Project Report No. 3
South Georgia Minerals Program

Georgia
State Divison Of Conservation
Department of Mines, Mining and Geology

A. S. Furcron, Director

By

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August 1966

This Program is being carried out under contract as
Project A-880 of the Georgia Institute of Technology,
Atlanta, Georgia.

PROJECT REPORT NO. 3

SOUTH GEORGIA MINERALS PROGRAM

BROOKS, CAMDEN, CLINCH, EFFINGHAM,
LANIER, LOWNDES, THOMAS, AND WARE COUNTIES

GEORGIA
State Division of Conservation
Department of Mines, Mining, and Geology

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Mineral Engineering Branch, Engineering Experiment Station
Georgia Institute of Technology, and
Georgia Department of Mines, Mining, and Geology

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ACKNOWLEDGEMENTS

Project Report No. 1 and Project Report No. 2 noted the several agencies and individuals from whom invaluable assistance was obtained in planning the program and in selecting the various drilling sites within the State.

As with Project Report No. 2, the value of this report has been enhanced through the cooperation of Norman K. Olson, Industrial Geologist of the Southern Railway System, who, with its permission, contributed "wash" samples from its drilling program and made available information gained from earlier drilling.

The United States Geological Survey, Water Resources Division, Georgia District, permitted the review of results of its gamma-ray logging as an aid in locating new hole sites. Active assistance was given by the County Commissioners in each of the counties in which drilling took place.

Acknowledgement is also made to the State Highway Department which permitted use of its storage lots and fenced facilities available at the county seat within each county in which drilling has taken place.

It is desired to express sincere gratitude to those mentioned above and to many others for their interest and assistance in this project.

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SOUTH GEORGIA MINERALS PROGRAM

INTRODUCTION

Project Report No. 1, released in January 1966, outlined, in general terms, the purpose, the scope, the background, and the procedures to be followed in this South Georgia Minerals Program.

Project Report No. 2, Echols County, released in May 1966, was the first technical report of a series to be published as the result of the state-funded program. This report gave, in addition to technical data, procedures and other information concerning the way in which the program was being conducted. These procedures were modified in part in the counties covered by Project Report No. 3 but the procedure flow chart remains essentially the same. Project Report No. 2 covered only Echols County, but a relatively extensive drilling program had been carried out in the county primarily due to its proximity to recent and large phosphate operations in Hamilton County, Florida.

Project Report No. 3 presents information obtained from core-drilling in Brooks County - two (2) holes; Camden County - two (2) holes; Clinch County - three (3) holes; Effingham County - one (1) hole; Lanier County - seven (7) holes; Lowndes County - seven (7) holes; Thomas County - one (1) hole; Ware County - one (1) hole. Effingham No. 1 was the first hole drilled under the minerals program and was used to test procedures for later work. Figure 1 is an outline map of counties in the Coastal Plain with a location index to holes drilled and results reported to date.

Drilling reported in Project Report No. 3 was both by contract drilling and a state-owned rig. Contract drilling was terminated as soon as feasible after the State's equipment was operable.

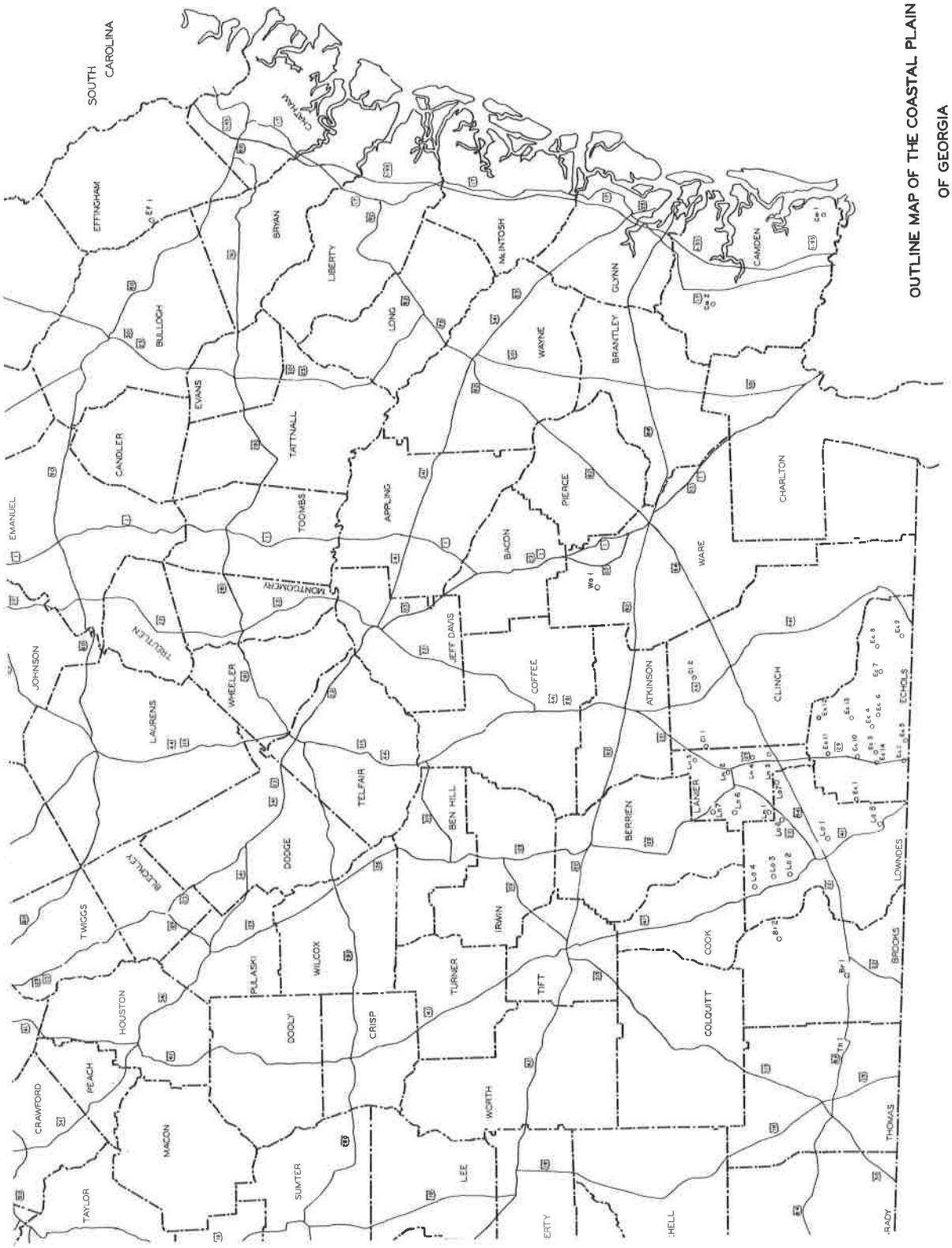

Figure 1. Index Map of Program Area

OBJECTIVE AND SCOPE

The objective of the South Georgia Minerals Program is, simply, to determine the existence, preliminary quality-quantity data, and approximate location of mineral deposits with potential for establishing new, or expanded, minerals industries in the state.

The information in this report is confined to the results from core samples obtained from the twenty-four (24) holes drilled, amplified by analyses of wash samples from the Southern Railway System from Clinch and Lowndes Counties. A complete minerals-geologic interpretation of the data involves consideration of the geologic structure of the county and of the surrounding region. No attempt to date has been made to present geologic interpretations.

It should be noted that the southernmost tier of counties east of Grady County, with the exception of Charlton County, have been investigated. The most promising area in Echols County (Project Report No. 2) directed attention westward into Lowndes County and northward into Lanier County. With the "discovery" from Lanier No. 1 hole of high quality phosphate, emphasis was placed on additional efforts in this region to delineate the area of this deposit and its trends.

SUMMARY

Of extreme interest is the area between Lanier No. 1 and Lanier No. 7. Lanier No. 1, in southwest Lanier County, was the "discovery" hole of what appears to be at least ten miles of high quality phosphate ore trending essentially north-south along the west side of Lanier County. Beneficiation products from cores from this area showed up to 80.4 percent bone phosphate of lime (BPL).

Results of drilling and beneficiation are reported by counties in alphabetical order. A map showing location of holes for each county is presented with the data obtained from drilling and laboratory studies for each county. Beneficiation studies were restricted to matrices showing about fourteen percent BPL and higher. Core samples showing BPL content down to eight percent may be beneficiated in the future if it is found to be desirable by industry.

Lanier County

Of all the holes drilled to date, Lanier No. 1, in the southwest portion of Lanier County, west of Highway 221, shows the highest purity of beneficiated phosphate for both pebble and concentrate. In the interval between 35 and 50 feet beneath the surface, the +4 pebble was 80.4 percent BPL, the 4 x 8 was 79.5 percent BPL, the 8 x 16 was 67.9 percent BPL, and the concentrates were 77.3 percent BPL. This appears to be a deposit that should demand the immediate attention of commercial phosphate companies interested in entering into Georgia.

Lanier No. 6, about five miles north of Lanier No. 1, and Lanier No. 7, about five miles further north, were then drilled. Neither Lanier No. 6 nor

Lanier No. 7 contains the amount of pebble found in Lanier No. 1. Lanier No. 6 is not quite as good as Lanier No. 7. The high percentage of BPL in the concentrate in both should encourage industrial testing of the area.

Lowndes County

Results from Southern Railway System's L-5, L-8, L-10, and L-11 indicate a continuation of the "best" area from Echols County (Project Report No. 2) into Lowndes County. The amount of material from the "wash" samples was insufficient for beneficiation procedures.

The Georgia Tech holes (prefix "Lo" on map) did not reveal commercial phosphate deposits. In holes Lo-1 through Lo-5 concentration was not attempted because of low BPL values in the five-foot sampling. In holes Lo-6 and Lo-7 (Table IX) screen analyses were completed but flotation was not attempted because of high slime values and low BPL values in the 16 x 150 mesh material.

Thomas County

A hole approximately two hundred yards due east of a pit worked for phosphate in the 1890's was drilled in Thomas County. Analyses of the interval from 26 to 38 feet showed rather high phosphate, but it is in a rather stiff clay and the possibilities of it being economic under current processing methods seem somewhat remote.

Clinch County

Results from fifty to sixty feet in hole No. 8 drilled by Southern Railway System (prefix "C" on map) are interesting, but sample size was insufficient for beneficiation studies. Clinch County holes 1, 2, and 3

by Georgia Tech (prefix "Cl" on map) did not reveal economic phosphate deposits.

Other Counties (Brooks, Camden, Effingham, and Ware)

Fourteen percent BPL was used as the minimum BPL for processing matrix through the flotation procedure. Cores drilled in these counties exhibited BPL content well below this minimum level, and beneficiation work was not deemed desirable.

PROCEDURE

A diagram of procedure is given in Figure 2. Locations of core drilling operations are selected by using available data from prior investigations, electric and gamma-ray logs of existing holes, and field investigations. The location of each hole is determined by the Project Geologists and the program is modified as new information is gained. Drilling is currently to one hundred feet as this is beyond the maximum depth of mining in Florida. The top of the Tampa Limestone proved unreliable as a structural guide; hence, drilling to this formation was discontinued.

A minimum size of 2 7/8 inch diameter cores was deemed necessary for study and analyses. Core barrels and drilling muds were varied to meet changing sedimentary conditions. Throughout the areas drilled, it was found that certain layers of the matrix were unconsolidated and water-saturated to such an extent that satisfactory core recovery was not feasible. In these cases, "wash" samples were taken. In "wash" samples the slimes, and most of the finely divided material, are lost, so that the analyses shown are not completely representative of the "in place" sediments.

Observations and descriptions of the samples were made in the field and recorded (lithologic logging), after which the samples were labeled, encased in plastic to preserve the moisture content, and taken to Georgia Tech for study, processing, and storage.

Three types of instrumental "logs" were obtained from each hole: earth resistivity and induced potential, called electric logs, which together provide an indication of sand, shale, and the content and porosity of the earth throughout the hole; and a gamma-ray log which, by measurement

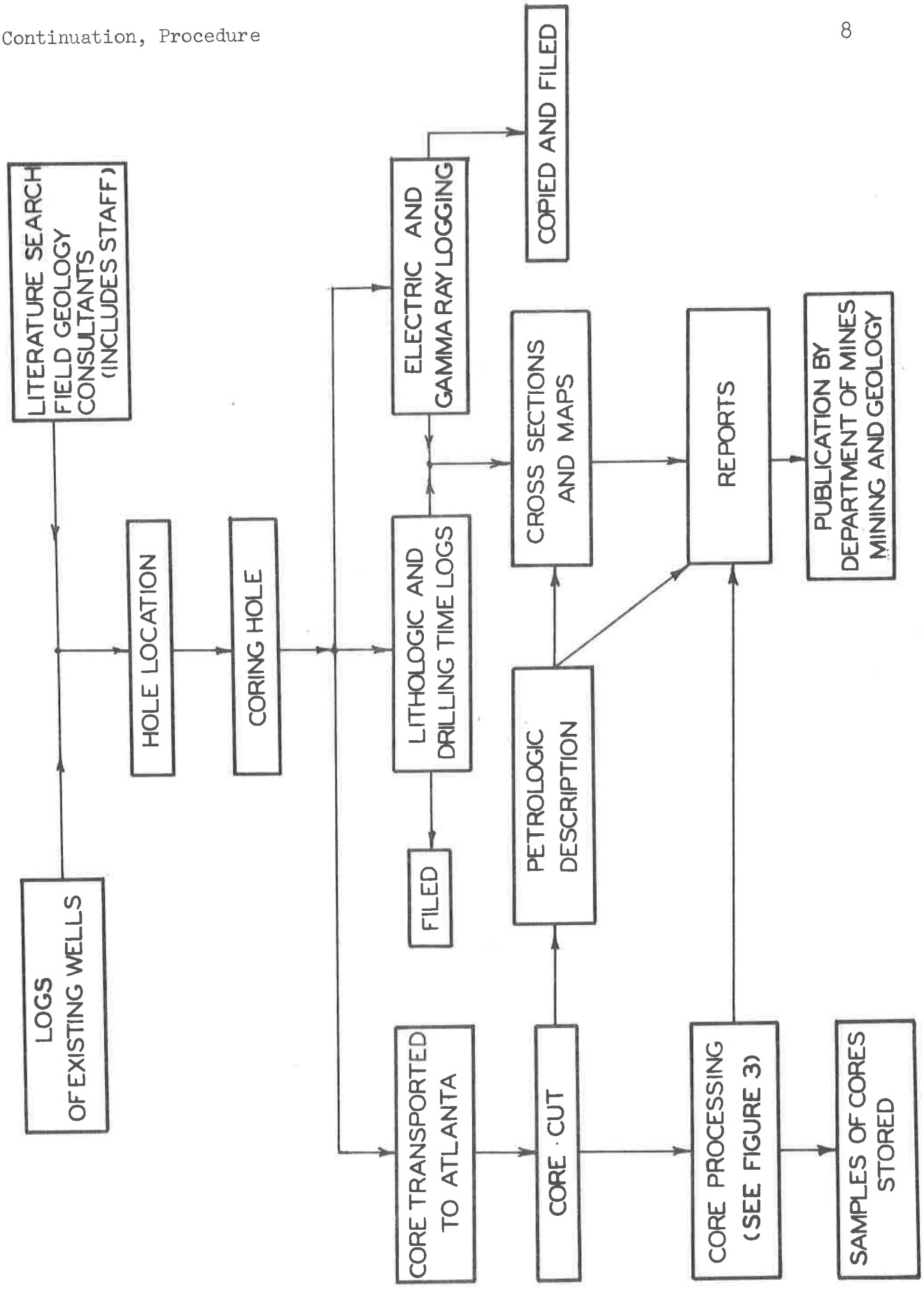

Figure 2. Flow Chart of Project Procedure.

of radiation emission, permits estimation of the amount of phosphorite and/or certain heavy minerals present.

