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MARL RESOURCES OF THE HAND HILLS AREA

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Alberta
RESEARCH COUNCIL

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Occurrences of outcropping marl in the Hand Hills area were first reported by Allan and Sanderson (1945). A photograph in the report shows marl plainly visible at surface along the flanks of the Hills with little or no covering vegetation (Plate I, Fig. 1). At the present time the same areas are heavily overgrown by trees and low growth. Vanden Berg and Lennox (1969) further confirmed the presence of calcareous beds during the course of drilling groundwater test holes. Recently, the demonstrated need to treat acid soils surrounding the Hand Hills area (Fig. 1) prompted the Department of Agriculture to approach the Earth Sciences Division of Alberta Research to investigate any possible sources of carbonate rich materials in south-central Alberta. As a result, Western Canadian Geological Drilling Services of Edmonton were retained to auger drill a number of test holes along the northern portions of the Hand Hills (Fig. 2).

The Hills are at a maximum elevation of over 3500 feet within the study area, more than 500 feet above the level of the surrounding plains. Bedrock is at or close to surface along the entire flanks of the Hills and the top is covered by a thin veneer of ground moraine. The bedrock along the lower slopes of the Hills belongs to the Tertiary and Cretaceous Paskapoo Formation. It mainly includes grey and buff siltstone and mudstone. Thin coal beds and laminae are also prevalent within the formation.

The top of the Hand Hills is capped by moderately to poorly cemented gravel beds belonging to the Tertiary Hand Hills Formation. In places, sand is more common than gravel and considerable reworking has taken place. Marl and light colored clays stratigraphically below the gravels are included within the formation (Plate I, Fig. 2). It is supposed that the Hills are present at least partially because of the gravel capping which protected the area from glacial erosion. The thickness of the gravel exceeds 15 feet as indicated by sections in local gravel pits. The marl is over 25 feet thick in places (test holes 64-6 and 64-8, Vanden Berg and Lennox).

The purpose of this study is to report on marl beds close to surface which are easily exploitable by conventional means of excavation at convenient localities. Drilling was therefore confined to depths of less than 30 feet. Twenty-one holes were drilled and samples were obtained at regular intervals wherever carbonate percentage values appeared to be high. The higher grade samples were analyzed for calcium carbonate equivalents at the soils laboratory of the Department of Agriculture, Edmonton. Figure 3 illustrates those test holes which yielded marl samples that were analyzed and also indicates the area underlain by more than 5 feet of marl at a depth of less than 10 feet. Individual test hole sections and analytical results are given in figures 5 to 25 (see Fig. 4 for legend).

Holes 3, 15, 19, 20 and 21 penetrated the most economically significant beds of marl. Grades achieve a maximum of 67 percent $CaCO_3$ and more commonly the values are between 30 and 40 percent. Holes 7, 9, 10, 11, 14 and 16 are worthy of note but samples were not subjected to detailed analyses.

The dry marl is typically soft and flaky (Plate II, Fig. 1) ranging in color from light grey to dull orange or light yellow (see Table I for Munsell color codes used). Thin lenses and laminae of white carbonate salts are common. Moisture contents at the time of sampling were normally less than 15 percent. Sand and granule size ranges typically comprise less than 10 percent by weight of the material (Figs. 27 to 32). Silt size fractions of those samples analyzed range from 54 to 64 percent and clay from 23 to 36 percent. Particles retained above the No. 230 mesh sieve include quartz, quartzite, chert, siltstone, ironstone, gypsum and fragments of weakly cemented marl (Plate II, Figs. 2 and 3). Shells and other organic remains are absent with the exception of occasional stubby, tubular structures composed of soft tufa. Small amounts of feldspar, obsidian and other miscellaneous rock and mineral fragments are also present. The nature of the material under high magnification is shown in plate II, figure 4.

X-ray diffraction analyses confirm the presence of calcite, dolomite, quartz and feldspar. Dolomite appears to be present in relatively high quantities but analytical results are not available to indicate the exact contents. Clay minerals in the form of montmorillonite, kaolinite, illite and chlorite are verified by X-ray diffraction patterns.

The concentration of carbonates is interpreted to be the result of precipitation of calcite and dolomite from discharging groundwaters. As noted above, residual indications of organic influences appear to be rare and this, together with the fact that higher grade sections appear nearer the flanks of the Hills, would tend to demonstrate a groundwater redistribution of carbonates towards these areas.

Development of the marl is feasible at several places within the study area (Fig. 3). Carbonate grades are not as high as could be desired and gravel beds commonly overlie the marl, especially along the edges of the Hills. Commercial exploitation of the gravel and marl simultaneously could be a possible approach to development. Although no estimates of reserves are available, it would appear that tonnages of marl in place are more than sufficient to meet the needs for local agricultural liming purposes.

References

Allan, J.A. and Sanderson, J.O.G. (1945): Geology of Red Deer and Rosebud Sheets. Res. Coun. Alberta Rept. 13.

Vanden Berg, A. and Lennox, D.H. (1969): Groundwater Chemistry and Hydrology of the Handhills Lake Area, Alberta. Res. Coun. Alberta Rept. 69-1.

Table I - Selected Munsell Color Standards

Code	Description
2.5Y 4/1	yellowish grey
2.5Y 4/2	dark greyish yellow
2.5Y 5/2	dark greyish yellow
2.5Y 5/3	yellowish brown
2.5Y 5/4	yellowish brown
2.5Y 6/1	yellowish grey
2.5Y 6/2	greyish yellow
2.5Y 6/3	dull yellow
2.5Y 7/2	greyish yellow
2.5Y 7/3	dull orange
2.5Y 7/4	light yellow
2.5Y 8/1	light grey
2.5Y 8/2	light grey
2.5Y 8/3	pale yellow
2.5Y 8/4	pale yellow
5Y 6/1	grey
5Y 6/2	greyish olive
5Y 7/1	light grey
5Y 7/2	light grey
5Y 7/3	light yellow
5Y 7/4	light yellow
5Y 8/2	light grey
5Y 8/3	pale yellow
7Y 7/1	light grey
7.5Y 6/1	grey
7.5Y 7/1	light grey
2.5YR 4/1	reddish grey
2.5YR 7/3	pale reddish orange
5YR 2/1	brownish black
5YR 5/1	brownish grey
5YR 6/4	dull orange
5YR 7/1	light brownish grey
5YR 7/3	dull orange
5YR 7/4	dull orange
5YR 8/3	pale orange
7YR 7/3	dull orange

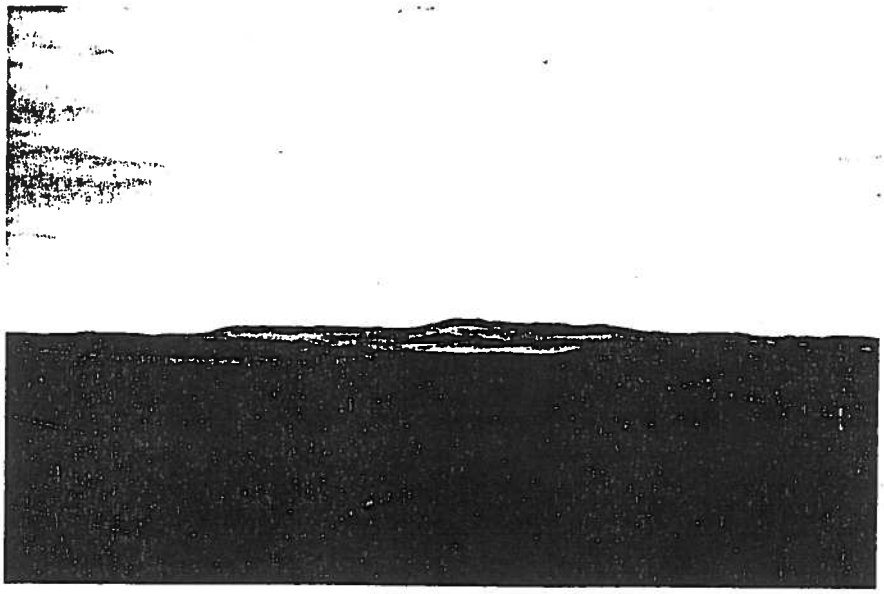
Table I - Selected Munsell Color Standards (continued)

Code	Description
7.5YR 4/1	brownish grey
7.5YR 5/2	greyish brown
7.5YR 6/1	brownish grey
7.5YR 6/2	greyish brown
7.5YR 6/3	dull brown
7.5YR 6/4	dull orange
7.5YR 7/1	light brownish grey
7.5YR 7/2	light brownish grey
7.5YR 7/3	dull orange
7.5YR 7/4	dull orange
7.5YR 8/1	light grey
7.5YR 8/2	light grey
7.5YR 8/3	light yellowish orange
10YR 4/1	brownish grey
10YR 6/2	greyish yellow brown
10YR 7/1	light grey
10YR 7/2	dull yellow orange
10YR 7/3	dull yellow orange
10YR 7/4	dull yellow orange
10YR 7/6	bright yellowish brown
10R 3/2	dark reddish brown
10GY 3/1	dark greenish grey

Plate I

Figure 1. Looking east towards the Hand Hills.

Figure 2. Marl outcrop adjacent to Hole 21. Note contact between marl and overlying gravel above the shovel handle.



1

2

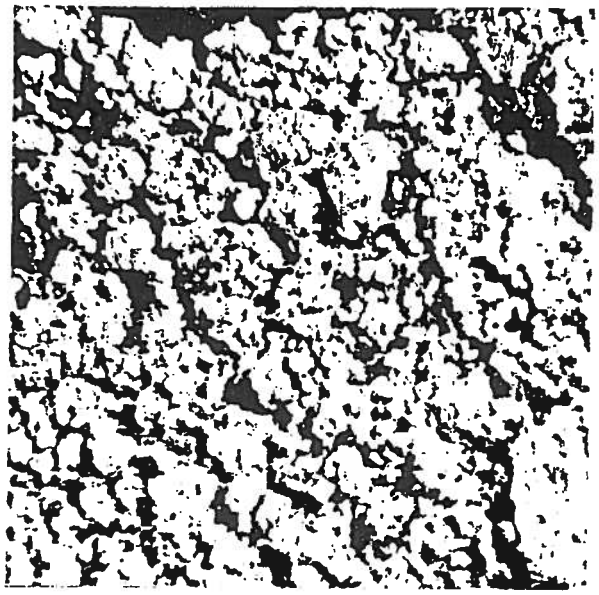
Plate II

Figure 1. Marl from a depth of 20 feet in Hole 15, 20X.

Figure 2. Particles retained on the No. 40 mesh sieve. Sample from a depth of 10 feet in Hole 15. Note quartz (clear), chert (dark) and hollow calcareous structures (white), 20X.

Figure 3. Particles retained on the No. 40 mesh sieve. Sample from a depth of 12 feet in Hole 20. Note round quartz (clear), chert (dark), marl (white) and gypsum (clear and elongate), 20X.

Figure 4. Marl from a depth of 12 feet in Hole 19, 125X.



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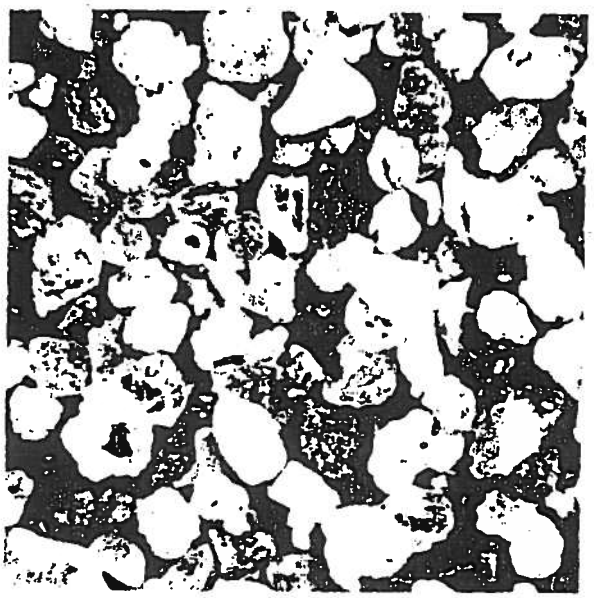

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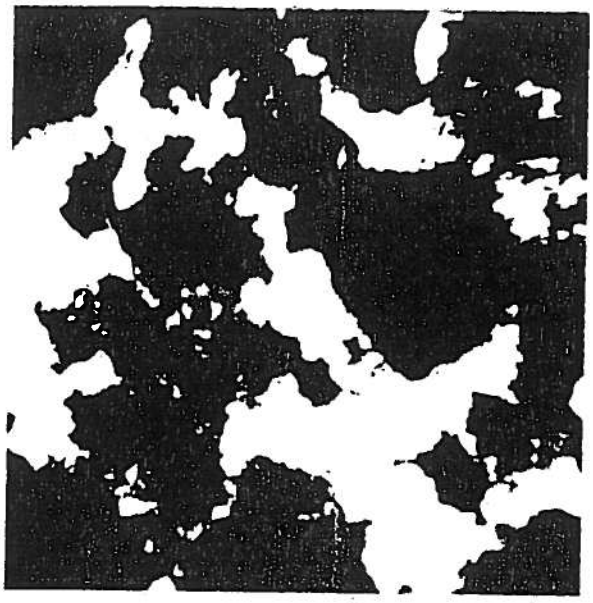

