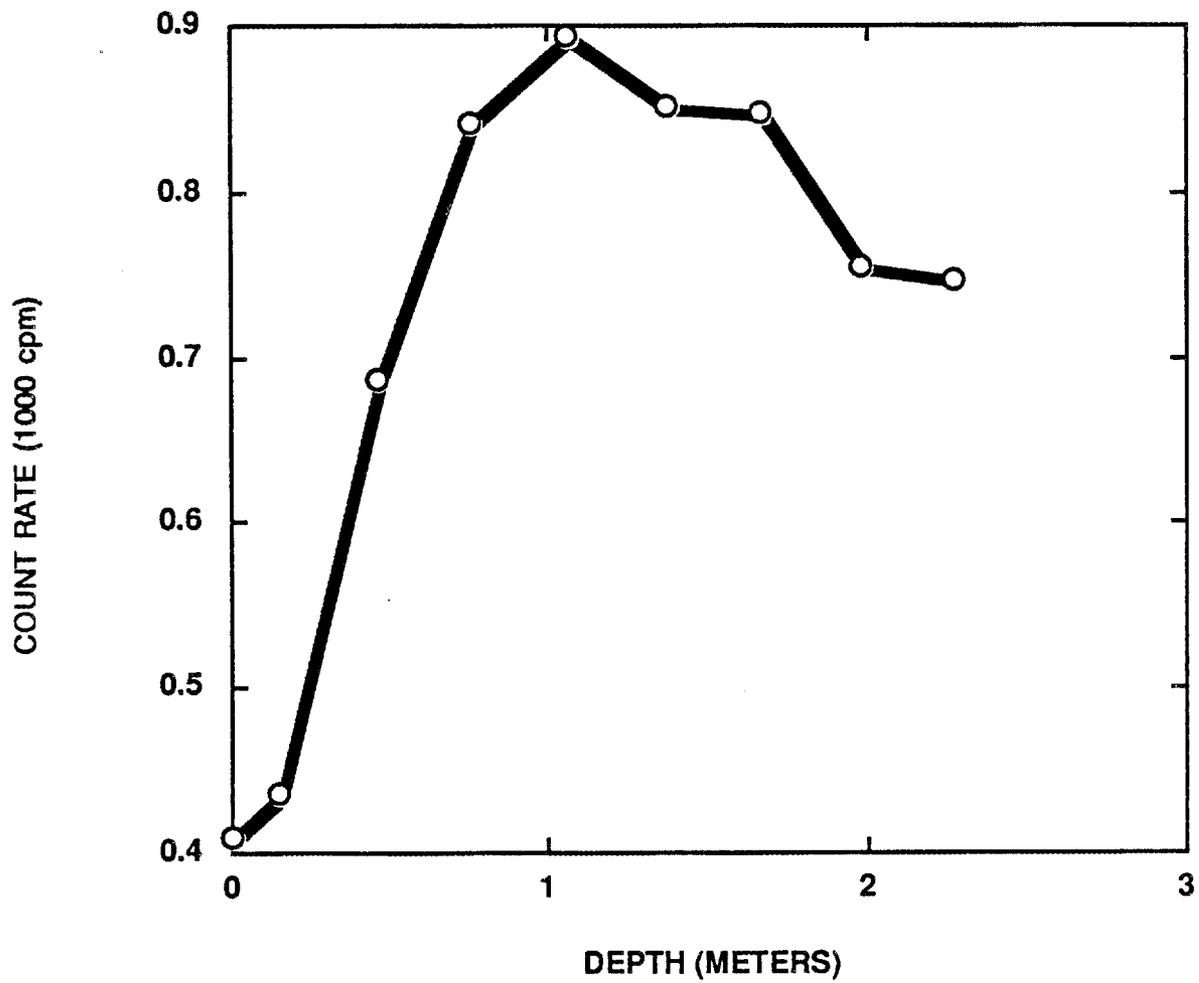


Fig. 54. Gamma profile for auger hole 46 (A46) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13120

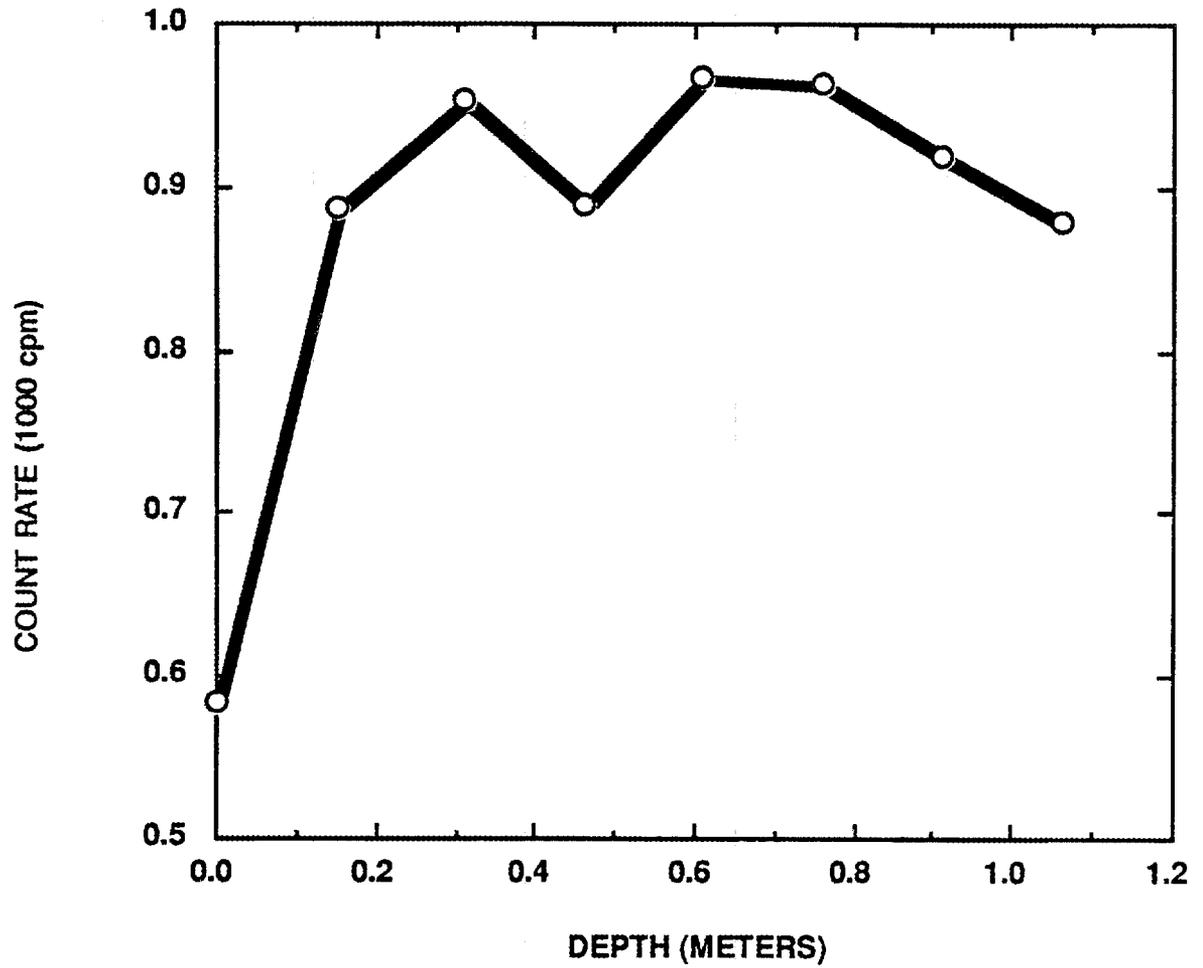


Fig. 55. Gamma profile for auger hole 47 (A47) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13121

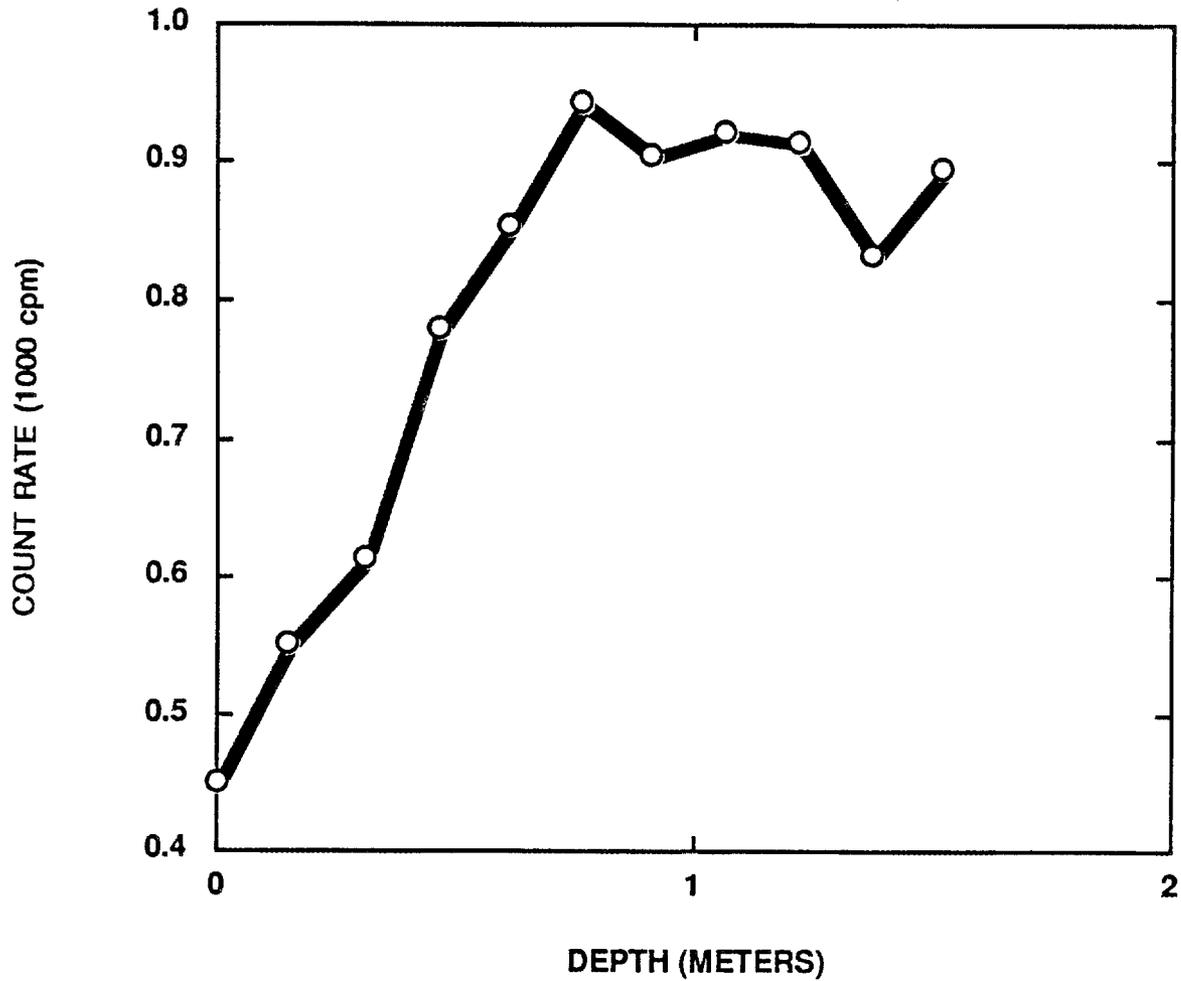


Fig. 56. Gamma profile for auger hole 48 (A48) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13122

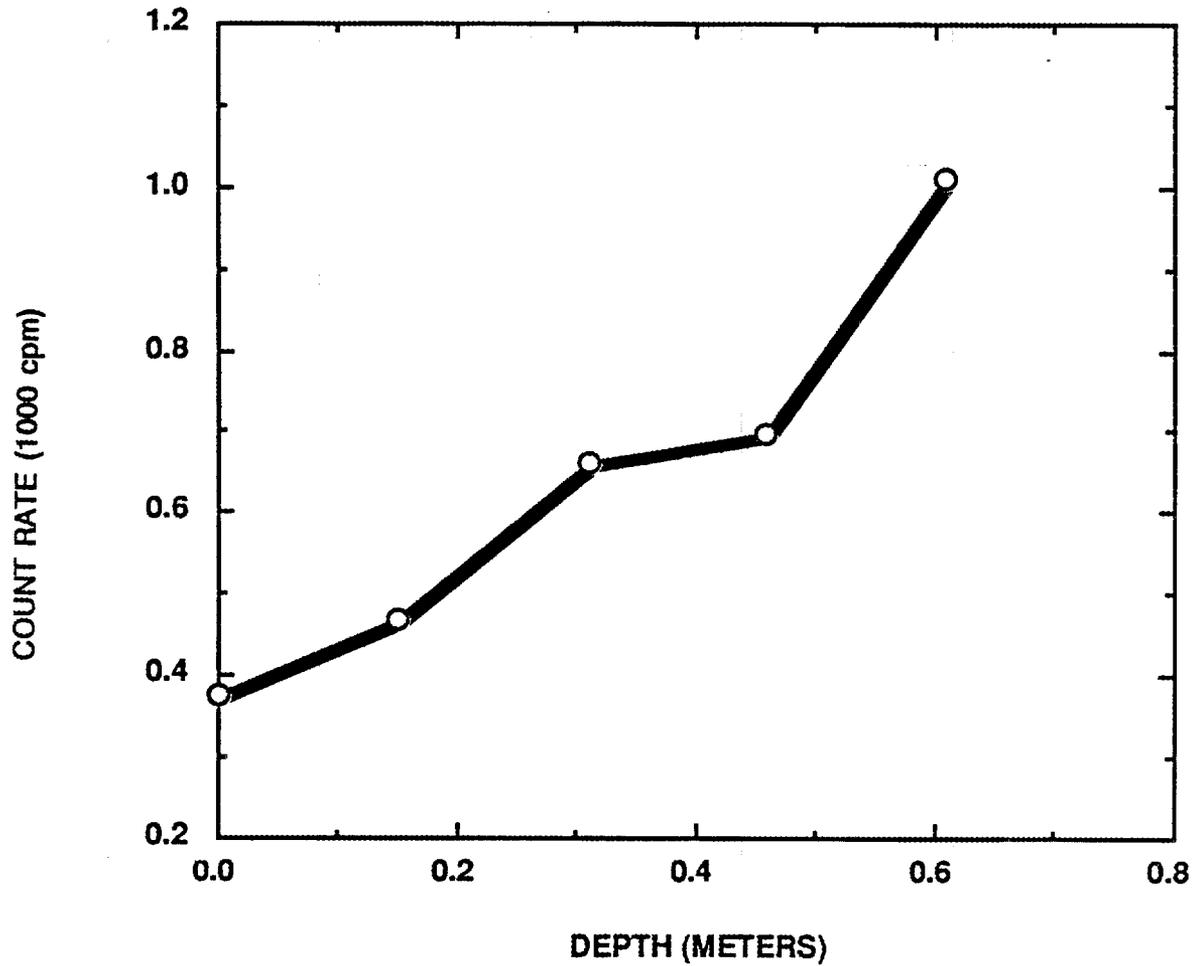


Fig. 57. Gamma profile for auger hole 49 (A49) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13123

