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Geologic Description of Cores from Holes P-3 MH-1 Through P-3 MH-5, Area G, Technical Area 54

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GEOLOGIC DESCRIPTION OF CORES FROM HOLES P-3 MH-1 THROUGH P-3 MH-5, AREA G, TECHNICAL AREA 54

by

William D. Purtymun
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ABSTRACT

Five horizontal holes were cored beneath Pit 3 near the southeast edge of Mesita del Buey at Area G. The pit, filled and covered by 1966, contains solid radioactive wastes. The holes were cored to obtain samples of the tuff underlying the pit to determine if there has been any migration of radionuclides by infiltration of water in the past 10 yr. The five holes were collared in Unit 2b of the Tshirege Member of the Bandelier Tuff; three of the holes plunged downward into Unit 2a. This report describes the rock units penetrated by core holes and the joint characteristics observed. The locations of core samples selected for analyses are related to the floor of the pit.

I. INTRODUCTION

Mesita del Buey is a narrow, southeast-trending mesa near the eastern margin of the Pajarito Plateau (Fig. 1). The mesa slopes gently from an elevation of about 2100 m near its western edge to about 2000 m at its eastern edge. It is covered with a thin clay soil, underlain by a series of ashflows of rhyolite tuff.[1] Southeast-trending canyons to the north and south of the mesa have cut 15 to 40 m below the mesa surface.

Area G, Technical Area 54 (TA-54), has been designated by the Los Alamos Scientific Laboratory (LASL) for the disposal and storage of solid radioactive wastes. These wastes are placed in shafts or pits dug into the surface of the mesa. Studies made by the U. S. Geological Survey in 1973-74 emphasized the need to determine if any contamination from these wastes had moved into the underlying tuff.[2]

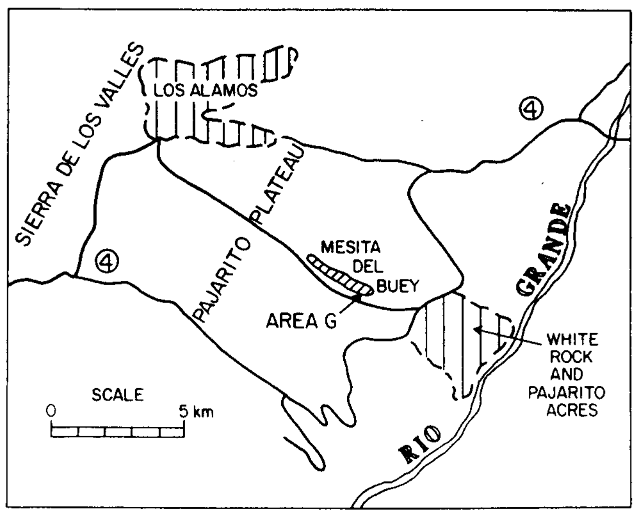

Fig. 1.
Location of Mesita del Buey on the Pajarito Plateau.

Pit 3, one of the older pits in Area G, was excavated in 1963 and covered by 1966. It is located in the southeastern part of the area (Fig. 2). Since Pit 3 waste was buried over 10 yr ago, this area is one of the better sites at LASL for studying the possible migration of radionuclides. Five horizontal holes were cored under Pit 3 using air as a cuttings carrier to avoid contamination of the core by water (Fig. 3). A vertical hole was also cored through the tuff and into the top of the underlying basalt, to obtain geologic information. The coring was done during the period from April 6 through May 23, 1976, by Reynolds Electrical and Engineering Company (REECo) of Las Vegas, Nevada. Construction and completion data for each core hole were published in a summary report prepared by REECo.[3]

The holes were oriented to pass about 1 m beneath the pit. The elevation of the floor of the pit ranged from 2021.3 to 2021.6 m above sea level. The core holes were collared at elevations ranging from 2019.6 to 2019.9 m and were oriented at angles of 00°57' to 4°00' above a horizontal plane (Table I). As coring of a given hole progressed, the vertical angle decreased due to gravitational forces and rotation of the coring assembly and drill stem. At some distance from the collar, the hole returned to horizontal and assumed a negative angle plunging gently downward beneath the pit.

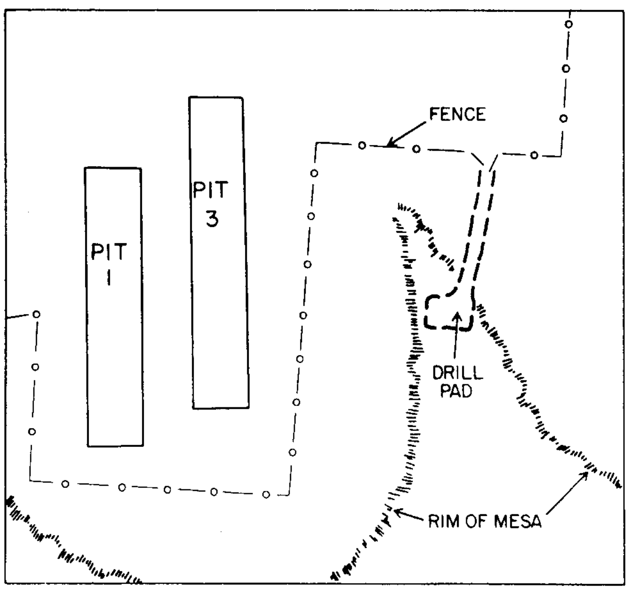

Fig. 2.
Southeastern part of Area G showing location of waste pits and drill pad.

During drilling operations, the air and cuttings from the hole were collected through air lines and discharged into a closed tank partially filled with water. The water retained most of the cuttings. The air from the tank was exhausted through high-velocity filters to retain any remaining dust that might otherwise have been transmitted into the atmosphere. Water and cuttings from the tank were monitored for radioactive contamination, as was ambient air in the area. No contamination was detected in the water, cuttings, or air.

The cores were about 4.8 cm in diameter. Each was packaged in plastic wrap and boxed according to hole and distance from hole collar. Later, in the laboratory, the cores were described, and sections of core were removed for radiochemical analyses.

Core runs varied in length from 1.5 to 6.1 m. In most runs, the first part of the core was lost due to abrasion in the core barrel and erosion of the core by the cuttings carrier (air). Thus all cores were described from the end of a run. A core was sampled about every 1.5 m to within a distance of 5.5 m of the pit. From that point onward the core was sampled about every 0.3 m. Where possible, every other sample included joints or fractures within the core. Core

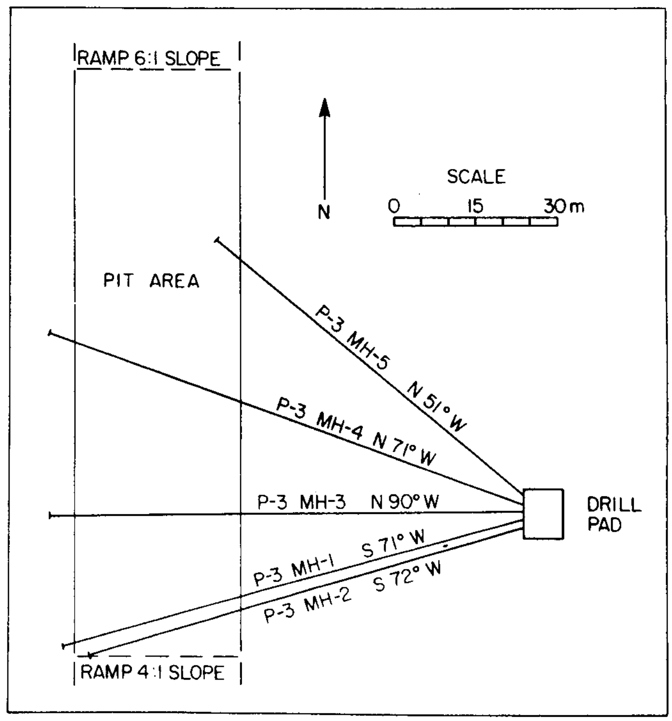

Fig. 3.
Orientation of core holes beneath Pit 3, Area G.