Upon arrival of the samples at the Georgia Tech laboratories, analyses were made to obtain representative lithologic logs of each hole over its entire length.

The procedure for handling cores outlined in Project Report No. 2 has been modified on subsequent holes. Practice now is to take, normal to the length, a one-inch diameter sample through the center of the core at one-foot intervals. Five one-inch samples are combined and thoroughly mixed to form a representative sample for the five-foot interval. However, it will be noted in the description of cores that five-foot intervals were not universally used due to either (1) incomplete core being obtained or (2) a quite visible matrix contact where it was better to get a representative sample of the matrix irrespective of a five-foot interval. A fourteen percent BPL by weight, or higher, a representative sample was processed, as shown in Figure 3, for screen sizes by weight and flotation concentrate. Chemical analyses were made on each fraction.

Heavy mineral determinations were made on some of the Lanier County holes but were later discontinued because of the small amount of heavy minerals apparent in the cores. The extensive petrologic detail presented in Project Report No. 2 was curtailed in order to give more effort on the drilling program.

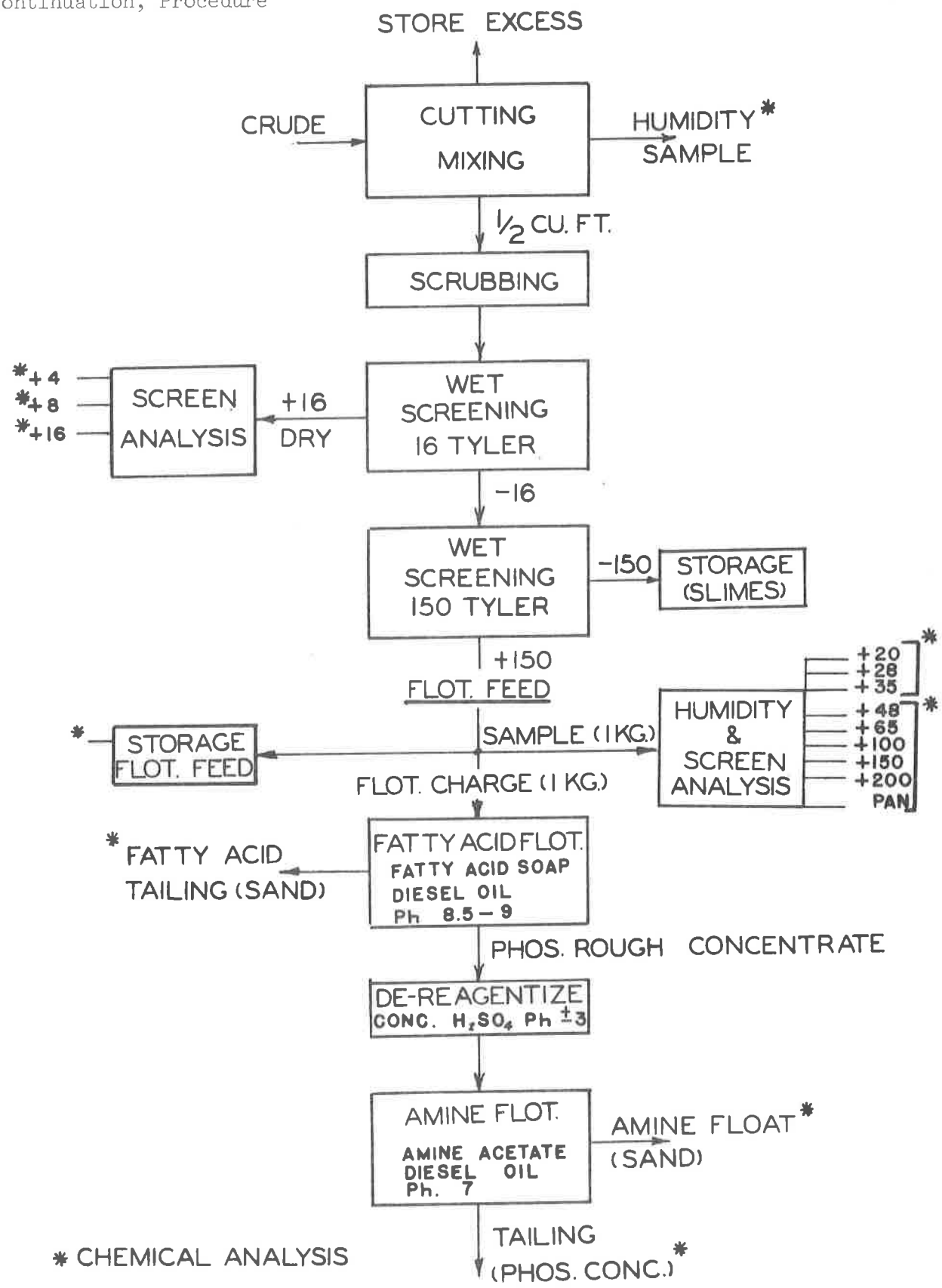

Figure 3. Flow Chart of Core Processing.

Chemical Analyses

Sample Preparation

All samples are analyzed on a dry basis (≥ one hour at 110° C) using portions quartered from larger amounts of cuts from the crude sand or clay and from the separate portions resulting from screen analyses and treatments performed in metallurgical laboratory processing. Grinding is performed by hand with a porcelain mortar and pestle, and by an electric mortar grinder with an alumina mortar and pestle.

Methods of Analyses

1. Acid Insoluble Residue - Acid insoluble residues on all of the samples reported were determined by a method adapted from the method for sand and insoluble silicates given on page 30 of Methods Used and Adopted by the Association of Florida Phosphate Chemists (1960). Thirty milliliters of concentrated hydrochloric acid and ten milliliters of concentrated nitric acid were used to digest 0.5000 or 1.0000 gram portions of sample until red fumes were no longer evolved and the solution became clear. The solution was diluted to 250 milliliters with distilled water and filtered through a Whatman No. 40 paper. The solid remaining in the beaker was transferred to the paper and rinsed several times with distilled water. The filter paper and residue were ignited to a constant weight at 800° C in a muffle furnace. The filtrate is reserved for wet chemical phosphorous analysis. The percent acid insoluble residue was calculated from the formula:

$$\text{Percent acid insoluble} = \frac{\text{weight of ignited solid} \times 100}{\text{weight of sample}}$$

2. Bone Phosphate of Lime (BPL) - Wet phosphate determinations are performed by a modification of the "Phosphoric Acid (P_2O_5) Tricalcium Phosphate or Bone Phosphate of Lime (BPL)" method described in Methods Used and Adopted by the Association of Florida Phosphate Chemists (1960), pp. 27-30. This method was adapted from the A.O.A.C. Volumetric Method. The alkali used is S_O-S-270 Sodium Hydroxide Solution N/2 (Fisher Scientific Company) tested against primary standard grade potassium acid phthalate as each container is opened. Nitric acid, 0.5000 N., was prepared using the standardized sodium hydroxide solution as a secondary standard.

Agreement among duplicate samples was within one percent of the phosphate detected. Slight differences in results detected between aliquot portions from the same sample precipitated overnight at room temperature or precipitated for twenty minutes at 50° C are corrected by an arithmetical factor derived from National Bureau of Standards sample 120a aliquots precipitated and titrated among the groups of unknown samples. Calculations for a typical 25 milliliter aliquot portion may be summarized as:

$$\text{Percent } P_2O_5 = \frac{0.5000}{0.3240} \times \frac{1}{\text{Weight of sample}} (\text{ml NaOH*-ml } HNO_3)$$

$$\text{Percent BPL} = \text{Percent } P_2O_5 \times 2.185$$

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*The terms "ml NaPH" and "ml HNO_3" refer to the number of milliliters of 0.5000 N. sodium hydroxide required to dissolve the precipitated and washed ammonium phosphonaolybdate and the number of milliliters of 0.5000 N. nitric acid required to neutralize the excess caustic respectively, using phenolphtalien as the indicator.

3. Lime (CaO) - Atomic absorption spectrophotometry results indicate better reproducibility than has been obtained with x-ray fluorescence methods and was normally used. The only exception was when the atomic absorption unit was not in use due to minor repairs. Ten cuts from La-1 (35 feet to 44 feet) were then determined gravimetrically rather than by atomic absorption.

CaO solutions for atomic absorption spectrophotometry were prepared by 1:19 dilution of the iron solutions described in Section 4 (below).

4. Iron Oxide (Fe_2O_3) - Iron oxide analyses were performed on a Perkin Elmer Model 303 Atomic Absorption Spectrophotometer. Standards included specially prepared iron solutions, NBS 120a, Florida phosphate rock. Measurements were performed on solutions prepared by boiling 0.5000 gram samples with 1:1 hydrochloric acid, dilution to one hundred milliliters with distilled water, and filtration through dry Whatman No. 40 filter paper.

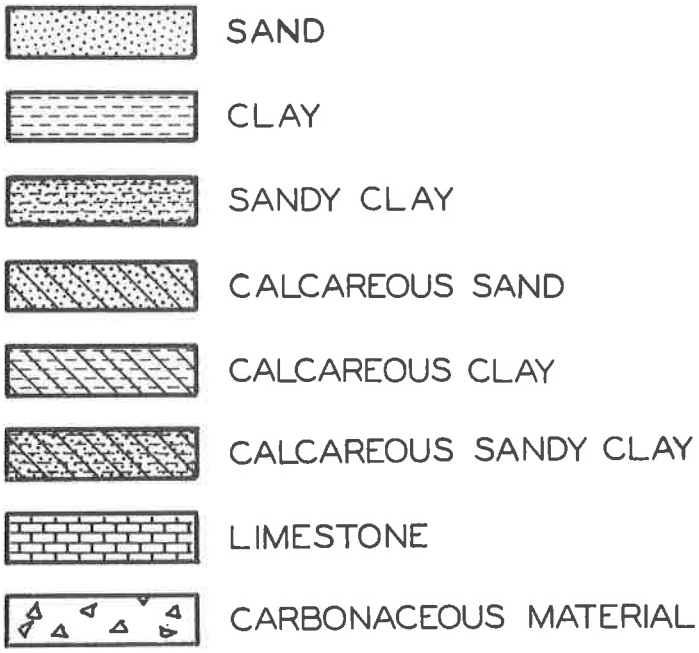
RESULTS

The data obtained are presented under the individual counties listed in alphabetical order.

It is recognized that in Lanier County, with seven holes, a more valid evaluation of economic potential is possible than from a single hole as in Ware County, or from two holes in Clinch County or Camden County, etc. It should be realized that a single hole neither makes nor condemns a county. In instances where exceptionally good results have been obtained, as in Lanier No. 1, this obviously will attract interest; but conversely, a few poor holes should not condemn an entire county or area.

A location map for each county, a lithologic log for each hole and the BPL results for sample intervals are given for each hole. Figure 4 presents the "legend" for the lithological description of the holes. "W.S." in the tables denotes "wash" samples. The "percent BPL" was obtained by chemical analyses. For Lanier holes No. 1, 6, and 7; Lowndes holes No. 6 and 7; and Thomas County hole No. 1, results of screening analyses are given, with flotation results for Lanier County holes 1, 6, and 7.

LEGEND



Note: Where circulation was lost before reaching desired depth, a new hole, using an "a" suffix to the same number, was drilled in close proximity. An exception is Lanier 3a which was drilled an approximate distance of three-eighths of a mile instead of close proximity.

Figure 4. Legend for Lithologic Logs.