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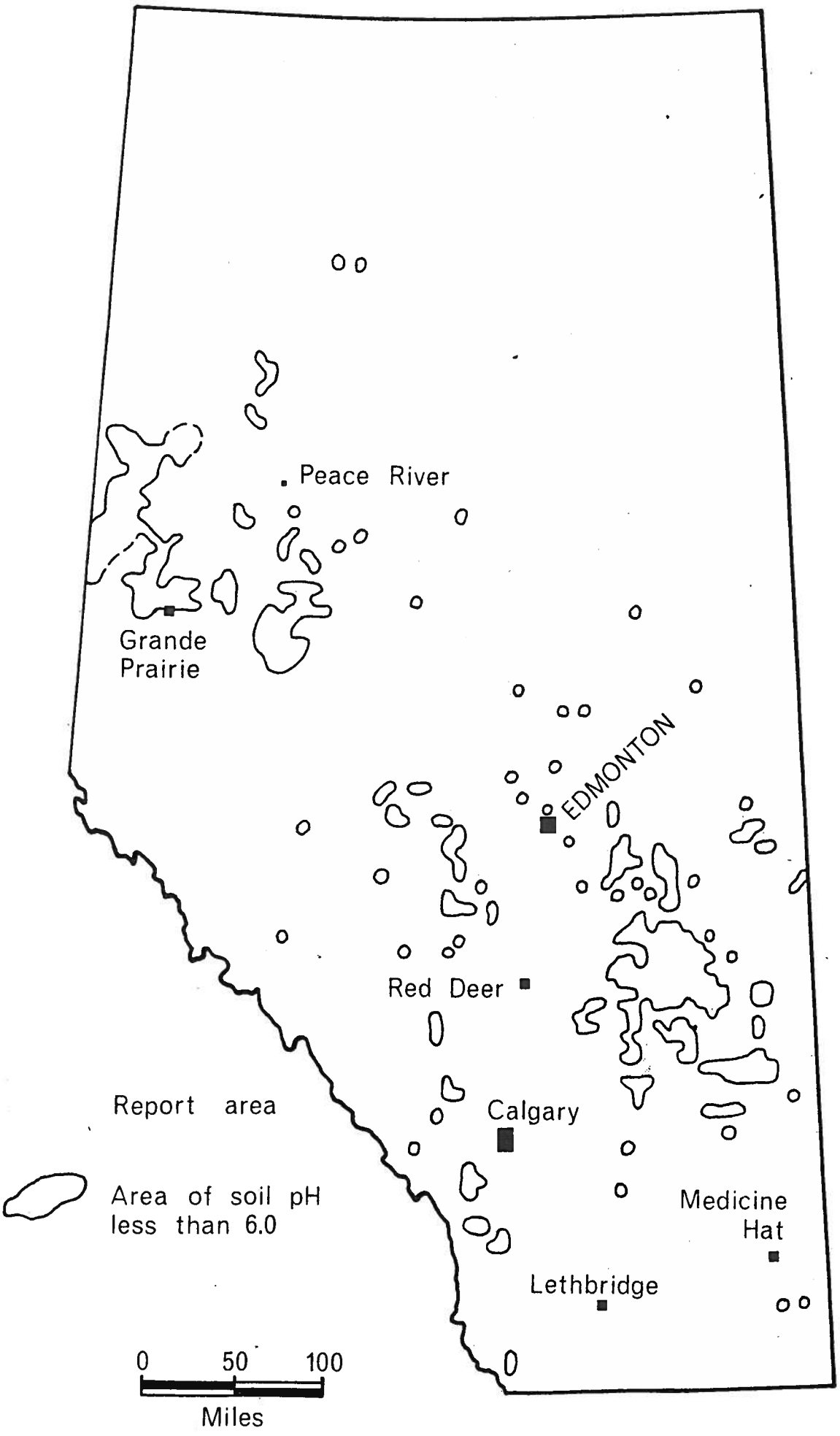
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Grande Prairie
EDMONTON
Red Deer
Report area
Calgary
Area of soil pH less than 6.0
Medicine Hat
Lethbridge
0 50 100
Miles

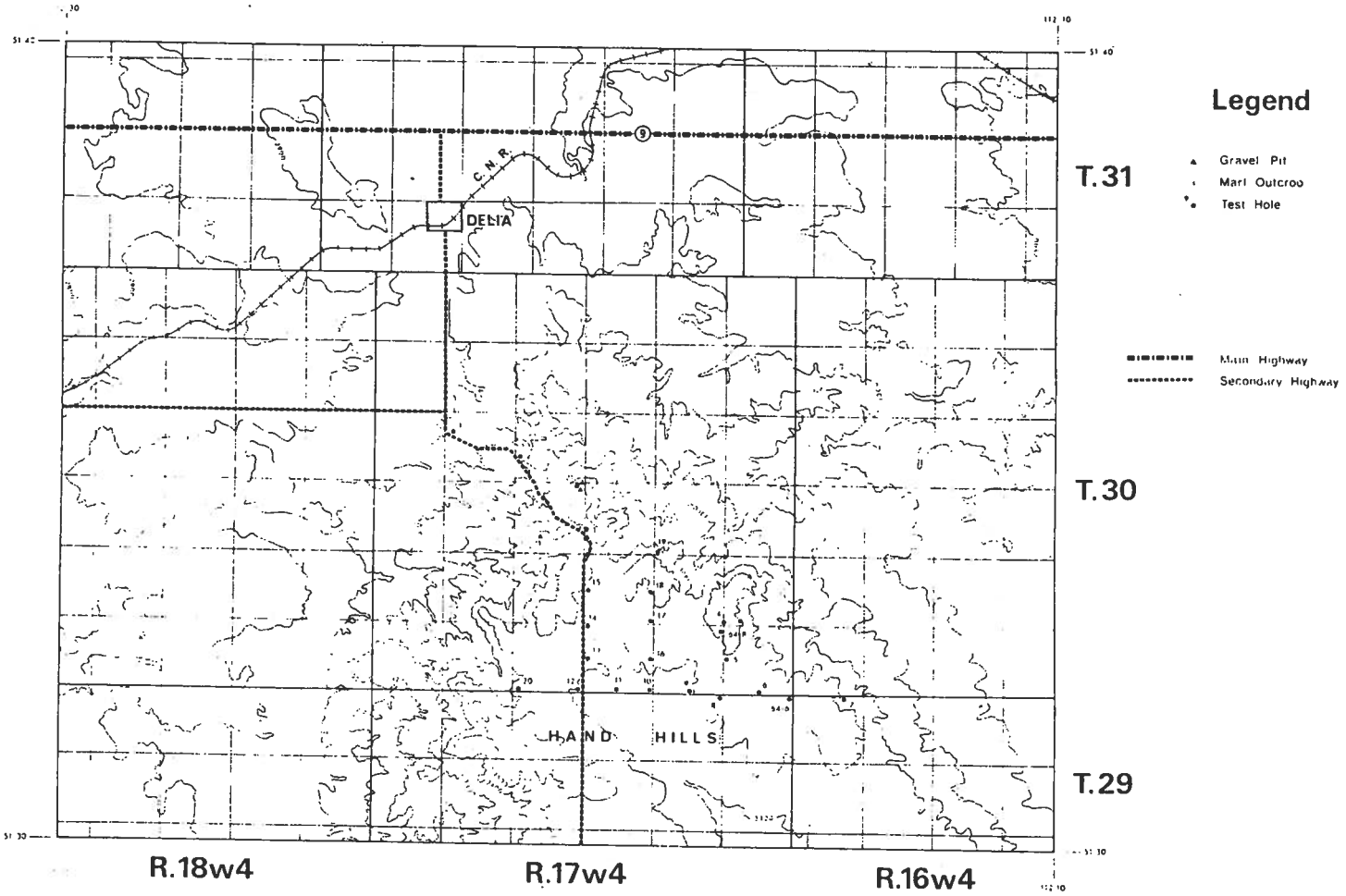


Figure 2. Location Map

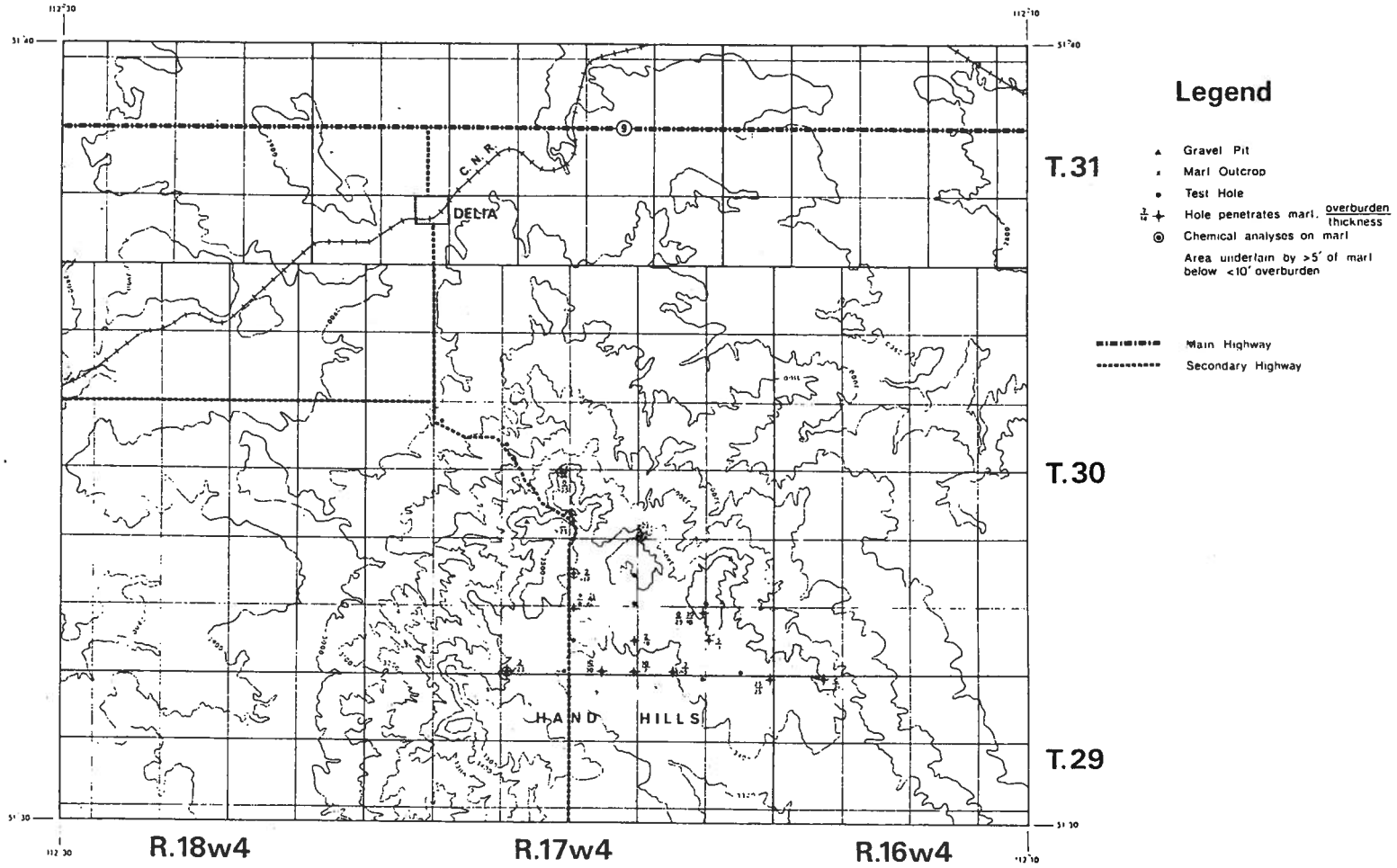


Figure 3. Marl Distribution Map.

