Project Report No. 2
South Georgia Minerals Program
Echols County

Project A-880, Georgia Institute of Technology
Atlanta, Georgia
May, 1966

PROJECT REPORT NO. 2

SOUTH GEORGIA MINERALS PROGRAM

ECHOLS COUNTY

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

A. S. Furcron, Director

By

Minerals Engineering Group, Engineering Experiment Station,
Georgia Institute of Technology, and
Georgia Department of Mines, Mining, and Geology

April 1966

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

ACKNOWLEDGMENTS

Project Report No. 1 noted the many agencies and individuals from whom invaluable assistance was obtained in planning the program and in selecting Echols County, Georgia, as the site for initial work.

The value of this report on Echols County has been enhanced through the cooperation of Norman K. Olson, Industrial Geologist of the Southern Railway System, who, with its permission, contributed recent wash samples from its drilling program and made available information gained from earlier drilling.

The United States Geological Survey, Water Resources Division, Georgia District, contributed results of their logging and other investigations of the areas under consideration.

Active assistance by the County Commissioners: D. B. Daniels, Chairman, Vernon Lightsey, and J. L. Corbett; by representatives of the State and County road agencies; by leaders in the communities in which operations were carried out; and by the Directors and staffs of Georgia Tech's School of Ceramic Engineering and School of Chemical Engineering, who made facilities and equipment available; all contributed significantly to the progress of this work.

Stimulating cooperation was rendered by the commercial drillers, employed for this program, whose best efforts exceeded that called for in their contracts.

It is desired to express sincere gratitude to each and all of 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, scope, background, and procedures to be followed in carrying out this South Georgia Minerals Program.

Based upon all available information, both published and obtained through consultation with many authorities, it was decided to initiate work in Echols County, with particular emphasis on phosphate minerals. The recent construction of a phosphate processing plant just south of Echols County, Georgia, in Hamilton County, Florida, demonstrated the northward trend of the large Florida operations and emphasized the need for early work near the Florida border. Recent wash samples were contributed by the Southern Railway System to Georgia Tech for analyses; analytical results of earlier drilling were also given. These data, and those from 14 holes drilled under this State project, are presented.

This Project Report No. 2 is the first technical report of a series to be published as a result of the State funded program. It is recognized that many factors in addition to scientific and technical data are considered by industry in reaching decisions for plant locations and expansion. Each company has its own "rules-of-thumb" which are applied to preliminary data to determine the degree of interest in carrying out more intensive drilling programs. Information gained on geology and minerals in Echols County are reported herein in a form to facilitate review and consideration by the minerals industries, primarily the phosphate industry.

Broad reconnaissance work, as permitted by the funds available, involved few holes cored at carefully selected locations, usually several miles apart. Hence, the presence or absence of adequate quality minerals from a single core is insufficient for a decision regarding economic utilization. To quote from U. S. Geological Survey Bulletin 1046-K, 1/ "To block out a deposit 16 holes per 40 acres are drilled, or 1 hole in each 2.5 acre block. The area of a standard drill hole is about one-millionth of the area of the 2.5 acre block. Thus, the accuracy of tonnage and grade estimates for this

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1/Results of Geologic Exploration by Core Drilling, 1953, Land-Pebble Phosphate District Florida, by J. B. Cathcart and L. J. McGreevy, U.S.G.S. Bull. 1046-K, p. 241, 1959.

drilling is extremely low, and tonnage and grade figures are not projected...." The data, therefore, serve only as guides for more intensive investigations into the feasibility of mining-plant processing of phosphorites, heavy minerals, and other minerals deposits.

Accordingly, results and discussions are presented on each core sample as an individual unit. Some more of less general observations are presented under "Summary."

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 having potential for establishing new, or expanded, minerals industries in the State.

The scope of the information in this report is confined to the results from core samples obtained in Echols County, Georgia. A complete interpretation of the data involves consideration of the geologic structure of the county and of the surrounding region. No attempt has been made, at this time, to present geologic interpretations.

SUMMARY

Echols County has areas (Figure 1) totaling over 100,000 acres that warrant more detailed exploration by industry.

The area that appears to be most promising for industrial investigation is a roughly semi-circular area with diameter approximately eight miles in length along the Lowndes County border to the west. Maximum overburden is 50 feet, a minimum of 20 feet, and an average of 35-40 feet. Zones containing phosphorite with economic potential (matrix) range in thickness of 10-70 feet, with an average of approximately 30 feet, with percent bone phosphate of lime (BPL) ranging from 9.6 to 36 with an average of 15-20 percent.

An irregular area east of the above, with larger range of depths and, in general, with less BPL and/or greater overburden is ranked next. Individual hole study will reveal exceptions, but the area appears to be one of commercial potential. In an area south of Statenville (vicinity of hole Ec-2) ilmenite concentrations are sufficient to be investigated as a potential by-product of phosphorite operations.

The immediate area south and east of Tarver warrants additional exploration, but an area of recommendation is not specifically delineated due to limited hole data.

For the southeastern section of the county, available data indicate deposits having commercial potential are somewhat deeper than in other areas. The limited number of holes preclude statements of potential on a confidence level as compared to the larger areas in the western part of the county.

Results from forty-seven holes drilled in Echols County are presented. The county has been broadly "covered," as shown by Figure 14, page 20. All data available on each hole are presented in the form of figures, charts, and tables. Data on each hole are, unfortunately, in some cases incomplete because of water saturated sands that were not recoverable in the coring process. Data presented include: location of hole, lithologic descriptions, electric and gamma-ray logs, thickness of overburden, thickness of mineral-matrix layers of interest, depth to a geologic control feature (usually the Tampa Limestone formation), particle size distribution, results of beneficiation treatment, and compositional features.