BROOKS COUNTY

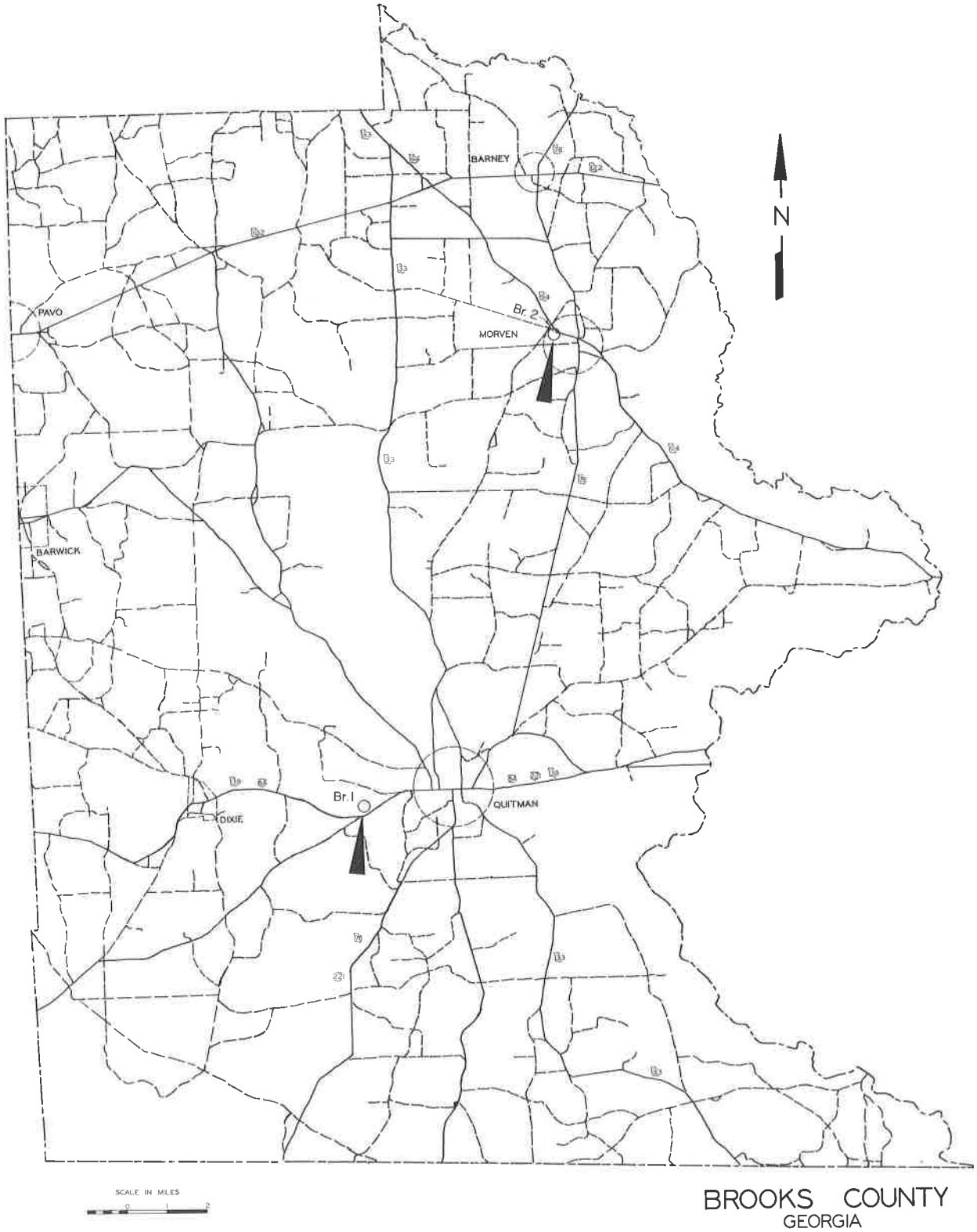


Figure 5. Location of Hole

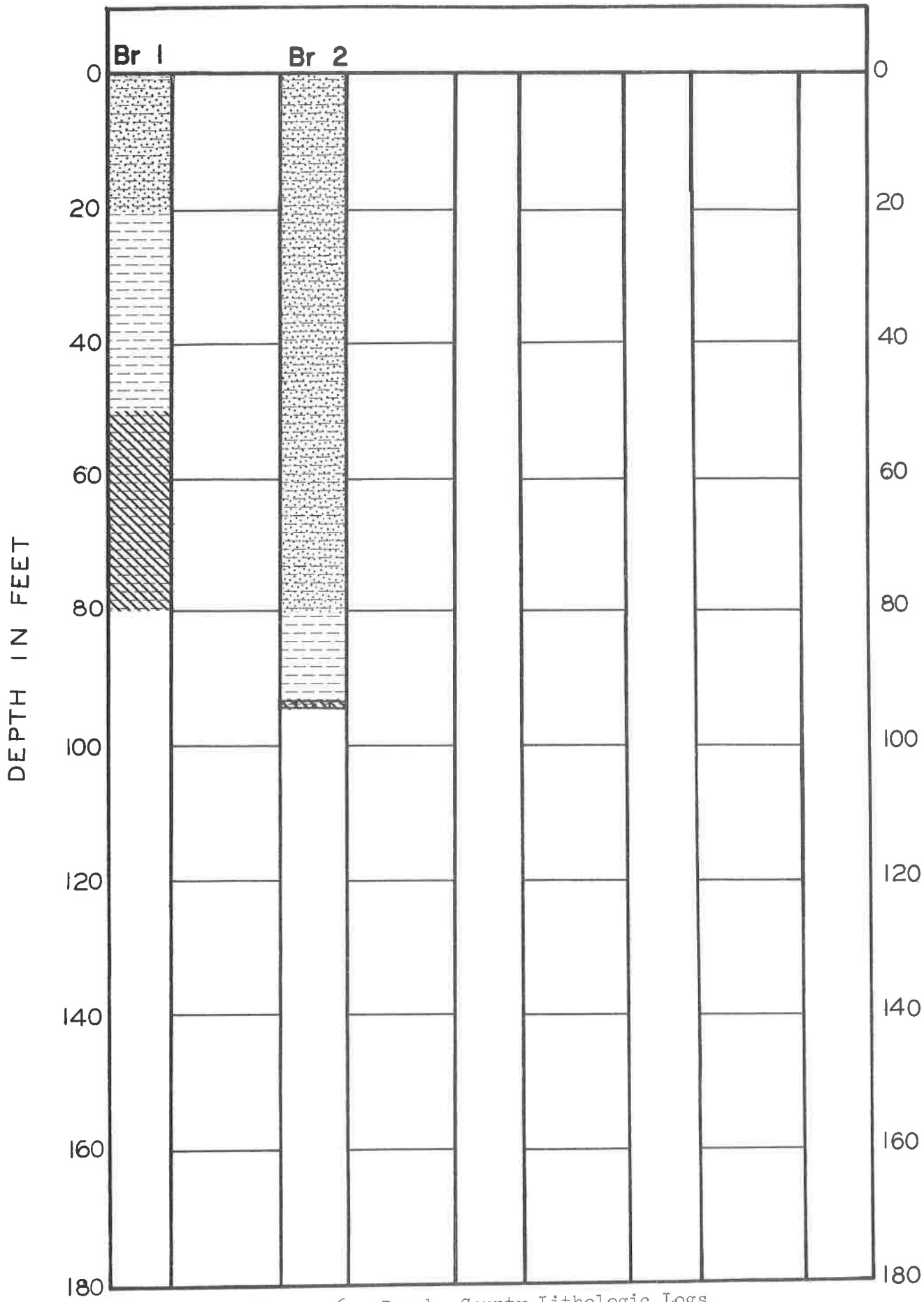


Figure 6. Brooks County Lithologic Logs.

TABLE I

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Br-1		
0-5	W.S.	1.35
5-10	W.S.	1.04
10-15	W.S.	0.00
15-25	1.0	0.00
25-35	2.0	1.68
35-43	3.0	0.18
43-45	2.0	0.68
45-53	5.0	1.68
53-55	2.0	2.19
55-65	6.0	1.51
65-74	5.0	5.91
74-75	1.0	1.36
75-80	3.0	1.01
HOLE NUMBER Br-2		
0-5	W.S.	0.11
5-10	W.S.	0.00
10-15	W.S.	0.00
15-25	5.0	0.00
25-35	5.0	0.00
35-45	1.0	0.00
45-55	1.0	0.00
55-63	3.0	0.00
63-65	2.0	0.00
67-74	5.0	0.00
74-75	1.0	0.20
75-80	3.0	2.16
80-85	2.0	1.52
85-94	4.0	3.87
94-95	1.0	7.63

CAMDEN COUNTY

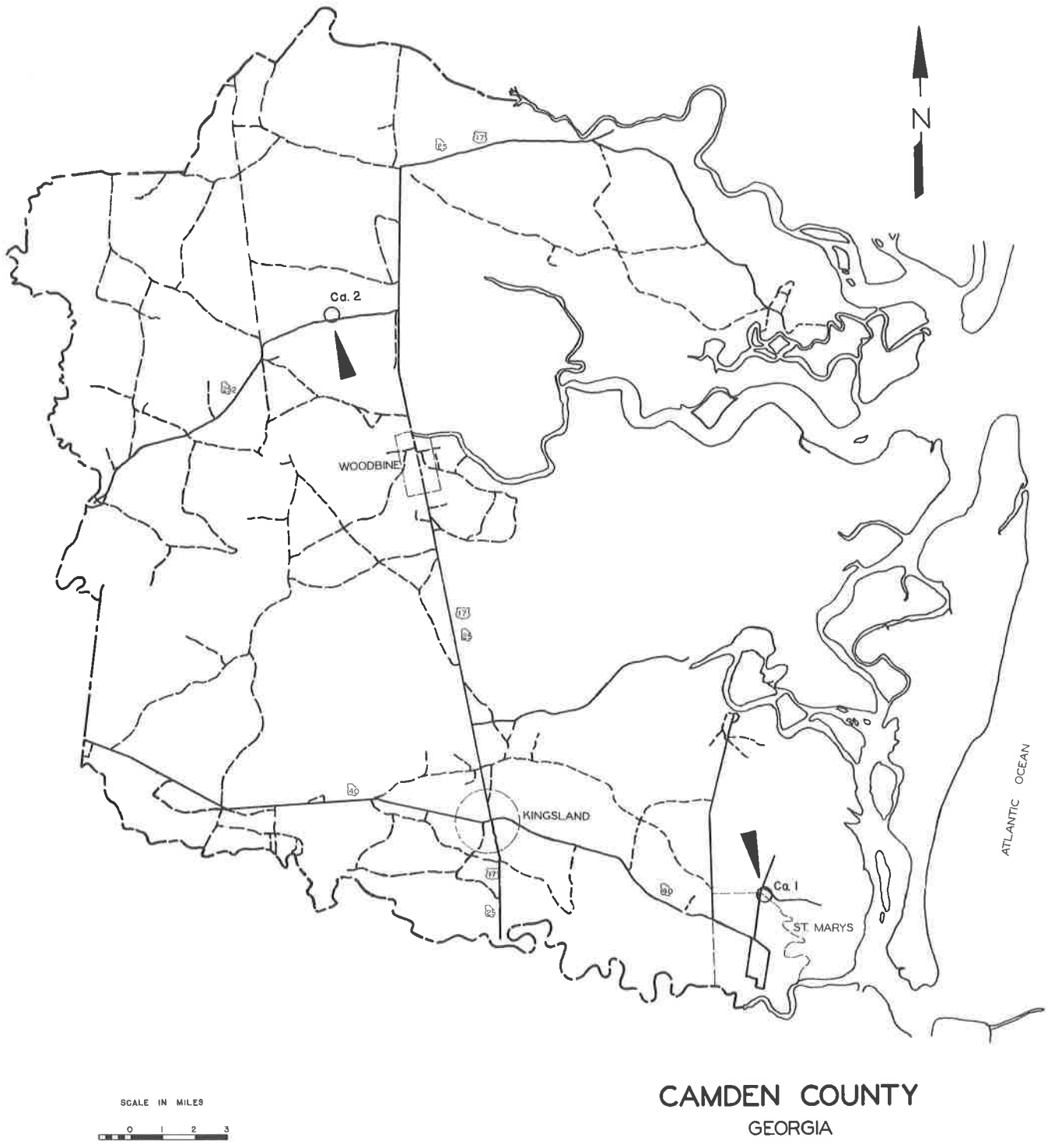


Figure 7. Location of Holes.

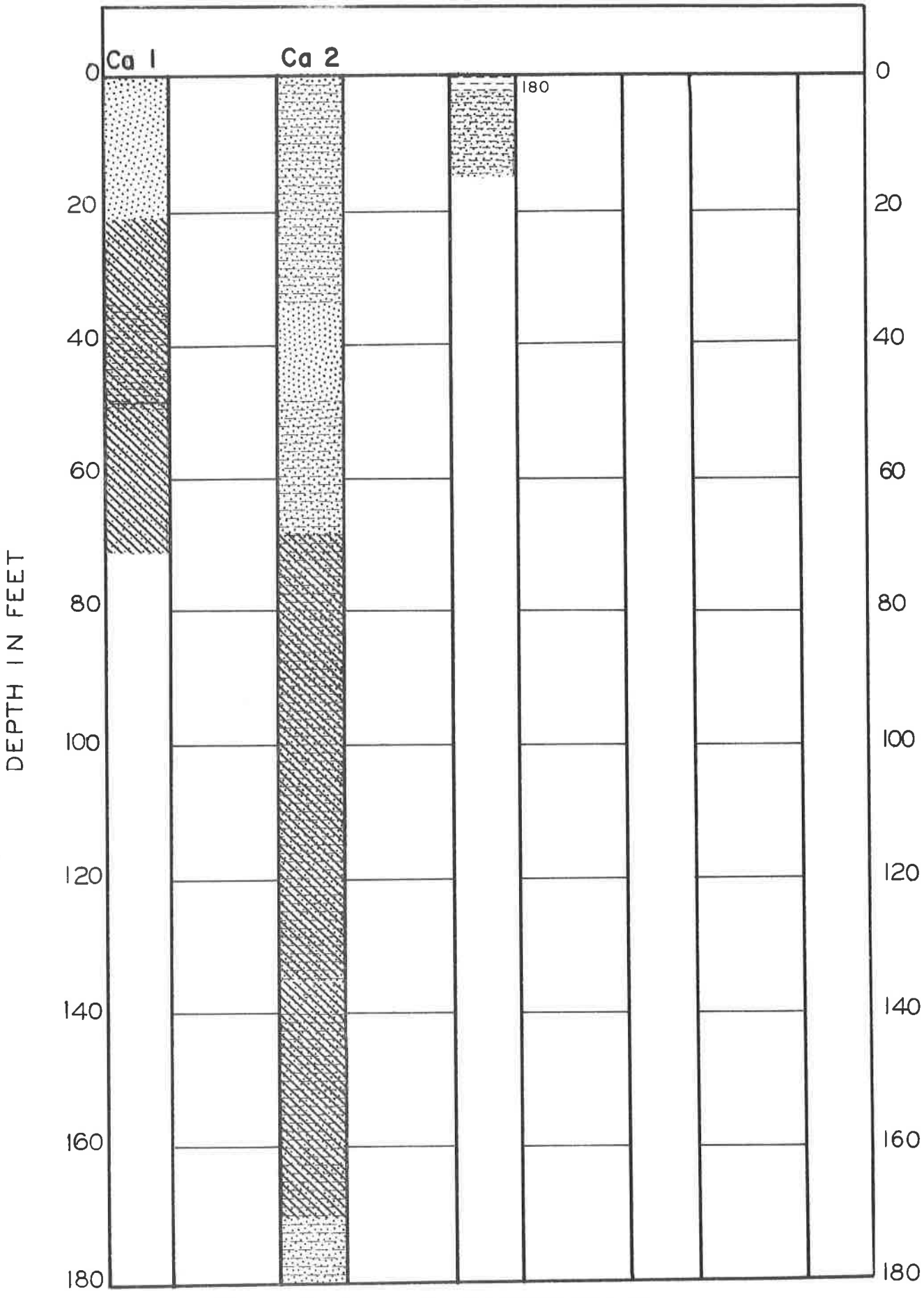


Figure 8. Camden County Lithologic Logs.

TABLE II

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Ca-1		
8-11	1.0	2.49
11-14	W.S.	0.00
14-18	W.S.	0.00
18-21	W.S.	0.00
21-29	W.S.	0.00
29-34	W.S.	0.00
34-39	5.0	1.01
39-41	0.0	----
41-47	5.0	1.62
47-55	5.0	1.62
55-71	0.0	----
HOLE NUMBER Ca-2		
8-13	5.0	0.13
13-19	6.0	0.20
19-24	5.0	0.00
24-29	5.0	0.50
29-34	5.0	1.01
34-38	4.0	0.68
38-42	4.0	0.33
42-47	5.0	1.01
47-52	5.0	2.69
52-57	5.0	3.67
57-60	3.0	4.89
60-64	4.0	7.27
64-67	3.0	5.40
67-71	4.0	4.54
71-76	5.0	1.86
76-81	5.0	2.77
81-85	4.0	5.90
85-90	5.0	6.58
90-104	5.0	7.79

CLINCH COUNTY

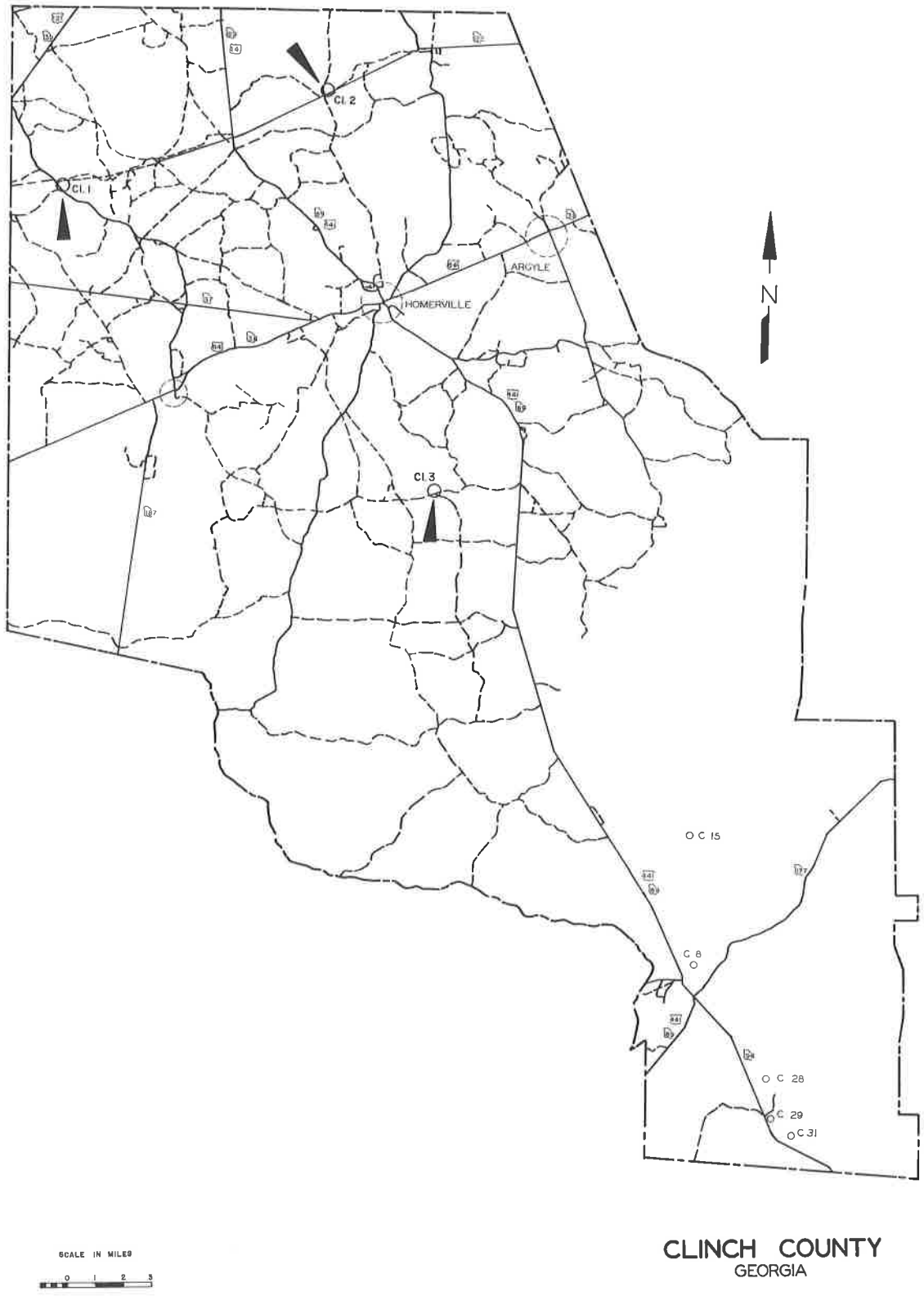


Figure 9. Location of Holes.