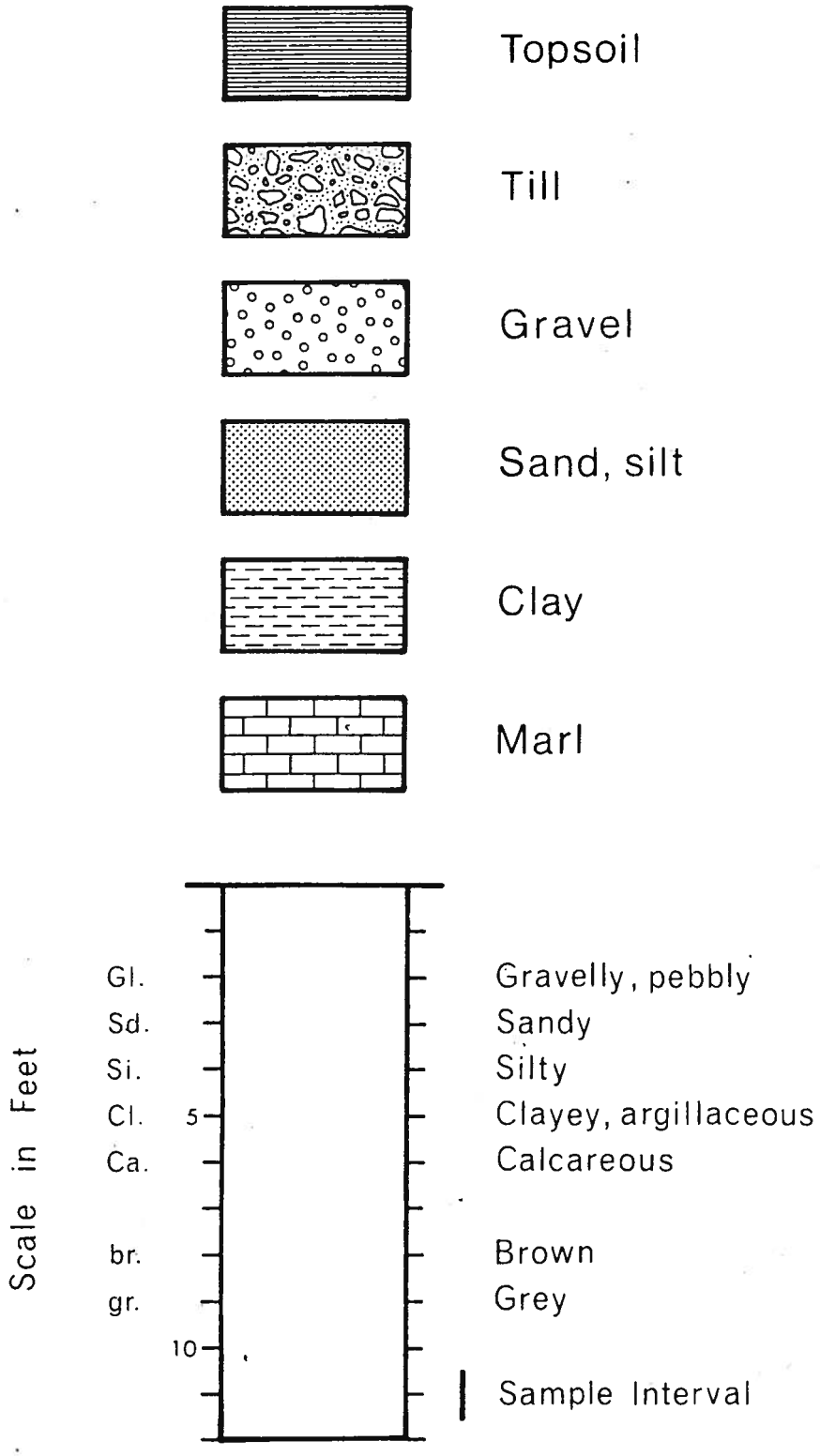
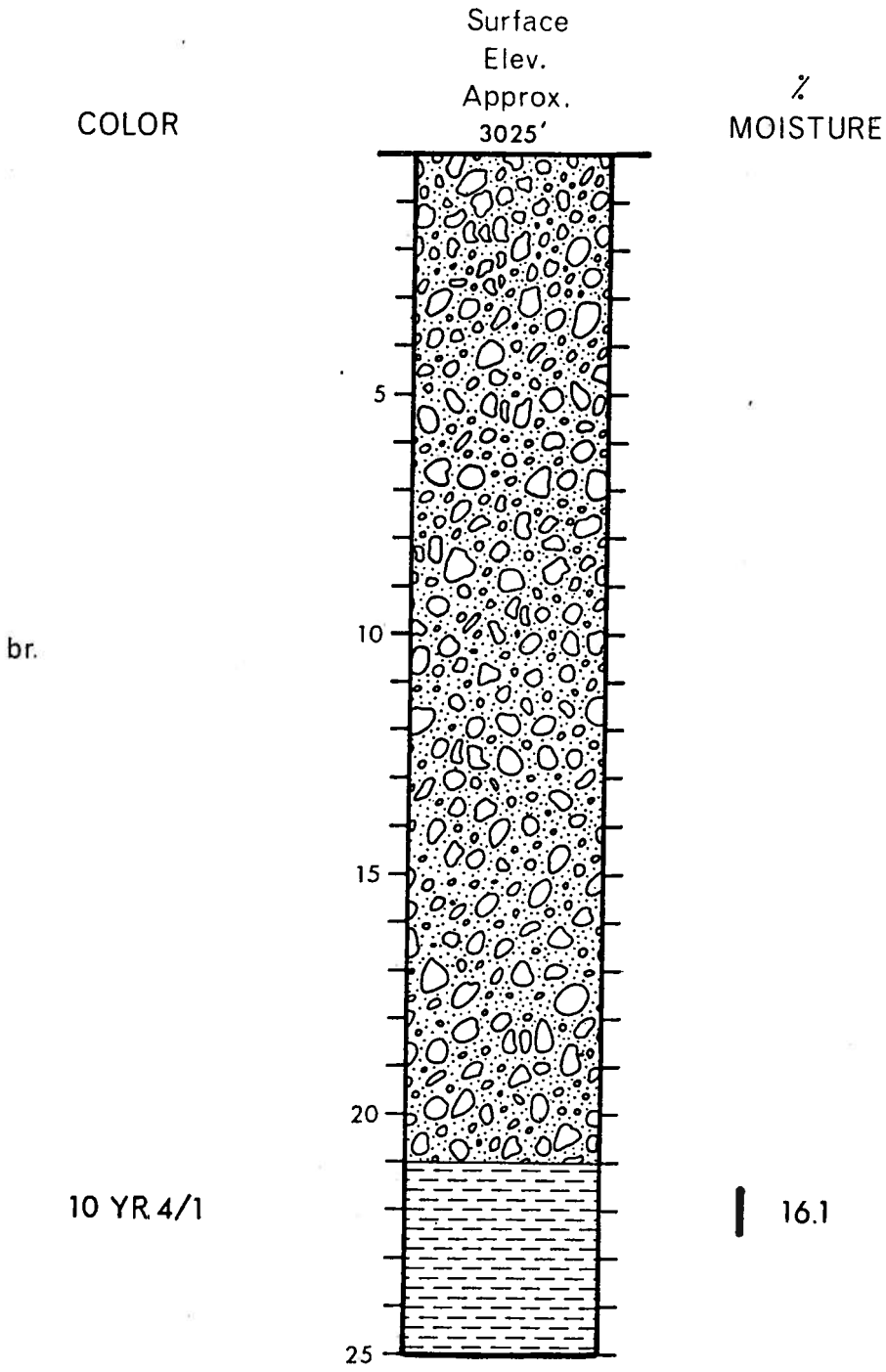
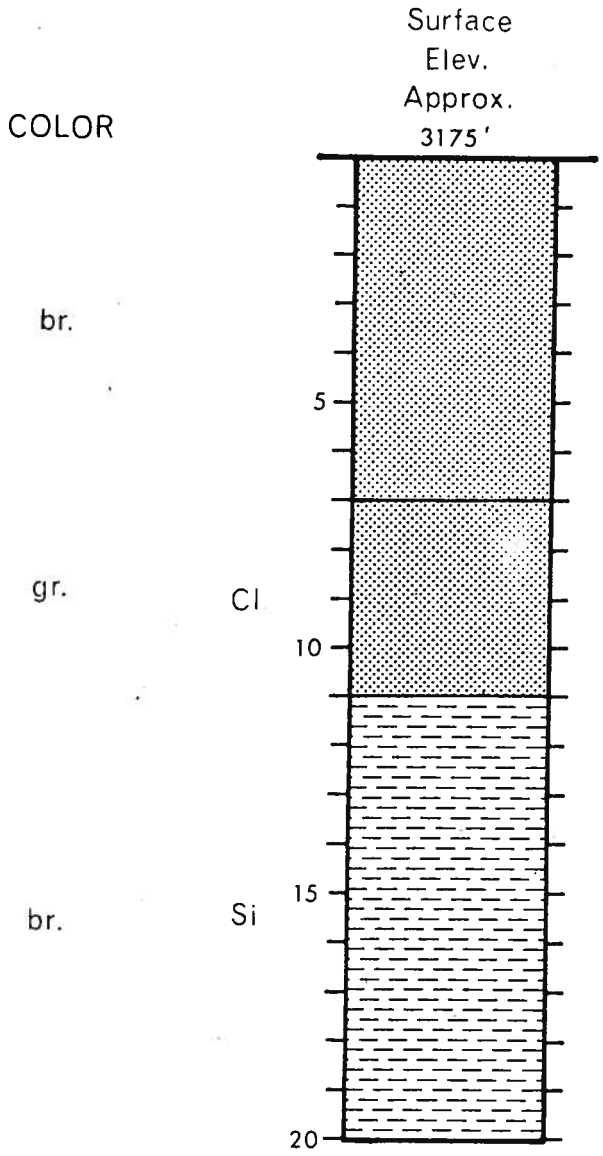


Figure 4. Legend for Test Hole Sections.



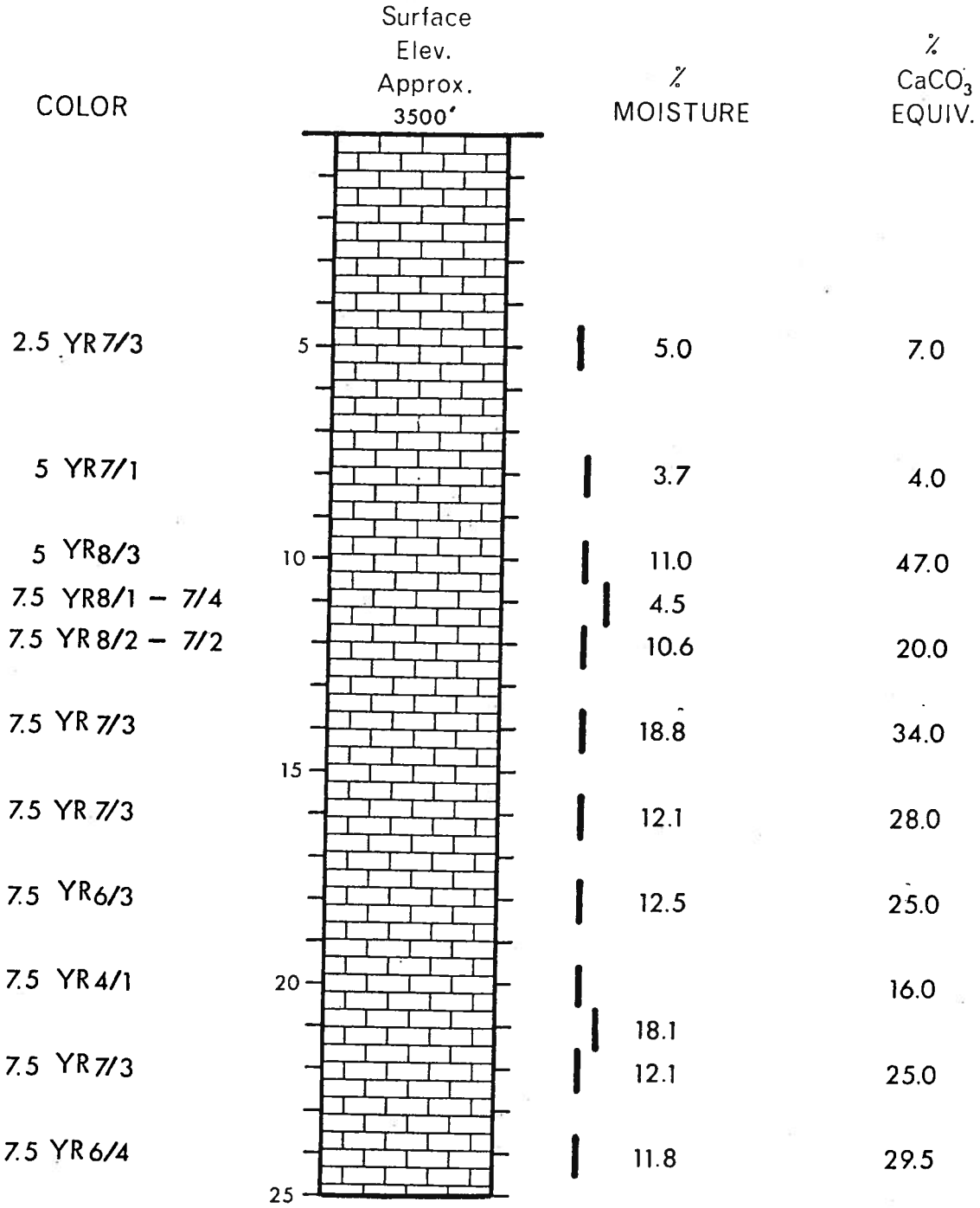
Hole No. 1

Figure 5.



Hole No. 2

Figure 6.



Hole No. 3

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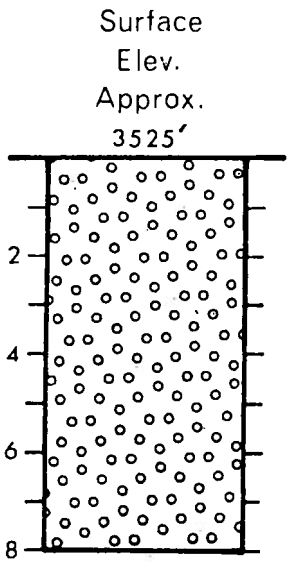

Hole No. 4

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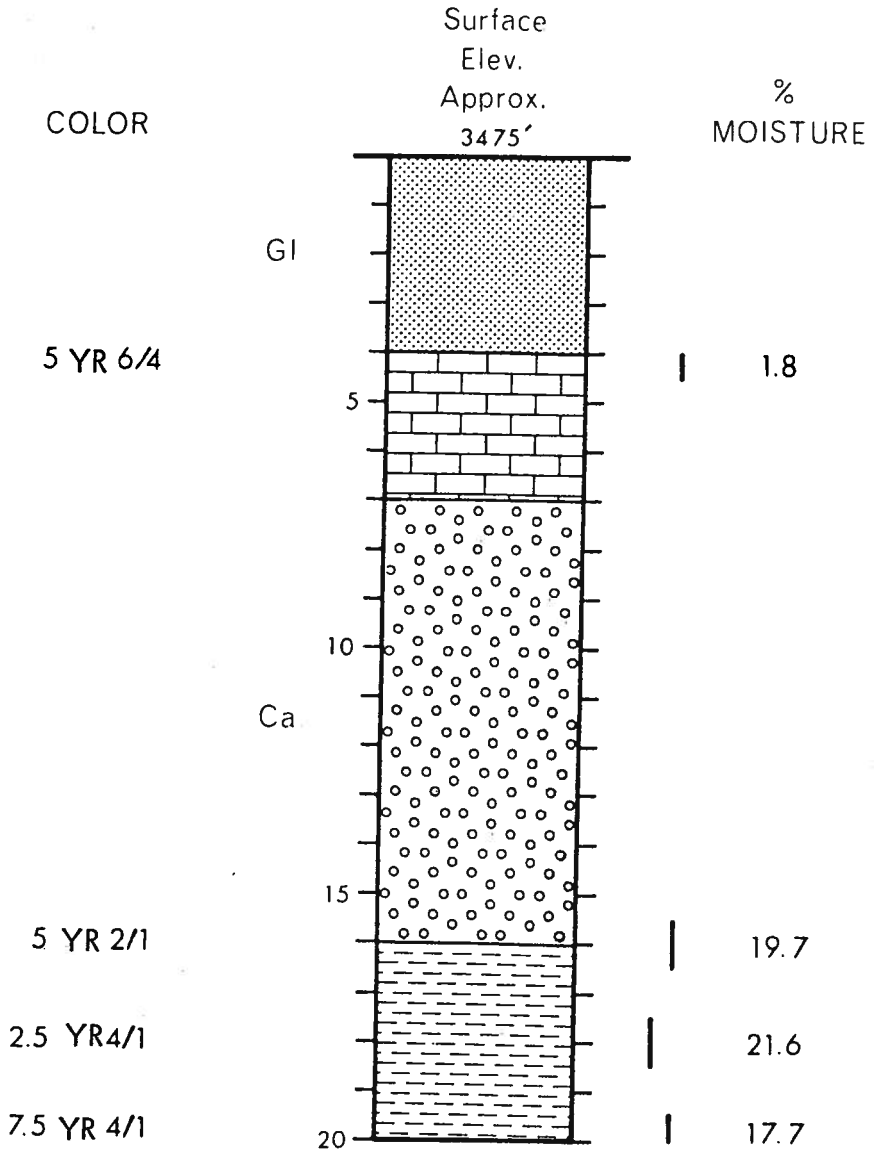