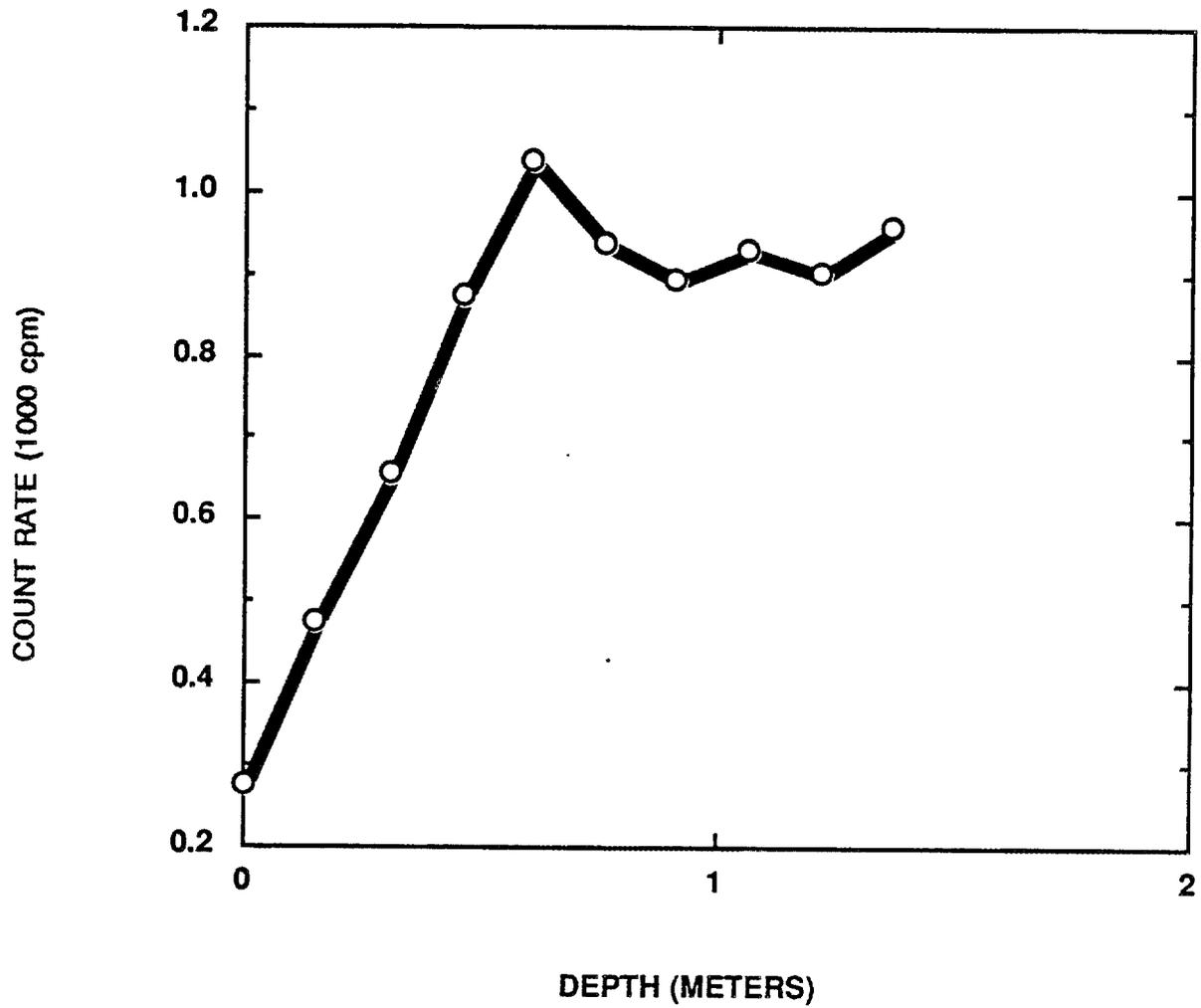


Fig. 58. Gamma profile for auger hole 50 (A50) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13124

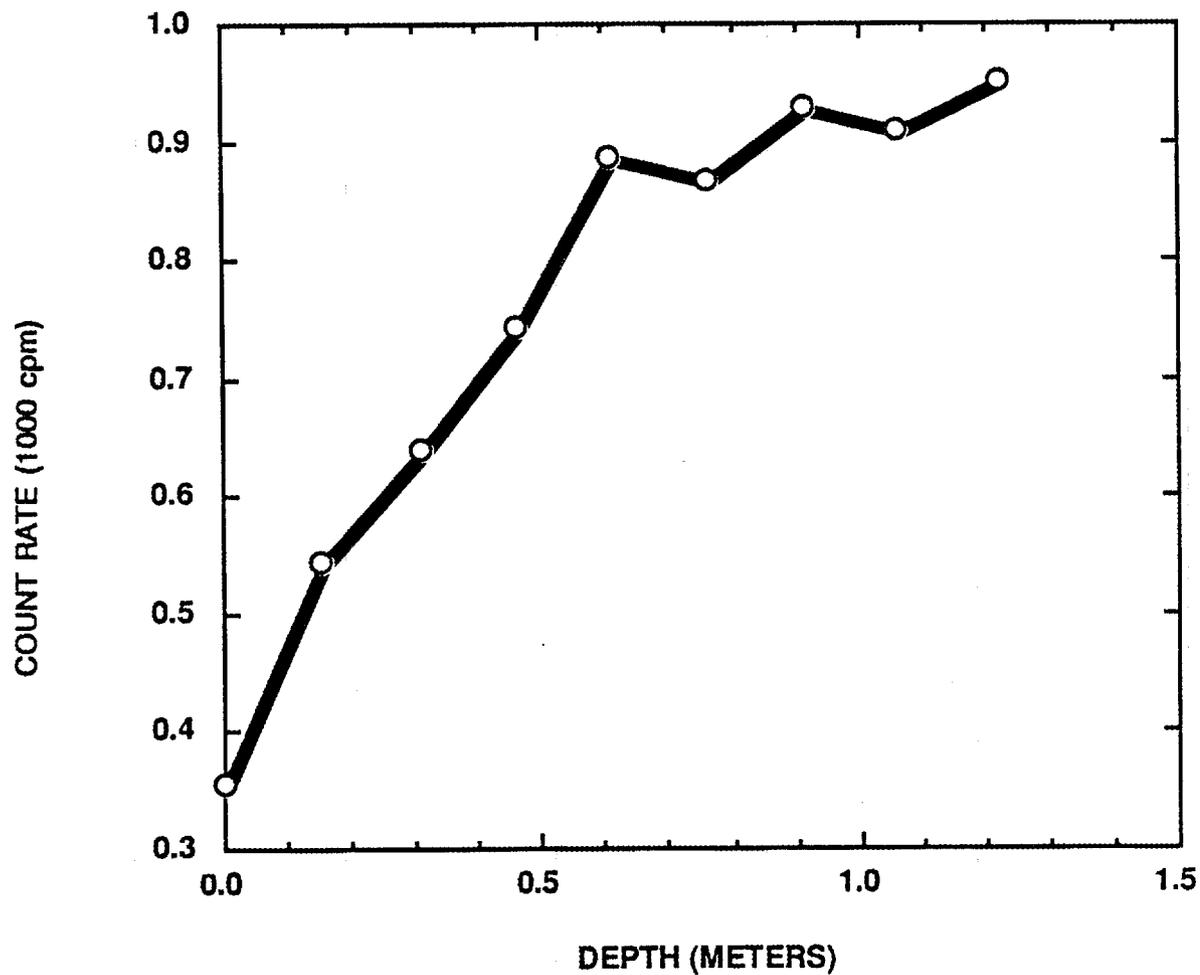


Fig. 59. Gamma profile for auger hole 51 (A51) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DGW 89-13125

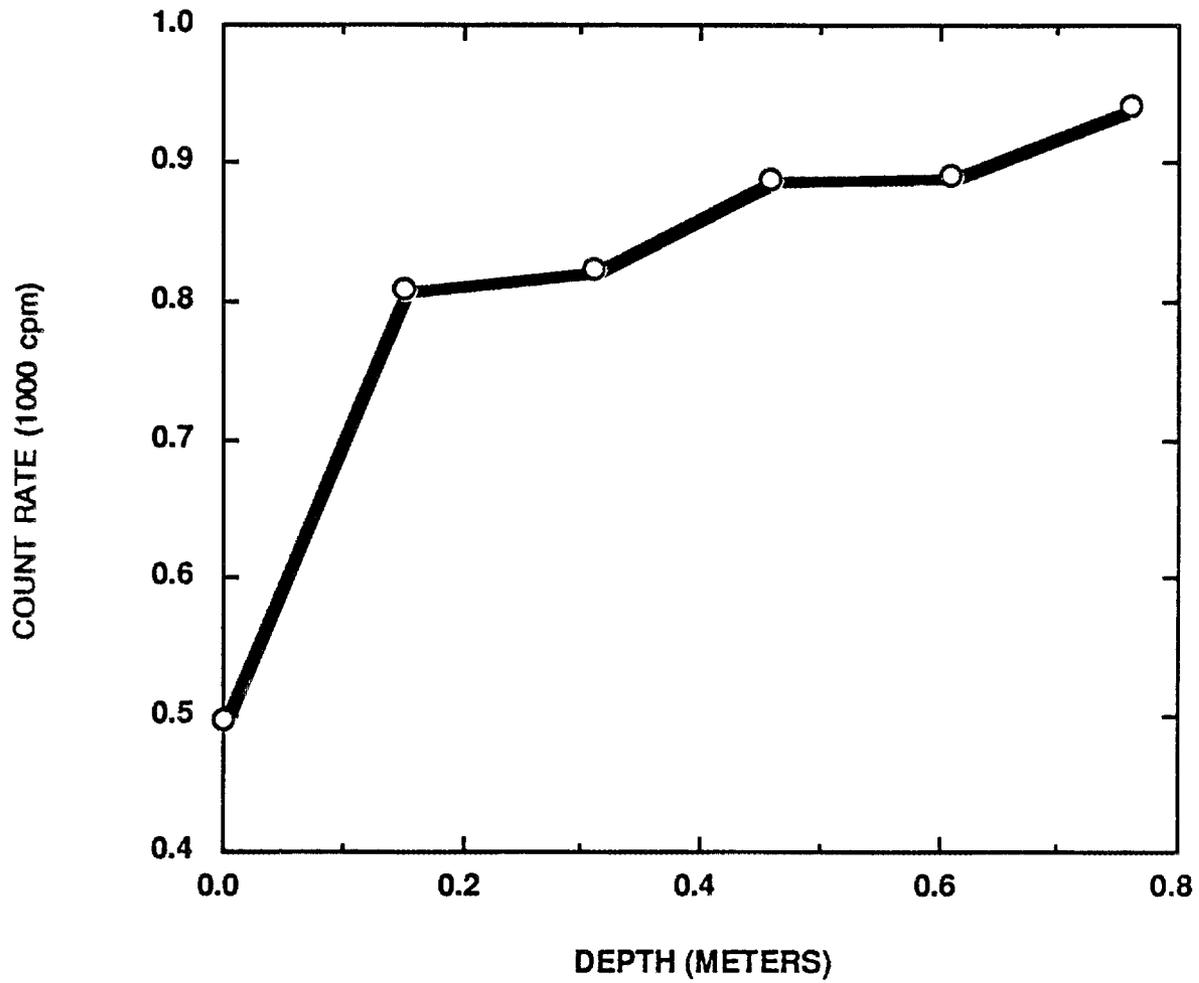


Fig. 60. Gamma profile for auger hole 52 (A52) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13126

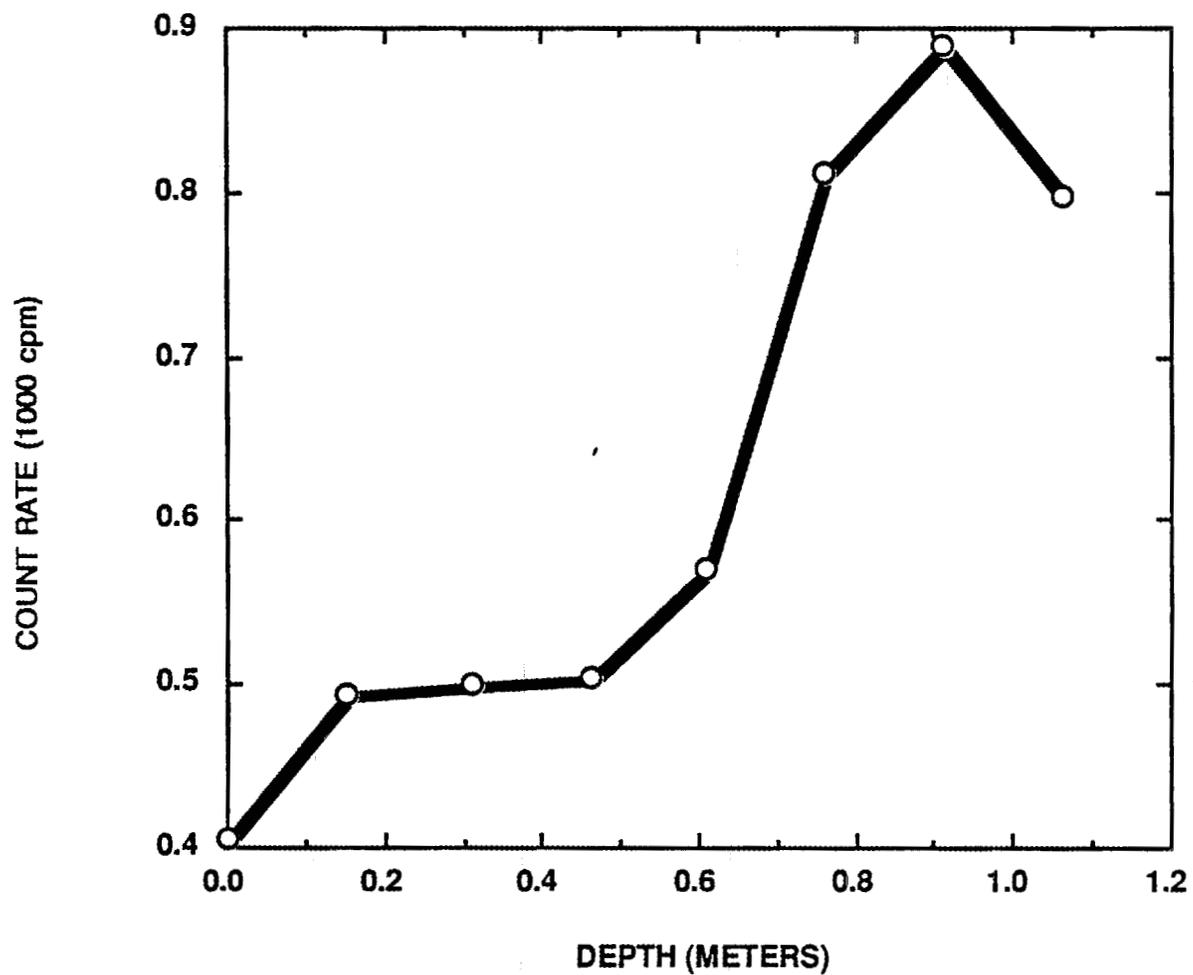


Fig. 61. Gamma profile for auger hole 53 (A53) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13127

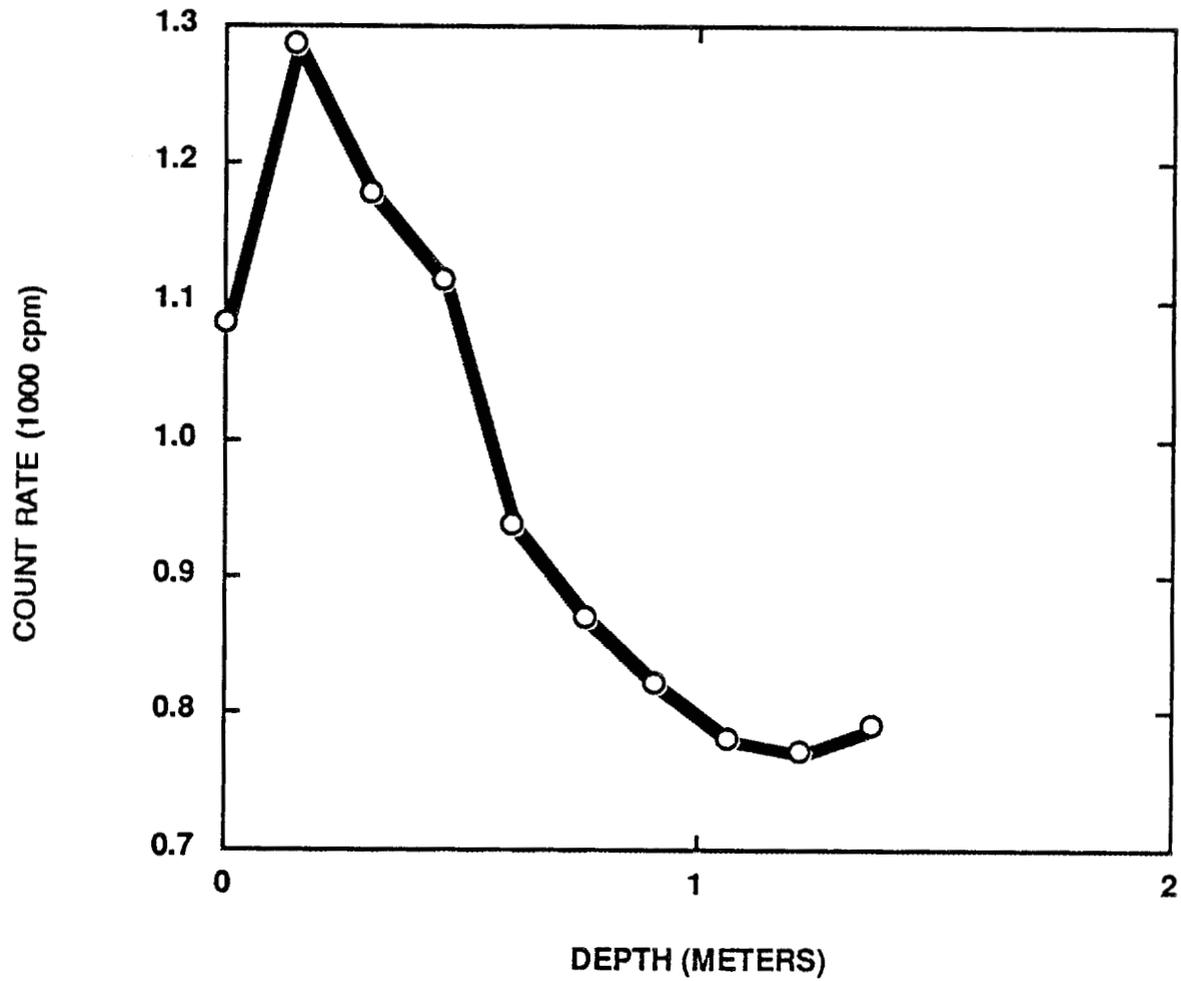


Fig. 62. Gamma profile for auger hole 54 (A54) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13128