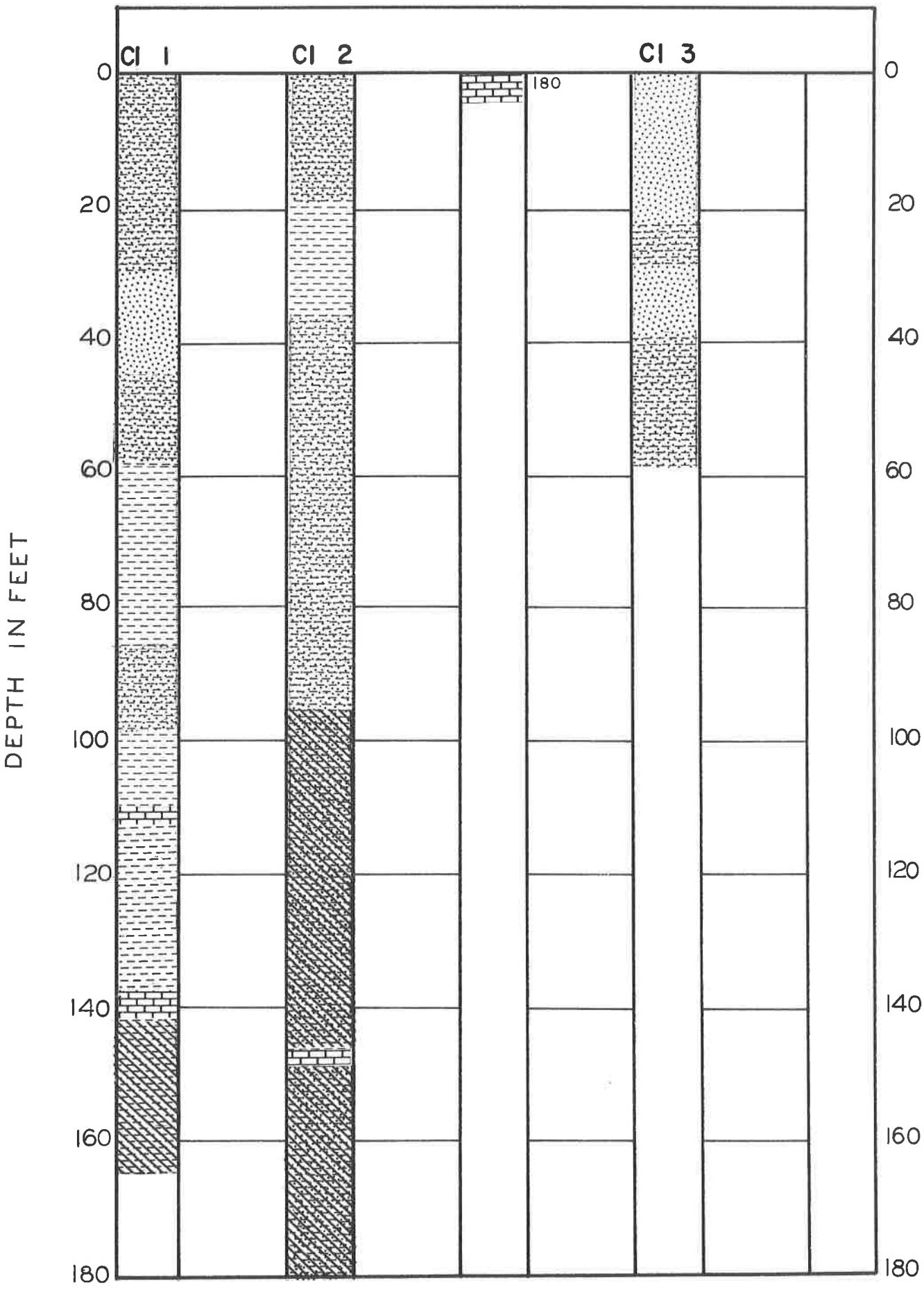


Figure 10. Clinch County Lithologic Logs.

TABLE III

BPL DETERMINATIONS FURNISHED BY SOUTHERN RAILWAY SYSTEM

	Hole Number				
Depth	8	15	28	29	31
10-15	-	-	-	-	-
15-20	-	-	-	-	-
20-25	-	-	-	-	-
25-30	-	-	-	-	-
30-35	-	-	-	2.73	-
35-40	-	-	4.74	2.73	-
40-45	-	-	3.40	2.03	5.03
45-50	9.72	-	3.12	2.19	4.92
50-55	22.68	-	2.31	2.47	-
55-60	22.68	-	1.52	6.97	-
60-65	-	-	1.83	-	-
65-70	-	1.31	3.71	-	-
70-75	-	1.60	-	-	-
75-80	-	2.34	-	-	-
80-85	-	3.65	-	-	-
85-90	-	4.50	-	-	-
90-95	-	5.40	-	-	-
95-100	-	9.13	-	-	-
100-105	-	8.74	-	-	-
105-110	-	8.02	-	-	-
110-115	-	9.48	-	-	-

TABLE IV

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER C1-1		
8-12	4.0	0.50
12-17	5.0	0.00
17-19	2.0	0.00
19-22	3.0	0.17
22-27	5.0	0.17
27-31	4.0	0.17
31-35	4.0	0.57
35-41	6.0	1.52
41-47	6.0	0.50
47-51	4.0	1.68
51-54	3.0	2.36
54-58	4.0	1.11
58-62	4.0	2.47
62-65	3.0	2.43
65-70	5.0	2.76
70-84	8.0	7.25
84-105	14.0	7.14
HOLE NUMBER C1-2		
8-14	6.0	0.48
14-16	2.0	0.00
16-18	2.0	0.57
18-21	3.0	0.00
21-26	5.0	0.00
26-31	4.0	0.00
31-36	5.0	0.00
36-41	5.0	0.98
41-45	4.0	0.68
45-50	5.0	4.04
50-54	4.0	0.68
54-58	4.0	0.68
58-63	5.0	3.28
63-73	8.0	1.48
73-83	5.0	0.00
83-93	2.0	6.75
93-100	5.0	4.22

(Continued)

TABLE IV
(Concluded)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER C1-3		
8-13	5.0	0.42
13-19	W.S.	0.00
19-22	0.0	----
22-27	5.0	0.13
27-29	2.0	0.13
29-34	W.S.	0.00
34-37	3.0	0.24
37-39	W.S.	0.26
39-41	0.0	----
41-43	2.0	0.37
43-48	5.0	0.39
48-54	6.0	2.78
54-59	0.0	----

EFFINGHAM COUNTY

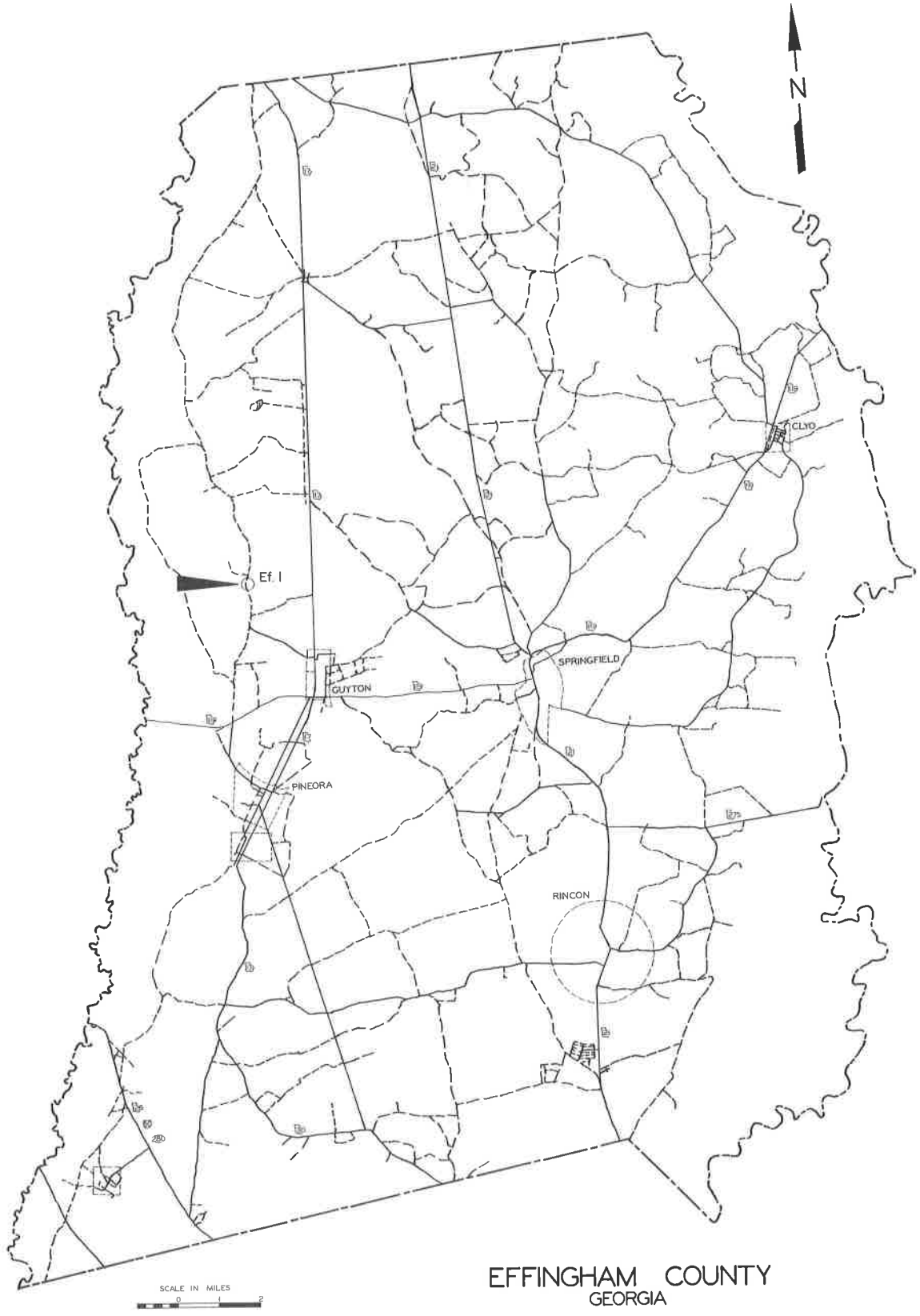


Figure 11. Location of Hole.

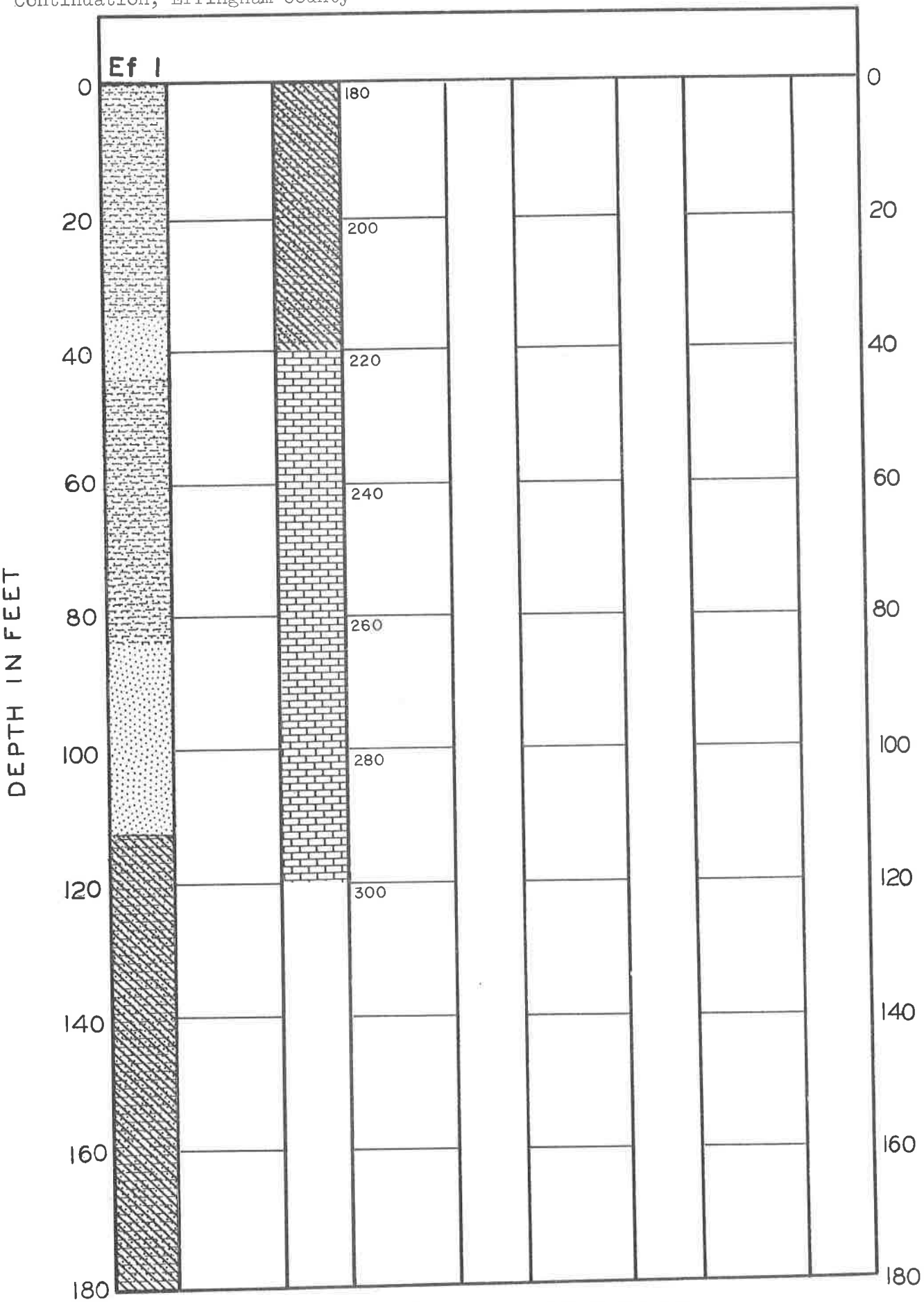


Figure 12. Effingham County Lithologic Log.