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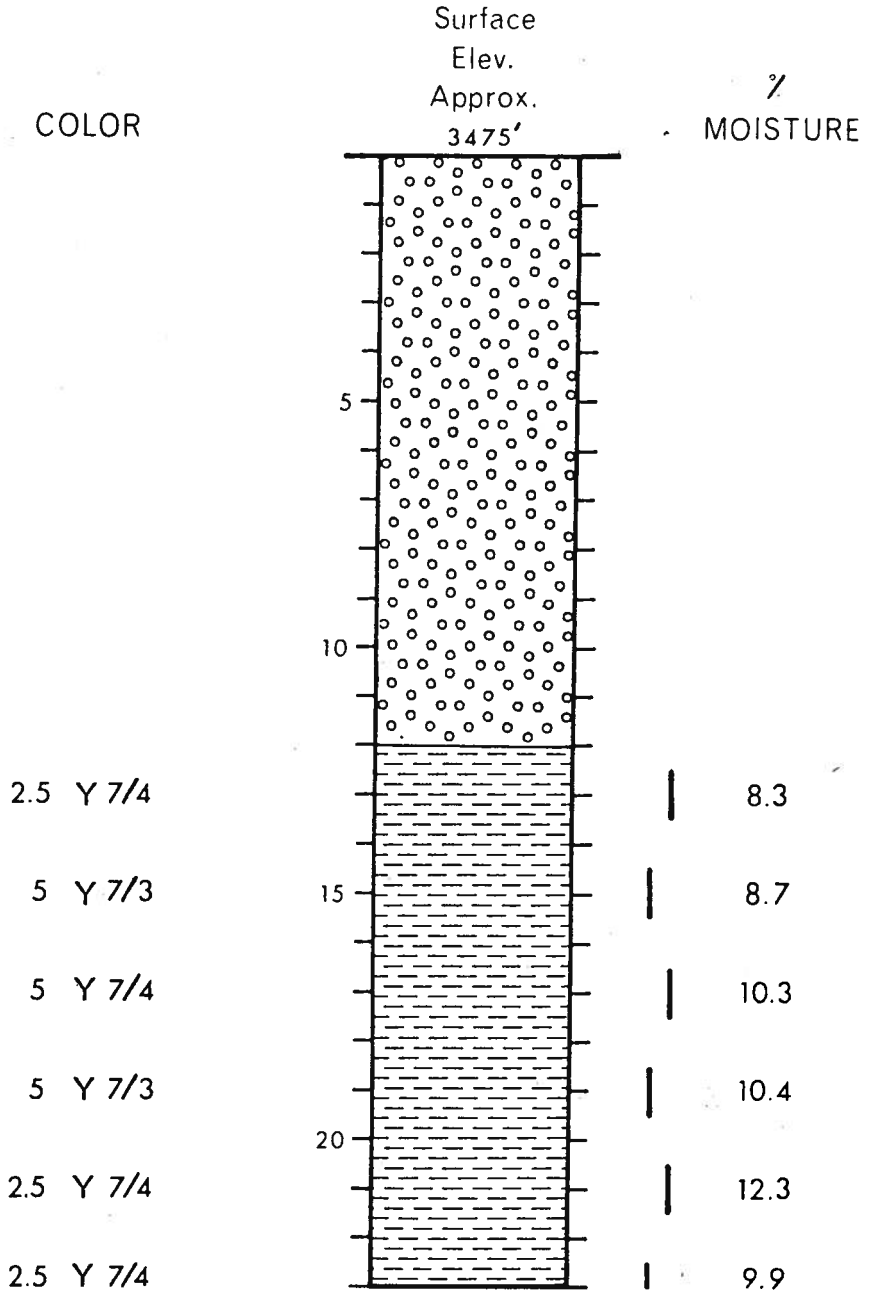

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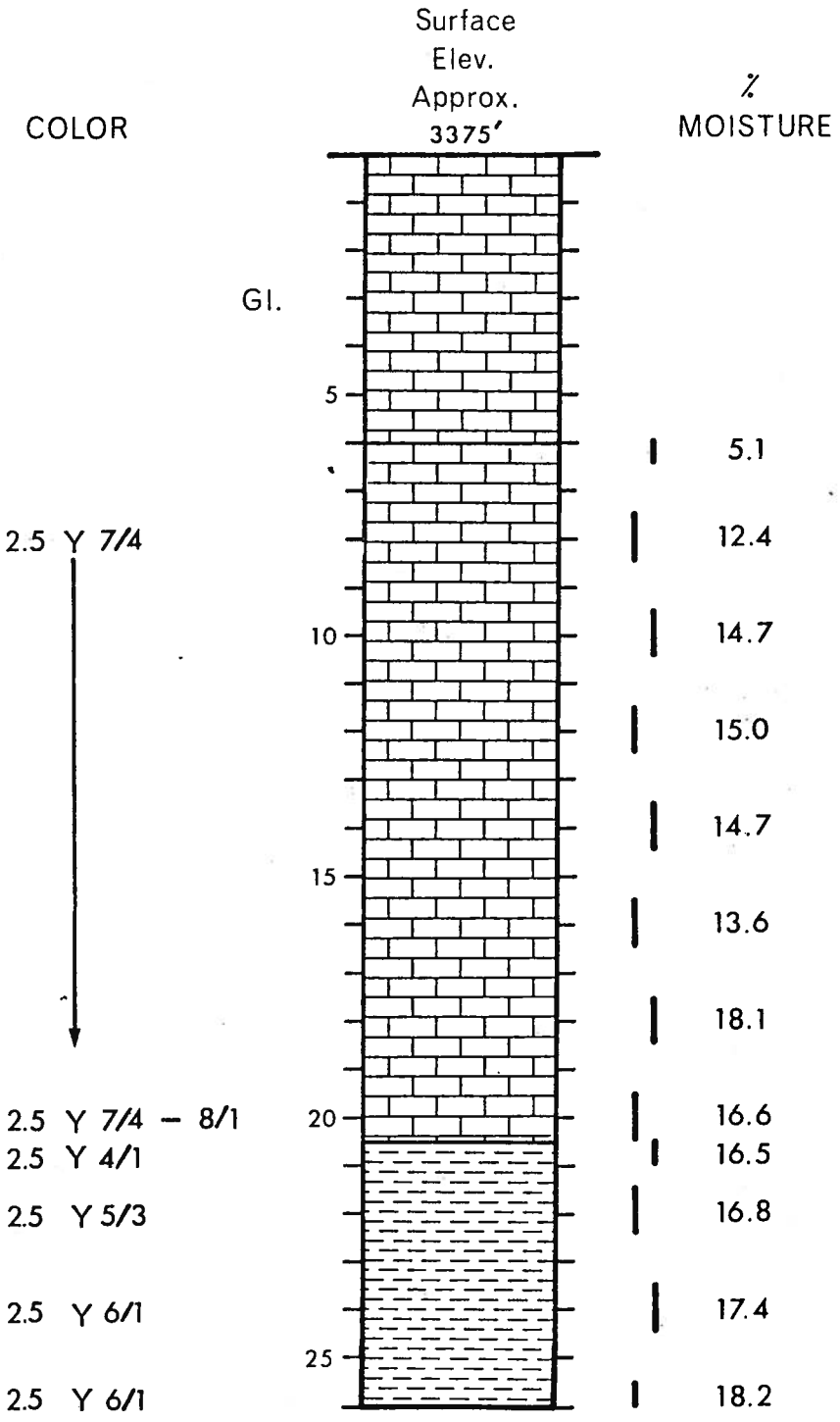
Figure 10.



Hole No. 7

Figure II.

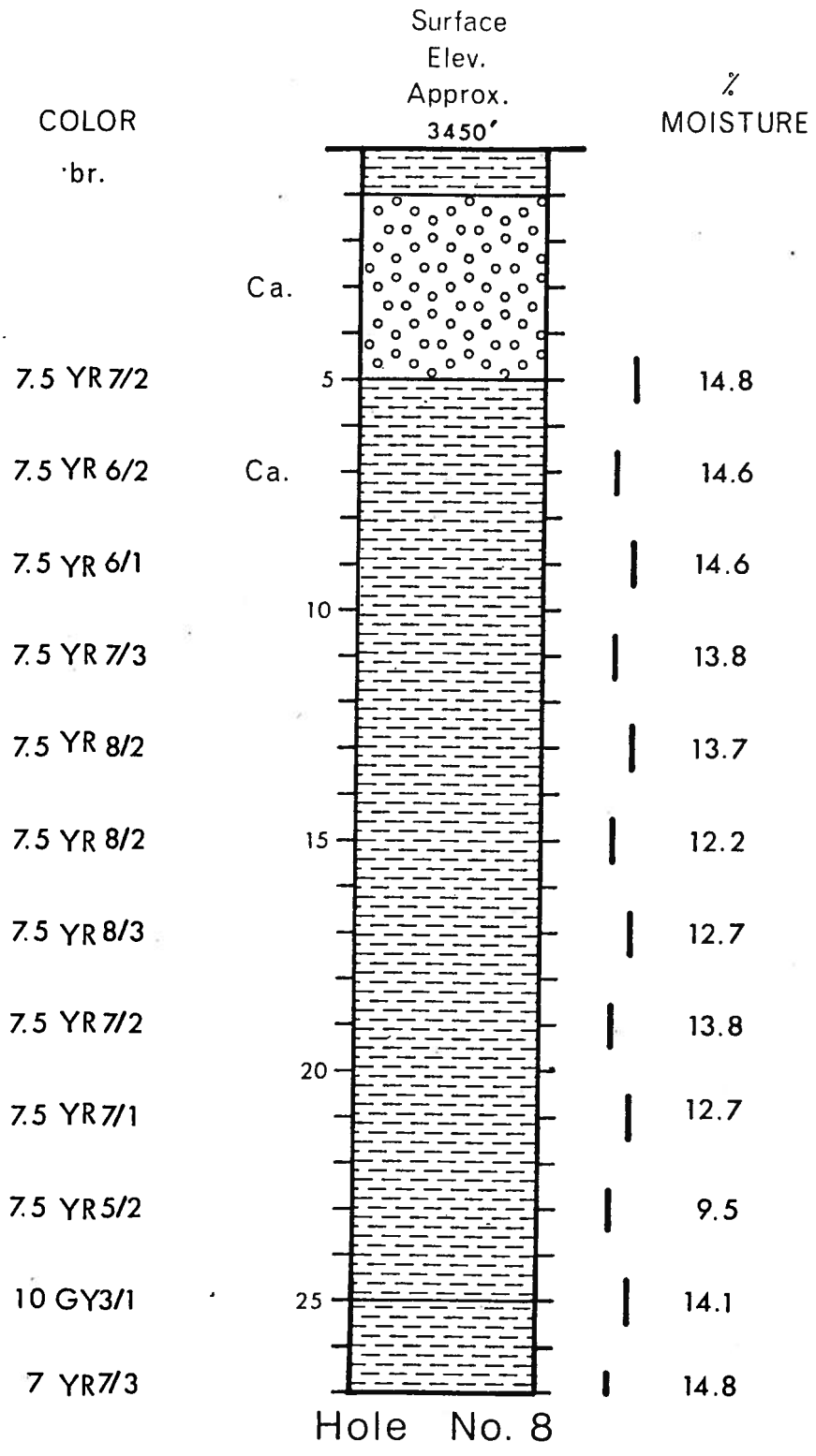
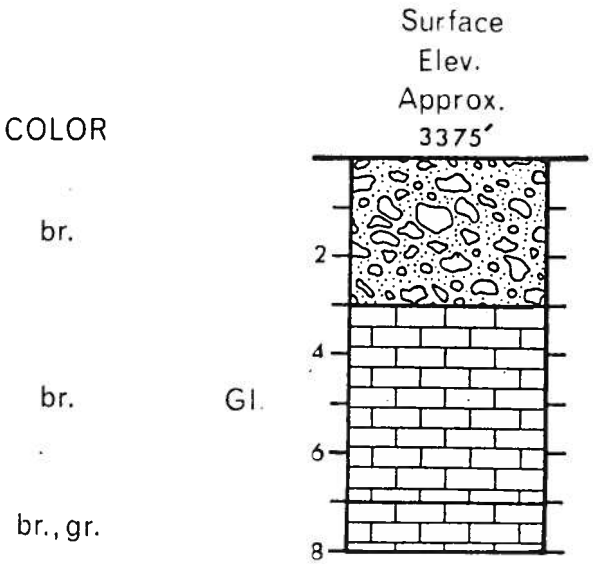
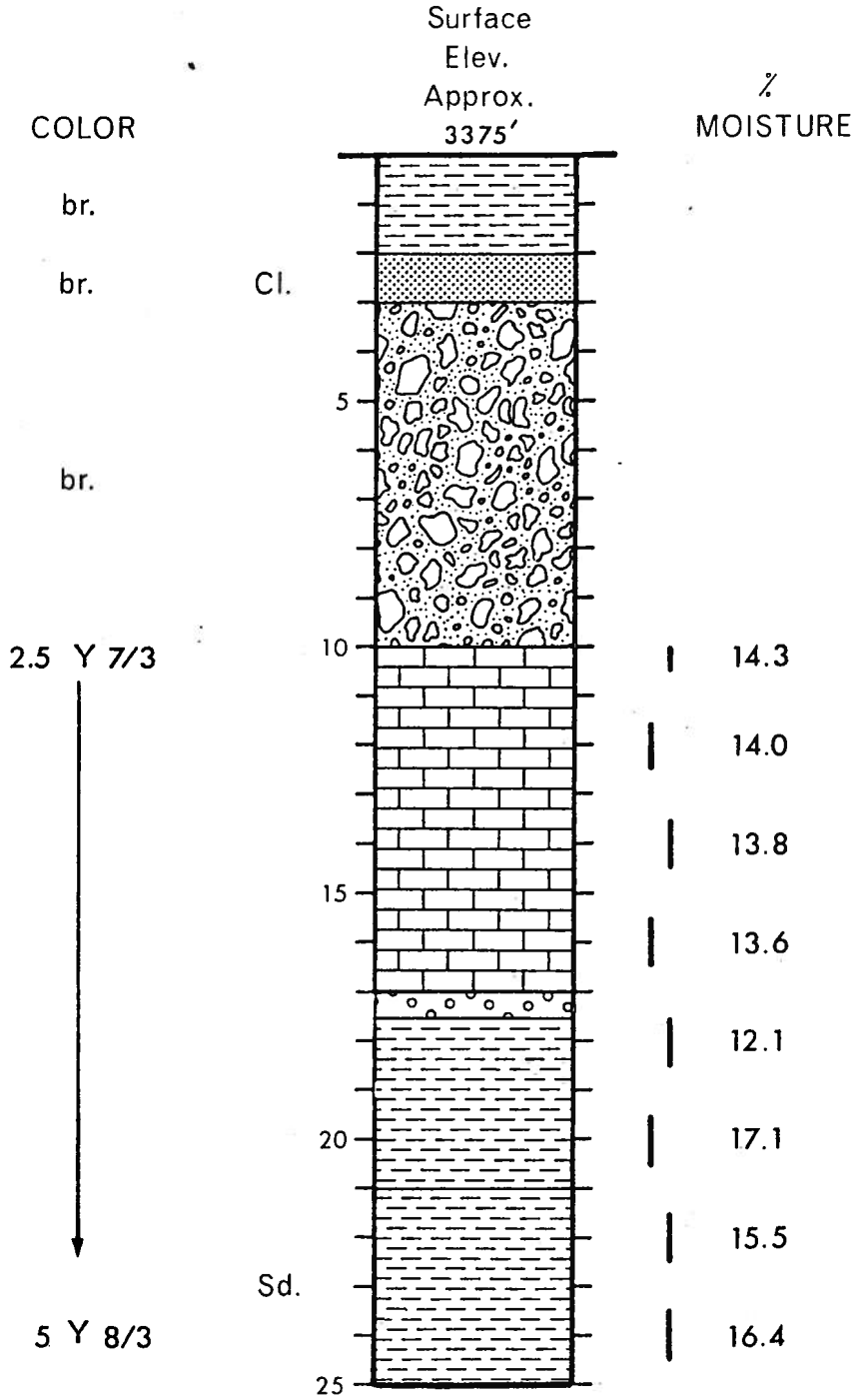