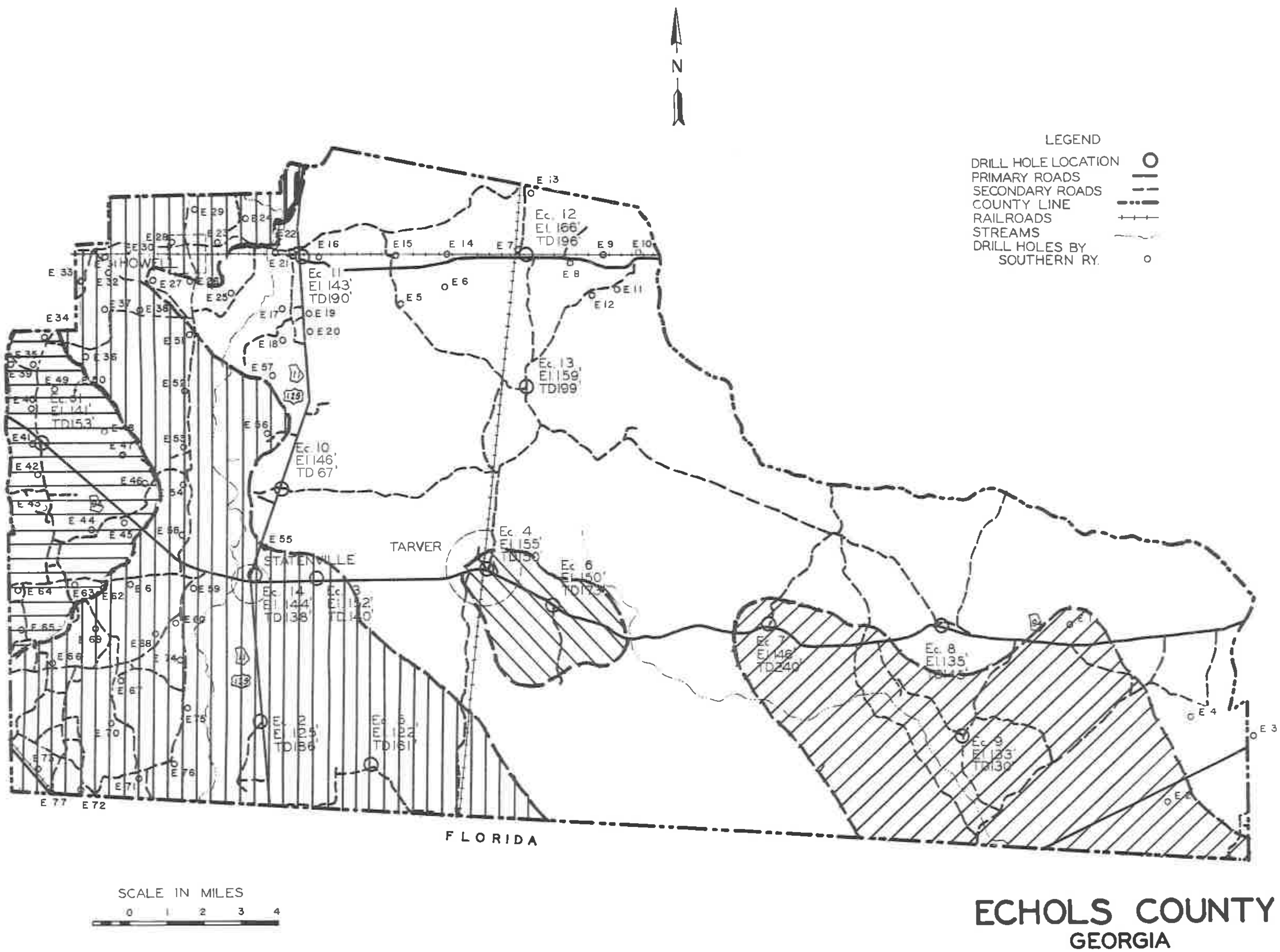


Figure 1. Areas recommended for additional exploration.

PROCEDURE

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. In most cases, drilling was continued to depth until a definite geologic reference formation was reached.

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 in Echols County, it was found that certain layers of the matrix were unconsolidated and water saturated to such an extent that core recovery was not possible. 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 representative of the "in place" sediments.

Drilling time records were made to show rates of penetration of differing sedimentary layers. Observations and descriptions of the samples were also 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 then 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 (x-ray) log which, by measurement of radiation emission, permits estimation of the amount present of phosphorite and/or certain heavy minerals.

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

Cores were then cut in half lengthwise - one half being used for analyses and the other half re-encased in plastic and stored in containers for future reference. Part of the core samples and "wash" samples from layers noted as of specific interest were analysed "as is." The remainder was screened to separate the pebble phosphate fraction (-4 + 16 mesh), then washed to remove slimes (-150), and used as the feed for beneficiation by flotation using current industrial procedures. Plus 200 mesh and pan material shown in the core processing flow sheet (Figure 14) are the results of attrition in sample handling and incomplete desliming. The percentage content of minerals of interest was determined on samples from the core. Chemical analyses were made after washing, after screening, and on the beneficiated product. Determinations included: moisture content, amount insoluble (mainly silica) in aqua regia, phosphates, iron, aluminum, silica, and in some instances, calcium.

Several methods of analyses were used which are described under "Methods of Analyses." They include x-ray fluorescence, atomic absorption, and wet-chemical procedures.

Figure 2 is a diagram of the project procedure. Figures 3 through 13 present a pictorial sequence of drilling to core-cutting operations. Figure 14 is a diagram of the steps involved in analyses of samples for particle size, mineralogical and chemical constituents, and amenability of the sample to be beneficiated through a flotation process.

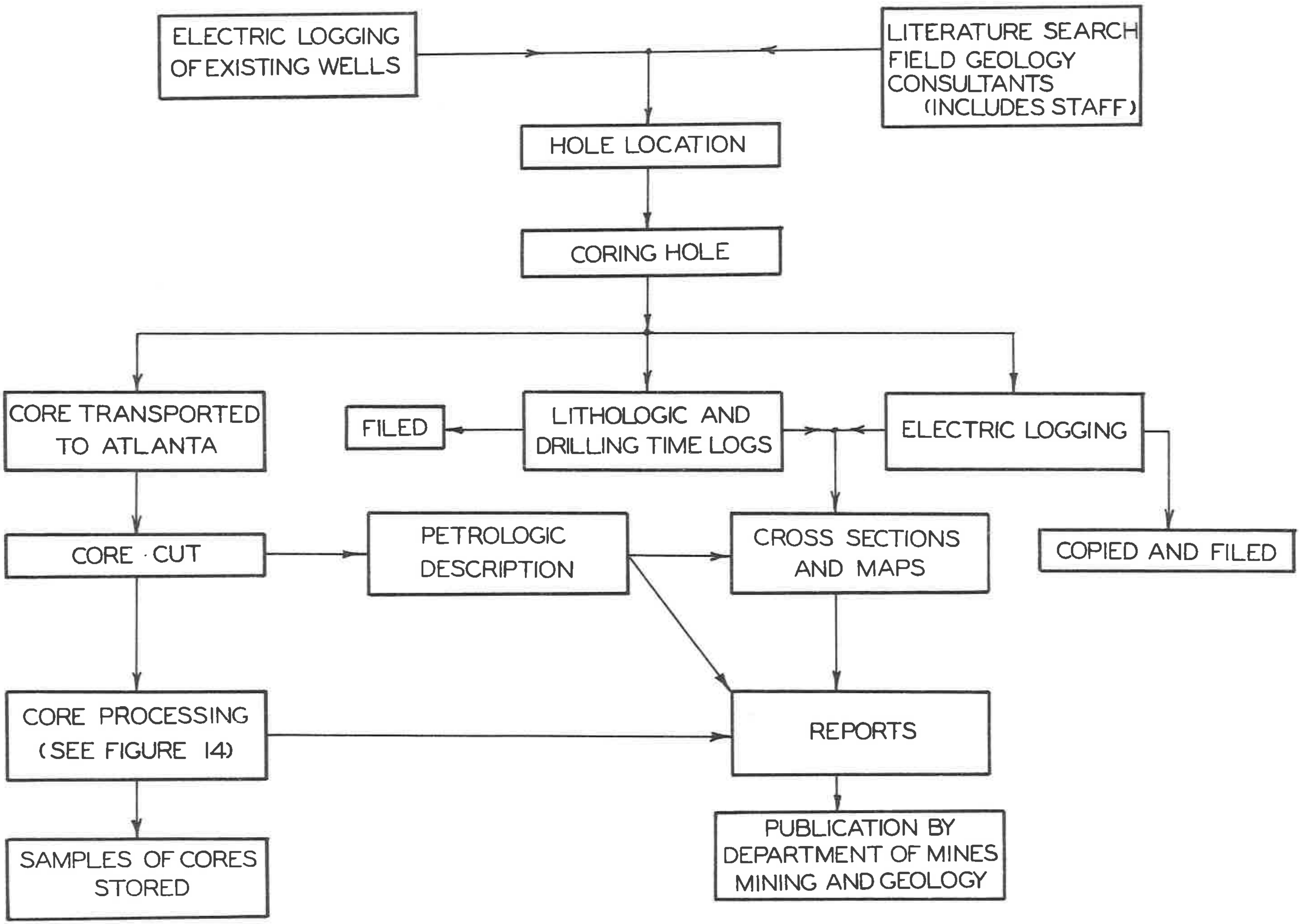


Figure 2. Flow chart of project procedure.