TABLE V

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Ef-1		
8-15	W.S.	0.00
15-24	W.S.	0.00
24-28	W.S.	0.00
28-32	5.0	0.00
32-38	0.0	----
38-42	4.0	0.85
42-45	W.S.	0.00
45-50	5.0	1.29
50-55	5.0	0.39
55-60	4.5	1.62
60-65	4.0	1.79
65-78	7.0	1.92
78-93	9.0	4.89
93-100	W.S.	6.41

LANIER COUNTY

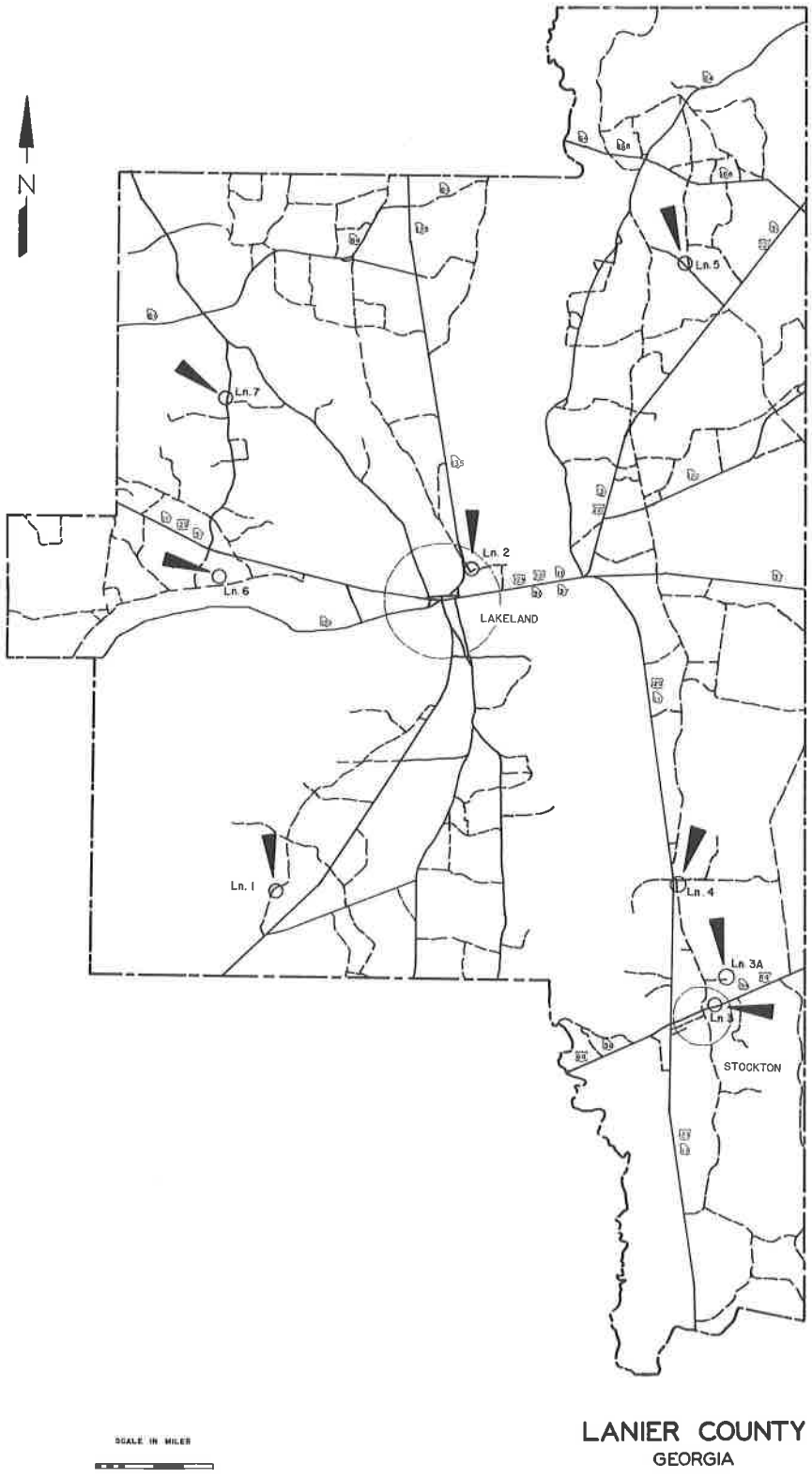


Figure 13. Location of Holes.

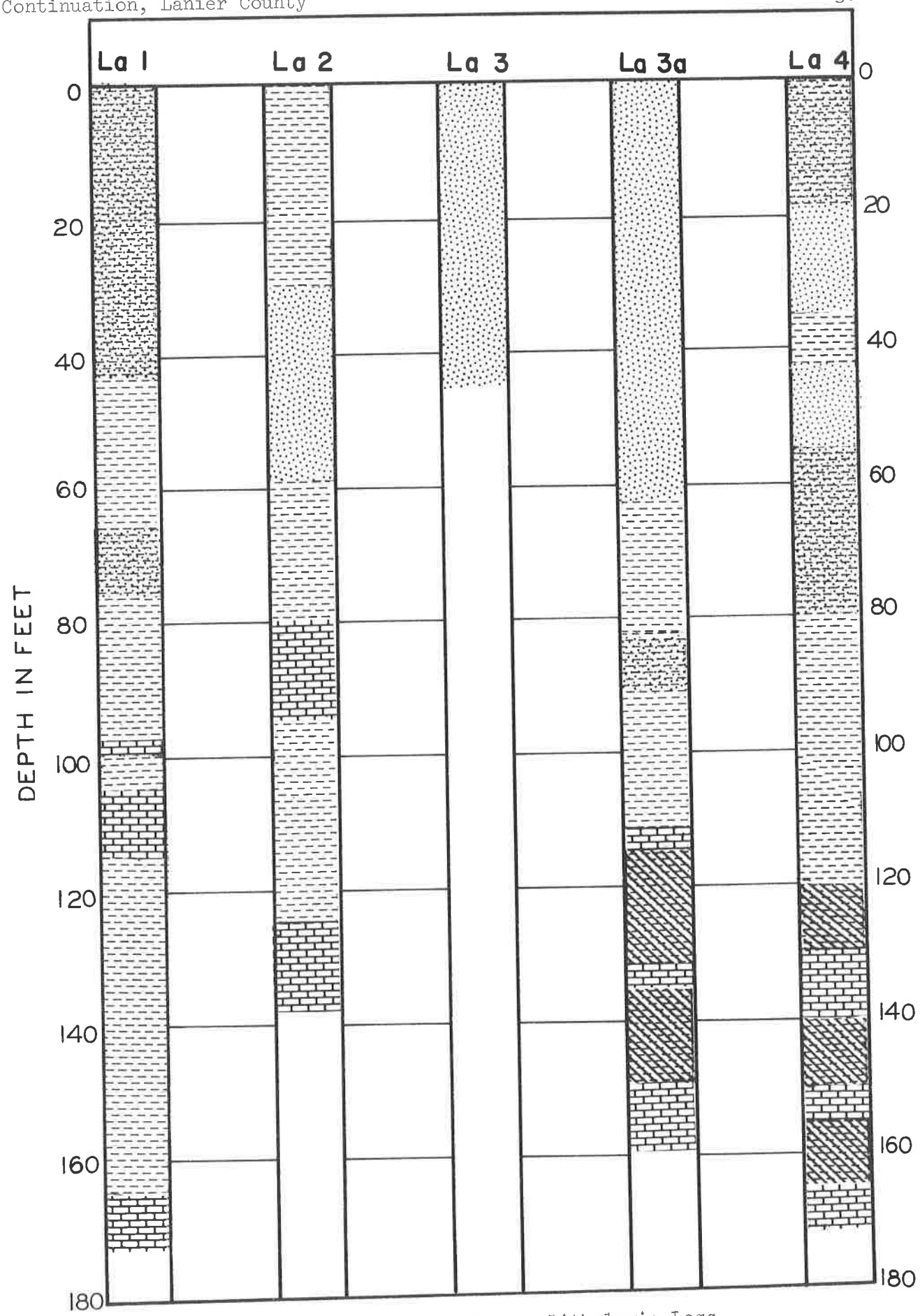


Figure 14. Lanier County Lithologic Logs.

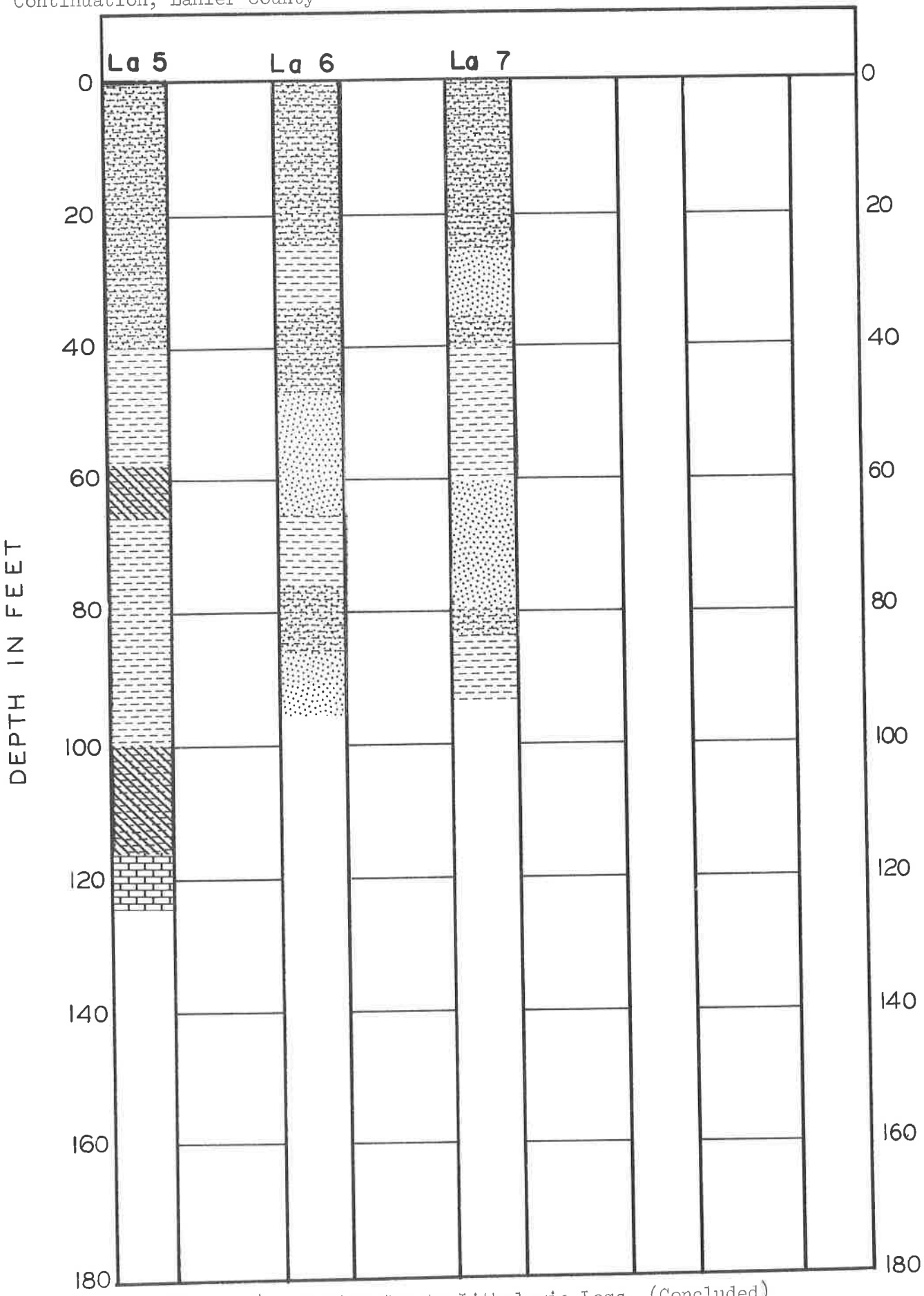


Figure 14. Lanier County Lithologic Logs. (Concluded)

TABLE VI

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER La-1		
7-10	3.0	0.68
10-15	4.0	0.17
15-20	4.0	0.94
20-25	5.0	0.76
25-30	3.0	4.15
30-35	2.0	1.05
35-40	5.0	24.32
45-50	5.0	32.20
45-50	4.0	4.83
50-55	5.0	4.39
55-60	5.0	5.77
60-65	4.5	7.27
65-67	1.5	3.26
67-77	4.0	14.09
77-87	5.0	6.34
87-95	4.0	5.64
95-105	6.0	4.55
HOLE NUMBER La-2		
10-15	5.0	3.80
15-20	5.0	5.77
20-22	2.0	10.76
22-29	4.0	6.34
29-36	4.0	7.05
36-50	WS	9.73
50-53	0.0	----
53-55	0.5	4.55
55-65	6.0	5.08
65-75	5.0	1.10
75-85	10.0	2.86
85-90	2.5	4.15
90-95	2.5	4.52
95-100	3.0	2.62

(Continued)

TABLE VI
(Continued)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER La-3		
13-19	5.5	0.33
19-27	W.S.	0.00
27-30	3.0	1.14
30-33	W.S.	0.00
33-36	W.S.	0.00
36-39	W.S.	0.00
39-42	W.S.	0.00
42-45	0.0	----
HOLE NUMBER La-3A		
9-15	5.5	0.61
15-20	5.0	0.55
20-23	W.S.	0.00
23-27	3.0	0.57
27-32	4.0	0.50
32-39	0.0	----
39-49	W.S.	0.00
49-63	W.S.	0.00
63-70	7.0	4.37
70-72	2.0	12.06
72-77	5.0	12.72
77-83	6.0	4.85
83-91	3.0	5.70
91-102	4.0	9.20

(Continued)

TABLE VI
(Continued)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER La-4		
10-16	5.0	0.00
16-23	5.0	0.44
23-26	0.0	----
26-35	4.0	1.05
35-40	5.0	1.10
40-45	5.0	3.23
45-50	5.0	1.50
50-53	3.0	4.38
53-58	4.0	12.24
58-61	3.0	7.95
61-64	3.0	4.61
64-70	0.0	----
70-75	5.0	6.14
75-95	5.0	5.09
HOLE NUMBER La-5		
8-14	5.5	0.39
14-21	5.0	0.50
21-26	5.0	0.50
26-27	1.0	0.76
27-31	4.0	0.84
31-38	7.0	0.00
38-43	5.0	0.00
43-48	5.0	0.00
48-52	5.0	0.78
52-57	5.0	2.73
57-74	7.0	3.23
74-85	5.0	4.98
85-90	4.0	9.26
90-103	8.0	7.93

(Continued)

TABLE VI
(Concluded)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER La-6		
0-5	W.S.	0.67
5-10	W.S.	0.00
10-15	5.0	0.00
15-20	5.0	0.00
20-24	4.0	2.76
24-29	5.0	1.25
29-31	2.0	0.74
31-33	2.0	1.35
33-37	3.5	0.78
37-41	4.0	1.35
41-46	5.0	4.01
46-50	4.0	12.51
50-55	5.0	14.16
55-60	5.0	16.15
60-65	1.0	9.68
65-70	5.0	11.20
70-75	5.0	10.18
75-80	5.0	12.21
80-85	5.0	8.06
85-90	5.0	8.63
90-95	4.0	9.14
HOLE NUMBER La-7		
0-5	W.S.	1.01
5-10	W.S.	1.65
10-15	5.0	0.00
15-20	5.0	0.00
20-25	5.0	0.00
25-30	5.0	0.00
30-35	5.0	0.00
35-40	5.0	0.00
40-44	3.5	0.00
44-51	7.0	0.68
51-54	3.0	2.19
54-60	6.0	0.00
60-62	2.0	1.01
62-67	5.0	8.94
67-73	5.5	9.95
73-78	4.5	12.66
78-83	5.0	18.01
83-88	5.0	7.05
88-93	5.0	5.42