Surface
Elev.
Approx.
3450'
COLOR
br.
%
MOISTURE
Ca.
Ca.
5
10
15
20
25
7.5 YR 7/2
7.5 YR 6/2
7.5 YR 6/1
7.5 YR 7/3
7.5 YR 8/2
7.5 YR 8/2
7.5 YR 8/3
7.5 YR 7/2
7.5 YR 7/1
7.5 YR 5/2
10 GY 3/1
7 YR 7/3
14.8
14.6
14.6
13.8
13.7
12.2
12.7
13.8
12.7
9.5
14.1
14.8
Hole No. 8

Figure 12.



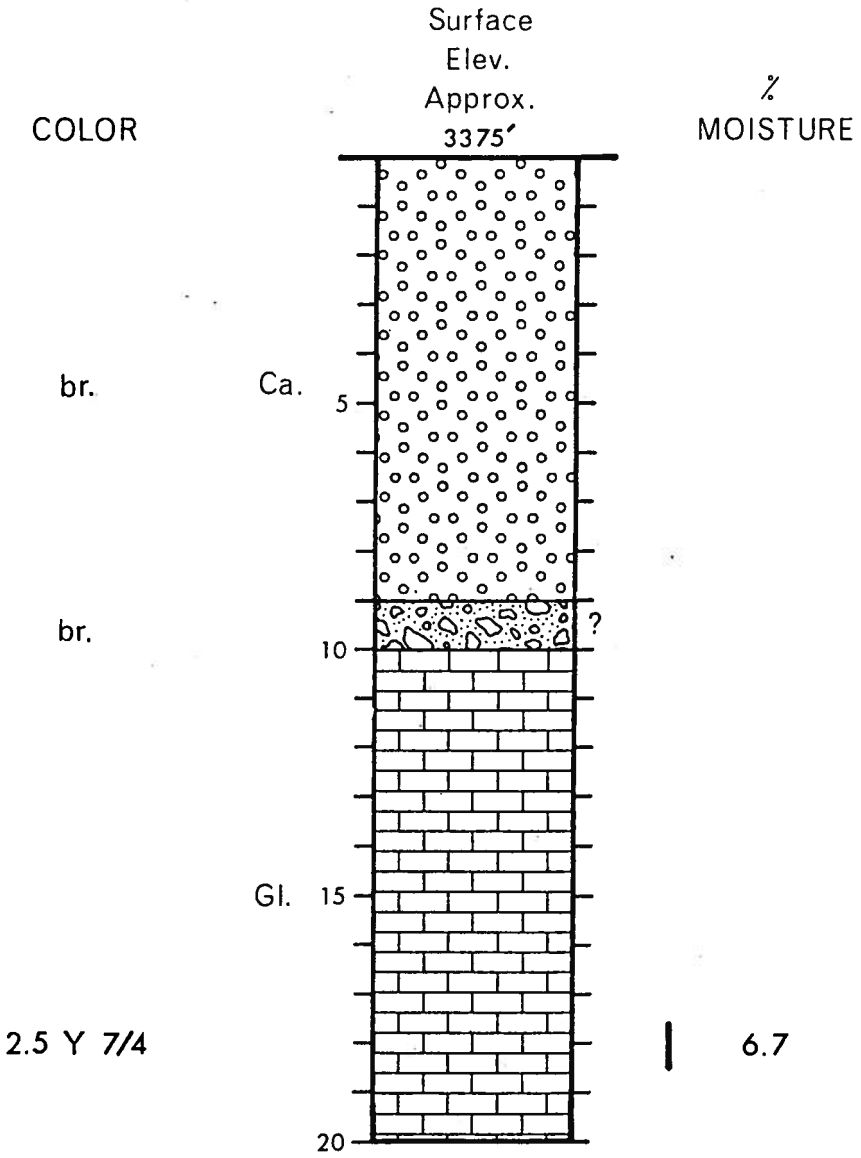
Hole No. 9

Figure 13.



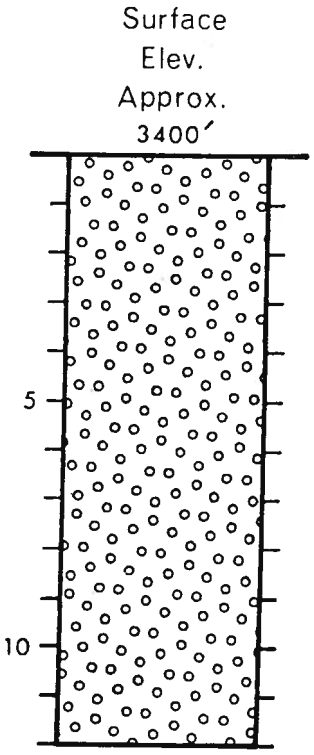
Hole No. 10

Figure 14.



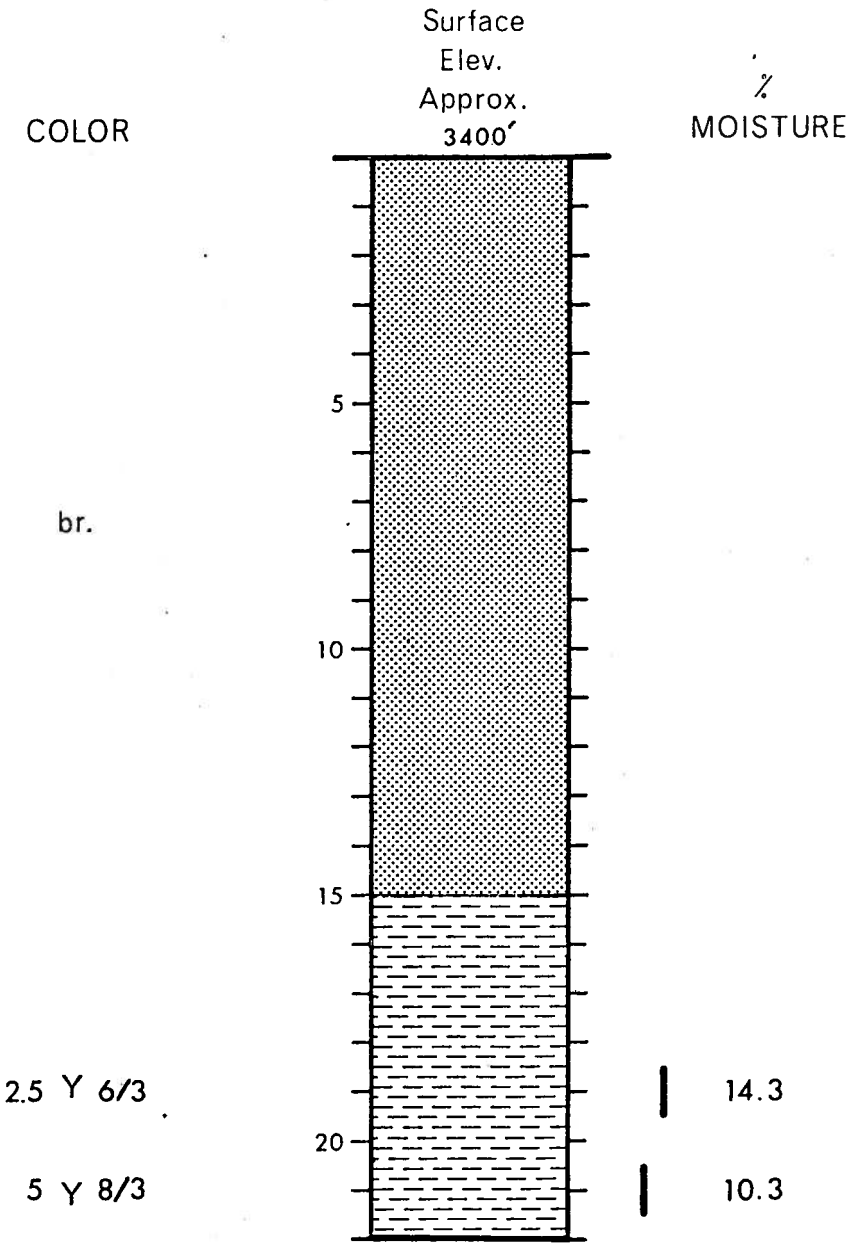
Hole No. 11

Figure 15.



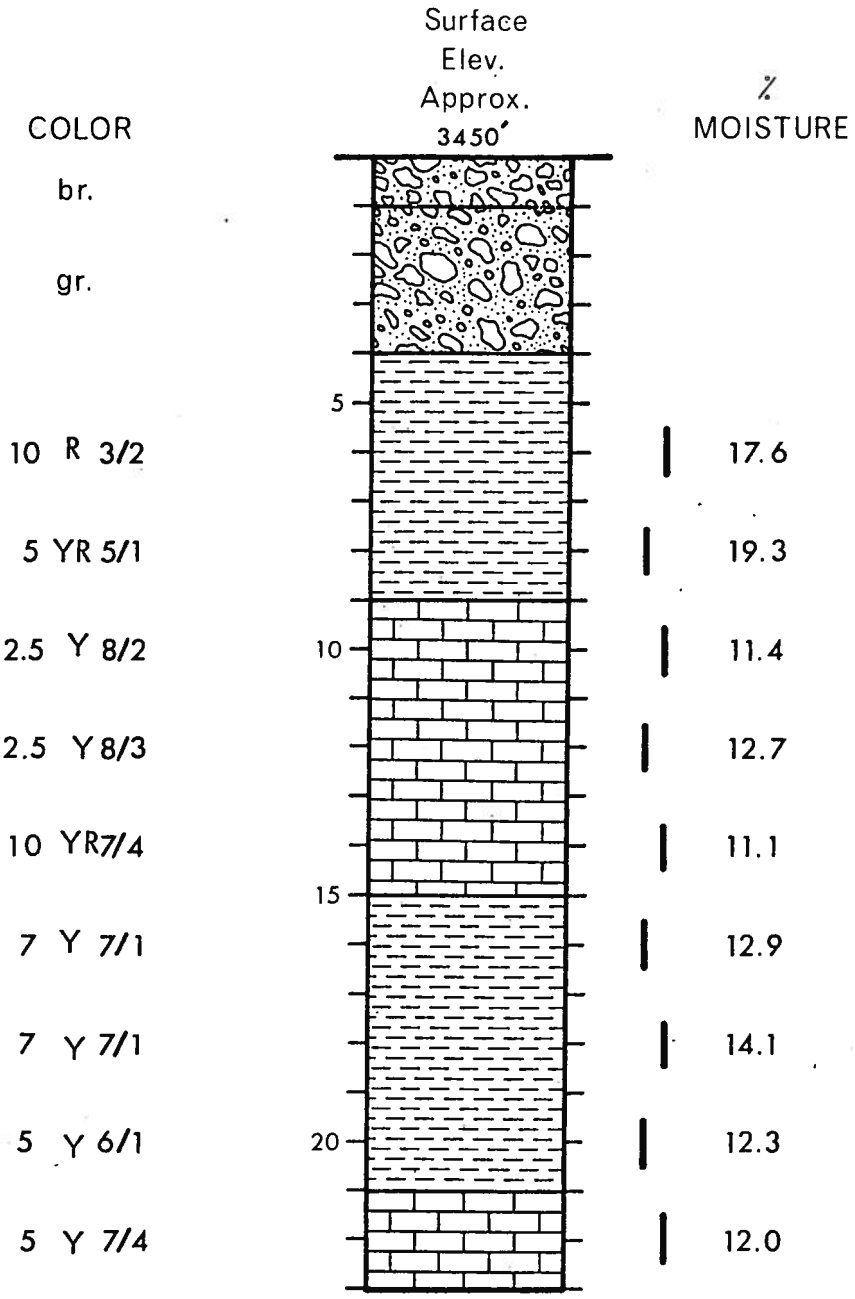
Hole No. 12

Figure 16.