TABLE I

SUMMARY OF CORE HOLE DATA

	Core Holes				
	P-3 MH-1	P-3 MH-2	P-3 MH-3	P-3 MH-4	P-3 MH-5
Hole collar elevation (m)	2019.6	2019.8	2019.7	2019.8	2019.9
Initial angle above horizontal	00°57'	03.°00'	03°15'	03°00'	04°00'
Hole orientation	S73°W	S72°W	N90°W	N70°W	N51°W
Distance to horizontal (m)	12	34	38	28	42
Total distance cored (m)	87.5	82.9	86.9	92.7	73.2
Total core recovered (%)	56	74	59	51	75
Unit 2b cored (m)	45.1	82.9	85.4	69.5	73.2
Unit 2b core recovered (%)	75	74	58	52	75
Unit 2a cored (m)	42.5	---	1.5	23.2	---
Unit 2a core recovered (%)	37	---	100	49	---
Hole length at near edge of pit (m)	53.2	53.6	51.8	54.9	67.1
Hole length at far edge of pit (m)	84.6	82.9[a]	82.3	87.8	73.2[b]
Depth beneath pit at near edge (m)	3.4	1.2	0.6	0.8	0.0
Depth beneath pit at far edge (m)	7.2	3.1	3.1	4.4	0.3

[a]Completed beneath pit.
[b]Completed in fill within the pit.

sections, 5 to 6 cm in length, were stored in glass jars pending radiochemical analyses.

A radiochemical analyses sheet and core log were prepared. The sample number, depth, and designation of sample type were noted. BLK designated core with no joints or fractures; JO, core with open joint, light weathering on the joint surface; JFB; core with joint filled or plated with brown clay; and JFC, core with joint filled or plated with caliche and minor amounts of brown clay. Laboratory numbers ranged from MAR-77.00751 to MAR-77.01104,* for a total of 354 samples selected from the 5 core holes.

II. GEOLOGY

Mesita del Buey is underlain by the Tshirege Member of the Bandelier Tuff. The geology and hydrology have been described in previous reports.[4,5] The units of the Tshirege Member important to this study were Unit 2b (Qbt_{2b}) and the underlying Unit 2a (Qbt_{2a}).

Unit 2b is a light gray to light pinkish-brown, moderately welded tuff that contains quartz and sanidine crystals and crystal fragments in an ash matrix. The unit contains some fragments of latite,

*Laboratory numbers, Analytical Chemistry Data Base, Group H-8, LASL.

rhyolite, and pumice, which vary in size from less than 1 cm to over 5 cm in length. The pumice fragments, light to dark gray, are devitrified and increase in size and frequency near the contact with Unit 2a. Unit 2b color changes from a light pinkish-brown at the hole collars to light gray above the contact with the underlying unit. It is a moderately welded tuff at the hole collars grading into a nonwelded tuff at the contact.

The contact zone between Units 2b and 2a is a medium sand composed of quartz, sanidine, and reworked tuff in a matrix of ash. It is slightly more cohesive than the lower part of Unit 2b and the underlying Unit 2a.

The cored upper part of Unit 2a is a light gray, nonwelded tuff composed of quartz and sanidine crystals and crystal fragments with some rock fragments of latite, rhyolite, and pumice in an ash matrix. The pumice fragments are light gray to dark brown and decrease in size downward from the contact.

The two units at Area G dip gently to the southeast. Unit 2b, forming the upper surface and edge of the mesa, thins to the southeast as the result of deposition and erosion. Unit 2a also thins to the southeast; however, this is the result of deposition of the flow over a topographic high on older basalts.[5]

The thickness of Unit 2b in the southeast part of Area G (Pit 3) is about 11 m and is composed of a single ash flow. At the contact with Unit 2a the sand ranges from less than 2 cm to as much as 8 cm thick, dipping gently to the southeast. In this area, Unit 2a is about 10 m thick and is composed of two ashflows. Only the upper flow was penetrated by the core holes.

After completion of core hole P-3 MH-5, the last horizontal hole under Pit 3, a vertical hole was drilled to the Bandelier Tuff-basalt contact. The hole penetrated about 48.7 m of the Bandelier Tuff before entering the basalt. No cores or cuttings of the tuff were recovered, so correlation of the various units or members of the Bandelier Tuff was not possible. The hole was completed in the basalt at a depth of 50 m.

III. HORIZONTAL CORE HOLES

The horizontal core holes were cored from a drill pad located in a small canyon east of Pit 3 and were oriented to penetrate different areas beneath the pit (Figs. 2 and 3). Pit 3 is 30.5 m wide, 200 m long, and about 9 m deep. It was laid out with a north-south orientation and had ramps with slopes of 6:1 at one end and 4:1 at the other end of the long dimension to allow trucks to enter and discharge wastes. The wastes within the pit were buried in 1.5- to 2-m layers, and covered with 0.2 to 0.6 m of tuff that was excavated when the pit was dug. The pit was filled to 0.5 to 1 m below the surface of the mesa and then covered with 1.5 to 3 m of tuff, slightly mounded to encourage surface runoff. The pit was completed in the lower ashflow of Unit 2b. The contact between Unit 2b and Unit 2a lies at a depth of 3 to 3.5 m below the floor of the pit.

Core hole P-3 MH-1, cored to a distance of 87.5 m, assumed the horizontal at about 12 m then plunged gently downward through Unit 2b into Unit 2a (Fig. 4). The hole entered the area beneath the southern part of the pit at a distance of 53.2 m from the hole collar and a depth of 3.4 m below the pit floor and exited at a distance of 84.6 m and a depth of 7.2 m below the pit floor (Table I). Sample numbers in this interval were MAR-77.00784 through MAR-77.00805 (see Appendix A).

Core hole P-3 MH-2, cored to a distance of 82.9 m, assumed the horizontal at about 34 m and then plunged downward in Unit 2b (Fig. 5). The hole entered the area beneath the pit at a distance of 53.6 m from the hole collar and a depth of 1.2 m below the pit floor. The end of the hole was 3.1 m below the pit floor (Table I). Sample numbers in this interval were MAR-77.00838 to MAR-77.00888 (see Appendix B).