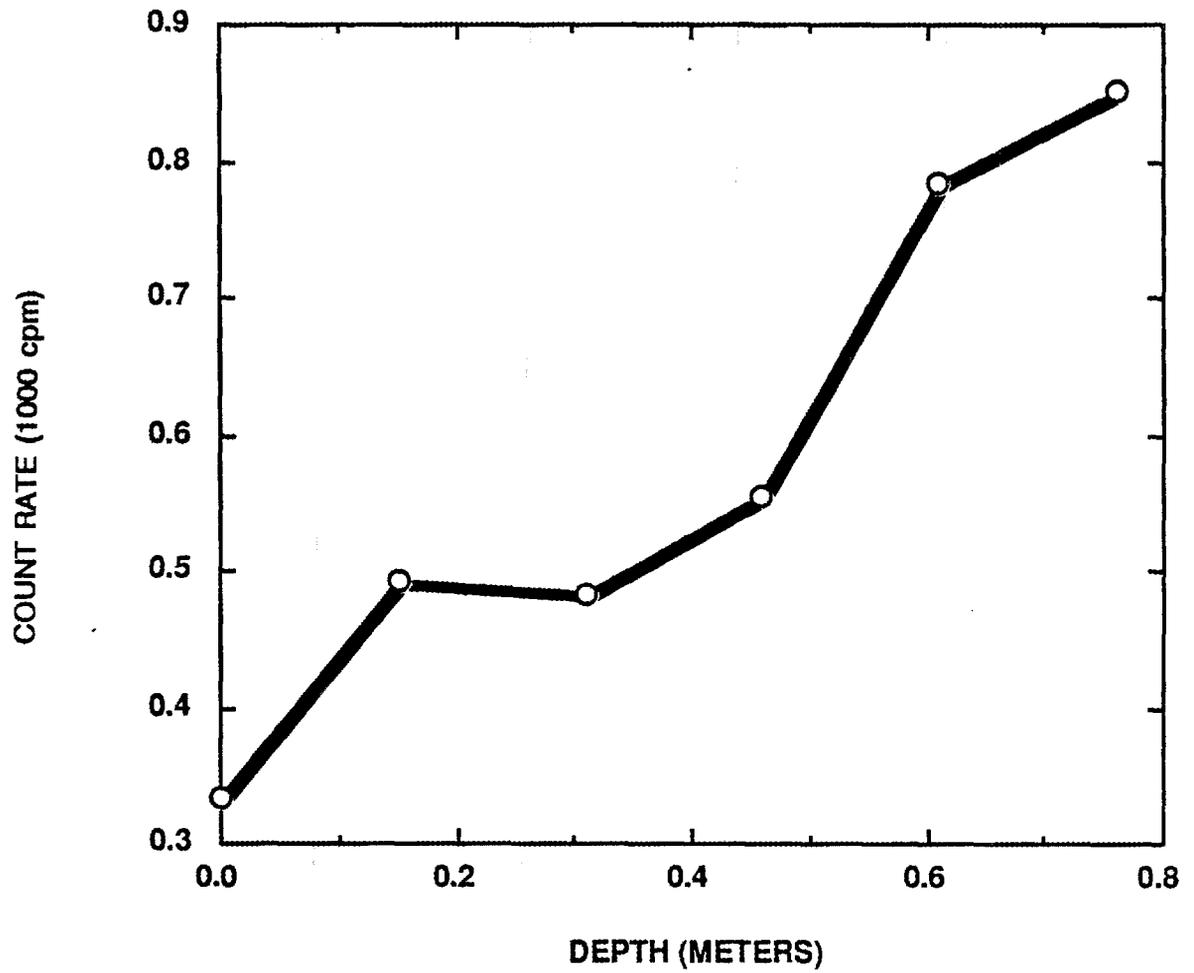


Fig. 63. Gamma profile for auger hole 55 (A55) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13129

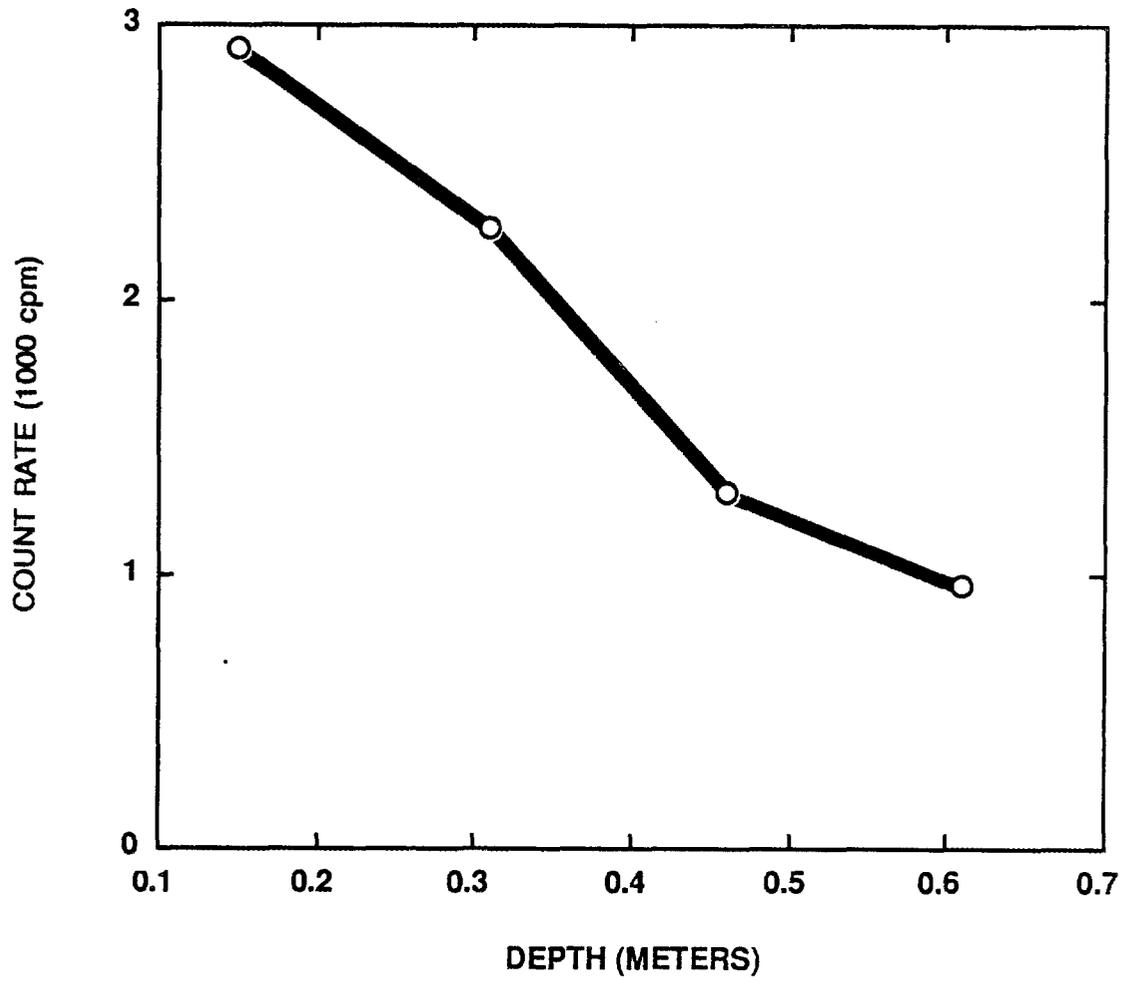


Fig. 64. Gamma profile for auger hole 56 (A56) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13130

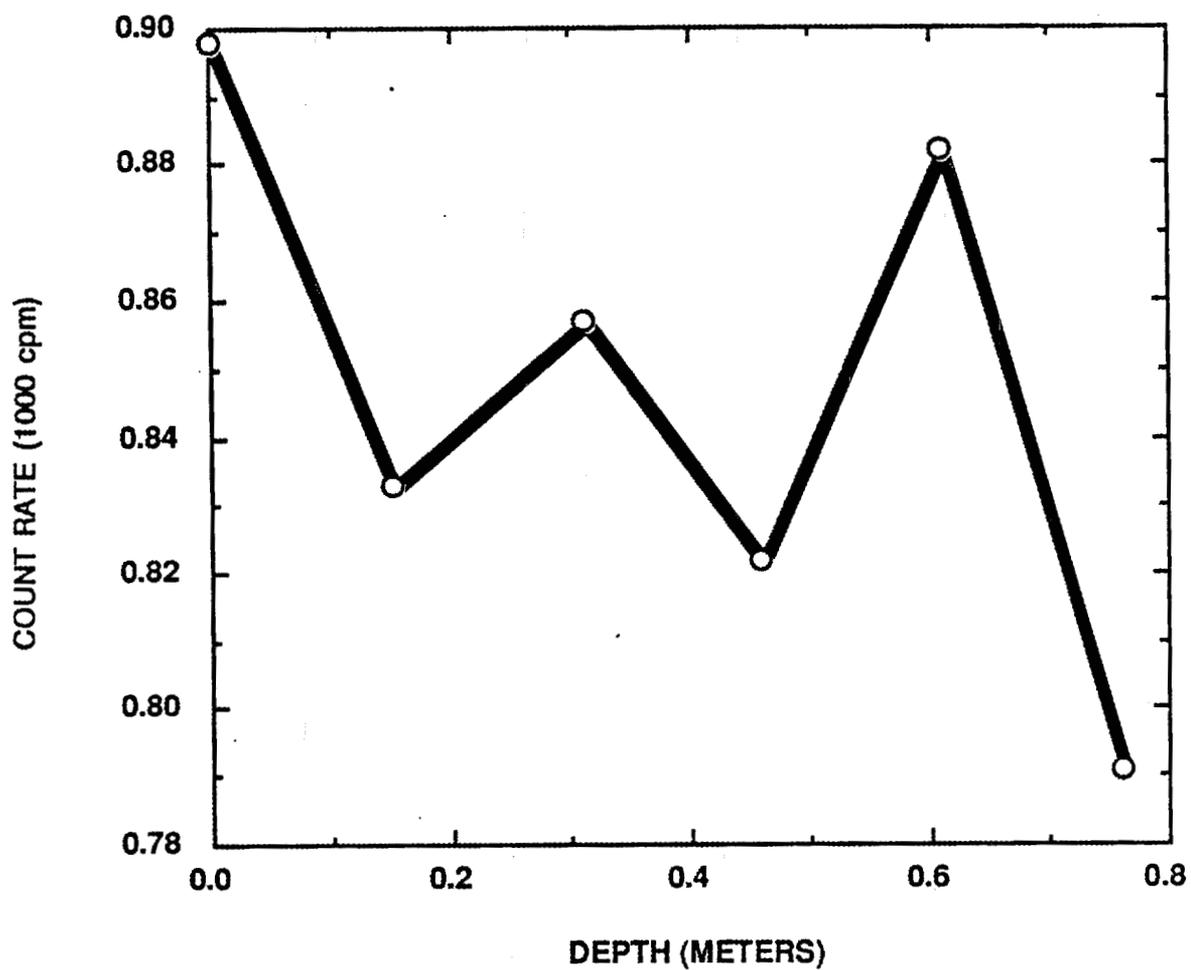


Fig. 65. Gamma profile for auger hole 57 (A57) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13131

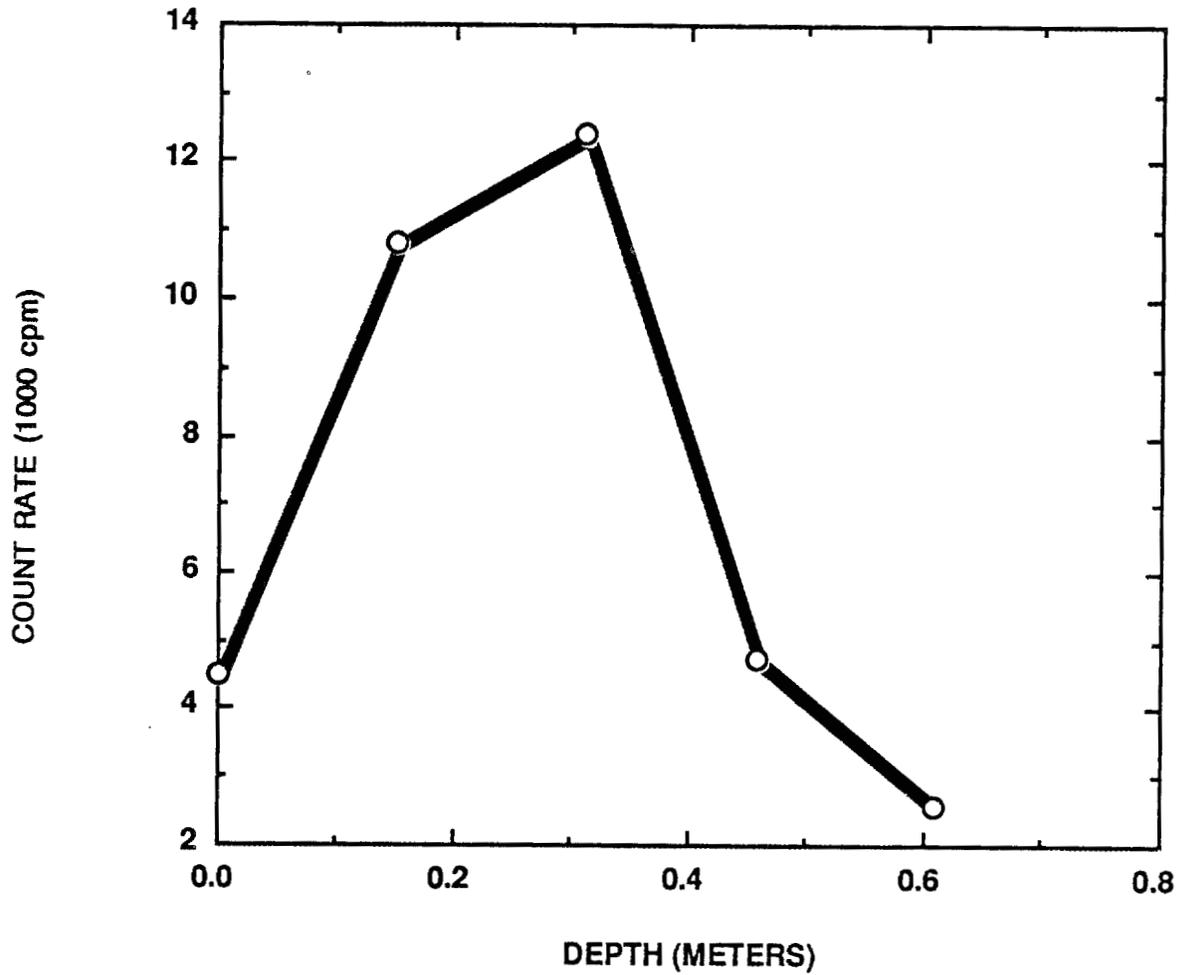


Fig. 66. Gamma profile for auger hole 58 (A58) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13189