Hole No. 13

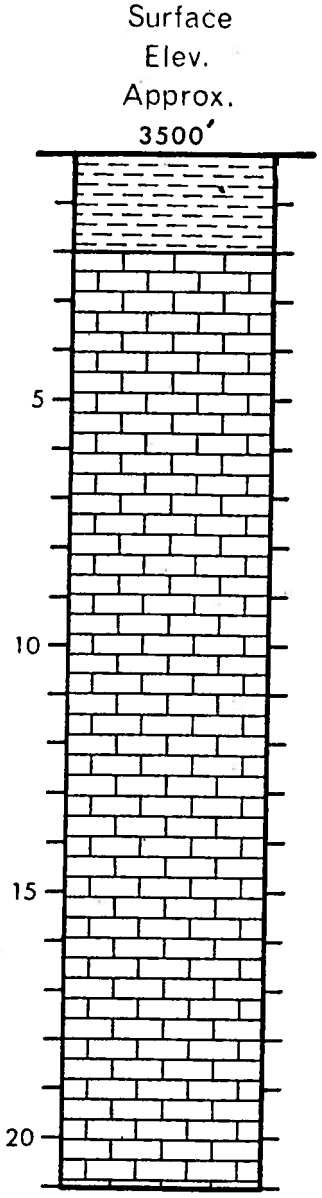
Figure 17.



Hole No. 14

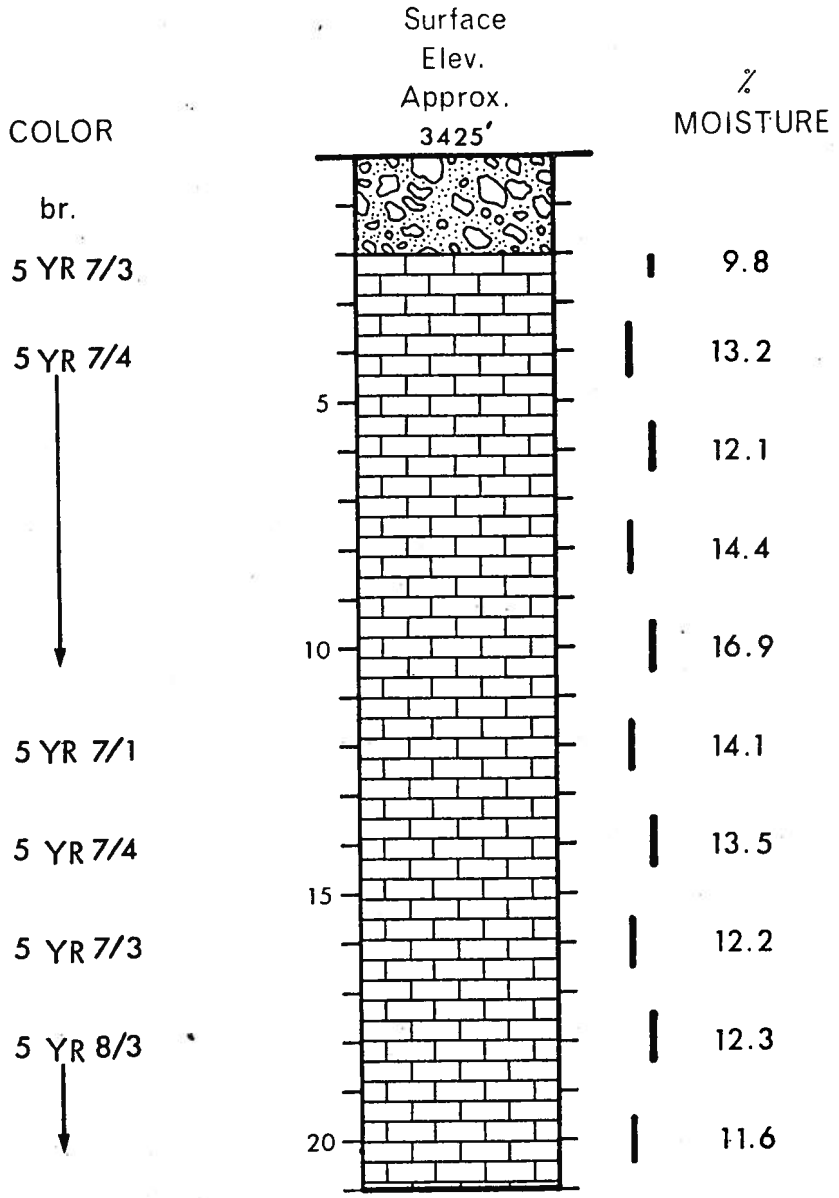
Figure 18.

COLOR	% MOISTURE	% $CaCO_3$ EQUIV.
br.		
10 YR 6/2	11.5	13.5
10 YR 6/2	11.0	12.5
10 YR 7/3	12.0	19.0
2.5 Y 7/1	11.5	29.5
2.5 Y 7/4	13.6	14.5
2.5 Y 7/2	13.4	20.0
2.5 Y 8/2	11.8	60.0
2.5 Y 8/4	12.1	66.5
2.5 Y 7/4	11.1	32.5
5 Y 7/2	12.7	34.5



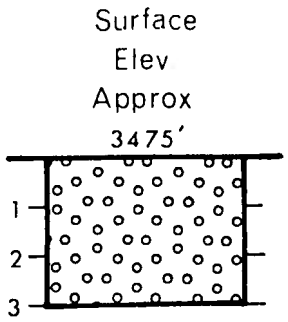
Hole No. 15

Figure 19.



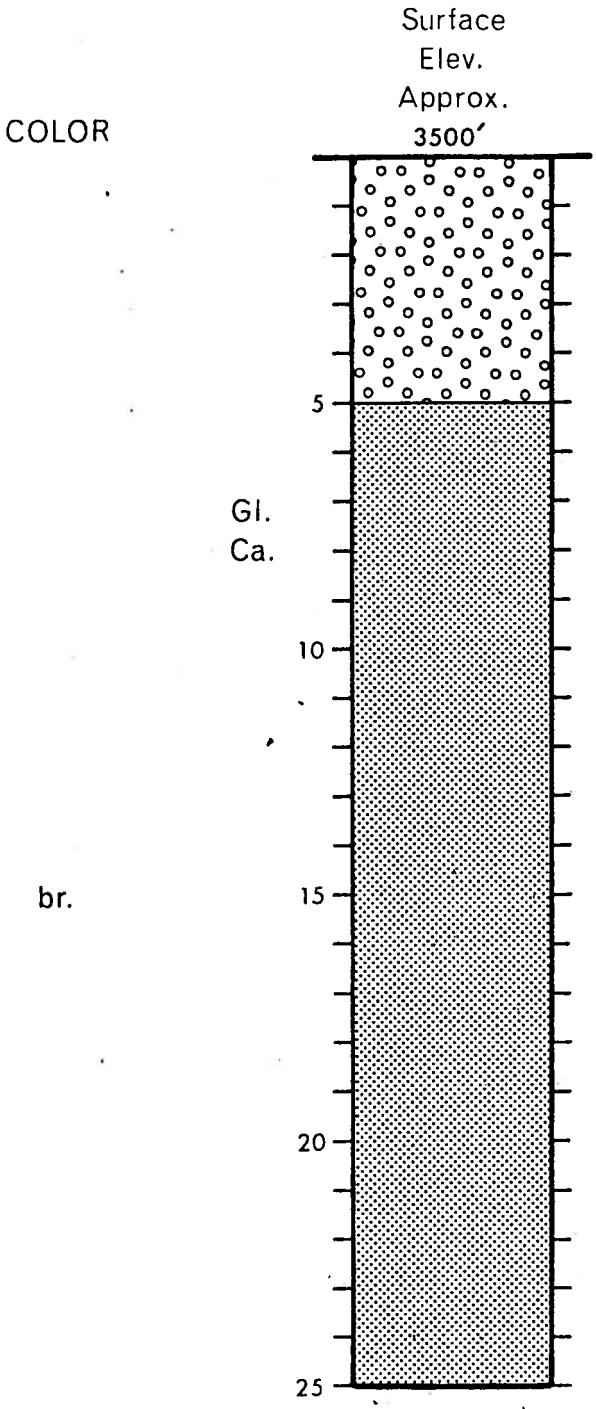
Hole No. 16

Figure 20.



Hole No. 17

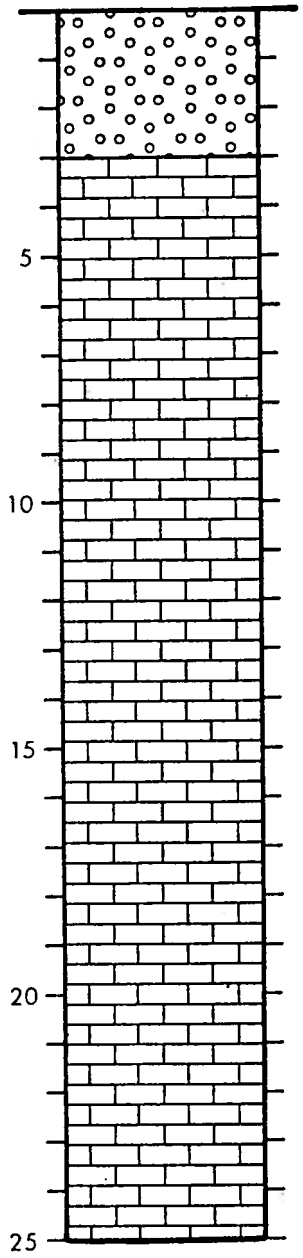
Figure 21.



Hole No. 18

Figure 22.

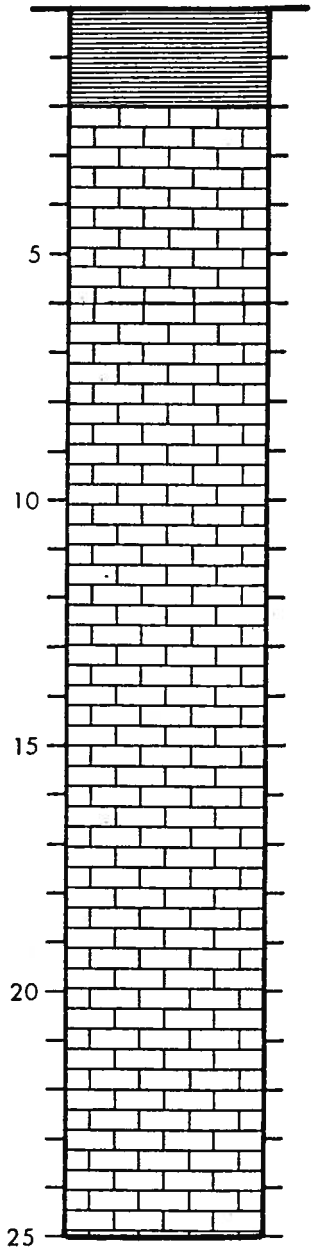
COLOR	% MOISTURE	% $CaCO_3$ EQUIV.
10 YR 7/4	15.3	28.0
10 YR 7/2	12.7	3.5
7 5 YR 8/2	10.4	25.0
10 YR7/2	13.9	16.5
10 YR 7/3	11.8	35.0
10 YR 7/3	12.5	34.5
5 Y 7/1	8.3	45.5
10YR 7/6	10.7	38.5
10 YR 7/3	11.0	29.0
10YR 7/2	11.4	14.5
10YR 7/3	11.2	21.5



Hole No. 19

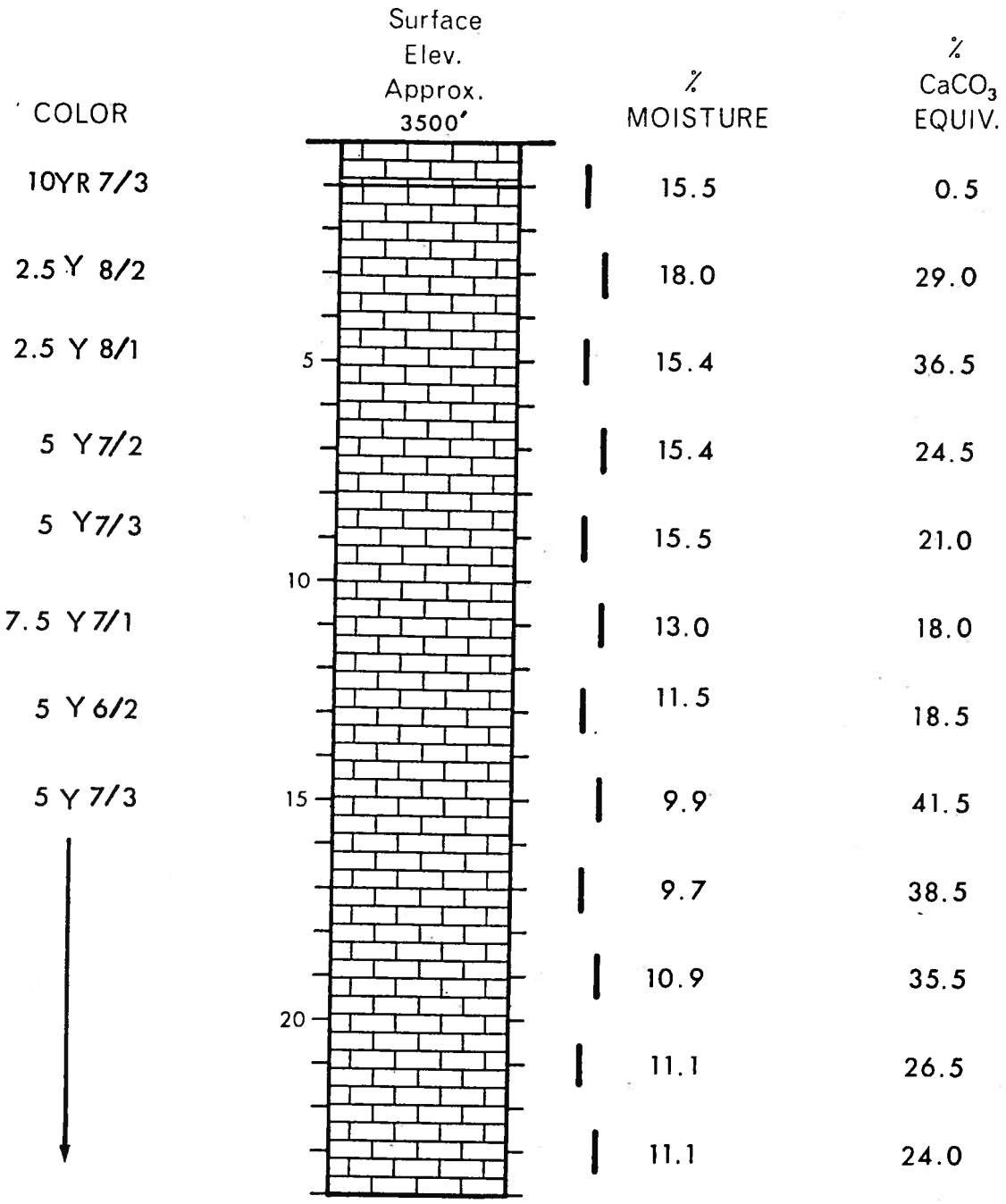
Figure 23.