Core hole P-3 MH-3, cored to a distance of 86.9 m, assumed the horizontal at about 38 m and then plunged downward through Unit 2b into the upper part of Unit 2a (Fig. 6). The hole entered the area beneath the central part of the pit at a distance of 51.8 m and a depth of 0.6 m from the hole collar and a depth of 0.6 m below the pit floor and exited at a distance of 82.3 m and a depth of 3.1 m below the pit floor. The entire hole was within Unit 2b (Table I). The sample numbers in this interval were MAR-77.00907 through MAR-77.00945 (see Appendix C).

Core hole P-3 MH-4, cored to a distance of 92.7 m, assumed the horizontal at about 28 m and then plunged downward through Unit 2b into Unit 2a (Fig. 7). The hole entered the area beneath the northern two-thirds of the pit. The point of entry beneath the pit was 54.9 m from the hole collar and

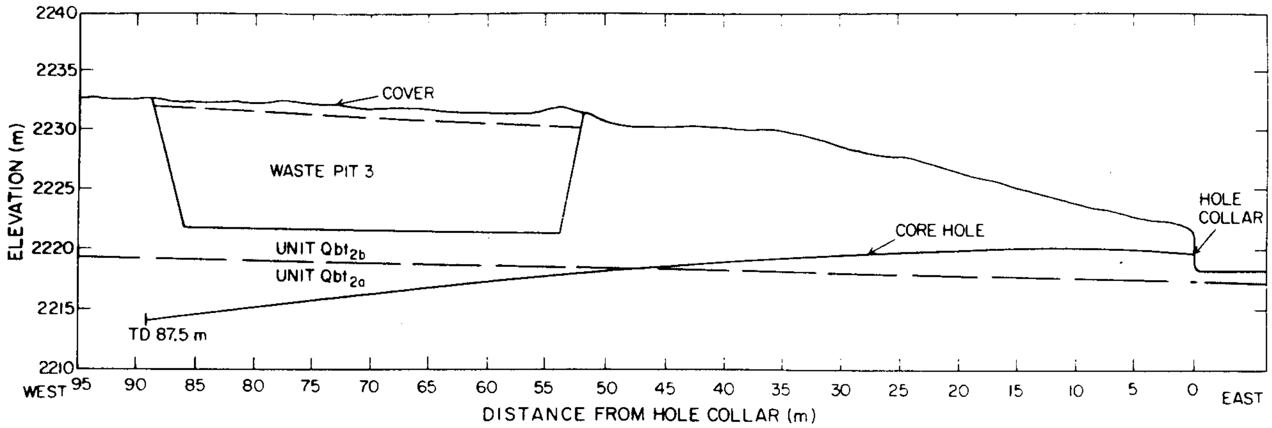

Fig. 4.

Cross section of the mesa showing the geologic units, Waste Pit 3, and the trace of core hole P-3 MH-1.

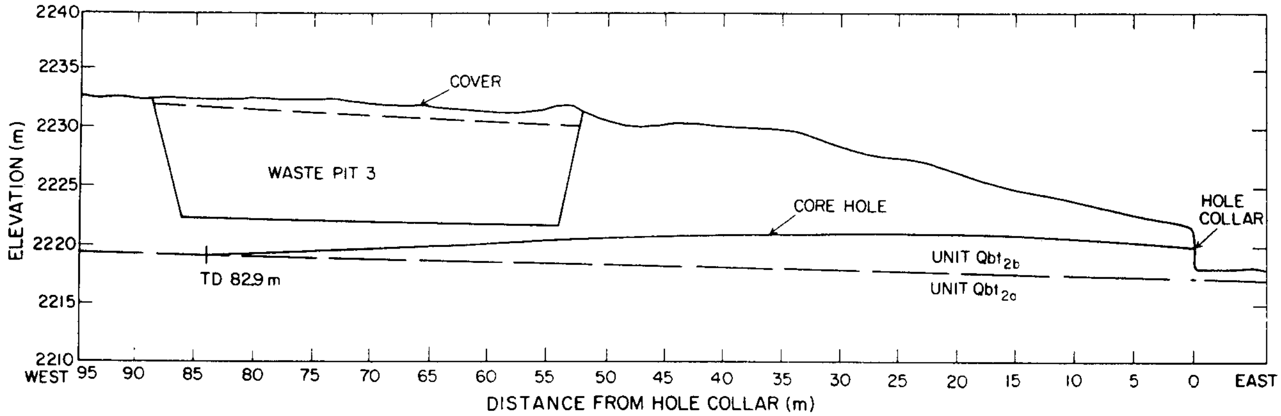

Fig. 5.

Cross section of the mesa showing the geologic units, Waste Pit 3, and the trace of core hole P-3 MH-2.

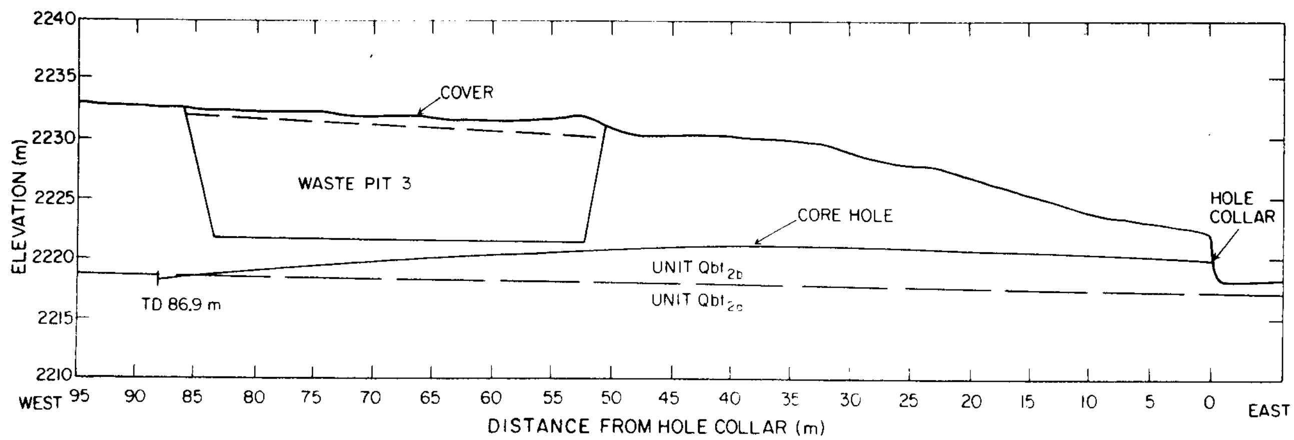

Fig. 6.

Cross section of the mesa showing geologic units, Waste Pit 3, and the trace of core hole P-3 MH-3.