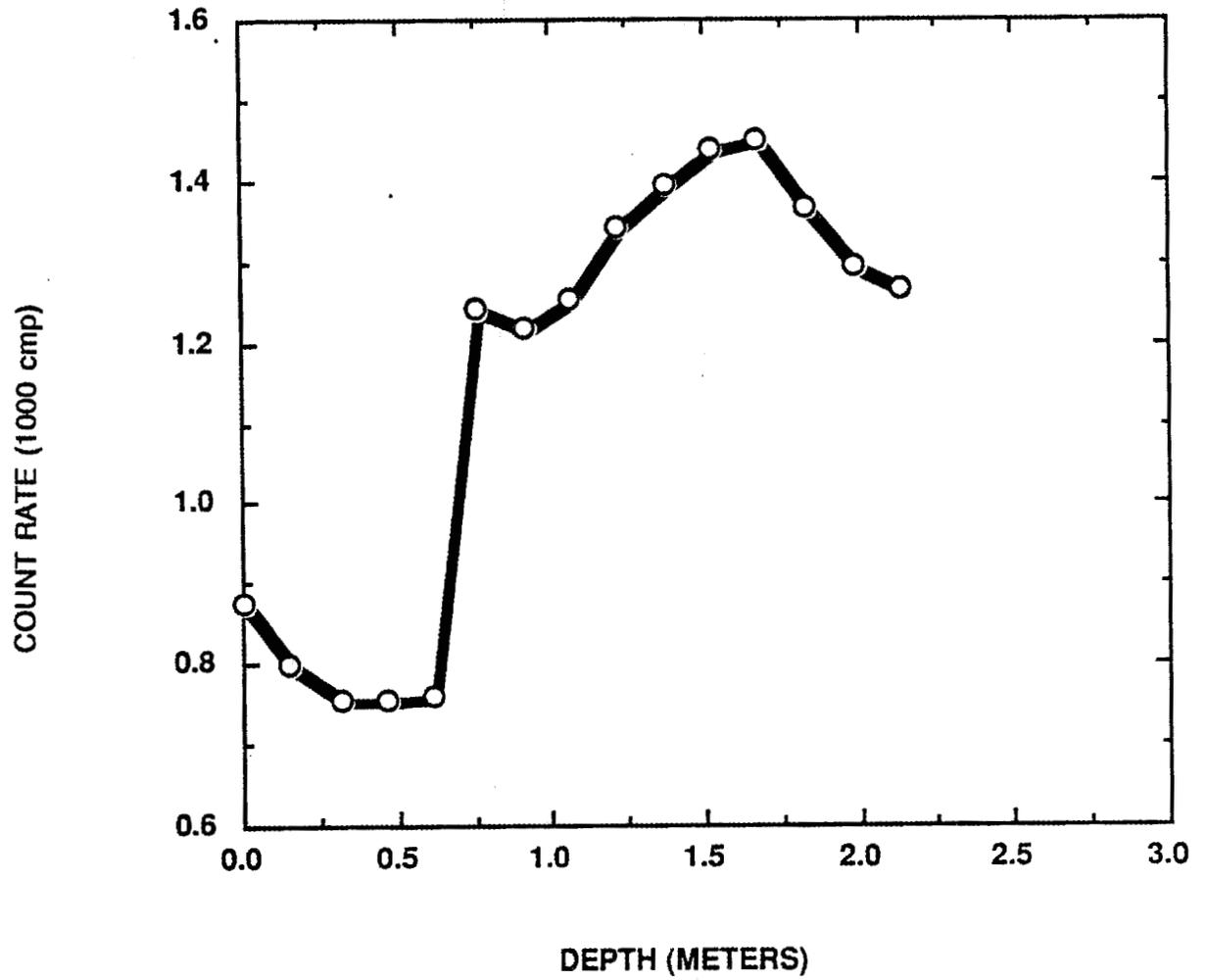


Fig. 67. Gamma profile for auger hole 59 (A59) at the former ore storage site, Palmerton, Pennsylvania (PP001).

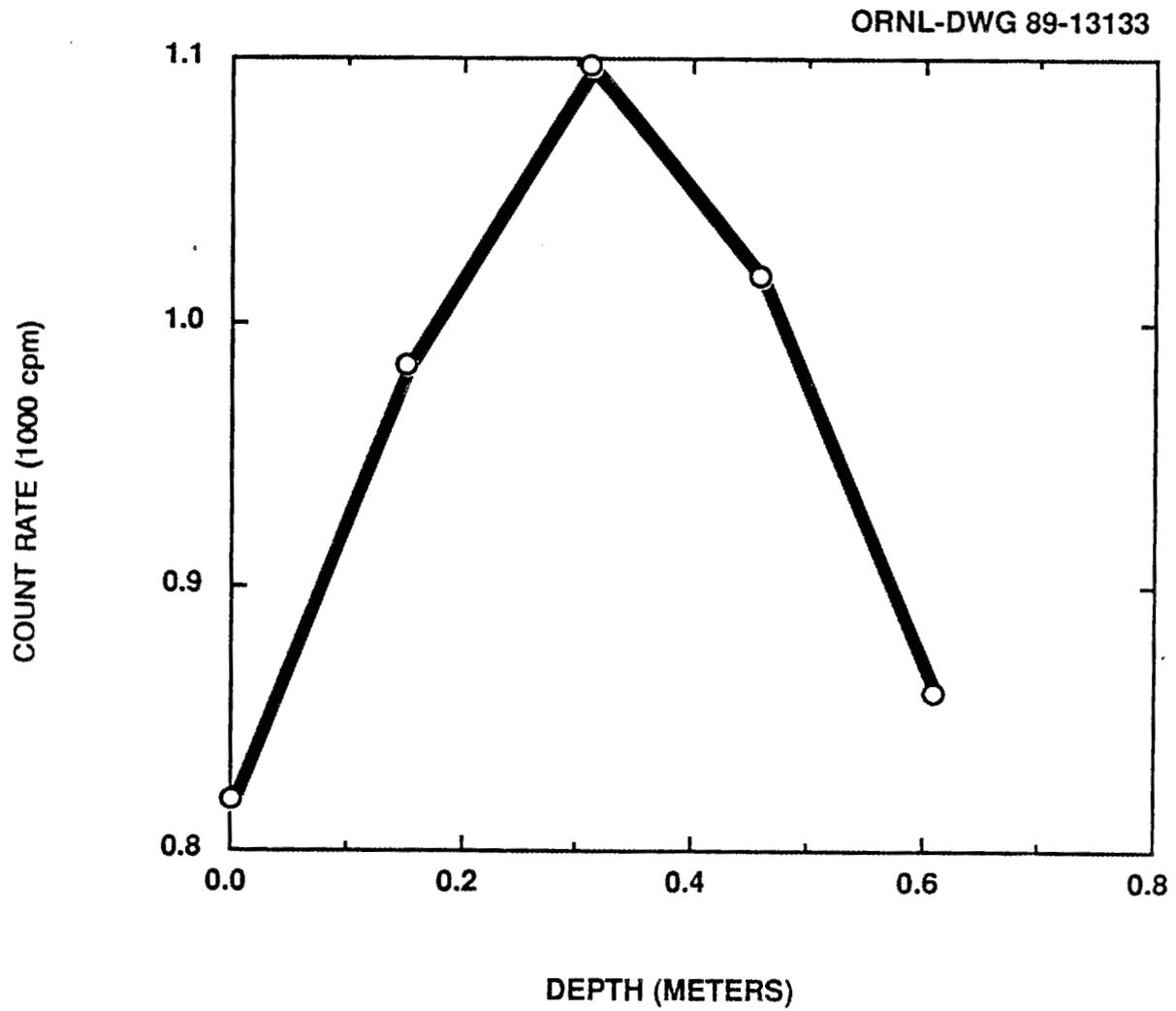


Fig. 68. Gamma profile for auger hole 60 (A60) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13134

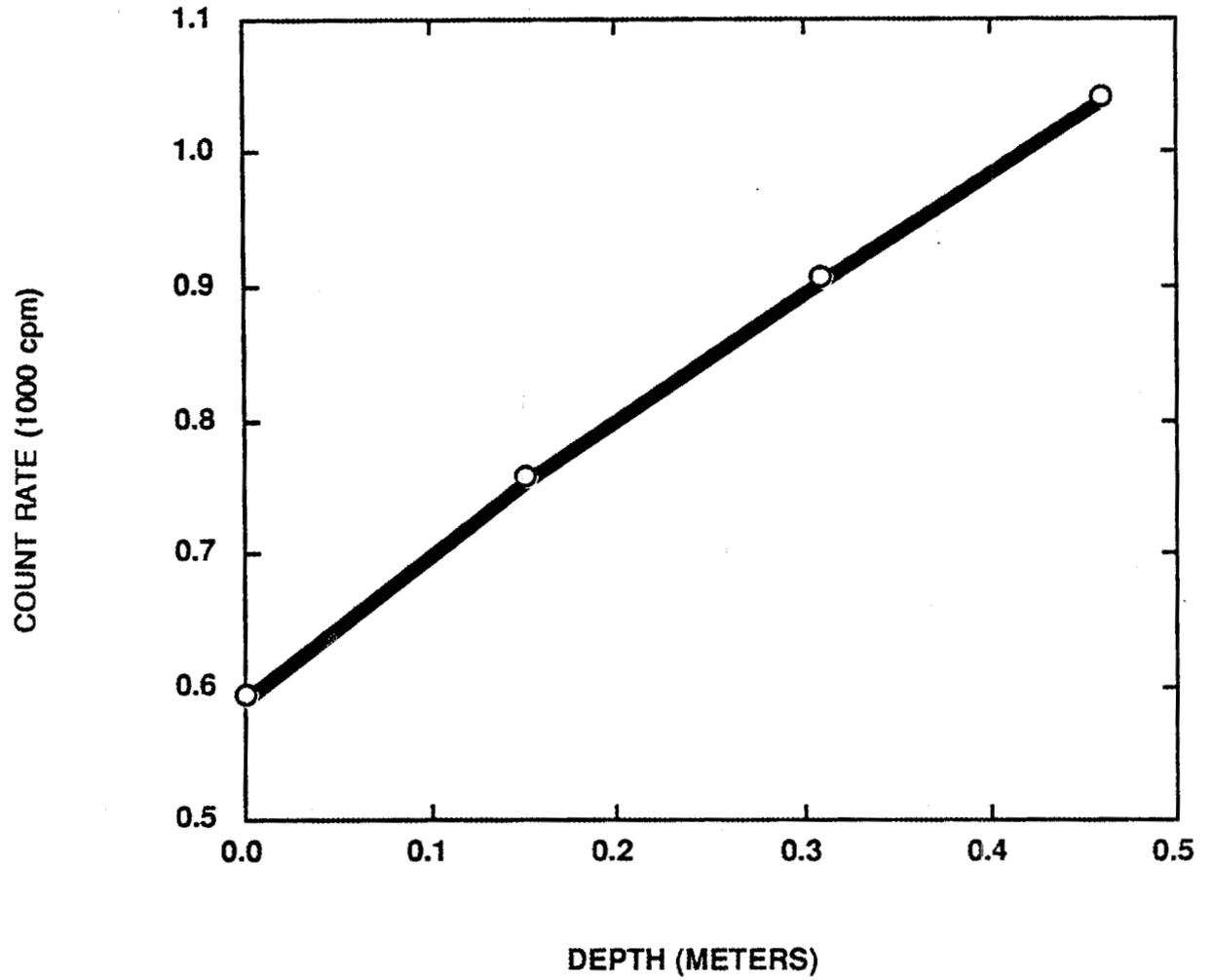


Fig. 69. Gamma profile for auger hole 61 (A61) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13135

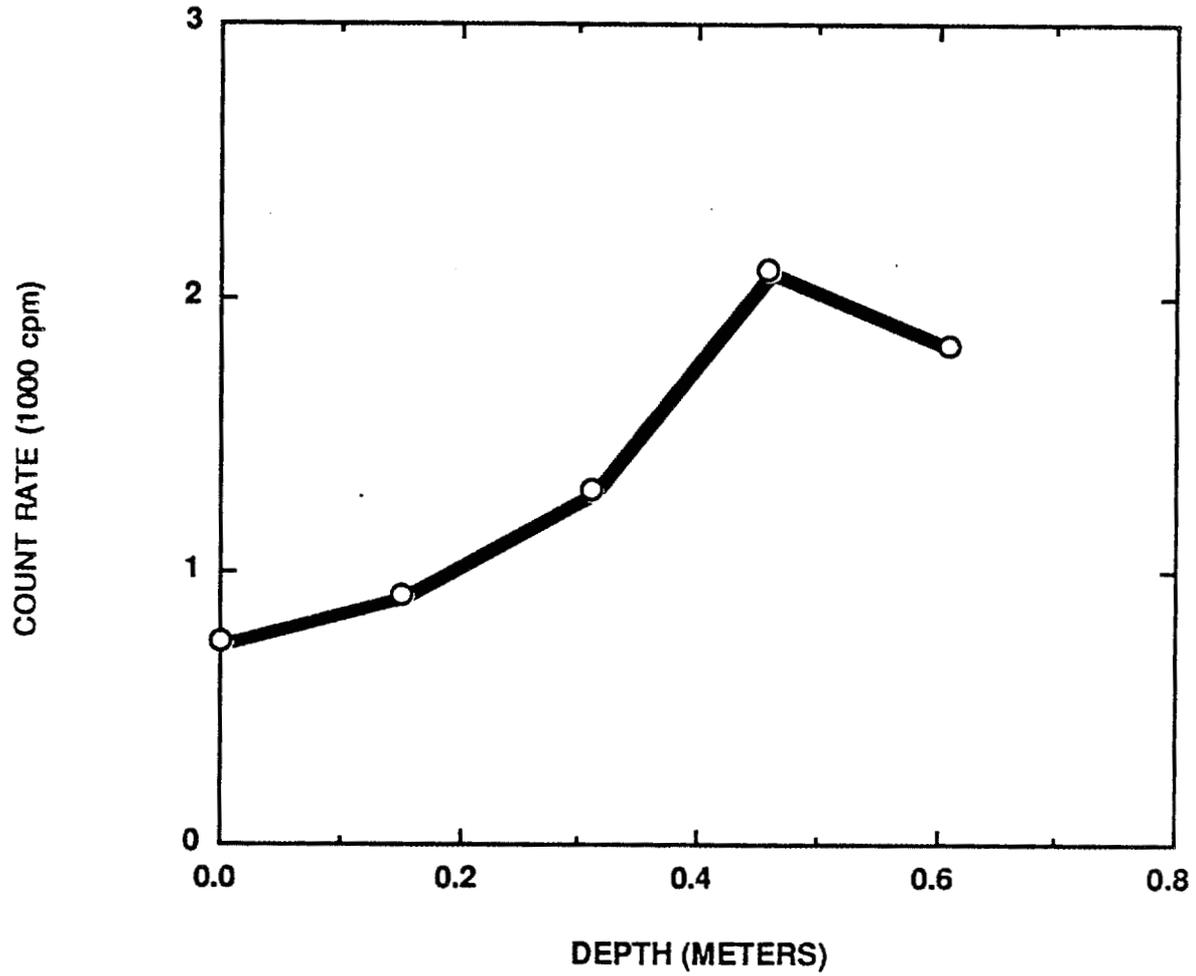


Fig. 70. Gamma profile for auger hole 62 (A62) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13136

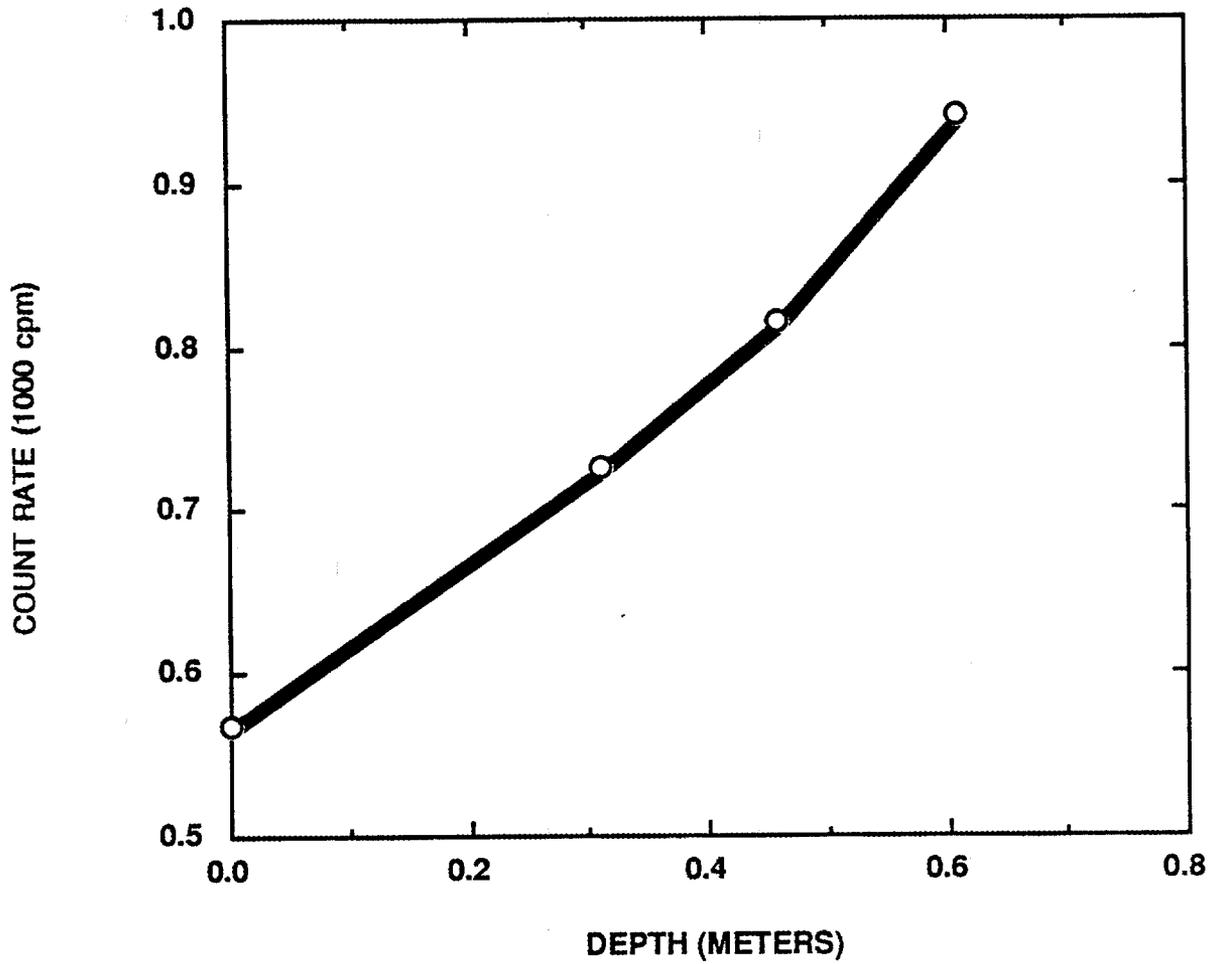


Fig. 71. Gamma profile for auger hole 63 (A63) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13137