COLOR		% MOISTURE	% $CaCO_3$ EQUIV.
2.5 Y 6/2	Gl.	3.6	15.5
7.5 Y6/1			2.0
2.5 Y 7/2		7.9	0.5
2.5 Y 7/2		10.6	7.5
2.5 Y 6/3		11.1	10.0
2.5 Y 5/4		14.7	9.0
2.5 Y 5/2		9.9	10.0
2.5 Y 4/2		12.8	5.0
2.5 Y 5/3		11.1	13.5
5 Y 7/3		10.6	19.5
2.5 Y 7/3		11.3	20.0



Hole No. 20

Figure 24.



Hole No. 21

Figure 25.

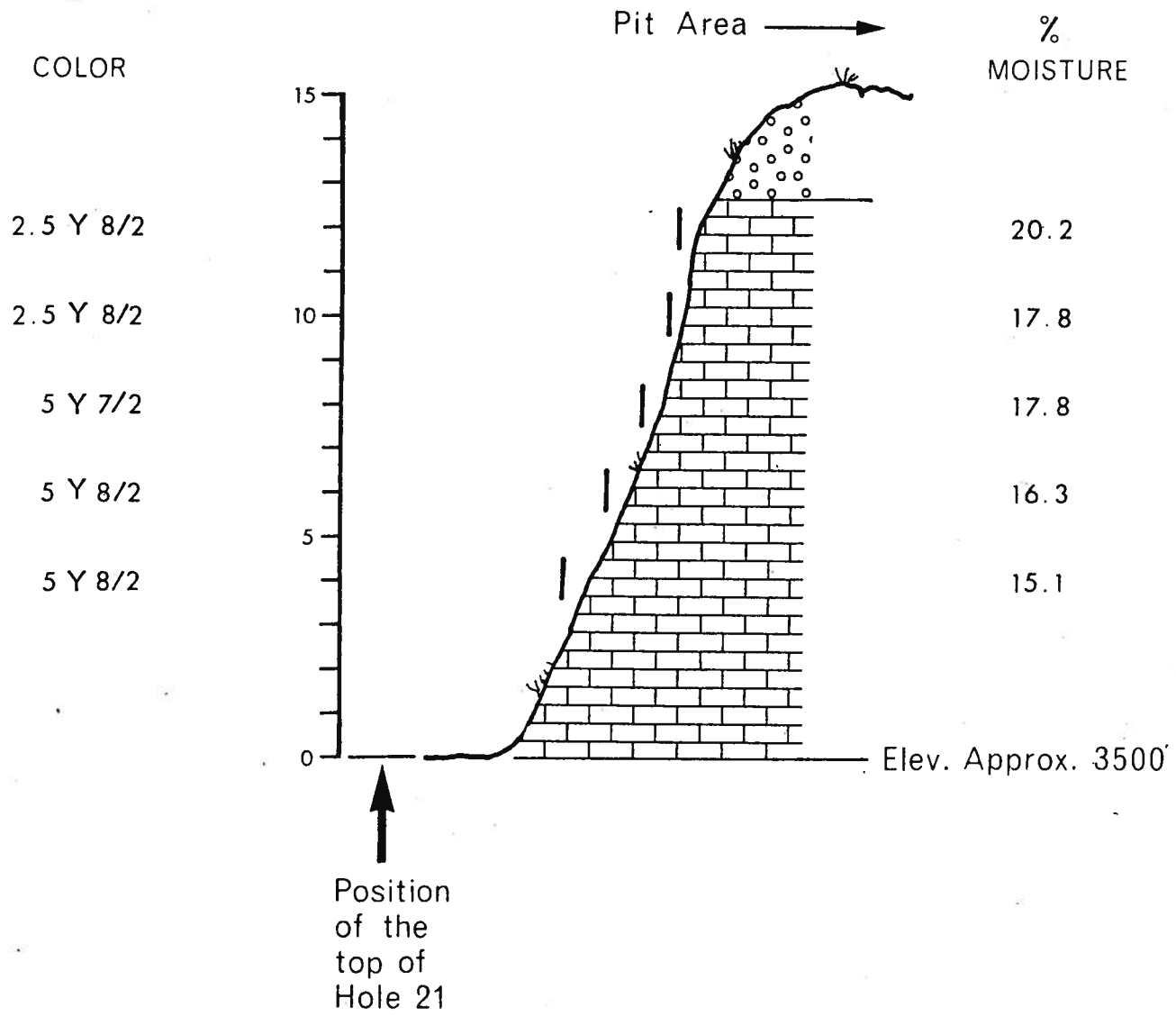
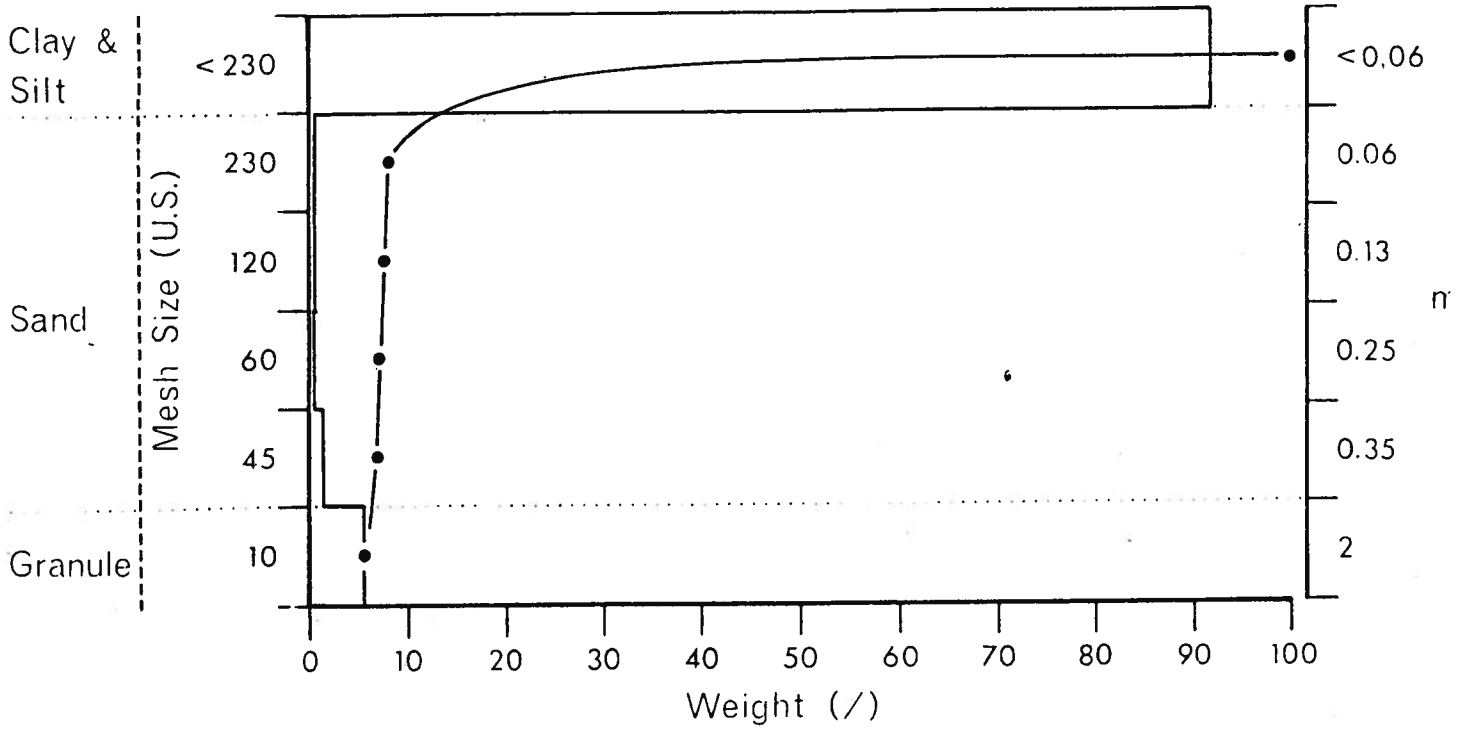


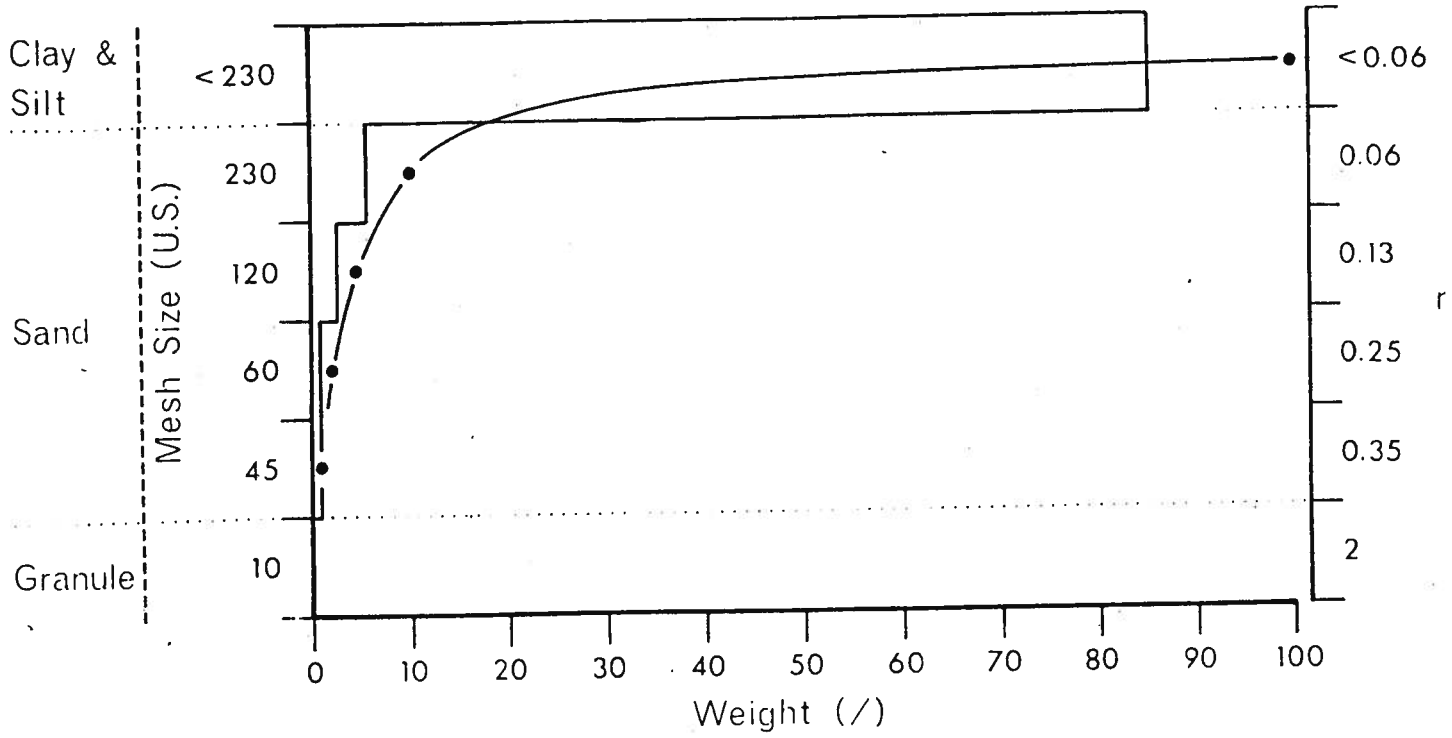
Figure 26. Outcrop Section.