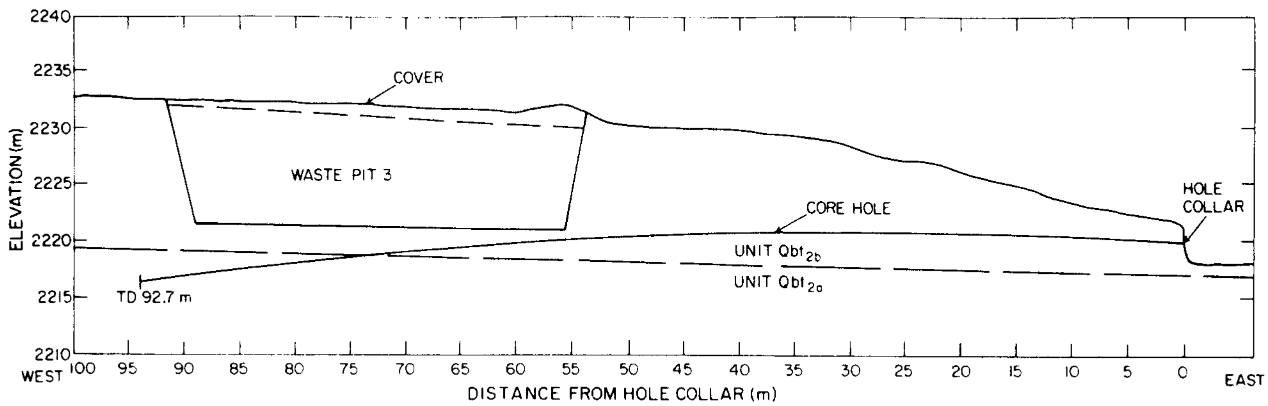

Fig. 7.
Cross section of the mesa showing geologic units, Waste Pit 3, and the trace of core hole P-3 MH-4.

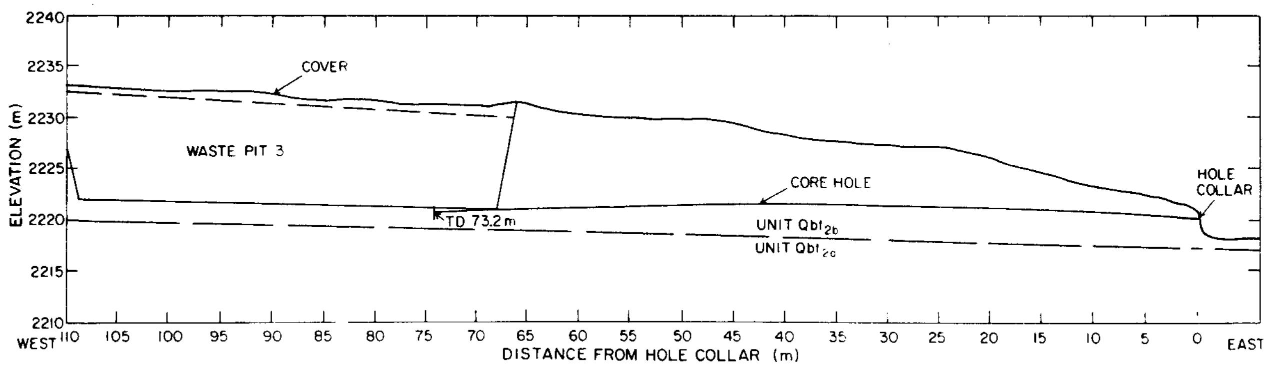

Fig. 8.
Cross section of the mesa showing geologic units, Waste Pit 3, and the trace of core hole P-3 MH-5.

0.8 m below the pit floor and the point of exit was at 87.8 m from the hole collar and 4.4 m below the pit floor. The sample numbers in this interval were MAR-77.00980 through MAR-77.01032 (see Appendix D).

Core Hole P-3 MH-5, cored to a distance of 73.2 m, assumed the horizontal at 42 m and then plunged gently downward in Unit 2b (Fig. 8). The hole entered the area beneath the northern half of the pit at a distance of 67.1 m and terminated beneath the pit at a distance of 73.2 m (Table I). The hole appeared to have penetrated the crushed-tuff backfill in the pit. The hole terminated at a depth of 0.3 m below the pit floor. Only 0.6 m of tuff was recovered in the 6.1-m length of hole cored beneath the pit. The sample numbers beneath the pit were MAR-77.01100 through MAY-77.01104 (see Appendix E).

IV. JOINT CHARACTERISTICS AND CORE RECOVERY

The orientation of joints and fractures in the north-south walls of Pit 3 was determined after the pit was dug, prior to the disposal of wastes. The major joints were vertical or near vertical with dips greater than 70°. The joints were filled or plated with brown clay or caliche. A few were open with only light weathering of the joint face. Joints open at depth within the pit were totally filled with clay beneath the thin soil zone.

There were 199 joints logged in cores from Unit 2b (Table II). Joints filled or plated with brown clay made up 72% of the joints, joints that were open with slightly weathered surfaces made up 19%, while joints filled or plated with caliche and minor amounts of brown clay made up the remaining 9%.

TABLE II

JOINT CHARACTERISTICS OF CORE

	No. of Joints	%
Unit 2b		
Joints open, slight weathering on joint face	38	19
Joints filled or plated with brown clay	144	72
Joints filled or plated with caliche	17	9
Unit 2a		
Joints open, slight weathering	3	18
Joints filled or plated with brown clay	14	82

There were 17 joints logged in Unit 2a, of which 82% were filled or plated with brown clay and the remaining 18% were open with a slightly weathered surface. Joints filled or plated with caliche did not occur in this unit.

The joint orientation for 166 joints in Unit 2b of Pit 3 indicated two major sets, N40°W to N70°W and N20°E to N60°E (Fig. 9). The number of joints in these two sets comprised 57% of the joints measured. A rose diagram of 1078 joints in Unit 2b at Mesita del Buey indicated three major joint sets: N30°W to N50°W, N60°W to N80°W, and N40°E to N60°E (Fig. 9). These three joint sets constitute 40% of the 1078 joints measured.[5] The orientation of the major joint sets at Pit 3 and on Mesita del Buey were comparable. These are tension joints, which formed as the ash flow cooled.

The joint frequency in Pit 3 averaged one joint for every 2.2 m along the pit wall. This frequency compares favorably with the joint frequency found in other pits in the area, which ranged from one joint for every 1.8 to 2.1 m of pit wall.

The joint frequency in Unit 2b for holes P-3 MH-1, P-3 MH-2, and P-3 MH-5 was one joint per 0.9 to 1.0 m of core recovered, or one joint per 1.2 to 1.4 m of holes cored (Table III). This joint frequency is higher than that observed in Pit 3, which was one joint per 2.2 m. The joint frequency in holes P-3 MH-3 and P-3 MH-4 was one joint per 1.6 to 1.7 m of core recovered, or one joint per 2.8 to 3.3 m of holes cored (Table III). This frequency brackets the observed frequency in Pit 3. The joint frequency in Unit 2a was one joint per 0.8 m (P-3 MH-3), 1.2 m (P-3 MH-4), and 2.6 m (P-3 MH-1) of core recovered. Minor joints were probably not completely mapped on the wall of the pit, because of difficulties in identifying them. However, these minor joints were prominent in the cores, which tended to break along joint faces. Thus, as seen in holes P-3 MH-1, P-3 MH-2, and P-3 MH-5, joint frequency was higher in the cores than in the pit walls.