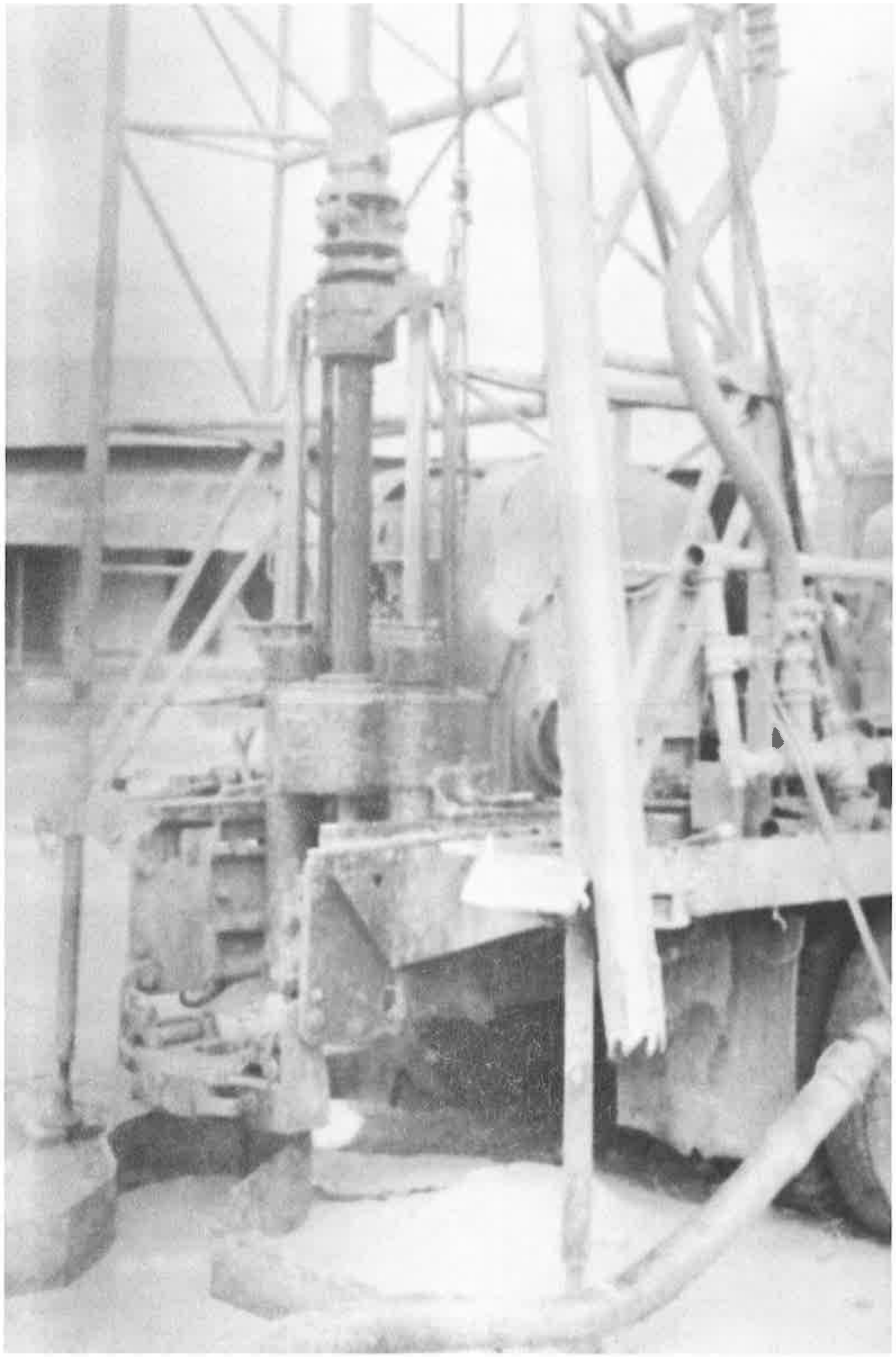


Figure 3. Drilling, showing core barrel in rack at side. Mud pit in left foreground.

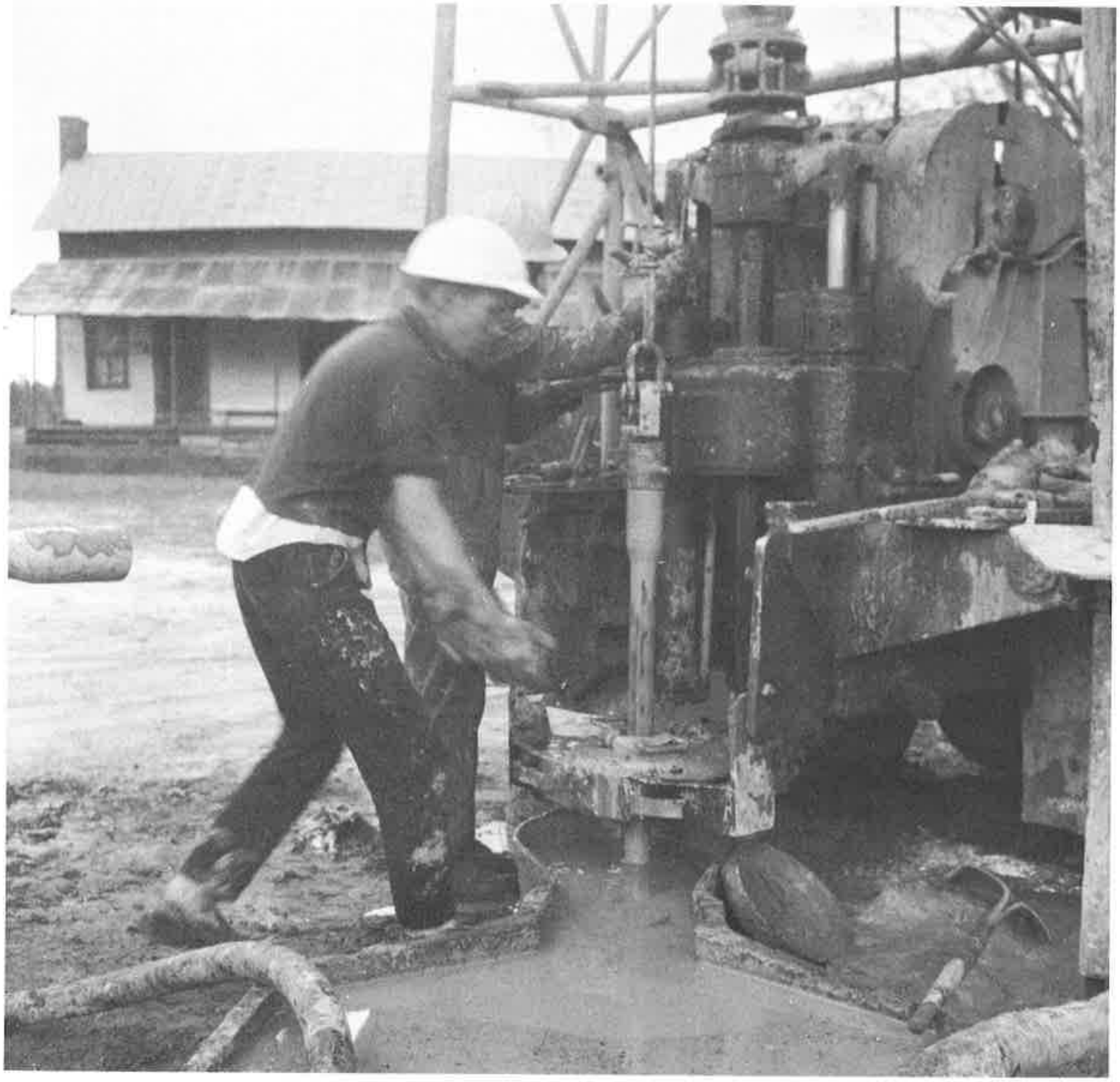


Figure 4. Drilling, going back into hole with core barrel under surface. Mud pit in foreground.