PER CENT CLAY, BY PIPETTE METHOD : 34.7

SILT : 57.1

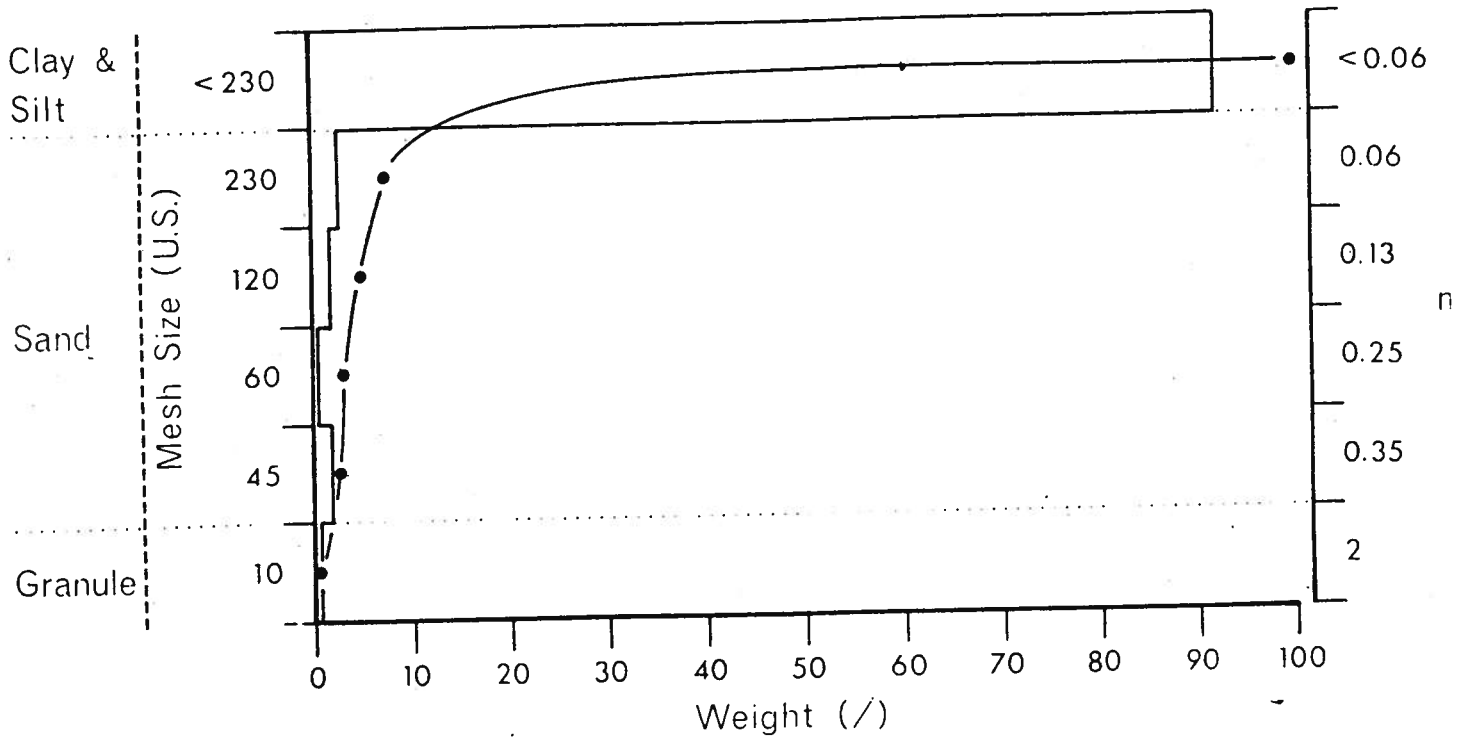
Figure 27. Particle Size Histogram and Cumulative Curve for Hole 3, 10' Depth.



PER CENT CLAY, BY PIPETTE METHOD : 22.8

SILT. : 62.3

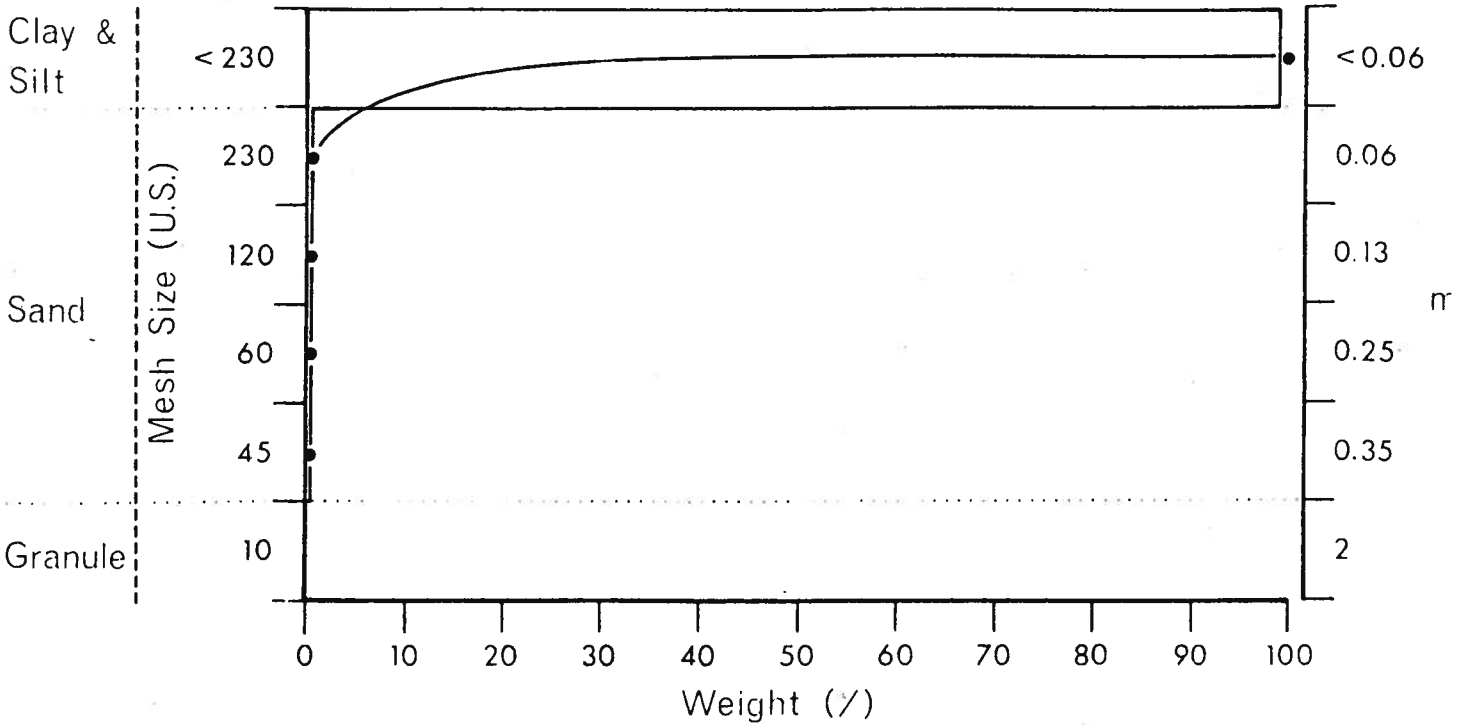
Figure 28. Particle Size Histogram and Cumulative Curve for Hole 15, 6' Depth.



PER CENT CLAY, BY PIPETTE METHOD : 32.4

SILT : 59.6

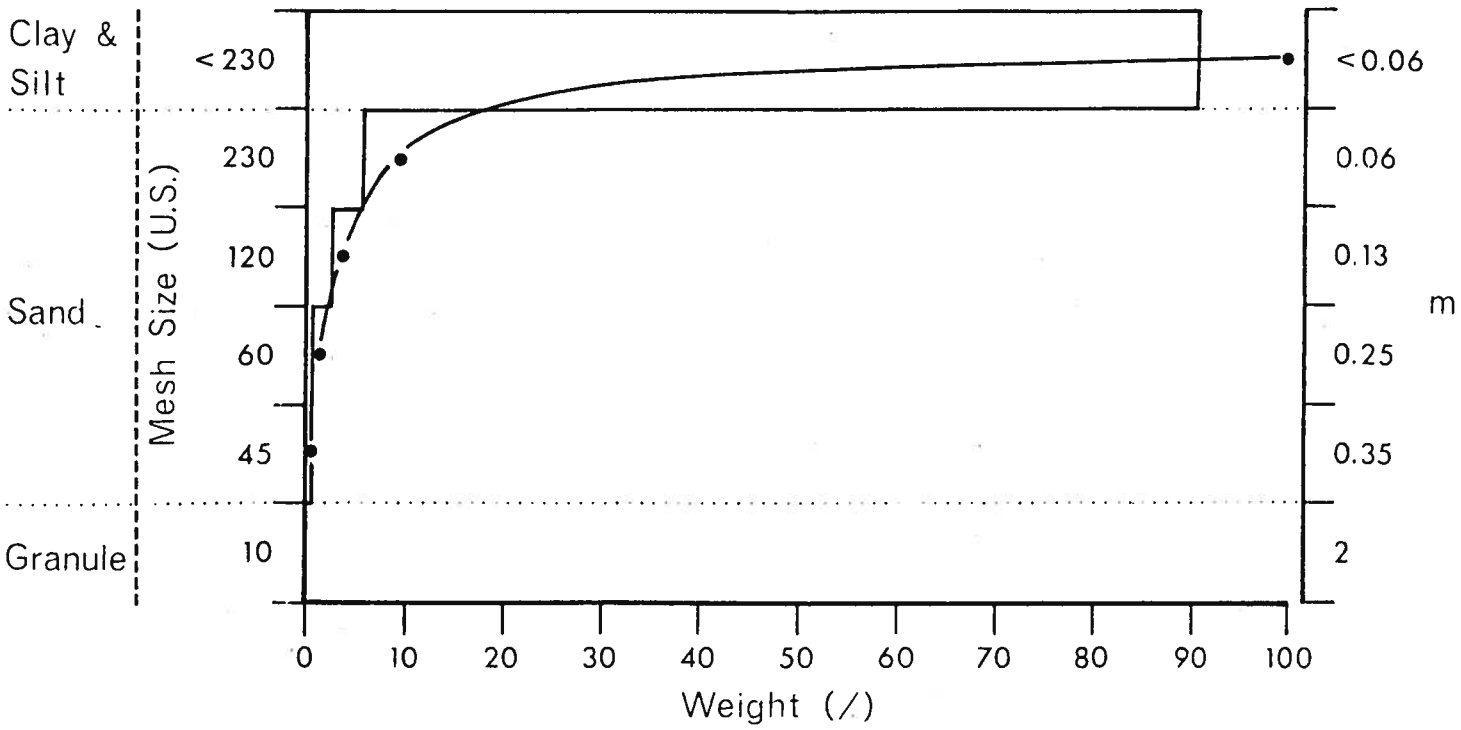
Figure 29. Particle Size Histogram and Cumulative Curve for Hole 15, 16' Depth.



PER CENT CLAY, BY PIPETTE METHOD : 35.4

SILT : 63.7

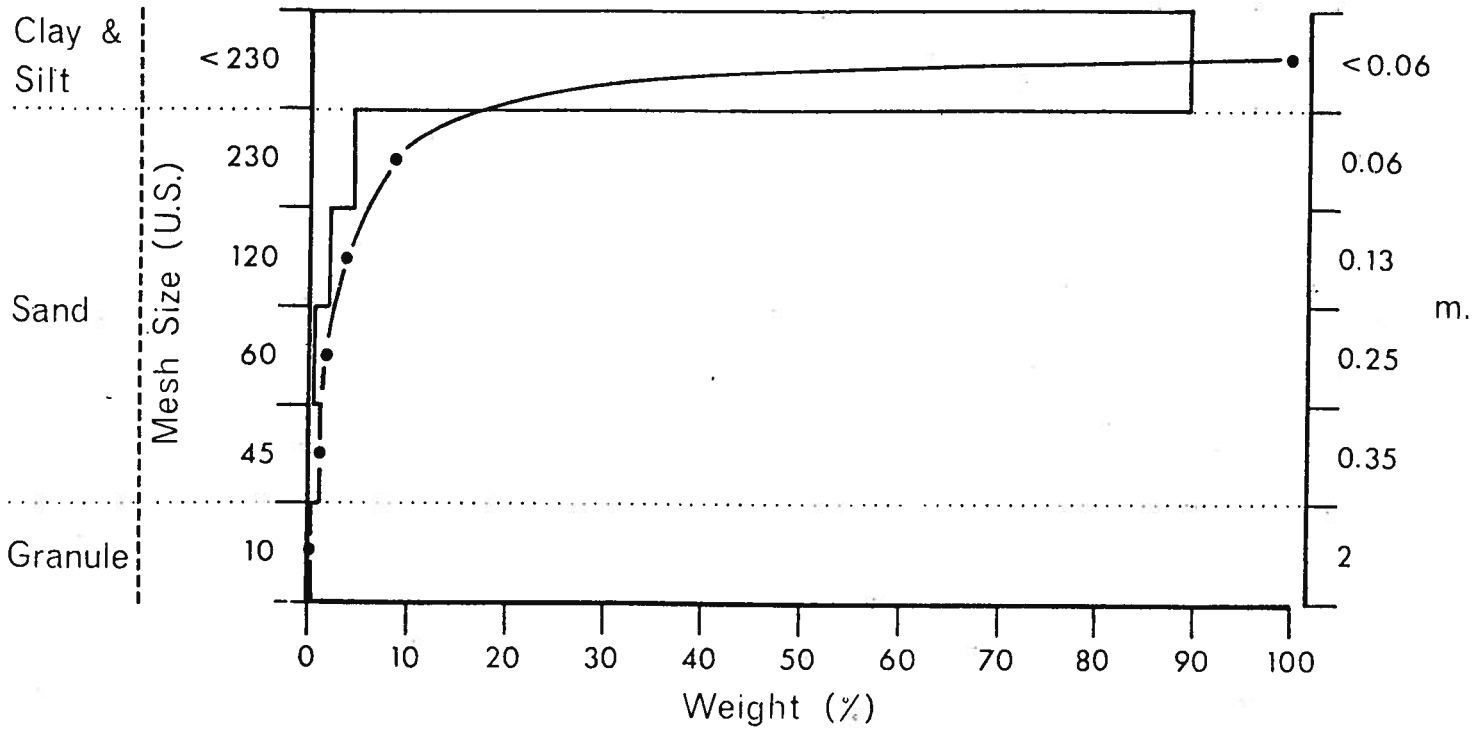
Figure 30. Particle Size Histogram and Cumulative Curve for Hole 19, 12' Depth.



PER CENT CLAY, BY PIPETTE METHOD : 33.8

SILT : 54.8

Figure 31. Particle Size Histogram and Cumulative Curve for Hole 20, 12' Depth.



PER CENT CLAY, BY PIPETTE METHOD : 36.2

SILT : 53.5

Figure 32. Particle Size Histogram and Cumulative Curve for Hole 21, 5' Depth.