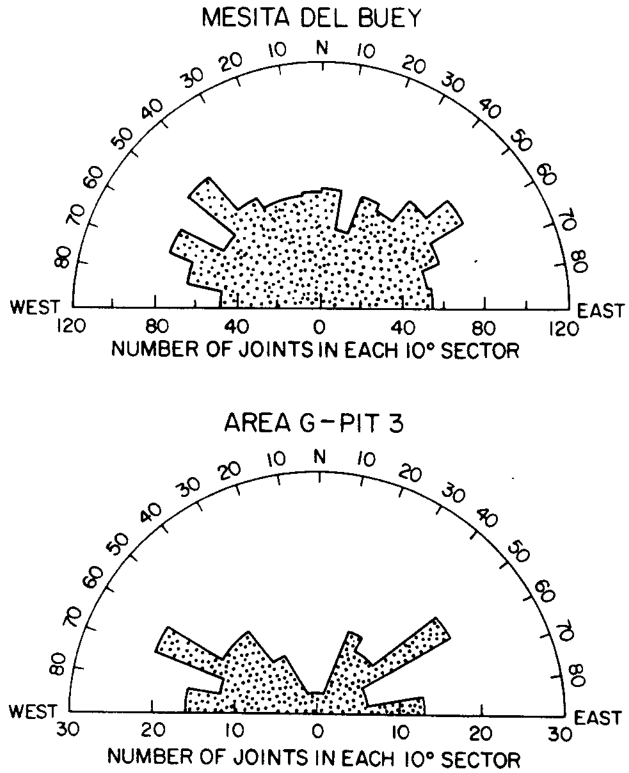

Fig. 9.
Joint orientation in Unit 2b on Mesita del Buey and in the walls of Pit 3, Area G.

An evaluation was made to determine if variations in joint frequency or core recovery were related to the orientation and intersection of the core holes with the major joint sets. No relationship was established.

TABLE III

CORE RECOVERY AND JOINT FREQUENCY

	P3 MH-1	P3 MH-2	P-3 MH-3	P-3 MH-4	P-3 MH-5
Core recovered (%)	75	74	58	52	75
Joint frequency (per m)[a]	0.9	1.0	1.6	1.7	1.0
Joint frequency (per m)[b]	1.2	1.4	2.8	3.3	1.4

[a]Per meter of core recovered.
[b]Per meter of hole cored.

Variations in the tuff such as degree of welding, size of pumice and other rock fragments, and orientation of joints intersecting the core will affect the amount of core recovered. Other factors such as the type of coring assembly, the drilling pressure, the rotation speed, length of the core run, and the volume and velocity of the cuttings carrier also affect core recovery. Core recovery in Unit 2b for holes P-3 MH-1, P-3 MH-2, and P-3 MH-5 ranged from 74 to 75%, while in holes P-3 MH-3 and P-3 MH-4 recovery was lower, at 52 and 58% (Table I). Core recovery in Unit 2a was 37 % for hole P-3 MH-1, 100% for hole P-3 MH-3, and 49% for hole P-3 MH-4. This unit is very friable. In hole P-3 MH-3 the core barrel was pushed into Unit 2a with little or no rotation or circulation of air to remove cuttings; thus recovery was 100%.

The majority of joints logged in the cores intersected the core at angles of 30° to 90°. Intersection of the core at angles of less than 30° caused some of the core to break up in the barrel because of drill stem and outer coring assembly rotation. As a result, these sections of core were eroded and dispersed by the the cuttings carrier (air).

V. CONCLUSIONS

Cores were obtained at depths ranging from 0 to 7.2 m beneath the pit, from two units of a rhyolite tuff. The core holes were oriented to enter different locations beneath the pit. The sections of the core from beneath the pit were sampled at intervals of 0.3 m for radiochemical analyses. When possible, every other sampled section included a joint or fracture. Sufficient samples were obtained from the five core holes to aid in evaluating possible migration of radionuclides from solid wastes in the pit into the underlying tuff.

Core recovery from the five holes ranged from 52% to 75%, with joint frequencies ranging from 0.9 to 1.7 m of core recovered. The largest percentage of the joints were filled or plated with brown clay. The remainder were open with joint faces slightly weathered or plated with caliche. Joint orientations on the mesa and in the pit indicate that the joints formed as the ashflows cooled.