TABLE VII

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES ON ONE FOOT INTERVALS FROM CORES

DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	Percent Composition					
		QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER La-2							
9-15	0.04	26.6	8	Tr	Tr	65	0.4
15-20	0.08	43.5	6	Tr	Tr	50	0.5
20-25	0.04	16.6	3	Tr	Tr	80	0.2
25-30	0.17	57.6	7	Tr	Tr	35	0.4
30-35	0.15	44.3	20	Tr	5	30	0.7
35-40	0.20	67.4	15	7	1	10	0.6
40-45	0.18	81.0	6	3	2	7	1.0
45-50	0.17	69.5	9	1	8	12	0.5
50-55	----	----	--	--	--	--	---
55-60	----	----	--	--	--	--	---
60-65	0.10	52.5	4	Tr	10	33	0.5
65-70	0.12	77.5	--	--	22	10	0.5
70-75	0.09	40.0	12	--	7	40	1.0
75-80	----	----	--	--	--	--	---
80-85	0.10	39.8	--	--	30	30	0.2
85-90	----	----	--	--	--	--	---
90-95	----	----	--	--	--	--	---
95-100	0.04	11.4	4	--	34	50	0.6
100-105	0.5	----	--	--	--	--	---
105-110	0.05	10.8	1	Tr	38	50	0.2
110-115	0.04	11.0	1	Tr	30	55	Tr
115-120	0.04	10.0	Tr	Tr	30	60	Tr
120-125	0.04	12.0	Tr	Tr	28	60	Tr
125-130	----	----	--	--	--	--	---
130-135	0.04	35.5	5	Tr	30	30	0.5

(Continued)

TABLE VII
(Continued)

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES

DEPTH IN FEET	MEDIAN DIAMETER	Percent Composition					
		QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER La-3							
13-15		90.0	--	--	--	10	Tr
15-20	0.18	63.8	--	--	--	36	0.2
20-27	----	90.0	--	--	--	10	---
27-30	0.15	66.8	--	--	--	33	0.2
30-33	0.15	61.8	3	--	--	35	0.2
33-36	----	95.0	--	--	--	5	Tr
36-39	----	95.0	--	--	--	5	Tr
39-42	----	05.0	--	--	--	5	Tr
HOLE NUMBER La-3A							
9-15	----	78.0	--	--	--	21	1.0
15-20		----	--	--	--	--	---
20-23	----	80.0	--	--	--	20	Tr
30-32	----	78.0	--	--	--	21	1.0
34-49	----	----	--	--	--	--	---
49-63	----	----	--	--	--	--	---
63-70	----	34.9	5	--	Tr	60	0.1
70-75	0.18	66.0	2	4	2	25	1.0
75-80	0.04	10.0	Tr	Tr	Tr	90	Tr
80-85	0.04	10.0	Tr	3	Tr	87	Tr
85-90	0.09	49.8	5	3	2	40	0.2
90-95	0.04	36.8	2	4	2	55	0.2
95-100	----	----	--	--	--	--	---
100-105	----	----	--	--	--	--	---
105-110	----	----	--	--	--	--	---
110-115	----	----	--	--	--	--	---
115-122	----	----	--	--	--	--	---
122-134	----	----	--	--	--	--	---
134-140	----	54.0	3	Tr	2	38	1.0
140-145	0.15	28.5	4	2	10	10	0.5
145-150	0.04	28.5	4	2	10	10	0.5
150-159	----	----	--	--	--	--	---

(Continued)

TABLE VII
(Concluded)

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES

DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	Percent Composition					
		QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER La-4							
10-15	0.20	70.0	--	--	--	29	1.0
25-30	0.35	89.9	2	--	--	10	0.2
35-40	----	86.8	5	--	--	10	0.2
40-45	0.60	72.0	12	--	--	15	1.0
45-50	0.55	83.0	10	--	--	6	1.0
50-54	0.45	84.5	5	Tr	Tr	10	0.5
55-65	----	----	--	--	--	--	---
65-75	----	----	--	--	--	--	---
75-80	0.10	52.5	10	2	5	30	0.5
80-85	----	----	--	--	--	--	---
85-90	0.19	46.5	7	3	3	40	0.5
95-100	0.13	50.5	5	1	3	40	0.5
100-105	0.10	46.8	3	Tr	--	40	0.2
105-110	0.04	56.7	3	Tr	Tr	10	0.3
130-135	0.25	68.8	6	Tr	10	15	0.2
145-150	----	43.9	4	2	20	30	0.1
150-155	----	41.8	6	2	25	25	0.2

TABLE VIII

SAND BENEFICIATION RESULTS

	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty acid tailing	Amine float
HOLE NUMBER La-1 (35-44 ft.)											
Total sand footage	9										
Dry density	92.94										
Percent dry weight	100.00	1.10	6.80	12.00	58.20	12.80	45.40	21.90	8.60	74.90	16.50
Percent BPL	25.60	80.40	79.50	67.90	12.10	24.80	8.80	18.80	77.30	4.60	2.60
Percent acid insol	65.30	2.82	5.38	19.79	85.23	69.82	89.48	58.90	8.00	94.63	97.49
Percent Fe_2O_3	.99	.52	.52	.50	.24	.24	.21	3.47	1.05	.11	.18
Percent Al_2O_3											
Percent CaO	15.01	51.00	49.50	41.59	6.69	14.14	3.82	11.86	48.78	1.80	-----
HOLE NUMBER La-1 (66-77 ft.)											
Total sand footage	11										
Dry density	ND										
Percent dry weight	100.00	3.30	5.20	11.80	50.50	15.90	34.60	29.20			
Percent BPL	14.09	38.38	49.03	47.99	7.83	11.63	6.10	2.21			
Percent acid insol	74.58	38.80	23.57	48.12	91.23	87.07	93.20	69.96			
Percent Fe_2O_3											
Percent Al_2O_3											
Percent CaO											

(Continued)

TABLE VIII
(Continued)

SAND BENEFICIATION RESULTS

	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty acid tailing	Amine Float
HOLE NUMBER La-6 (46-65 ft.)											
Total sand footage	19										
Dry density	91.30										
Percent dry weight	100.00	0.10	0.40	1.60	80.90	16.70	64.20	17.00	5.00	86.40	8.60
Percent BPL	14.15	74.26	74.60	53.25	12.54	16.86	10.69	2.79	80.11	5.28	31.20
Percent acid insol	78.02	3.66	5.24	32.62	84.66	78.93	86.21	47.20	2.82	93.82	59.12
Percent Fe_2O_3	.83	1.16	1.17	.42	.24	.18	.22	3.65	.47	.11	.60
Percent Al_2O_3											
Percent CaO	8.05	44.46	42.67	31.67	7.07	9.74	9.38	9.47	39.91	2.79	18.30
HOLE NUMBER La-6 (65-95 ft.)											
Total sand footage	30										
Dry density	66.60										
Percent dry weight	100.00	.01	.03	.08	48.35	0.44	47.91	51.53	1.40	90.10	8.50
Percent BPL	9.71	46.68	57.86	43.97	5.92	21.14	5.70	12.18	77.25	1.72	22.42
Percent acid insol	81.83	18.32	12.54	34.34	91.13	64.45	91.63	72.66	5.70	97.94	72.40
Percent Fe_2O_3	2.48	.82	1.29	1.44	.69	2.60	.64	4.17	.57	.11	1.10
Percent Al_2O_3											
Percent CaO	5.58	24.66	31.15	23.36	3.12	11.29	2.98	7.84	42.67	.79	12.27

(Continued)

TABLE VIII
(Concluded)

SAND BENEFICIATION RESULTS

	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty acid tailing	Amine float
					HOLE NUMBER La-7 (62-83 ft.)						
Total sand footage	21										
Dry density	91.08										
Percent dry weight	100.00	.21	.69	2.18	77.59	14.70	62.89	19.33	8.30	78.40	13.30-
Percent BPL	11.72	84.47	79.06	61.58	9.97	16.96	8.22	9.88	80.45	2.62	5.60
Percent acid insol	82.46	2.16	2.86	24.36	87.72	79.24	90.07	71.61	3.65	97.18	93.54
Percent Fe_2O_3	.80	.55	.55	.44	.15	.16	.15	3.47	.46	.06	.24
Percent Al_2O_3											
Percent CaO	6.62	43.48	43.48	37.07	5.45	9.34	4.41	6.15	42.35	1.10	2.79

LOWNDES COUNTY

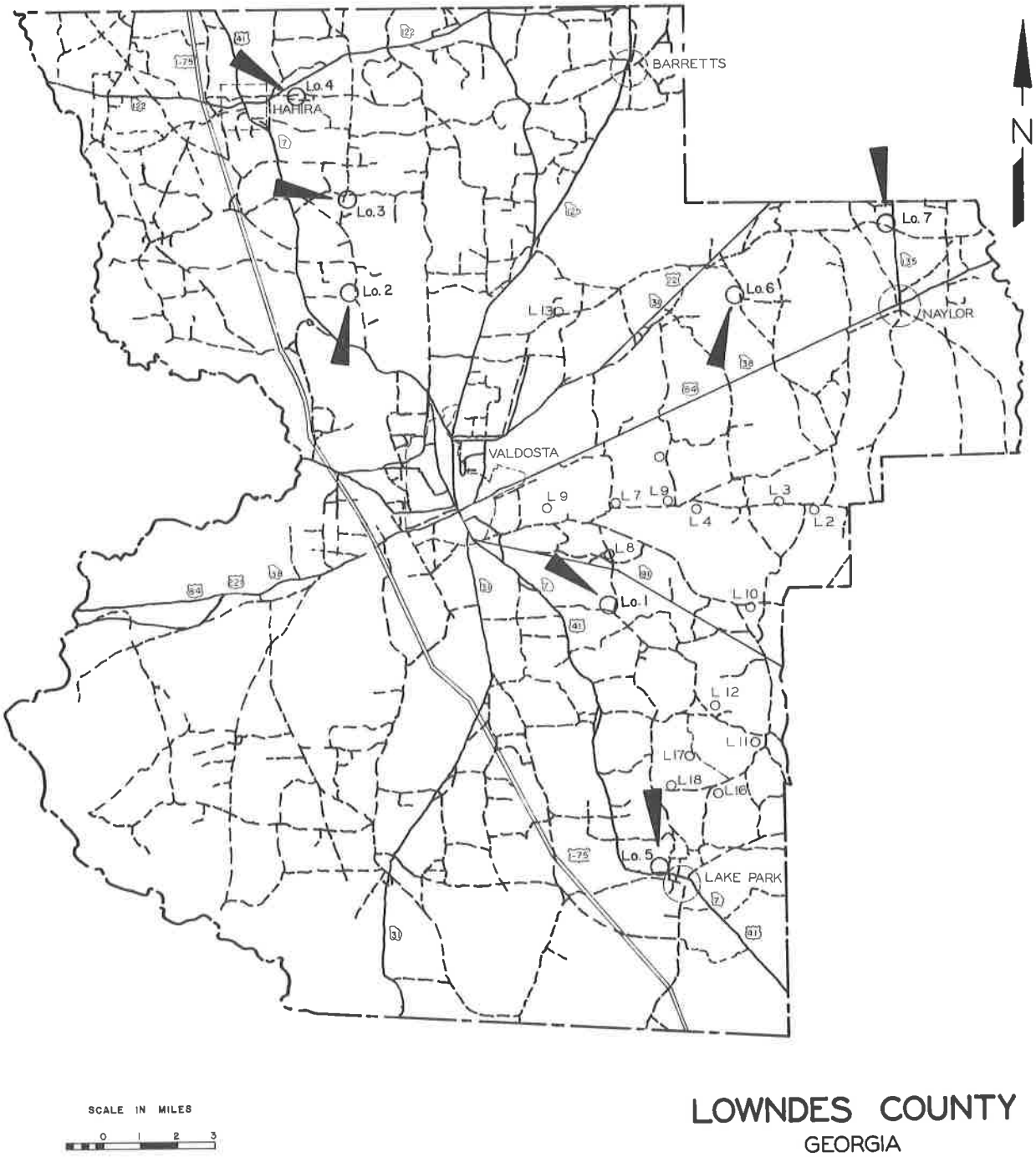


Figure 15. Location of Holes.

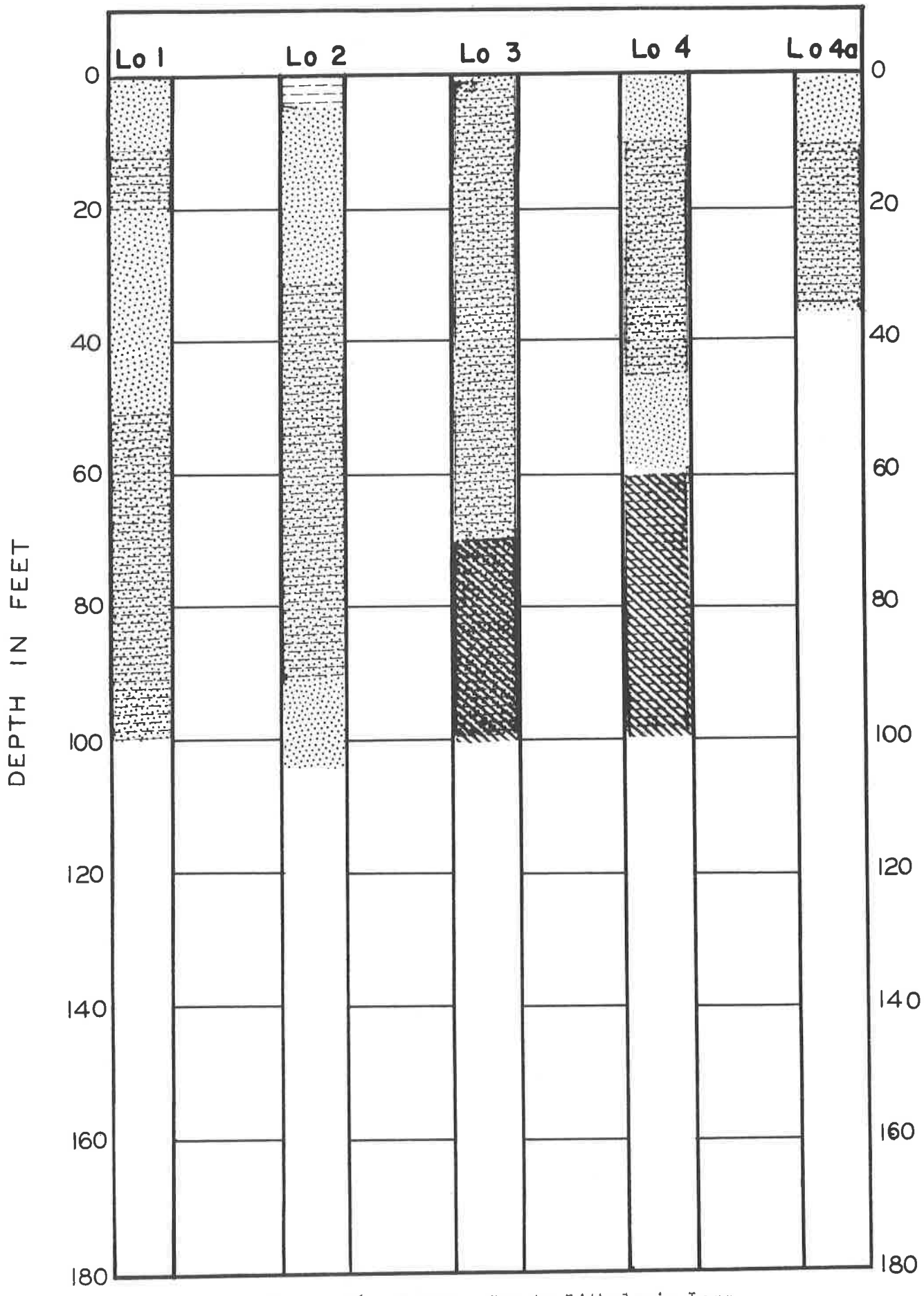


Figure 16. Lowndes County Lithologic Logs.