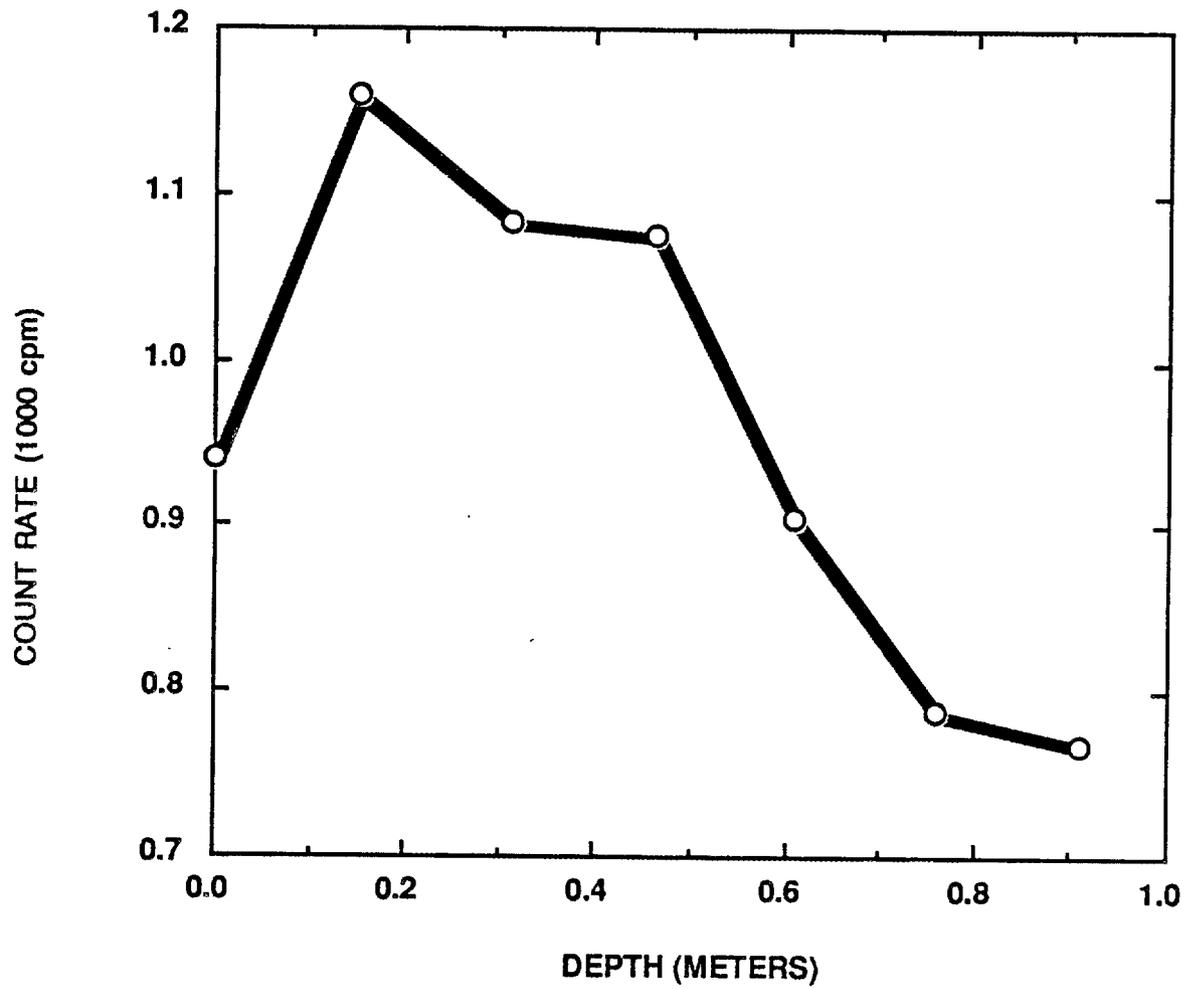


Fig. 72. Gamma profile for auger hole 64 (A64) at the former ore storage site, Palmerton, Pennsylvania (PP001).

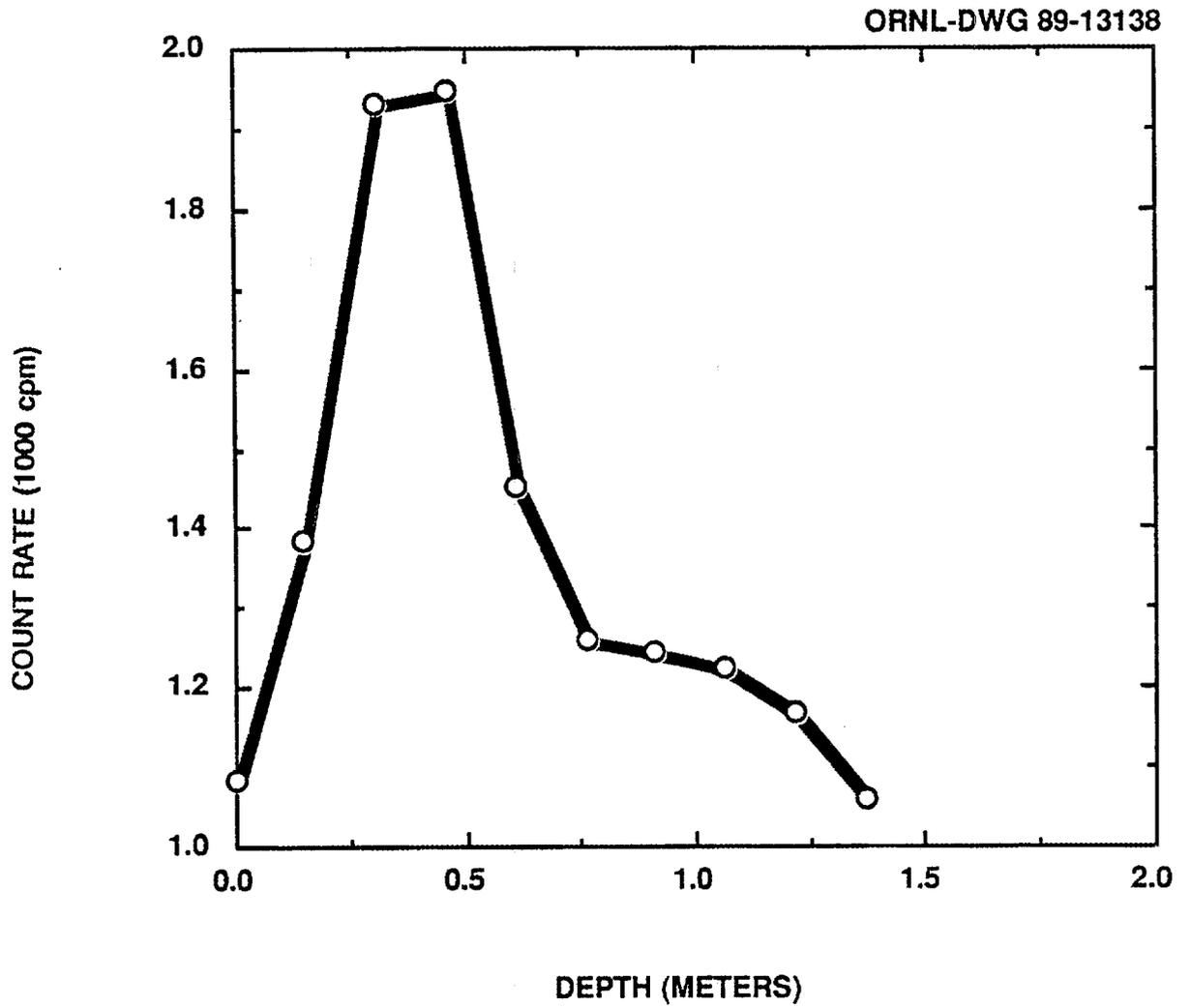


Fig. 73. Gamma profile for auger hole 65 (A65) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13139

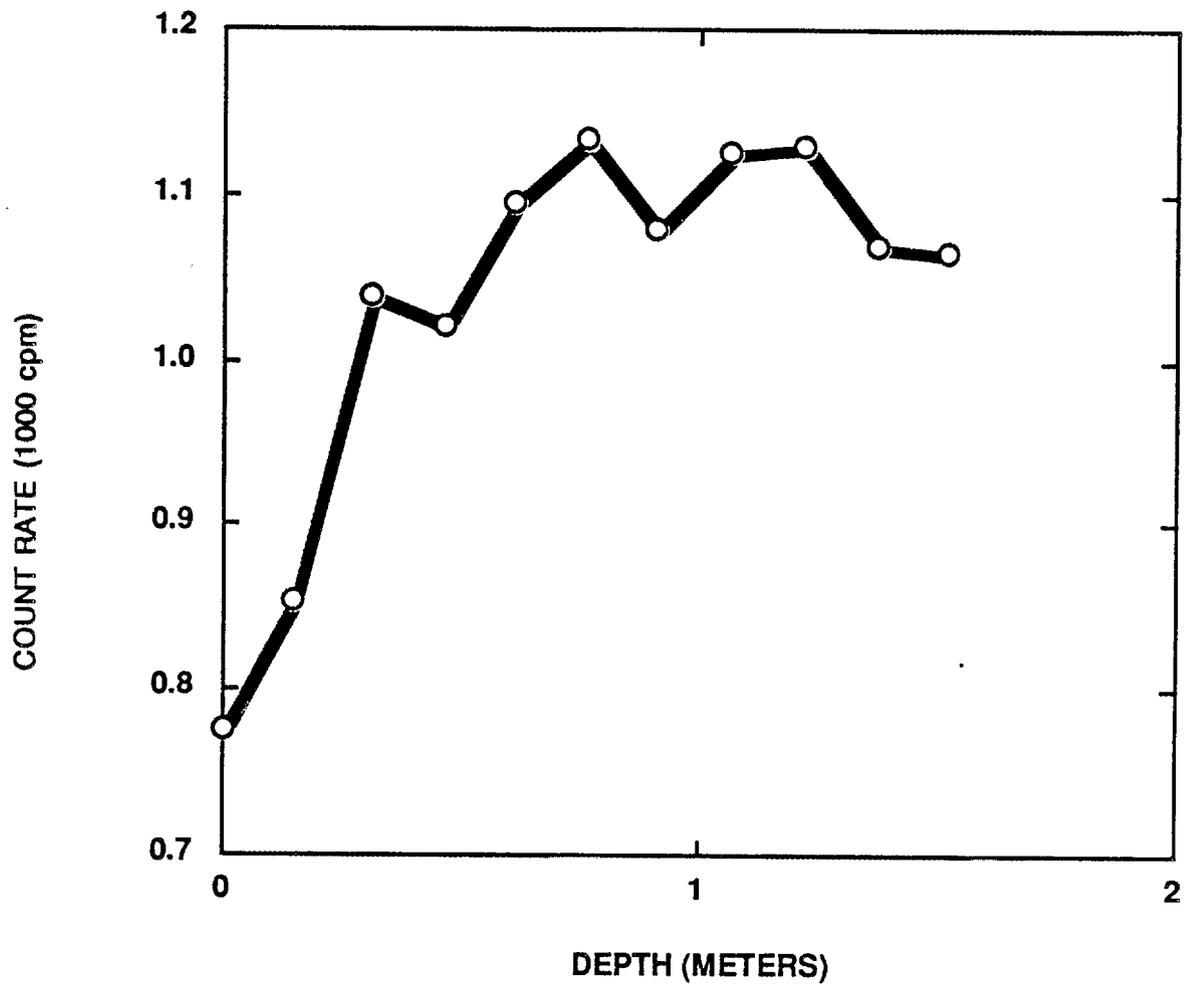


Fig. 74. Gamma profile for auger hole 66 (A66) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13140

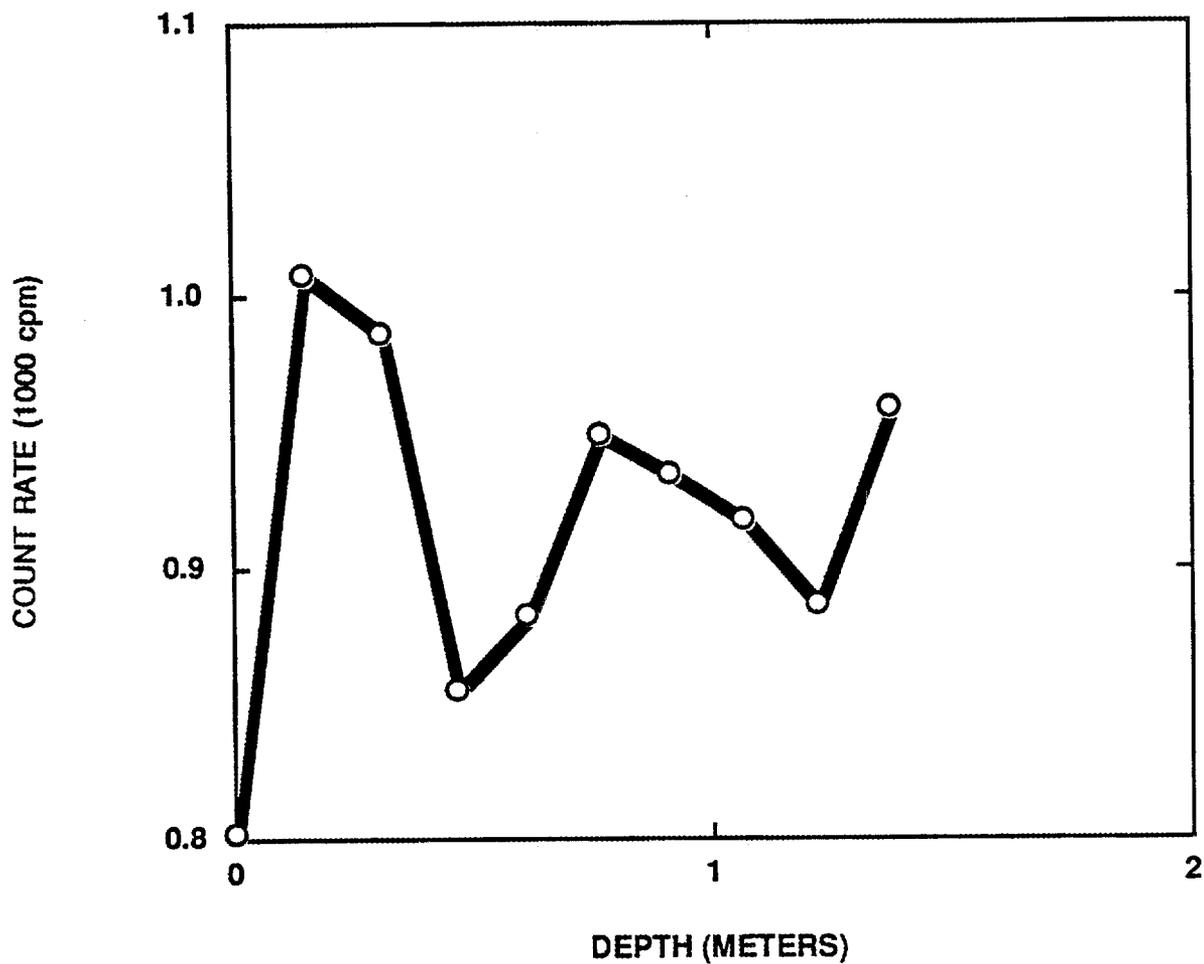


Fig. 75. Gamma profile for auger hole 67 (A67) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13141