Figure 5. Disconnecting drill stem sections.
Core barrel just emerging from hole.
Mud pit in foreground.

Figure 6. Removing core from barrel.
Some core section on board.
Outer core barrel, right center, attached to cable.
Core boxes to right.

Figure 7. Clay core coming from barrel.

Figure 8. Core sections just out of barrel on plank prior to putting in core boxes. Core on grass from hole abandoned due to caving-in first ten feet.

Figure 9. Placing waterproof wrapping in core box prior to core.

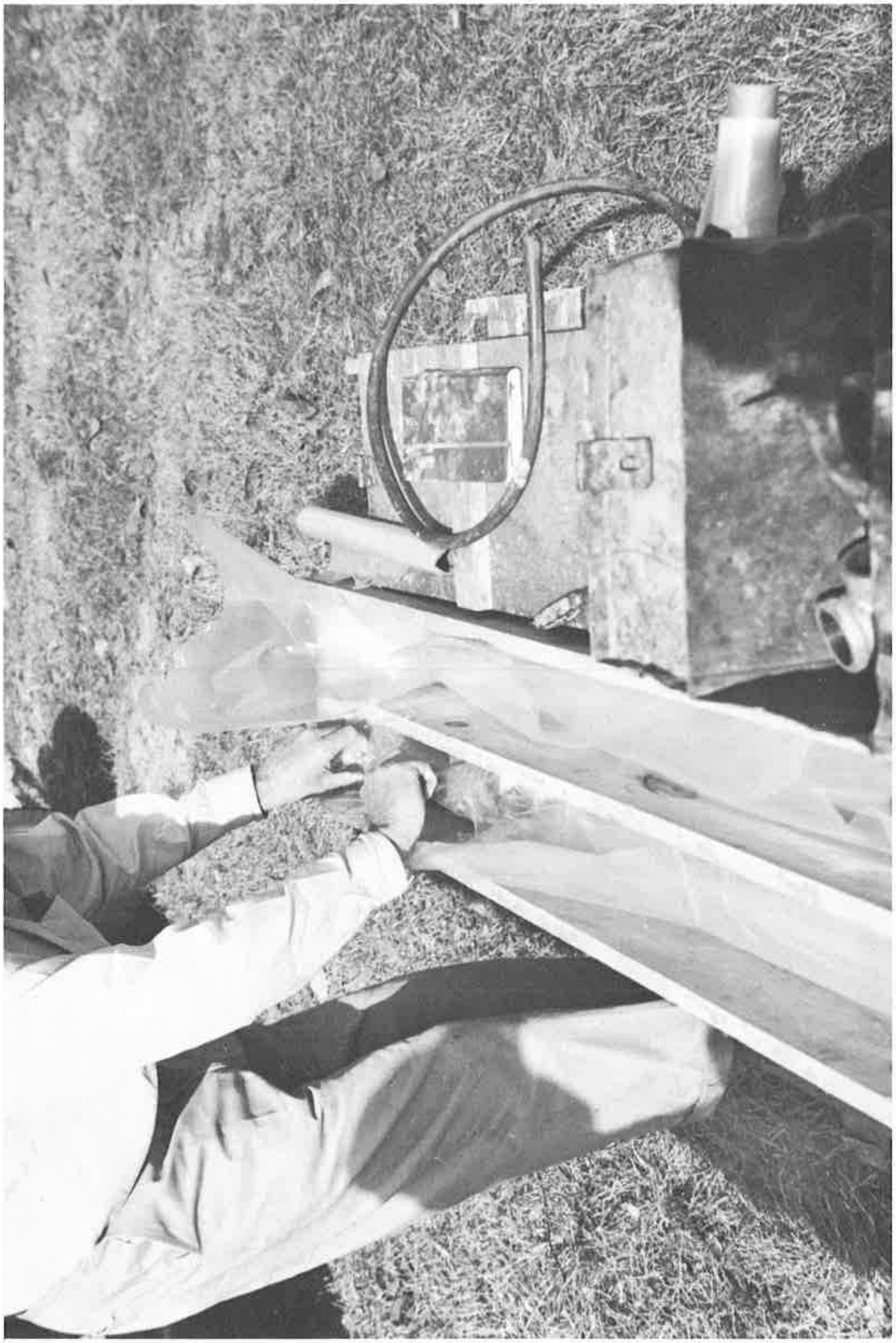


Figure 10. Placing core in core boxes.

Figure 11. Drilling Geologist describing cores.

Figure 12. Wrapping cores for moisture retention prior to transporting to Atlanta

Figure 13. Cutting of cores.
The core sample from the drilling operation is being cut in half.
One half will be used for laboratory analyses -
The other half for microscopic-mineralogical examination and retention.

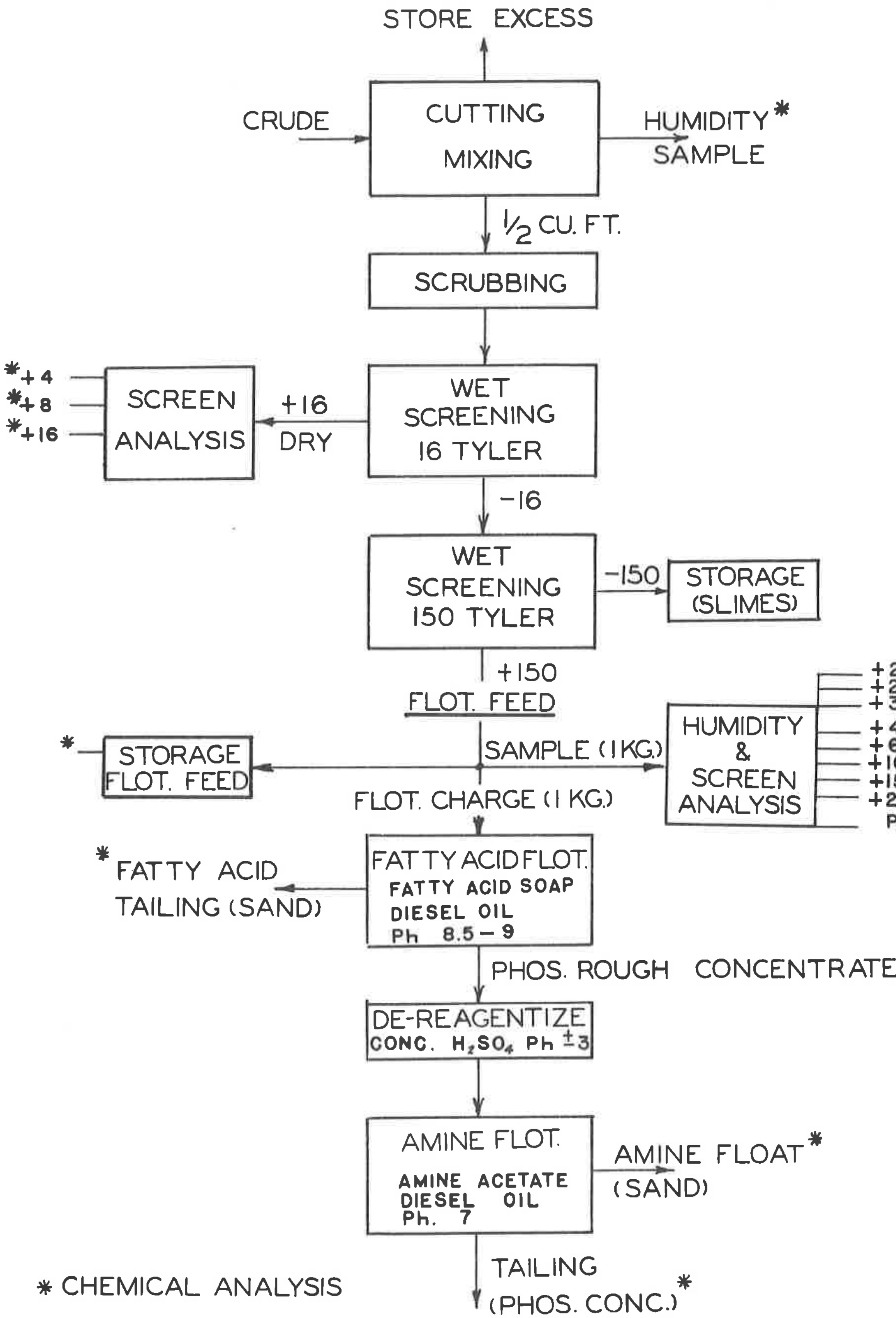


Figure 14. Flow chart of core processing.