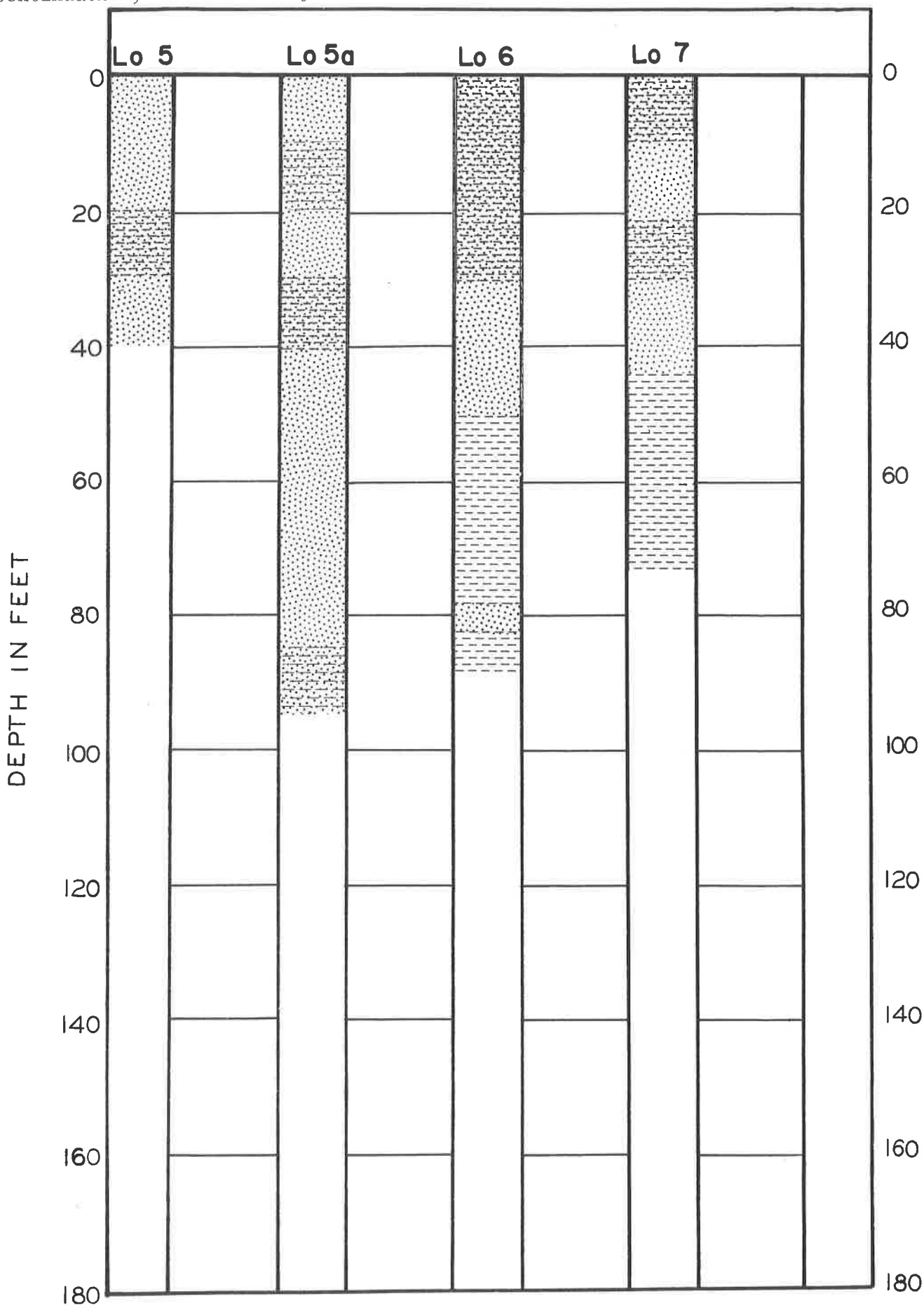


Figure 16. Lowndes County Lithologic Logs (Concluded).

TABLE IX

BPL DETERMINATIONS FURNISHED BY SOUTHERN RAILWAY SYSTEM

Depth	Hole Number				
	4	5	8	10	11
10-15	-	-	-	-	15.30
15-20	-	-	-	-	21.04
20-25	-	-	-	-	-
25-30	-	-	-	-	-
30-35	-	-	-	-	-
35-40	-	-	-	-	-
40-45	-	-	-	-	-
45-50	-	-	-	-	-
50-55	-	-	-	-	-
55-60	10.05	-	-	-	-
60-65	9.29	-	-	14.20	-
65-70	9.40	-	-	21.63	-
70-75	9.40	8.37	15.03	11.47	-
75-80	12.94	10.77	17.04	4.20	-
80-85	-	12.41	12.94	-	-
85-90	-	13.79	11.21	-	-
90-95	-	-	-	-	-
95-100	-	-	-	-	-
100-105	-	-	-	-	-
105-110	-	-	-	-	-
110-115	-	-	-	-	-
115-120	-	-	-	-	-

TABLE X

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Lo-1		
5-10	W.S.	0.31
10-20	W.S.	1.52
20-25	W.S.	0.50
25-30	W.S.	0.67
30-35	W.S.	0.57
35-40	W.S.	0.57
40-45	W.S.	0.57
45-50	W.S.	1.67
50-55	W.S.	6.91
55-60	W.S.	8.34
60-65	W.S.	7.02
65-70	W.S.	9.87
70-75	W.S.	9.61
75-80	W.S.	10.01
80-85	W.S.	11.41
85-90	W.S.	9.77
90-95	W.S.	7.66
95-100	W.S.	6.10
HOLE NUMBER Lo-2		
0-5	W.S.	1.01
5-10	W.S.	0.70
10-15	W.S.	0.00
15-20	W.S.	1.46
20-25	W.S.	1.46
25-30	W.S.	0.00
30-35	W.S.	0.00
35-40	W.S.	1.69
40-45	W.S.	4.11
45-50	W.S.	7.24
50-55	W.S.	7.06
55-60	W.S.	6.93
60-65	W.S.	9.91
65-70	W.S.	6.56
70-75	W.S.	5.73

(Continued)

TABLE X
(Continued)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Lo-2, Continued		
75-80	W.S.	5.06
80-85	W.S.	6.07
85-90	W.S.	5.06
90-95	W.S.	2.20
95-100	W.S.	3.86
HOLE NUMBER Lo-3		
0-5	W.S.	0.00
5-10	W.S.	1.03
10-15	W.S.	1.35
15-20	W.S.	0.85
20-25	W.S.	4.05
25-30	W.S.	4.49
30-35	W.S.	5.61
35-40	W.S.	5.92
40-45	W.S.	8.27
45-50	W.S.	5.40
50-55	W.S.	4.71
55-60	W.S.	5.34
60-65	W.S.	5.12
65-70	W.S.	4.89
70-75	W.S.	4.89
75-80	W.S.	4.53
80-85	W.S.	2.53
85-90	W.S.	3.66
90-95	W.S.	5.22
95-100	W.S.	5.66

(Continued)

TABLE X
(Continued)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Lo-4		
0-5	W.S.	0.26
5-10	W.S.	0.11
10-15	W.S.	0.98
15-20	W.S.	2.67
20-25	W.S.	1.07
25-30	W.S.	0.68
30-35	W.S.	1.59
35-40	W.S.	0.78
40-50	4.0	5.73
50-60	9.0	2.29
60-65	5.0	2.05
65-70	5.0	2.73
70-75	5.0	1.11
75-80	5.0	1.99
80-86	5.0	0.40
86-90	4.0	2.19
90-100	5.0	2.63
HOLE NUMBER Lo-4A		
15-25	3.0	2.22
25-29	2.0	1.65
29-34	0.0	----
HOLE NUMBER Lo-5		
5-10	0.0	----
10-15	0.0	----
15-20	W.S.	0.32
20-30	3.0	4.73
30-40	0.0	----

(Continued)

TABLE X
(Continued)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Lo-5A		
0-5	W.S.	0.00
5-10	W.S.	0.18
10-15	W.S.	0.32
15-20	W.S.	0.00
20-25	W.S.	0.18
25-30	W.S.	1.51
30-35	W.S.	2.68
35-55	6.0	1.01
55-65	1.0	3.37
65-75	5.0	1.96
75-85	5.0	8.37
85-95	6.0	10.10
HOLE NUMBER Lo-6		
0-5	W.S.	0.57
5-10	W.S.	0.00
10-15	5.0	0.00
15-19	3.5	0.00
19-21	2.0	0.00
21-26	4.0	1.18
26-31	5.0	0.78
31-35	4.0	1.11
35-39	3.0	0.67
39-43	2.0	2.33
43-46	2.0	2.09
46-50	4.0	3.03
50-55	5.0	8.33
55-60	5.0	8.87
60-65	5.0	13.49
65-70	5.0	8.33
70-75	5.0	8.26
75-78	3.0	8.16
78-81	3.0	9.41
81-83	2.0	17.47
83-88	2.0	13.49

(Continued)

TABLE X
(Concluded)

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Lo-7		
0-5	W.S.	0.44
5-10	W.S.	1.25
10-13	3.0	0.00
13-17	3.5	0.00
17-20	2.5	0.00
20-24	3.5	1.01
24-29	0.0	0.00
29-33	4.0	1.32
33-36	3.0	0.40
36-40	3.0	0.71
40-44	3.0	0.91
44-49	5.0	3.30
49-54	5.0	5.60
54-59	5.0	12.11
59-64	5.0	16.73
65-68	4.0	9.91
68-73	5.0	9.81

TABLE XI

SAND BENEFICIATION RESULTS

	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty acid tailing	Amine float
HOLE NUMBER Lo-6 (50-88 ft.)											
Total sand footage	38										
Dry density	76.70										
Percent dry weight	100.00	.35	.35	.87	43.06	1.91	41.15	55.37	*		
Percent BPL	9.41	22.23	28.52	18.32	6.69	11.59	6.06	11.17			
Percent acid insol	75.44	54.29	46.42	59.05	87.65	73.28	88.28	66.53			
Percent Fe_2O_3	2.60	4.35	3.12	3.34	.99	2.41	.90	3.81			
Percent Al_2O_3											
Percent CaO	3.63	12.01	14.67	9.93	3.50	6.16	3.37	3.50			
HOLE NUMBER Lo-7 (54-73 ft.)											
Total sand footage	19										
Dry density	64.87										
Percent dry weight	100.00	1.64	.34	.78	30.11	2.67	27.44	67.13	*		
Percent BPL	13.52	7.65	25.47	22.82	9.68	18.88	9.24	15.40			
Percent acid insol	75.69	83.10	55.31	57.60	84.17	69.26	86.34	72.02			
Percent Fe_2O_3	2.18	1.26	2.68	2.79	.75	1.31	.67	2.83			
Percent Al_2O_3											
Percent CaO	7.40	4.09	13.69	12.20	5.32	10.51	4.72	9.06			

*Not floated because of high slime content and/or relatively low BPL values.

THOMAS COUNTY

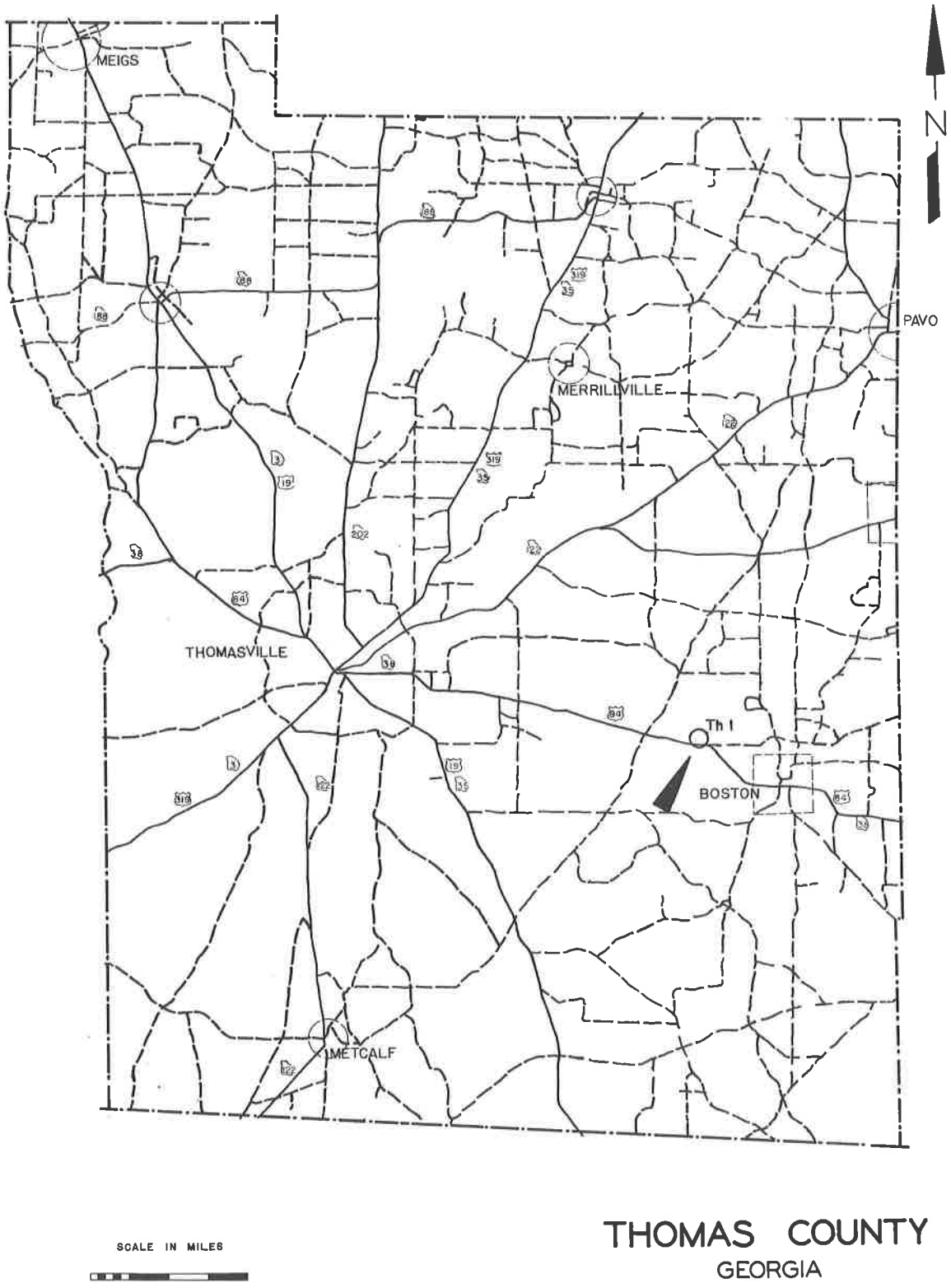


Figure 17. Location of Hole.