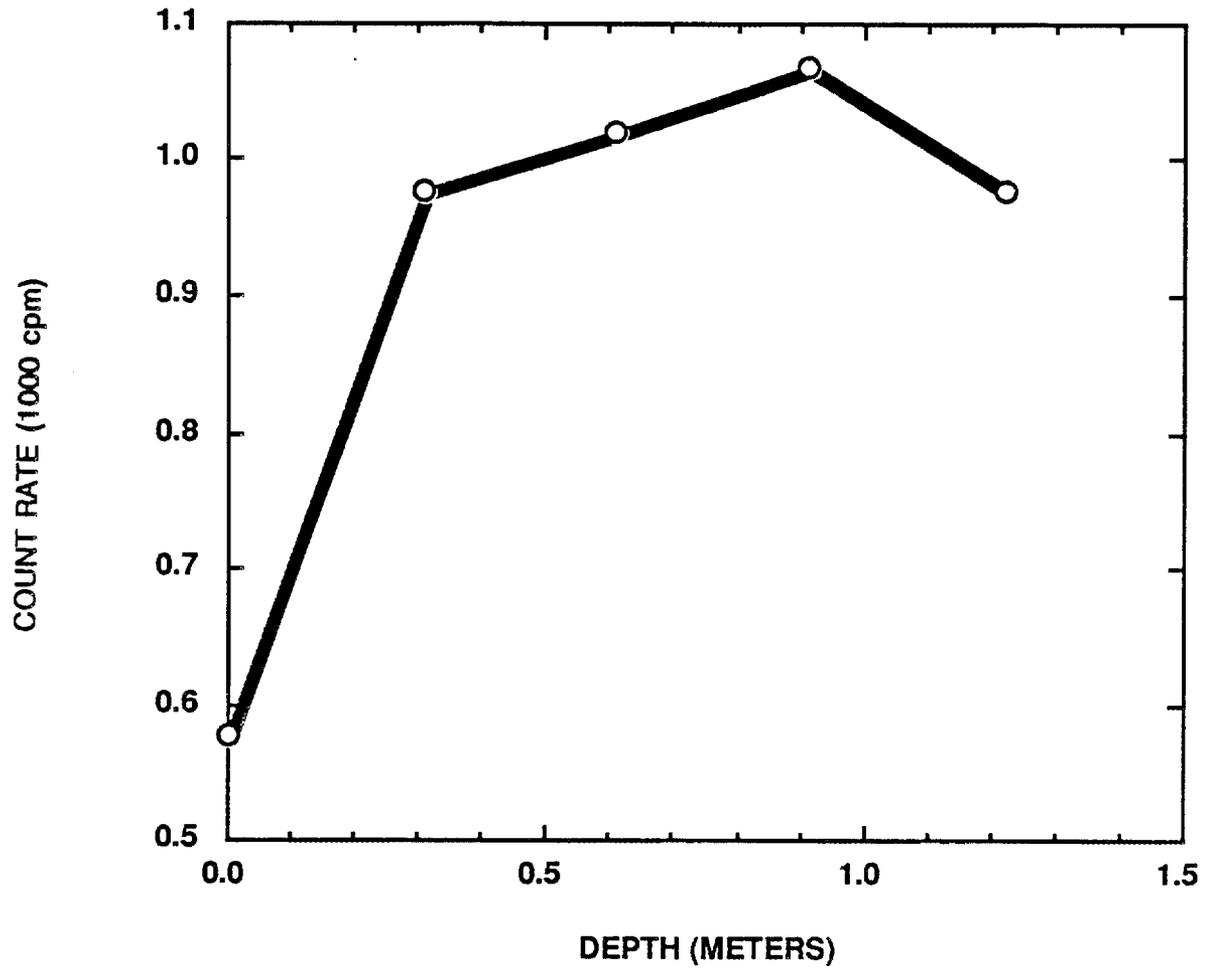


Fig. 76. Gamma profile for auger hole 68 (A68) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13142

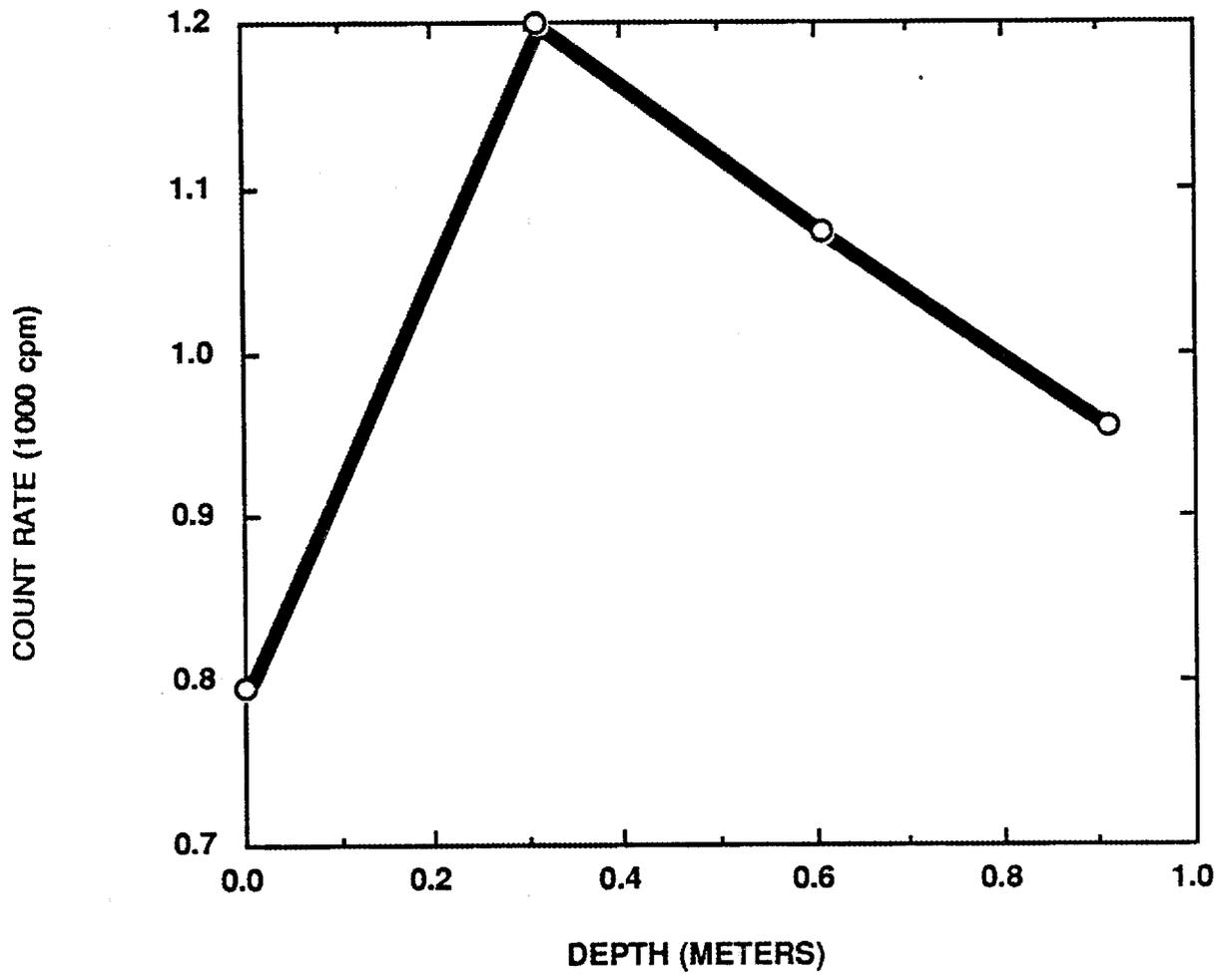


Fig. 77. Gamma profile for auger hole 69 (A69) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13143

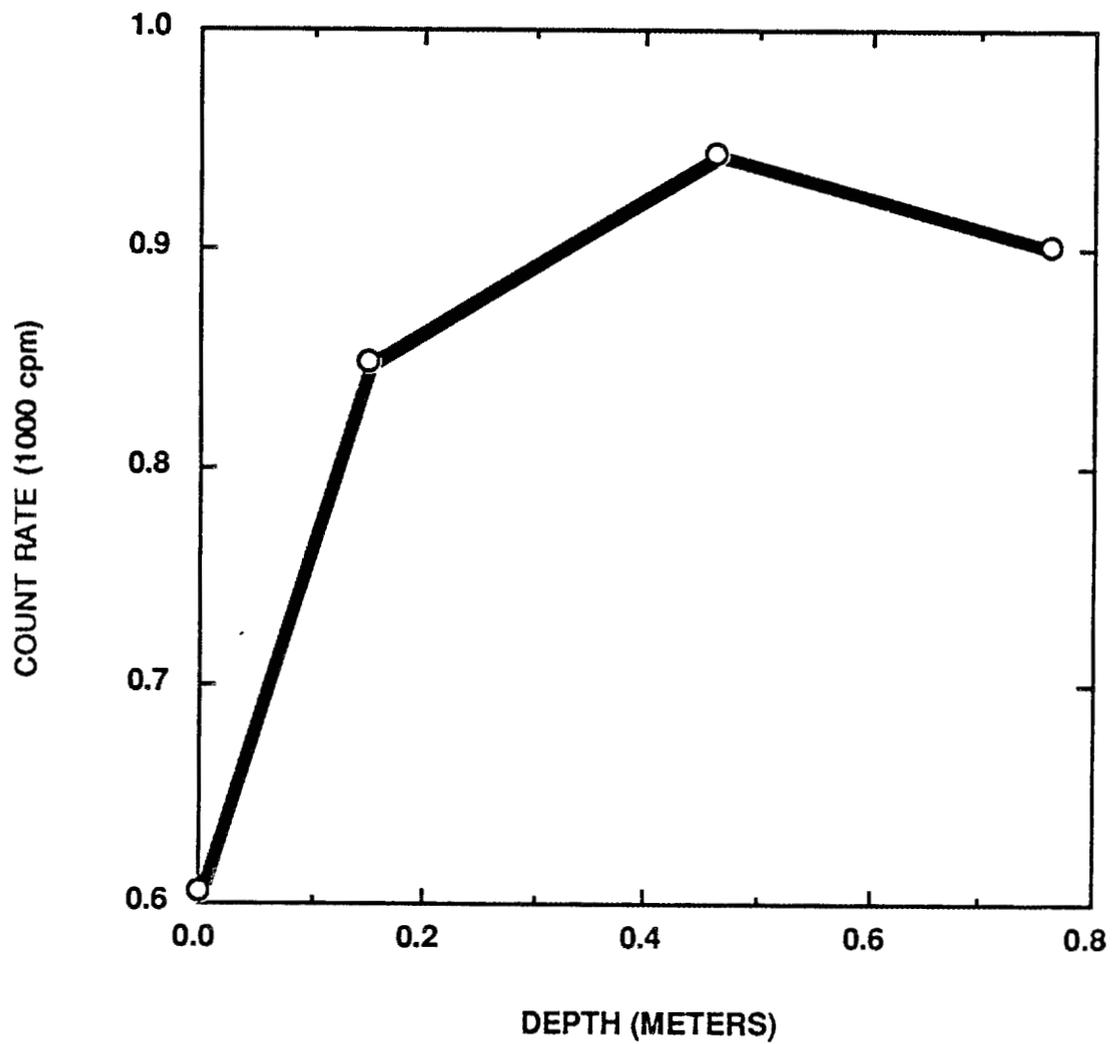


Fig. 78. Gamma profile for auger hole 70 (A70) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13145

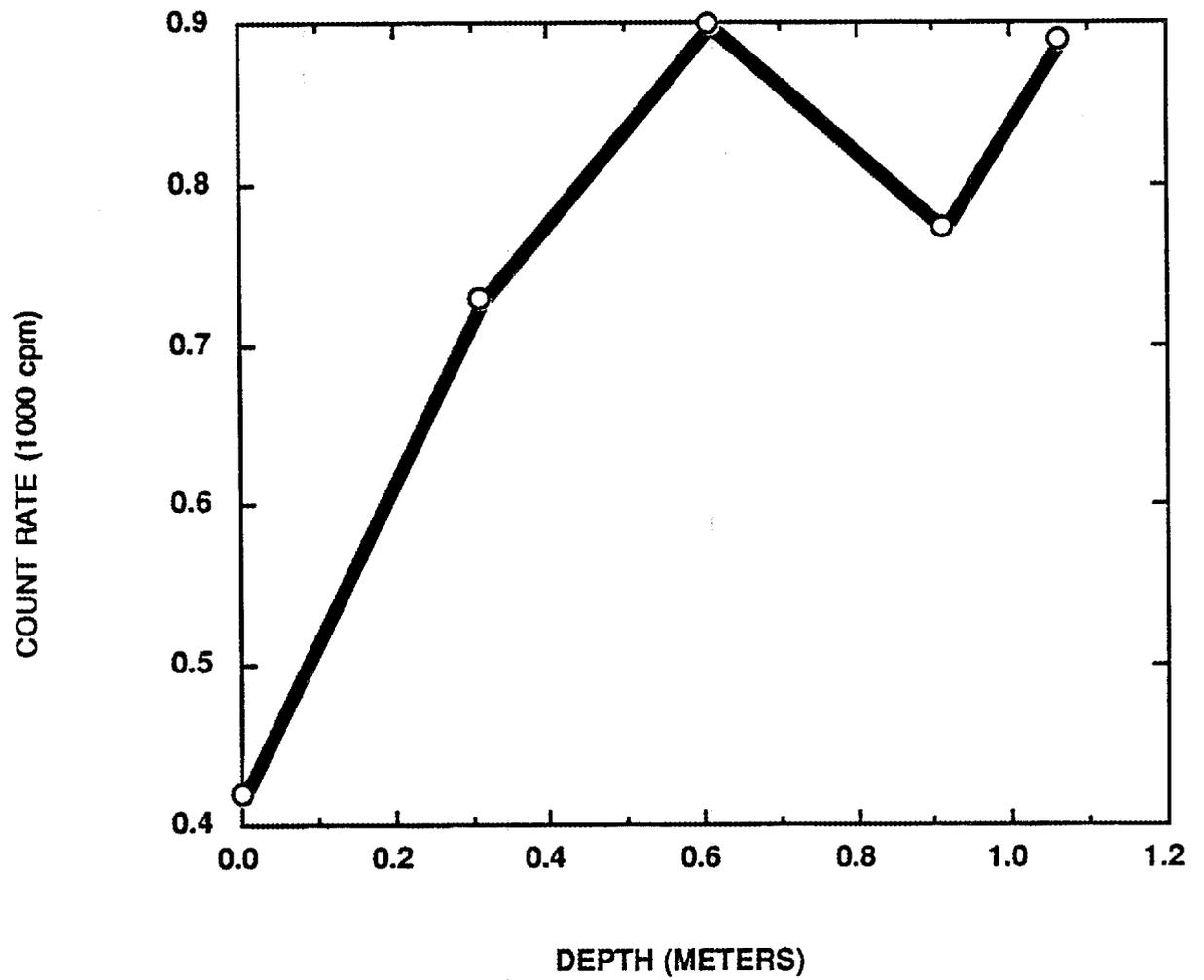


Fig. 79. Gamma profile for auger hole 71 (A71) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13146