LOCATION OF HOLES - SAMPLES

As this is a State funded program, drilling was restricted to the public domain. Samples contributed by the Southern Railway System were obtained under its drilling program. The location of each hole, involved in these Echols County programs, is shown in Figure 15. Locations marked "E" refer to holes drilled by the Southern Railway System; those marked "Ec" being those drilled under this contracted program.

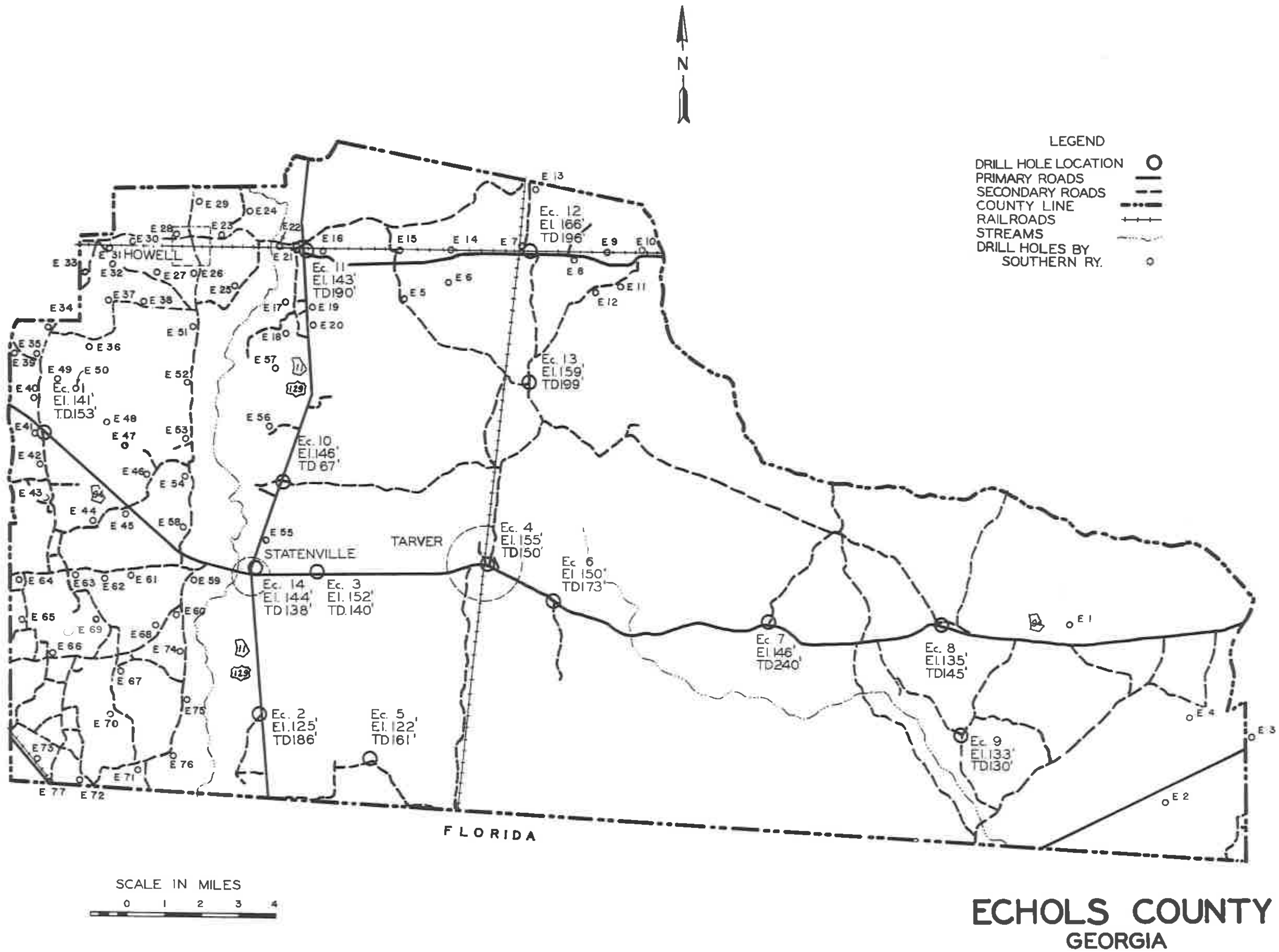


Figure 15. Location map of holes in Echols County.

EXPERIMENTAL DATA

Logging Results

Drilling Time

On each hole the time necessary to drill through different types of sediment was plotted on the driller's lithologic log as a function of time. This will permit drilling contractors and industry to estimate drilling costs for that area. These logs are available at the Georgia Institute of Technology.

Electric and Gamma-Ray Logging

Each hole was logged by two probes - one that measures the electrical resistivity of the earth through which it passes, as well as an induced electrical potential; and one that measures radiation (gamma-rays) emitted by radioactive materials by which it passes. These probes are lowered separately into the hole and the results which they measure are automatically plotted as a function of depth on a strip of special graph paper attached to the equipment at the surface. The plotted graphs are referred to as electric and gamma-ray logs respectively.

The electric log permits an estimate of type of sediment (sand, shale, etc.) and a degree of the porosity found therein. The gamma-ray logging probe measures radiation.

Sources of radiation in Georgia Coastal Plain sediments are (1) uranium in very small amounts associated with phosphorite, and (2) some heavy minerals such as monazite. The uranium may be found directly with the phosphorite, where it is reported in Florida to be in the crystal lattice of apatite, or it may be leached from the apatite, and be found separated from phosphorite concentrations. To date, however, high gamma-ray activity has indicated high phosphorite within the hole, although not always at the same depths. Conversely, holes with small gamma-ray activity have to date been found to be essentially barren of phosphorite. Readings obtained from heavy minerals have not been significant because of small amounts and lower radiation rates.

Copies of the electric and gamma-ray logs are available for study at the Georgia Department of Mines, Mining, and Geology.

Lithologic Logging

A descriptive log for the entire length of each hole was made by the geologist at the drilling site. The description gives the type of sediments in the core and the degree of consolidation. Intervals for which core could not be recovered and the nature of wash samples for intervals where core was lost due to water saturation and lack of consolidation were noted. This description is used to plot a driller's lithologic (rock type) log for each hole. These logs are also available at the Georgia Institute of Technology.

In the Atlanta laboratories, more detailed descriptions were made using petrologic techniques. For selected five foot intervals representative grab samples were taken for each foot of core and combined, thoroughly mixed, and used for mineral species and heavy mineral particle counts, as reported in Table I.

Figure 16 gives a lithologic (rock type) log for each hole that represents combined data from the driller's lithologic log, petrologic studies in the laboratory, and electric logging.