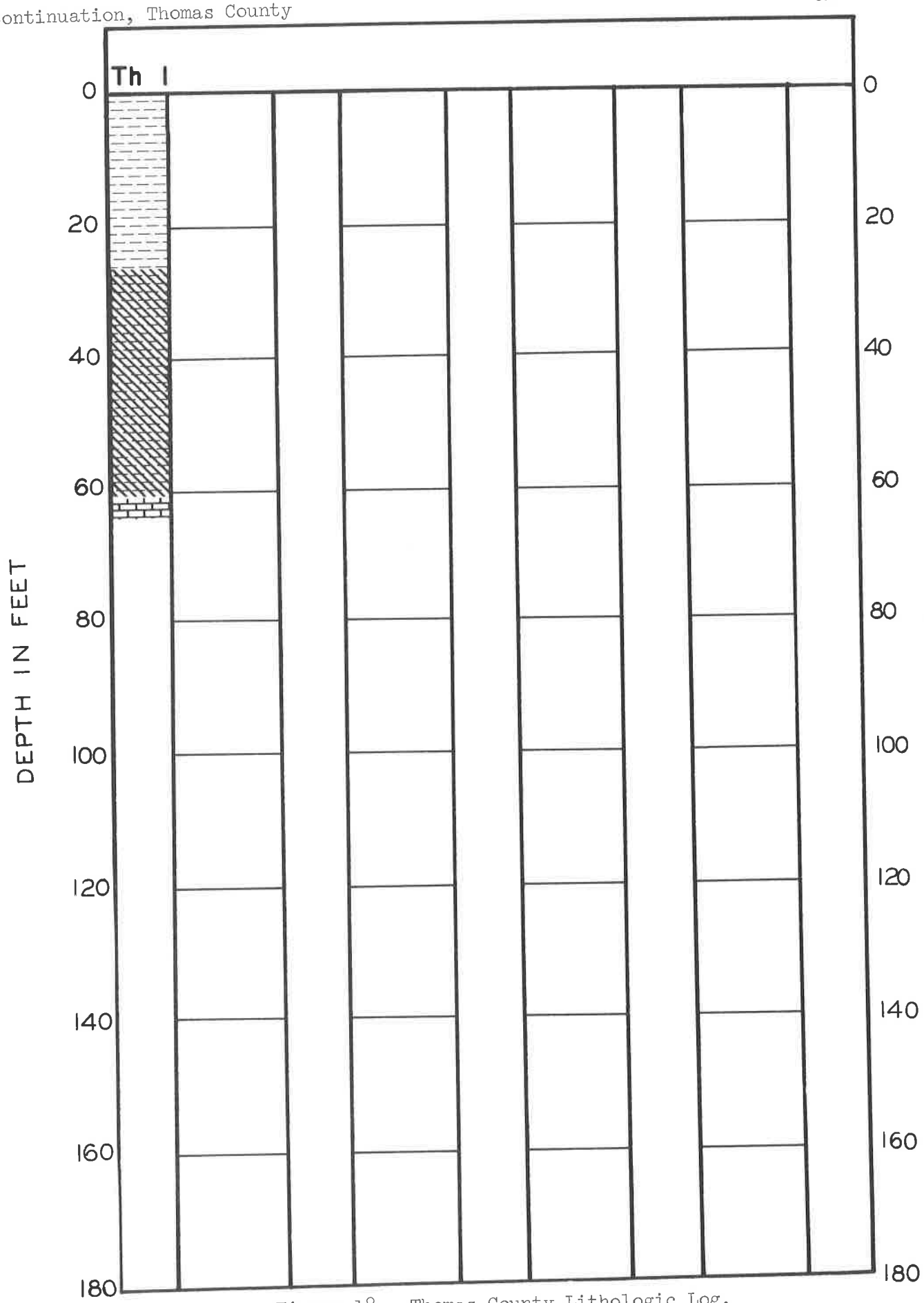


Figure 18. Thomas County Lithologic Log.

TABLE XII

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
	HOLE NUMBER Th-1	
0-5	W.S.	0.33
5-10	W.S.	0.00
10-12	0.0	----
12-14	2.0	0.00
14-16	2.0	0.00
16-18	1.0	0.00
18-20	1.5	0.37
20-22	1.5	0.74
22-26	4.0	7.63
26-31	5.0	18.18
31-33	2.0	22.96
33-38	4.0	13.50
38-40	W.S.	7.42
40-50	0.0	----
50-61	7.0	4.97
61-64	3.0	1.68

TABLE XIII

SAND BENEFICIATION RESULTS

	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty acid tailing	Amine float
	HOLE NUMBER Th-1 (26-40 ft.)										
Total sand footage	14										
Dry density	65.86										
Percent dry weight	100.00	4.17	1.02	1.51	12.37	-----	-----	80.93	-----	-----	-----
Percent BPL	20.60	4.55	20.53	37.70							
Percent acid insol	63.06	76.93	61.80	43.70							
Percent Fe_2O_3											
Percent Al_2O_3											
Percent CaO											

Note: Attention is called that approximately eighty-one percent of the dry weight of the material is below 150 mesh.

WARE COUNTY

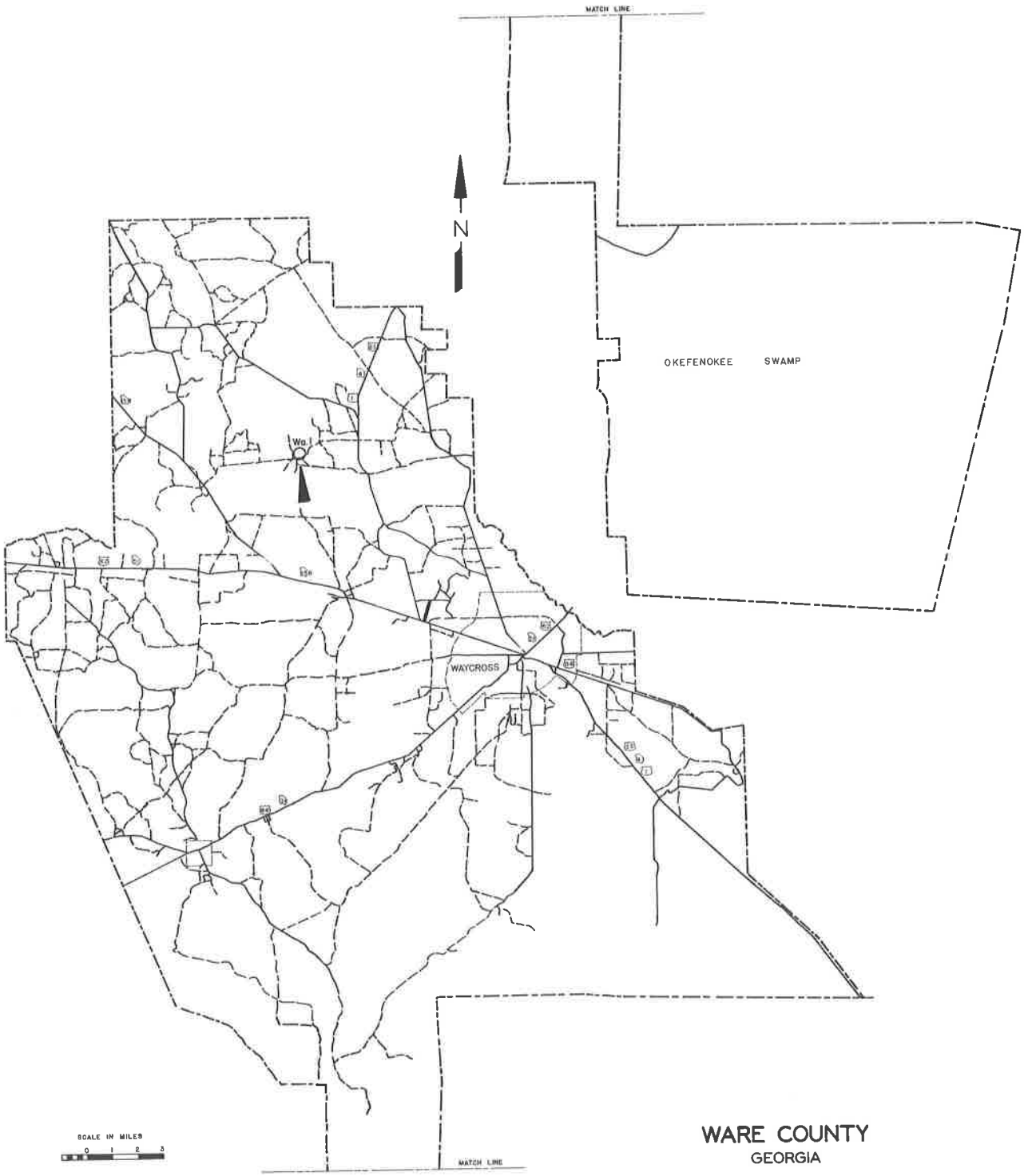


Figure 19. Location of Hole.

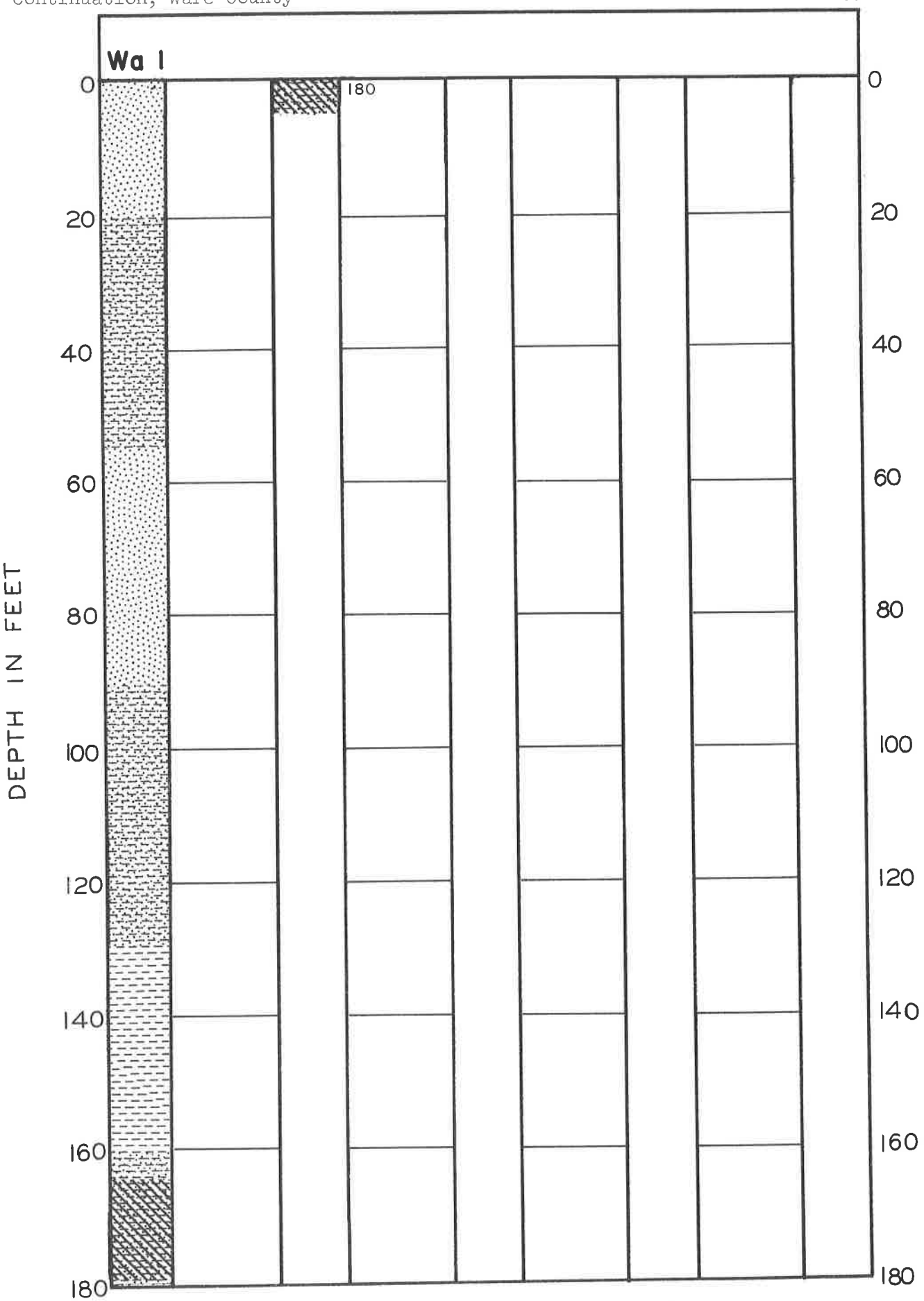


Figure 20. Ware County Lithologic Log.

TABLE XIV

BPL DETERMINATIONS ON CORES

Depth (Feet)	Recovery (Feet)	Percent BPL
HOLE NUMBER Wa-1		
0-5	W.S.	0.00
5-10	W.S.	0.37
10-15	W.S.	0.63
15-20	W.S.	0.00
20-25	W.S.	0.17
25-30	W.S.	0.00
30-35	W.S.	0.00
35-40	W.S.	0.00
40-45	W.S.	0.00
45-50	W.S.	0.00
50-55	W.S.	0.00
55-60	W.S.	0.00
60-65	W.S.	0.00
65-70	W.S.	0.00
70-75	W.S.	0.00
75-80	W.S.	0.00
80-85	W.S.	0.00
85-90	W.S.	0.00
90-95	W.S.	0.00
95-100	W.S.	0.17
100-105	W.S.	0.17
105-110	W.S.	0.20
110-115	W.S.	0.17
115-120	W.S.	0.20
120-125	W.S.	0.17
125-130	W.S.	0.50
130-135	W.S.	1.68
135-140	W.S.	2.69
140-145	W.S.	4.90
145-150	W.S.	5.20
150-155	W.S.	2.93
155-160	W.S.	2.25
160-165	W.S.	4.19
165-170	W.S.	7.83
170-175	W.S.	9.58
175-180	W.S.	5.73
180-185	W.S.	0.00

GLOSSARY 1/

Apatite . . . . . Used in this report to mean the mineral carbonate-fluorapatite.

BPL . . . . . Bone phosphate of lime ($Ca_3(PO_4)_2$). Equals percent P_2O_5 x 2.185.

Concentrate . . . . . Fine phosphate product - 1 mm + 0.1 mm in size. Separated from quartz by flotation.

Matrix . . . . . That part of the calcium phosphate zone from which phosphate particles can be economically recovered. Equal to "ore."

Nodule . . . . . Rounded, irregular mass of any size. The term may apply to rock fragments, as well as apatite particles.

Overburden . . . . . All rock overlying the matrix.

Pebble . . . . . Coarse phosphate product, +1 mm in size.

Pellet . . . . . General term for rounded, oviform sedimentary apatite particles, commonly sand to granule in size.

Phosphorite . . . . . Rock name, called phosphate rock in the land-pebble district. Used in this report to denote a rock or specimen containing substantial amounts of sedimentary apatite.

Slime . . . . . -0.1 mm material. Includes clay minerals, quartz, and phosphate minerals (apatite, crandallite, and wavellite).

1/ Taken from: The Geology and Geochemistry of the Bone Valley Formation and its Phosphate Deposits West Central Florida, by Z. S. Altschuler, J. B. Cathcart, and E. J. Young, Guidebook for Field Trip No. 6, pp. 22-23, Geol. Soc. Amer. Convention, Nov. 1964.