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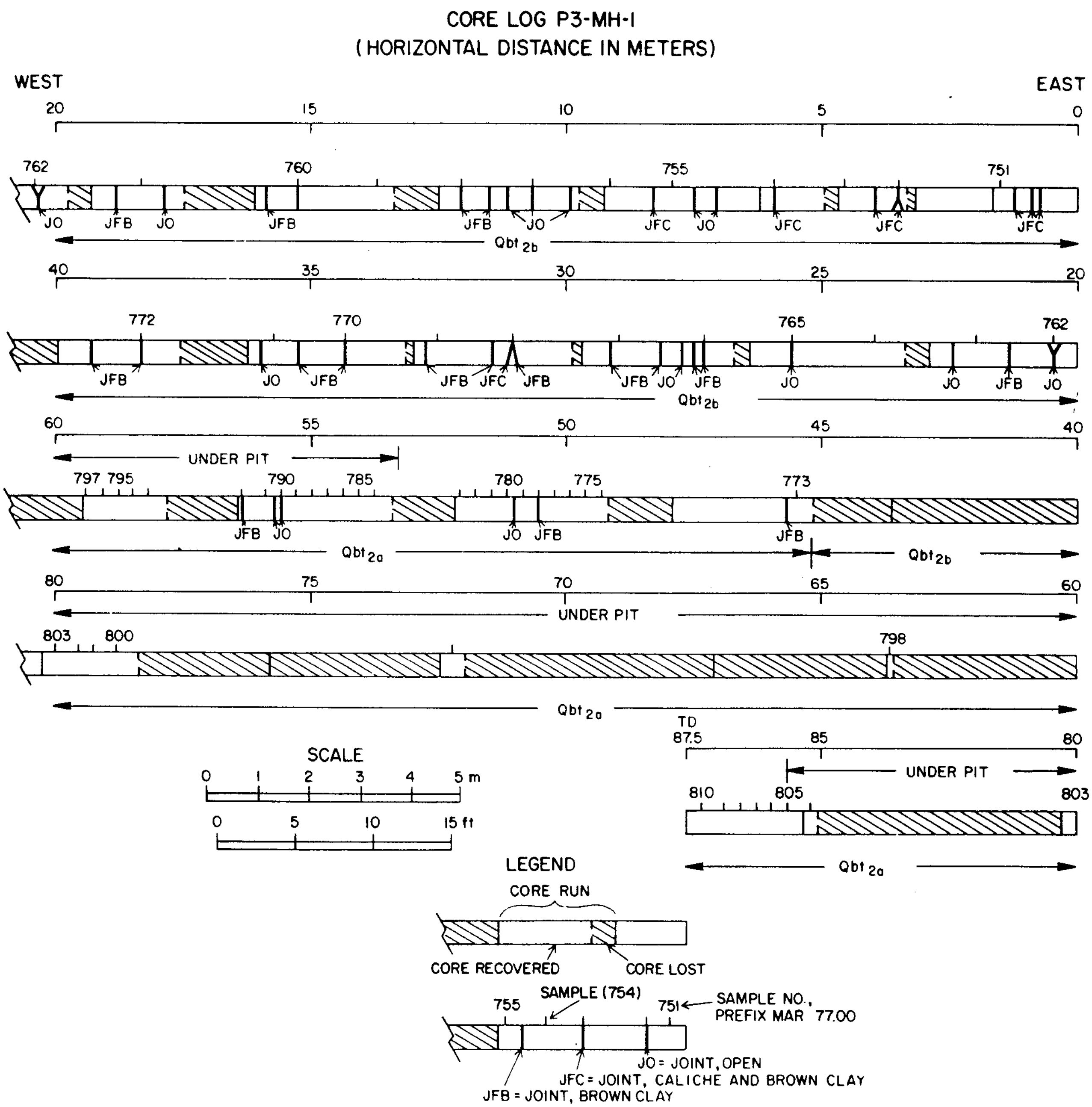
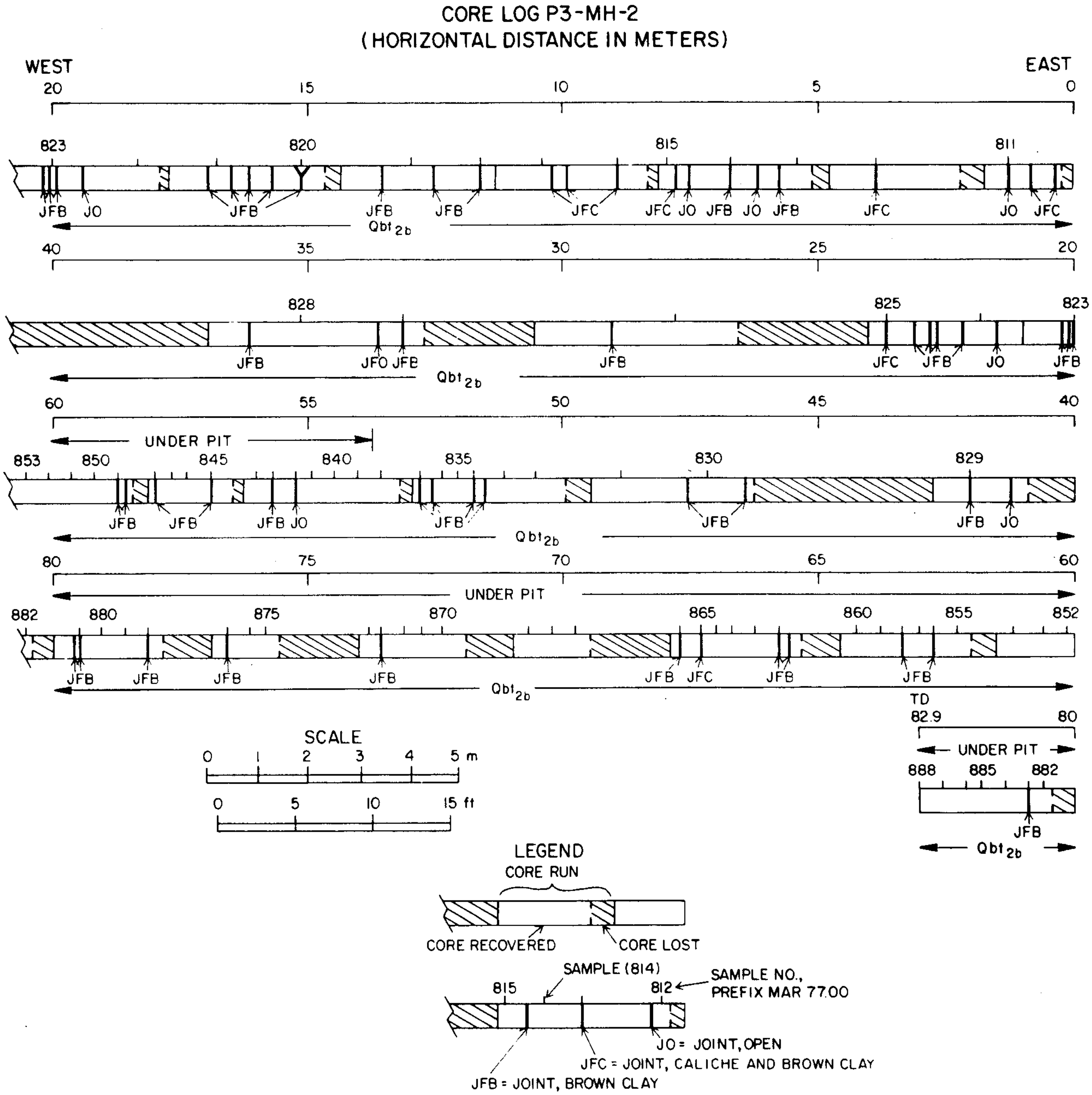
4. W. D. Purtymun, "Geology and Hydrology of Area G, Mesita del Buey, Los Alamos County, New Mexico," U. S. Geol. Survey Admin. report (1966).

5. W. D. Purtymun and W. R. Kennedy, "Geology and Hydrology of Mesita del Buey," Los Alamos Scientific Laboratory report LA-4660 (1971).