TABLE I

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES
ECHOLS COUNTY, GEORGIA

DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	MAXIMUM QUARTZ IN MILLIMETERS	Percent Composition					
			QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER ONE								
10-15	0.33	6.1	89	4	1	Tr	5	0.2
20-25	0.45	7.1	80	3	5	1	10	0.3
30-35	0.31	7.1	76	2	8	1	12	0.5
35-40	0.29	10.0	54	5	10	4	23	0.5
40-45	0.18	10.0	63	5	5	5	20	0.4
55-60	0.14	-	62	5	1	2	28	0.5
60-65	0.12	1.5	86	3	Tr	Tr	10	0.5
HOLE NUMBER TWO								
10-25	0.19	3.1	77	4	2	1	15	0.8
25-40	0.19	2.6	71	7	4	5	12	0.5
40-50	0.20	3.5	71	5	7	4	11	1.8
50-70	0.19	5.3	76	3	11	2	6	1.1
70-80	0.05	7.1	31	1	2	5	60	0.1
80-90	0.31	4.6	48	2	11	8	30	0.3
90-100	0.65	7.1	60	1	8	25	5	0.4
105-130	0.04	1.3	24	Tr	Tr	5	70	0.1
130-145	-	-	31	1	Tr	3	65	0.3
145-155	0.07	-	30	1	Tr	8	60	0.2
HOLE NUMBER THREE								
6-21	0.22	2.0	80	4	Tr	Tr	15	0.2
21-47	0.32	2.6	82	4	6	1	7	0.2
47-61	0.16	6.2	51	11	6	1	30	0.5
61-70	0.65	4.2	10	2	7	80	1	0.1
80-95	0.07	1.2	40	5	1	33	20	0.3
95-110	0.04	2.1	32	4	Tr	60	3	0.3
110-135	0.03	2.6	20	3	Tr	74	2	0.1

(Continued)

TABLE I

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES ON ONE FOOT INTERVALS FROM CORES ECHOLS COUNTY, GEORGIA (Continued)

			Percent Composition					
DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	MAXIMUM QUARTZ IN MILLIMETERS	QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
			HOLE NUMBER FOUR					
0-14	0.80	3.1	99	Tr	Tr	Tr	1	0.1
14-25	0.15	2.3	65	4	Tr	1	29	0.4
25-30	0.15	2.2	66	6	2	1	25	0.2
30-35	-	-	71	5	2	1	20	0.3
35-45	0.15	4.2	74	7	2	1	15	0.3
45-50	0.13	1.5	60	2	4	1	33	0.1
50-55	0.25	1.2	76	7	4	1	10	0.2
55-65	0.21	2.4	72	3	7	1	15	0.3
65-70	0.25	1.2	79	5	3	2	10	0.2
70-82	0.05	2.0	30	2	3	62	2	0.2
82-92	0.05	2.0	24	2	4	65	5	0.4
92-102	0.17	1.9	41	5	2	47	2	0.4
102-112	0.21	2.1	42	5	2	30	20	0.5
112-122	0.25	3.2	29	4	7	55	5	0.5
122-132	0.12	3.0	19	2	4	70	5	0.3
132-150	0.20	2.3	22	3	3	70	2	0.2
			HOLE NUMBER FIVE					
10-25	0.05	2.8	41	4	Tr	-	55	0.2
25-50	0.30	3.3	73	2	8	2	15	0.3
50-80	0.05	2.5	19	1	Tr	60	20	0.1
80-95	0.05	1.6	6	Tr	Tr	92	2	0.2
95-110	0.05	1.2	11	1	2	84	2	0.2
			HOLE NUMBER SIX					
10-18	-	1.8	75	Tr	Tr	-	25	0.2
18-25	0.14	1.5	56	4	-	-	40	0.2
25-40	0.18	2.3	76	4	3	-	16	0.6
40-45	-	-	84	4	2	-	10	0.3
45-55	0.05	2.0	44	6	2	45	5	0.2
55-60	0.14	1.6	43	3	10	30	14	0.3

(Continued)

TABLE I

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES
ECHOLS COUNTY, GEORGIA
(Continued)

			Percent Composition					
DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	MAXIMUM QUARTZ IN MILLIMETERS	QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER SIX, Continued								
60-75	0.15	1.8	41	3	15	20	21	0.4
75-90	0.18	1.4	52	3	15	15	15	0.4
90-110	0.15	2.2	39	3	18	20	20	0.3
HOLE NUMBER SEVEN								
10-20	0.10	1.7	52	2	1	-	45	0.2
20-30	0.16	2.7	55	10	2	-	33	0.5
30-65	0.20	2.6	61	7	10	20	2	0.3
65-85	0.16	1.8	60	9	10	6	25	0.3
85-130	0.18	3.6	64	4	10	10	12	0.4
160-205	0.12	1.3	45	4	1	40	10	0.2
HOLE NUMBER EIGHT								
10-15	0.18	2.6	80	-	-	-	20	0.2
15-35	0.16	2.5	77	8	-	-	15	0.4
35-50	0.09	2.4	58	12	5	20	5	0.5
50-75	0.10	1.6	44	5	6	40	5	0.3
75-100	0.22	1.1	63	5	7	20	5	0.2
100-135	0.42	3.0	42	4	10	41	3	0.2
135-150	-	-	-	-	3	-	-	-
HOLE NUMBER NINE								
10-20	0.16	1.7	56	14	-	-	30	0.4
20-45	0.20	2.0	71	11	3	5	10	0.5
45-65	0.19	2.5	63	11	10	-	15	0.6
65-85	0.19	2.0	52	9	15	5	20	0.4
85-115	0.27	3.1	60	3	12	20	5	0.2
HOLE NUMBER TEN								
6-19	0.25	2.5	82	1	-	-	18	0.2
20-40	0.21	6.0	89	1	-	-	10	0.1

(Continued)

TABLE I

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES
ECHOLS COUNTY, GEORGIA
(Continued)

DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	MAXIMUM QUARTZ IN MILLIMETERS	Percent Composition: QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER TEN, Continued								
40-45	-	5.2	80	7	1	1	10	0.3
45-55	0.48	5.5	76	8	10	1	5	0.3
55-65	0.05	2.6	29	5	12	Tr	55	0.1
HOLE NUMBER ELEVEN								
0-15	0.16	4.0	70	-	-	-	30	0.2
15-30	0.35	5.3	90	-	-	-	10	0.1
30-45	0.28	2.8	95	Tr	-	Tr	5	0.1
45-65	0.60	4.5	85	2	-	-	12	0.2
65-90	0.42	5.5	94	4	-	-	2	0.2
90-100	-	1.2	10	Tr	-	-	98	0.5
100-105	0.33	4.4	54	2	10	Tr	34	0.5
105-135	0.17	4.3	35	2	1	30	30	0.2
135-180	-	2.8	14	2	Tr	44	40	0.2
180-195	0.02	1.3	3	1	-	96	Tr	0.1
HOLE NUMBER TWELVE								
10-15	0.55	2.7	99	-	-	-	1	0.1
15-30	0.28	3.5	85	-	-	-	15	0.1
30-45	0.22	5.2	72	2	-	1	25	0.5
45-75	0.15	7.0	54	7	4	-	35	0.3
75-90	0.45	8.0	61	3	7	3	26	0.2
90-125	0.16	3.5	59	10	4	7	20	0.2
125-145	0.15	4.5	48	3	4	10	35	0.1
145-175	0.03	2.5	13	1	1	10	65	0.1
175-196	0.02	2.3	16	2	-	80	2	0.1
HOLE NUMBER THIRTEEN								
15-20	-	3.0	60	Tr	-	-	40	0.2
20-30	0.33	3.5	92	1	Tr	-	17	0.1
30-50	0.05	2.2	38	10	-	-	52	0.2

(Continued)