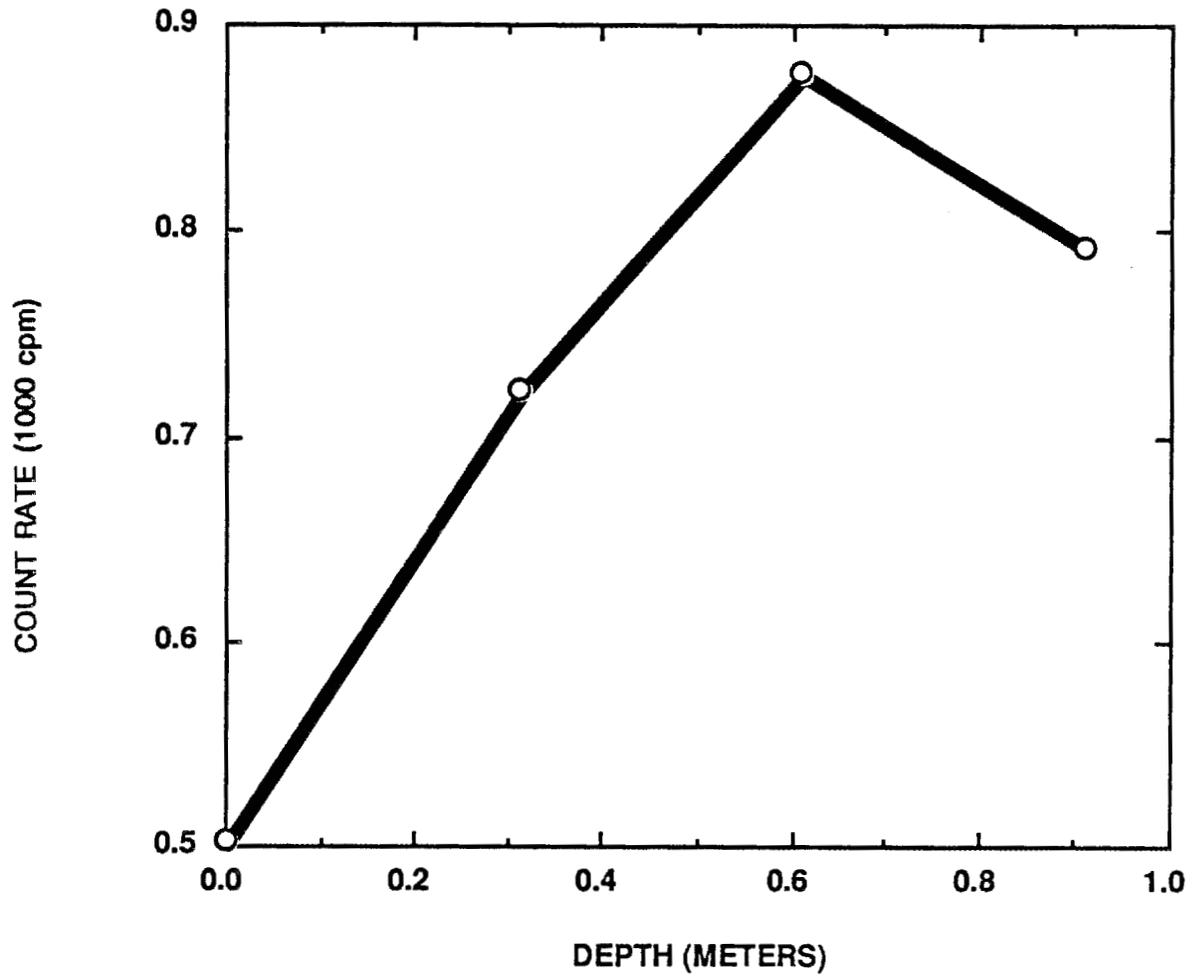


Fig. 80. Gamma profile for auger hole 72 (A72) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13147

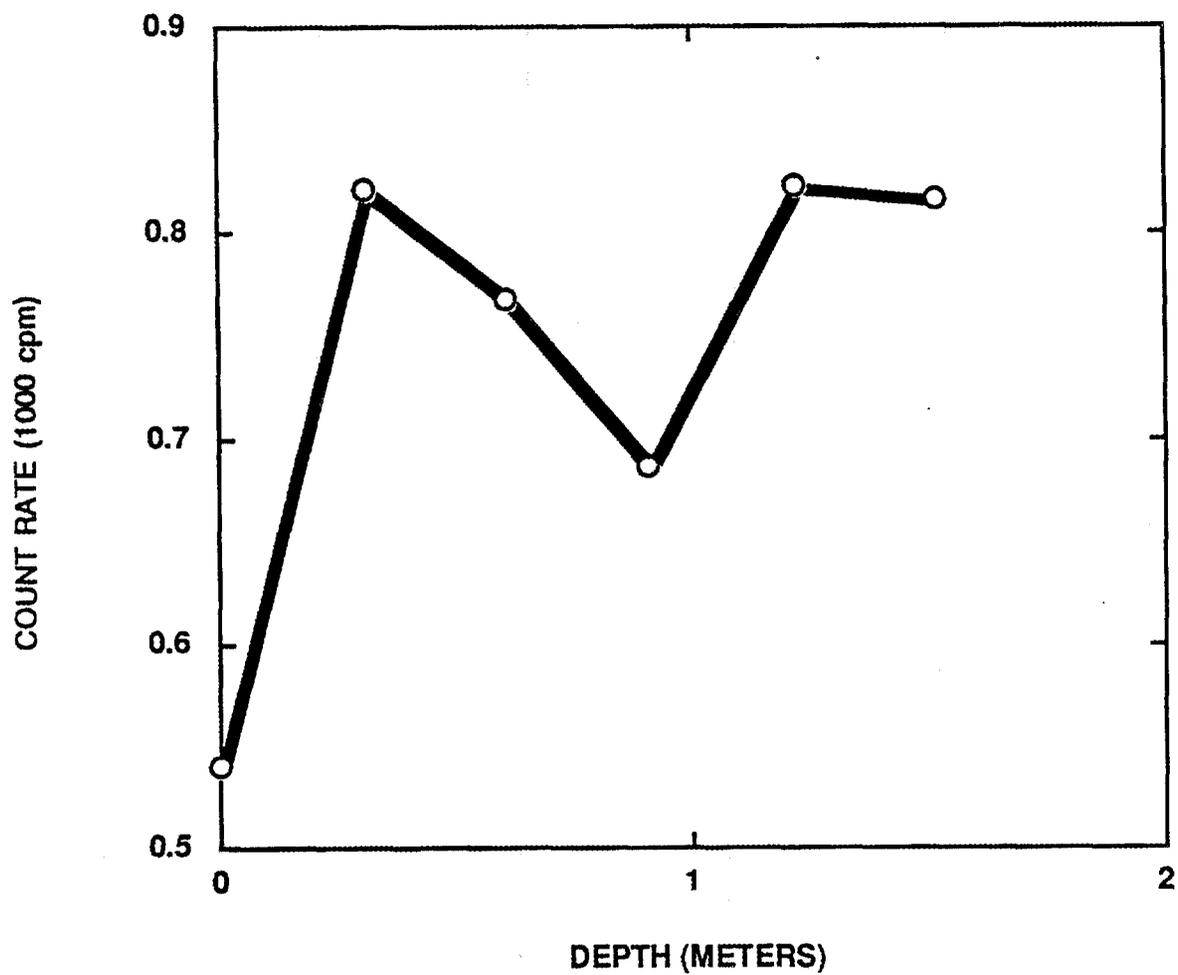


Fig. 81. Gamma profile for auger hole 73 (A73) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13144

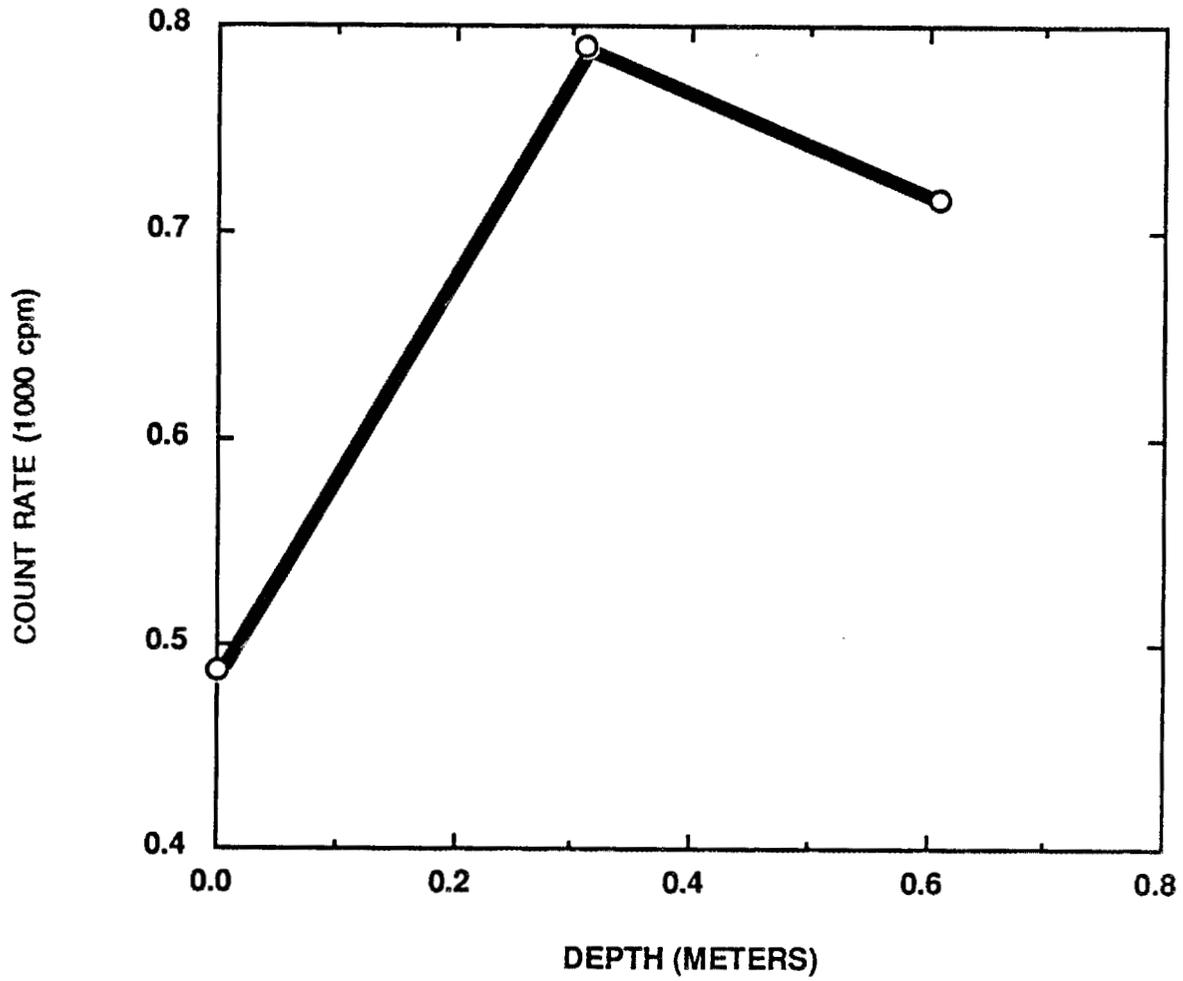


Fig. 82. Gamma profile for auger hole 74 (A74) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13149

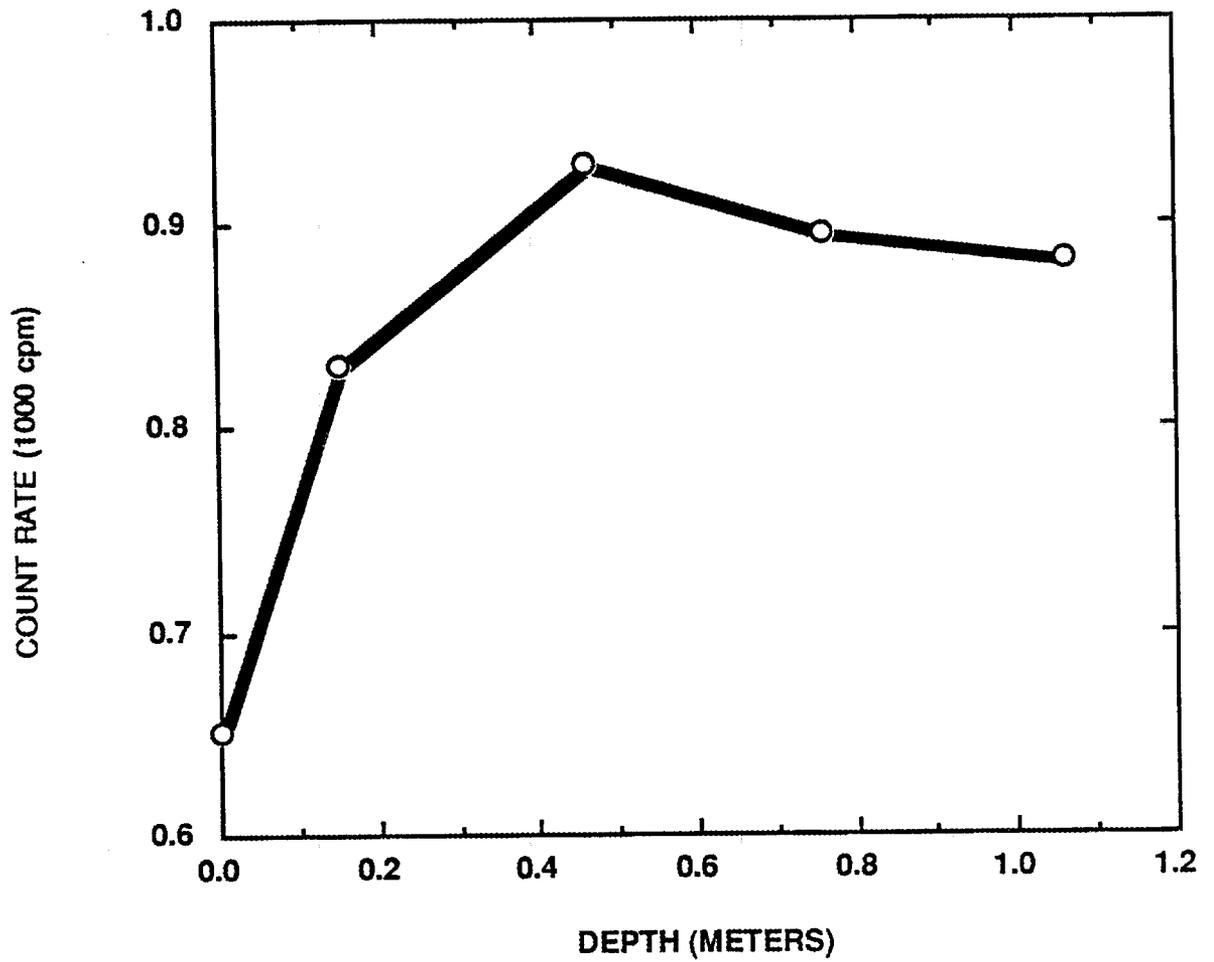


Fig. 83. Gamma profile for auger hole 75 (A75) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13148

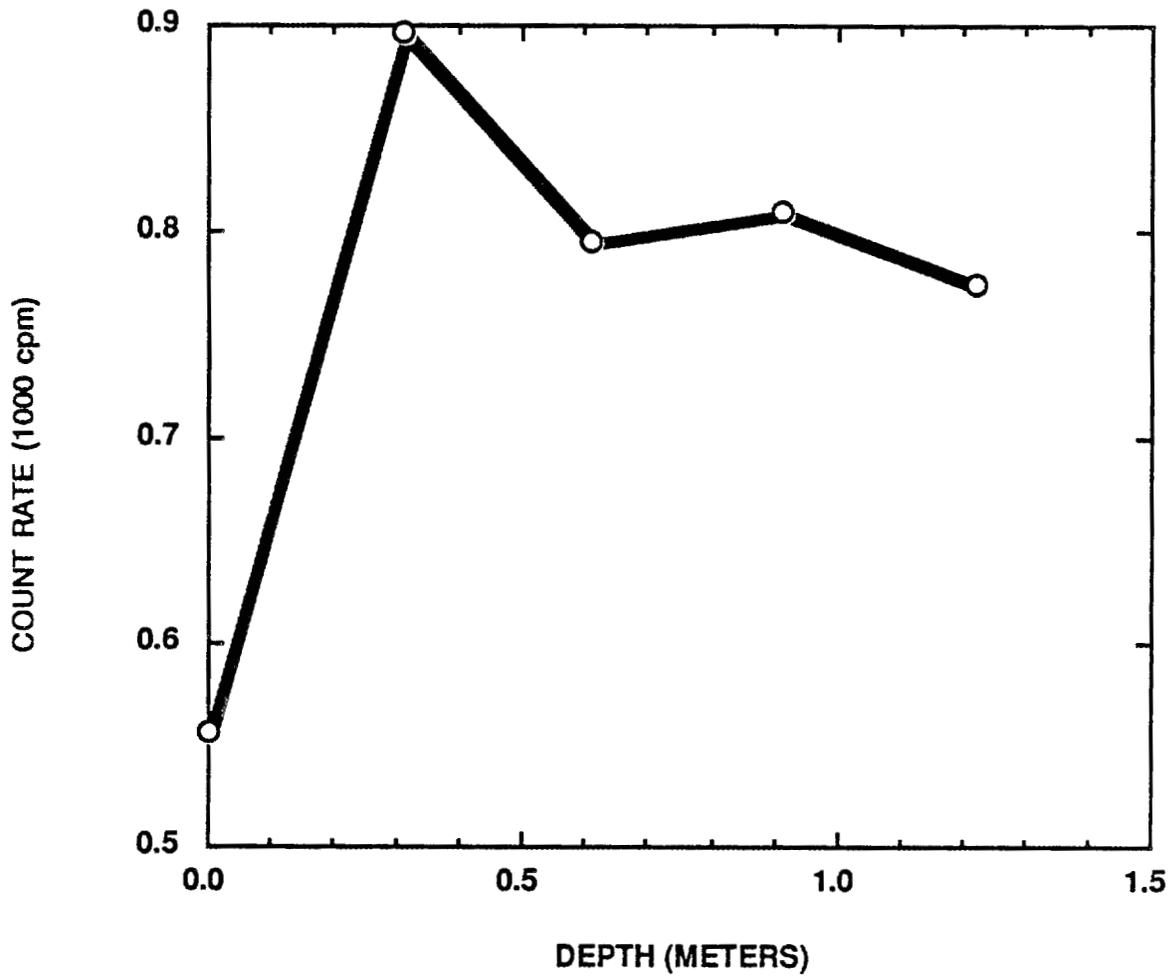


Fig. 84. Gamma profile for auger hole 76 (A76) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13150