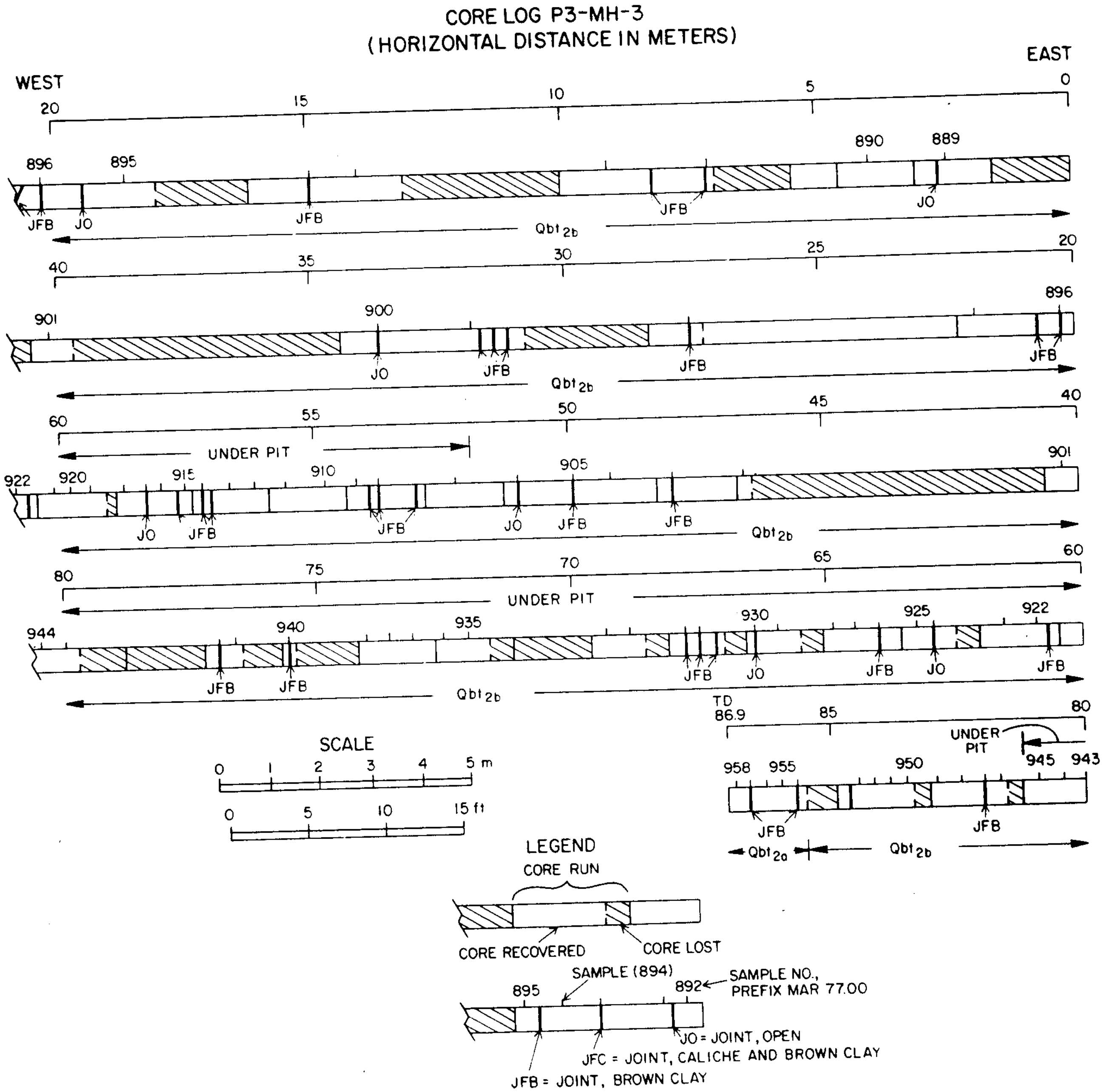
APPENDIX A


CORE LOG P3-MH-1
(HORIZONTAL DISTANCE IN METERS)
WEST
EAST
UNDER PIT
Qbt 2b
Qbt 2a
TD 87.5
SCALE
0 1 2 3 4 5 m
0 5 10 15 ft
LEGEND
CORE RUN
CORE RECOVERED
CORE LOST
SAMPLE (754)
SAMPLE NO., PREFIX MAR 77.00
JO = JOINT, OPEN
JFC = JOINT, CALICHE AND BROWN CLAY
JFB = JOINT, BROWN CLAY

APPENDIX B

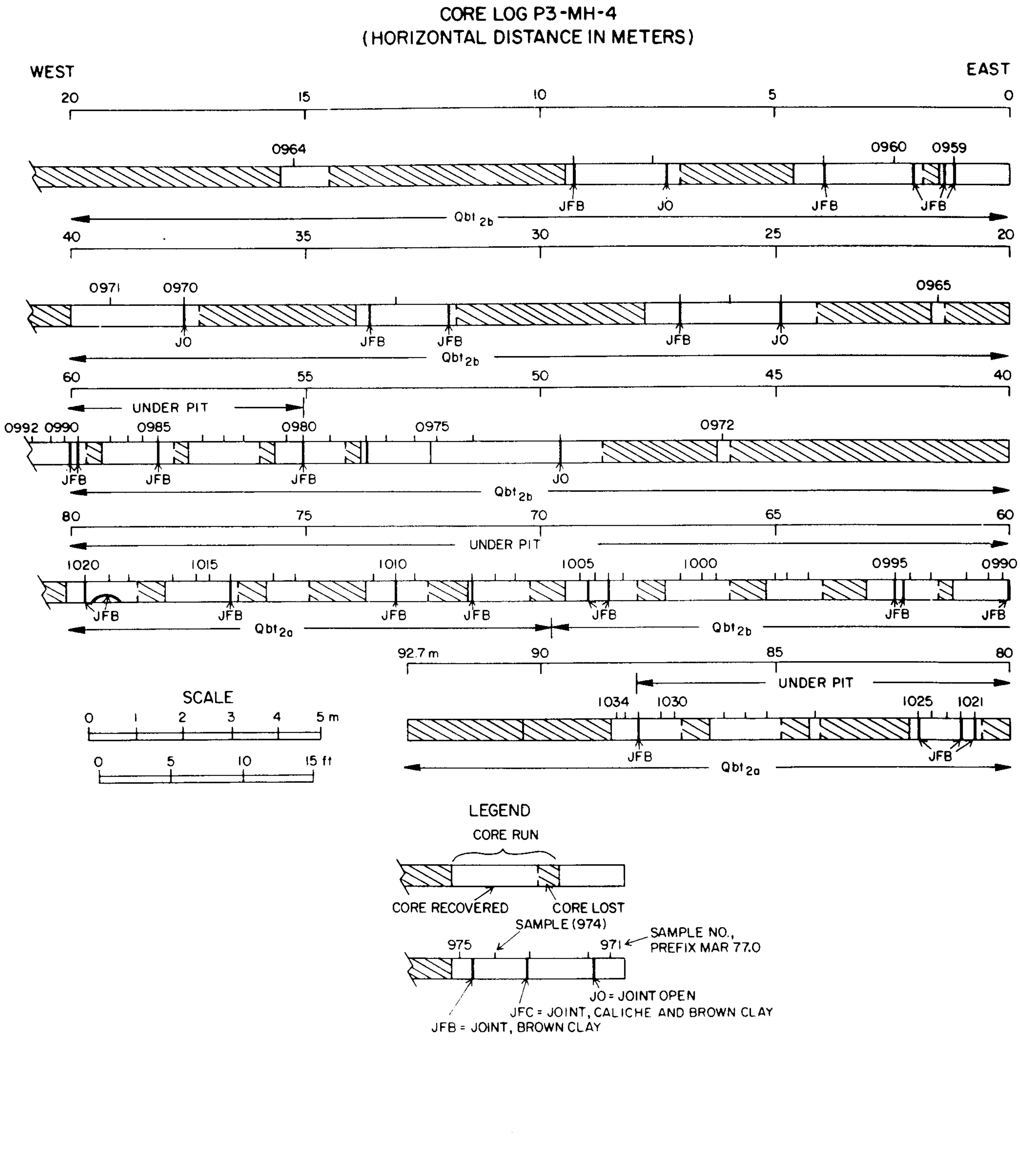

CORE LOG P3-MH-2
(HORIZONTAL DISTANCE IN METERS)
WEST
EAST
20 15 10 5 0
823 820 815 811
JFB JO JFB JFB JFB JFC JFC JO JFB JO JFB JFC JO JFC
Qbt2b
40 35 30 25 20
828 825 823
JFB JFO JFB JFB JFC JFB JO JFB
Qbt2b
60 55 50 45 40
UNDER PIT
853 850 845 840 835 830 829
JFB JFB JFB JO JFB JFB JFB JO
Qbt2b
80 75 70 65 60
UNDER PIT
882 880 875 870 865 860 855 852
JFB JFB JFB JFB JFB JFC JFB JFB
Qbt2b
TD
82.9 80
UNDER PIT
888 885 882
JFB
Qbt2b
SCALE
0 1 2 3 4 5 m
0 5 10 15 ft
LEGEND
CORE RUN
CORE RECOVERED
CORE LOST
SAMPLE (814)
815
812
SAMPLE NO., PREFIX MAR 77.00
JO = JOINT, OPEN
JFC = JOINT, CALICHE AND BROWN CLAY
JFB = JOINT, BROWN CLAY