TABLE I

COMPOSITION AND SEDIMENTARY PARAMETERS OF SEDIMENT GRAB SAMPLES
ON ONE FOOT INTERVALS FROM CORES
ECHOLS COUNTY, GEORGIA
(Concluded)

			Percent Composition					
DEPTH IN FEET	MEDIAN DIAMETER IN MILLIMETERS	MAXIMUM QUARTZ IN MILLIMETERS	QUARTZ	FELDSPAR	PHOSPHORITE	CARBONATE MINERALS	CLAY	HEAVY MINERALS
HOLE NUMBER THIRTEEN, Continued								
50-75	0.15	3.0	40	7	8	5	40	0.3
75-95	0.05	2.6	42	5	3	45	5	0.1
95-115	0.16	2.5	55	1	2	40	2	0.1
115-130	0.18	4.5	71	5	6	15	3	0.2
130-150	0.04	4.1	31	3	6	50	10	0.2
150-190	0.03	2.1	10	Tr	Tr	10	80	0.1
190-200	0.80	1.1	11	2	2	80	5	0.1
HOLE NUMBER FOURTEEN								
10-25	0.19	2.1	80	Tr	-	-	20	0.1
25-40	0.15	4.8	88	6	-	-	5	0.3
40-45	0.27	3.2	74	5	2	2	17	0.2
45-57	0.95	2.3	90	3	5	2	-	0.4
62-70	0.55	3.8	80	5	5	5	5	0.2
70-80	0.05	1.3	14	1	3	60	20	0.4
80-95	0.14	1.5	59	3	1	10	27	0.4
95-105	0.05	2.6	14	Tr	1	75	10	0.4
105-130	0.05	3.0	18	Tr	Tr	72	10	0.2

Note: Median diameter in millimeters computed from cumulative distribution curve.
Composition based on point count and weighted distribution per sieve size.
Tr = trace amounts less than 0.5 percent.

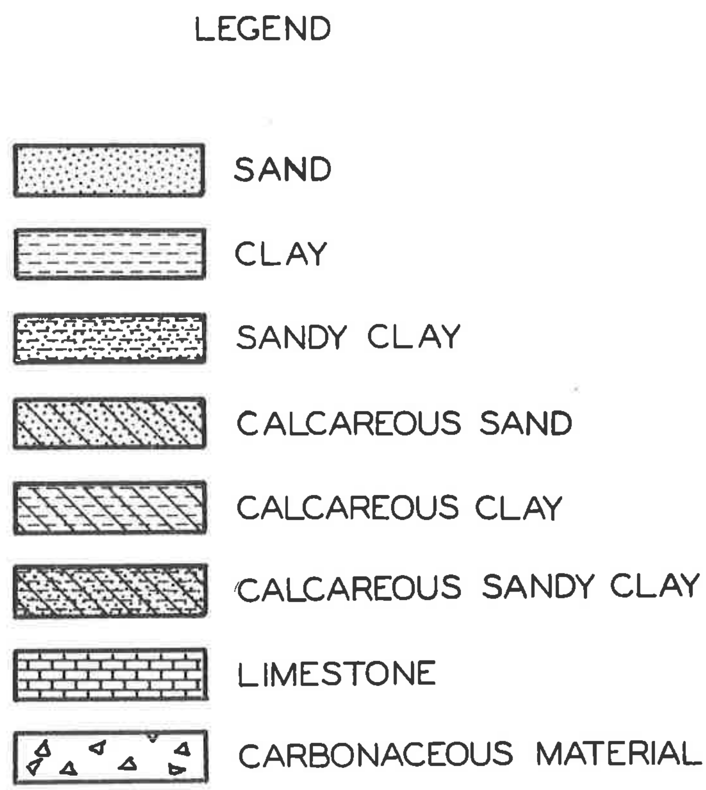
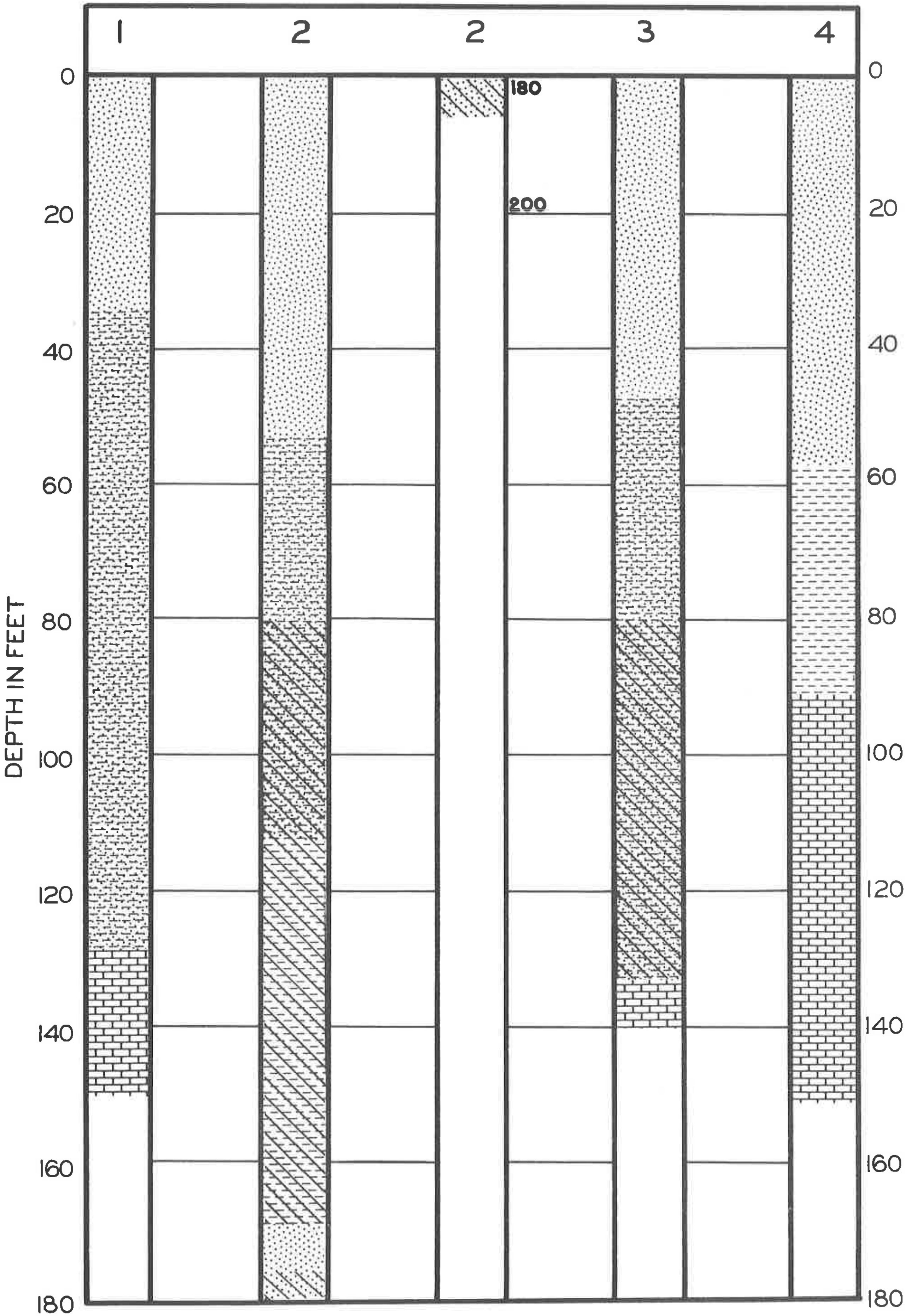
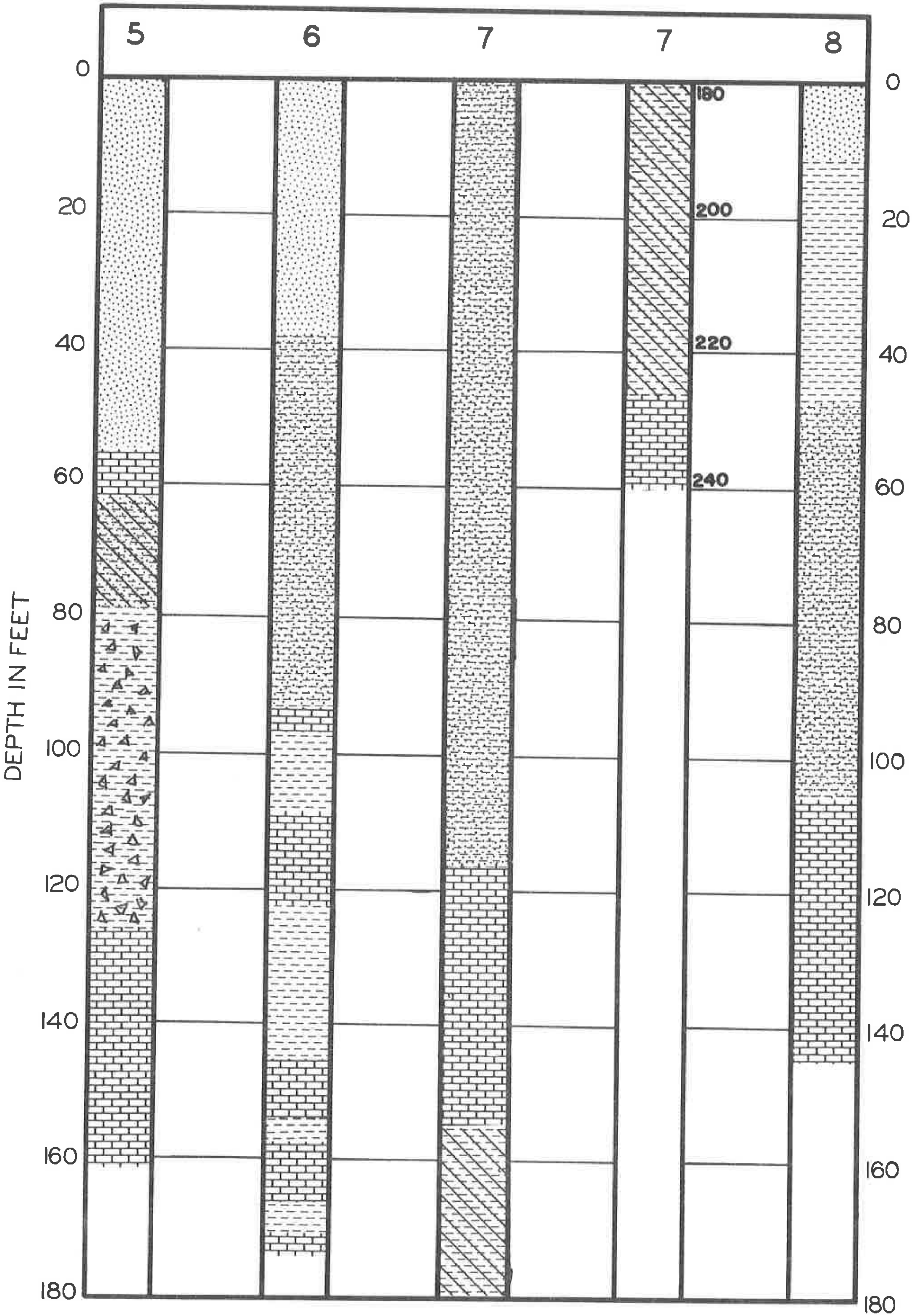