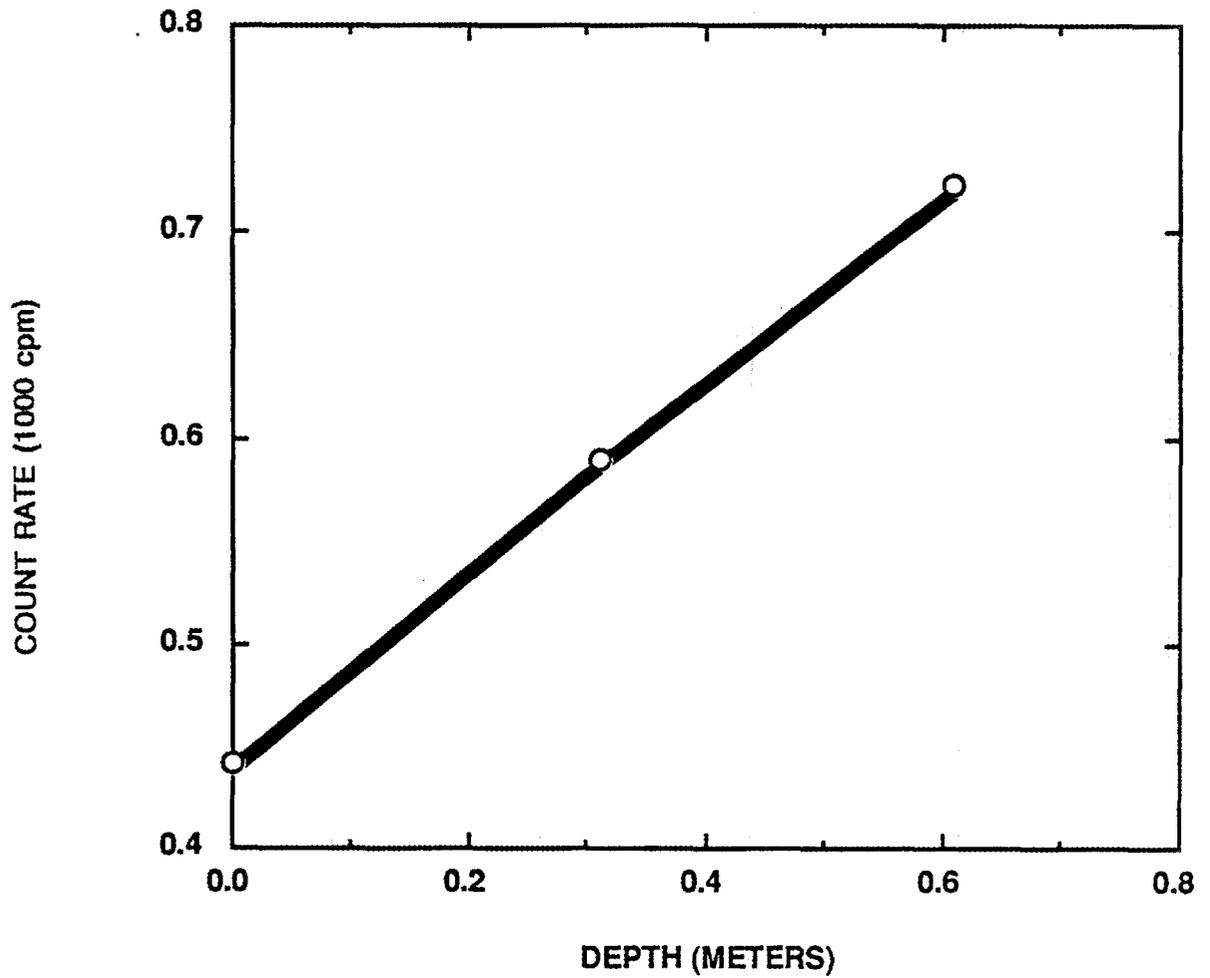


Fig. 85. Gamma profile for auger hole 77 (A77) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13151

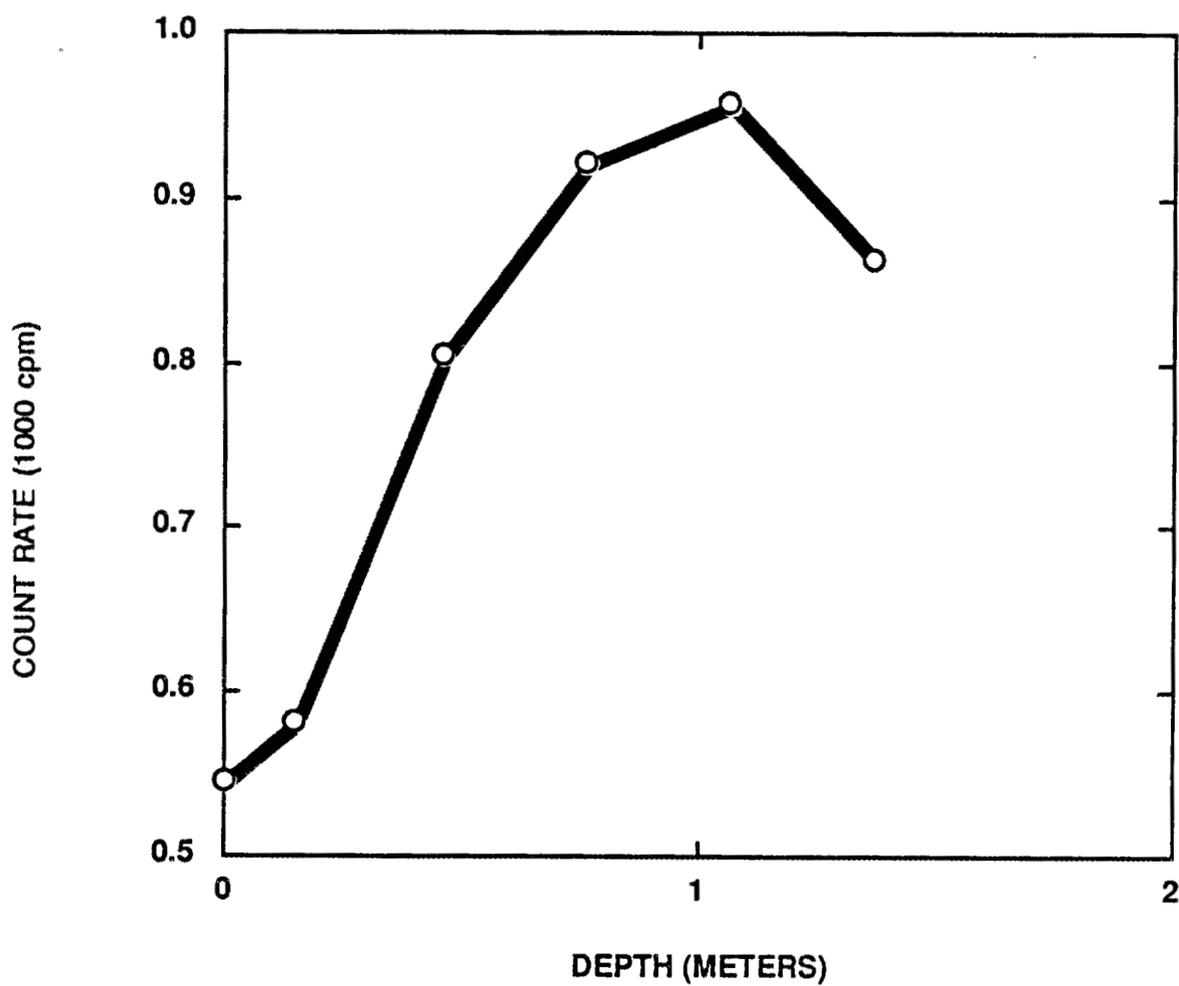


Fig. 86. Gamma profile for auger hole 78 (A78) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13152

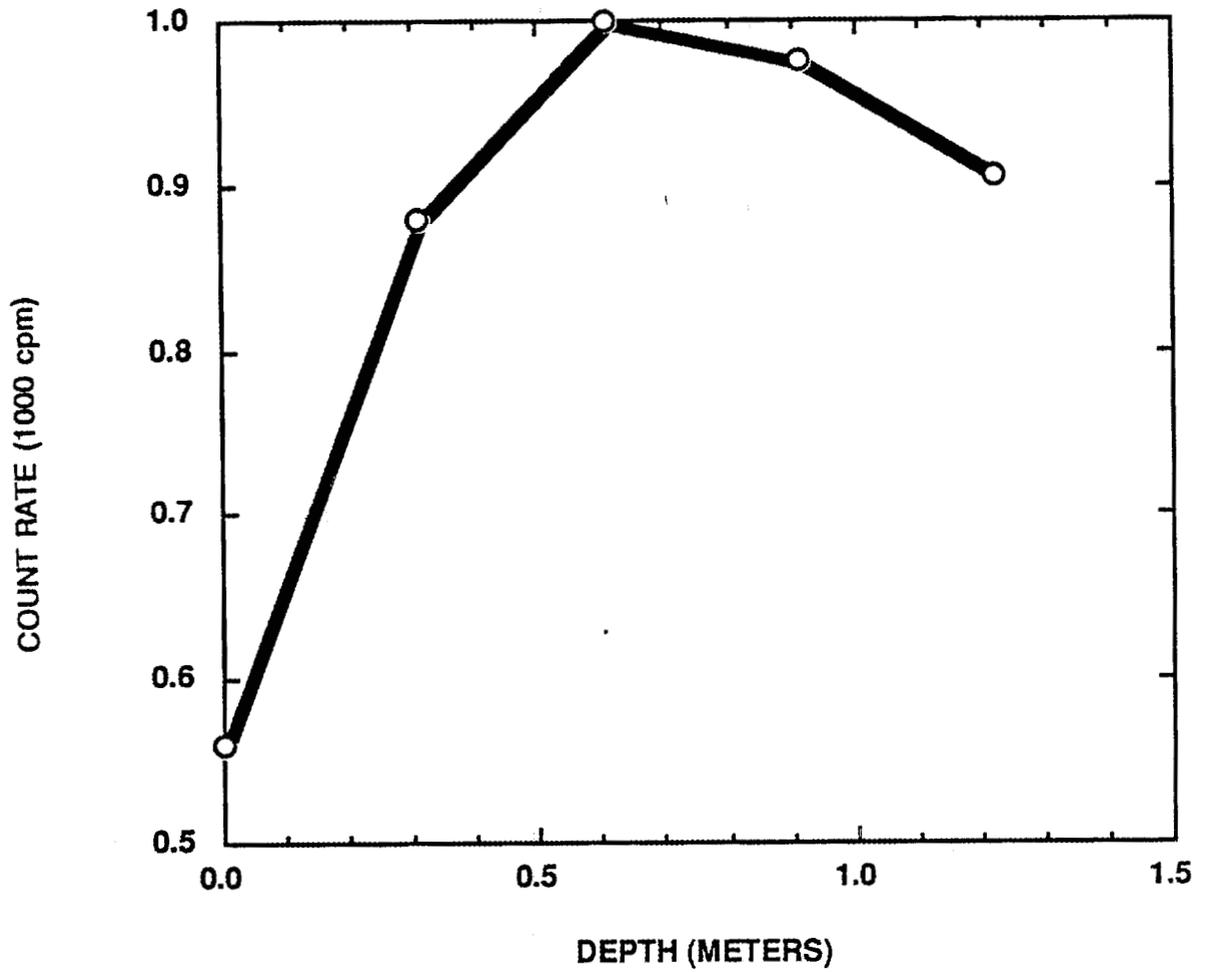


Fig. 87. Gamma profile for auger hole 79 (A79) at the former ore storage site, Palmerton, Pennsylvania (PP001).

ORNL-DWG 89-13153

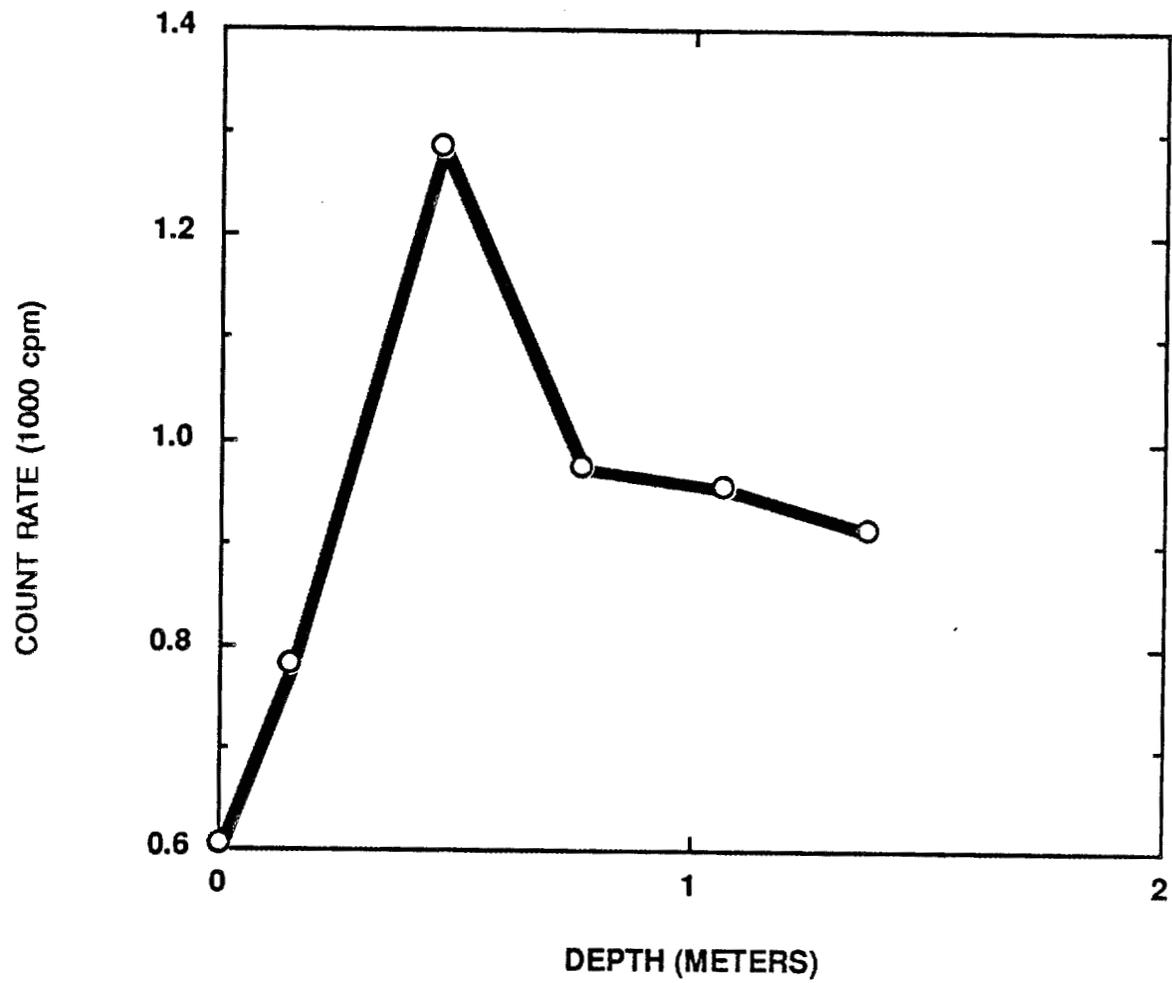


Fig. 88. Gamma profile for auger hole 80 (A80) at the former ore storage site, Palmerton, Pennsylvania (PP001).

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