APPENDIX C



CORE LOG P3-MH-3
(HORIZONTAL DISTANCE IN METERS)
WEST
EAST
20
15
10
5
0
896
895
890
889
JFB
JO
JFB
JFB
JO
Qbt 2b
40
35
30
25
20
901
900
896
JO
JFB
JFB
JFB
Qbt 2b
60
55
50
45
40
UNDER PIT
922
920
915
910
905
901
JO
JFB
JFB
JO
JFB
JFB
Qbt 2b
80
75
70
65
60
UNDER PIT
944
940
935
930
925
922
JFB
JFB
JFB
JO
JFB
JO
JFB
Qbt 2b
TD
86.9
85
80
UNDER PIT
958
955
950
945
943
JFB
JFB
Qbt 2a
Qbt 2b
SCALE
0
1
2
3
4
5 m
0
5
10
15 ft
LEGEND
CORE RUN
CORE RECOVERED
CORE LOST
SAMPLE (894)
895
892
SAMPLE NO.,
PREFIX MAR 77.00
JO = JOINT, OPEN
JFC = JOINT, CALICHE AND BROWN CLAY
JFB = JOINT, BROWN CLAY

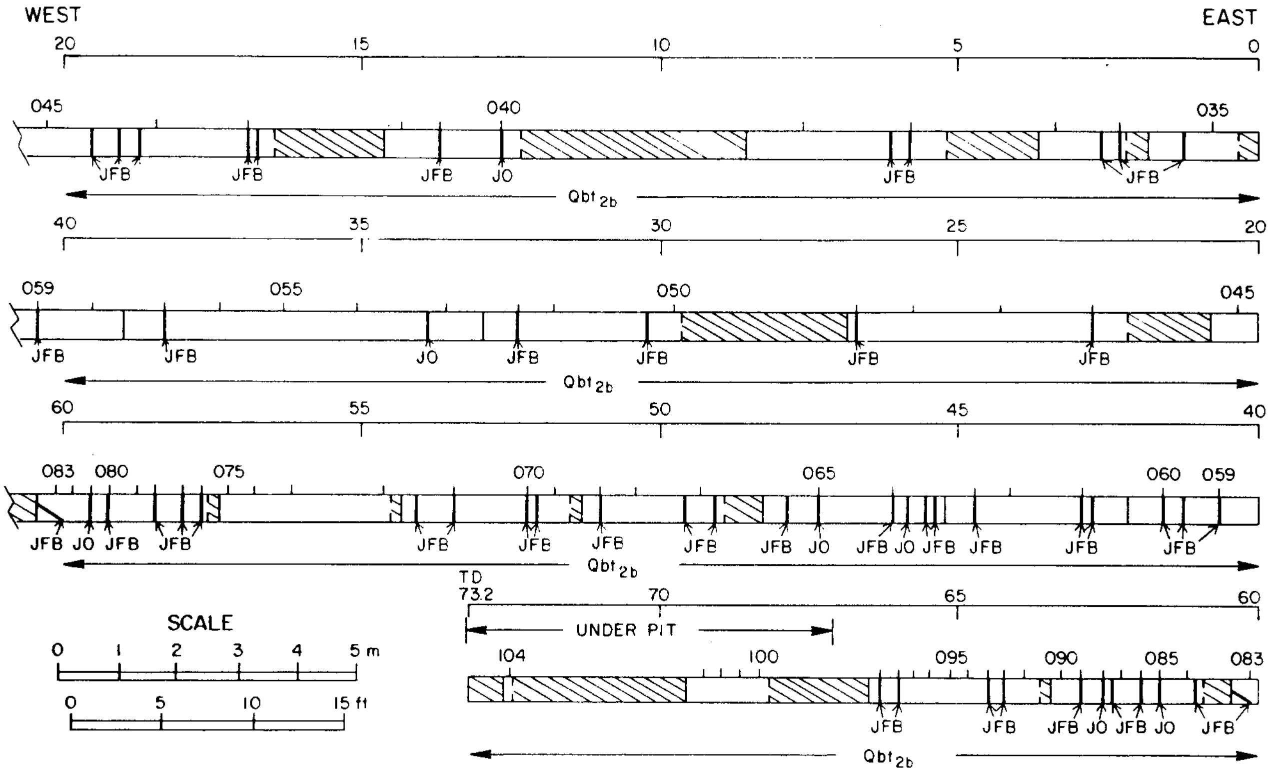
APPENDIX D



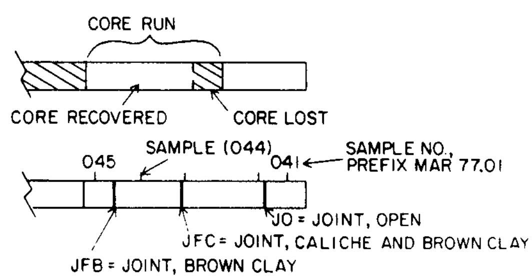
CORE LOG P3-MH-4
(HORIZONTAL DISTANCE IN METERS)
WEST
EAST
20
15
10
5
0
0964
0960
0959
JFB
JO
JFB
JFB
Qbt 2b
40
35
30
25
20
0971
0970
0965
JO
JFB
JFB
JFB
JO
Qbt2b
60
55
50
45
40
UNDER PIT
0992 0990
0985
0980
0975
0972
JFB
JFB
JFB
JO
Qbt2b
80
75
70
65
60
UNDER PIT
1020
1015
1010
1005
1000
0995
0990
JFB
JFB
JFB
JFB
JFB
JFB
JFB
Qbt2a
Qbt2b
92.7 m
90
85
80
UNDER PIT
SCALE
0
1
2
3
4
5 m
0
5
10
15 ft
1034
1030
1025
1021
JFB
JFB
Qbt2a
LEGEND
CORE RUN
CORE RECOVERED
CORE LOST
SAMPLE (974)
SAMPLE NO.,
PREFIX MAR 77.0
975
971
JO = JOINT OPEN
JFC = JOINT, CALICHE AND BROWN CLAY
JFB = JOINT, BROWN CLAY

APPENDIX E

CORE LOG P3-MH-5
(HORIZONTAL DISTANCE IN METERS)



LEGEND



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