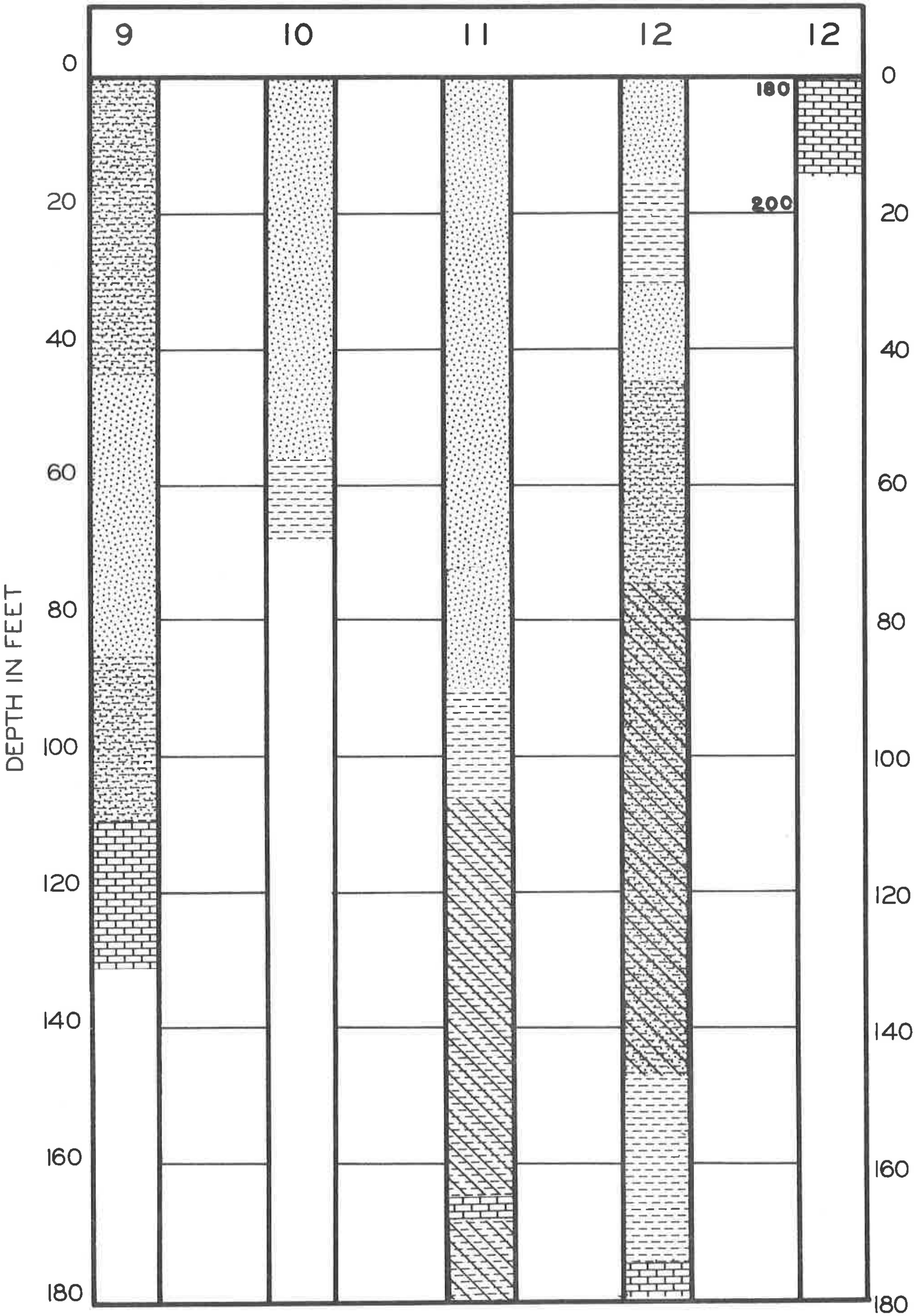
Figure 16. Logs showing lithology of holes. (Continued)



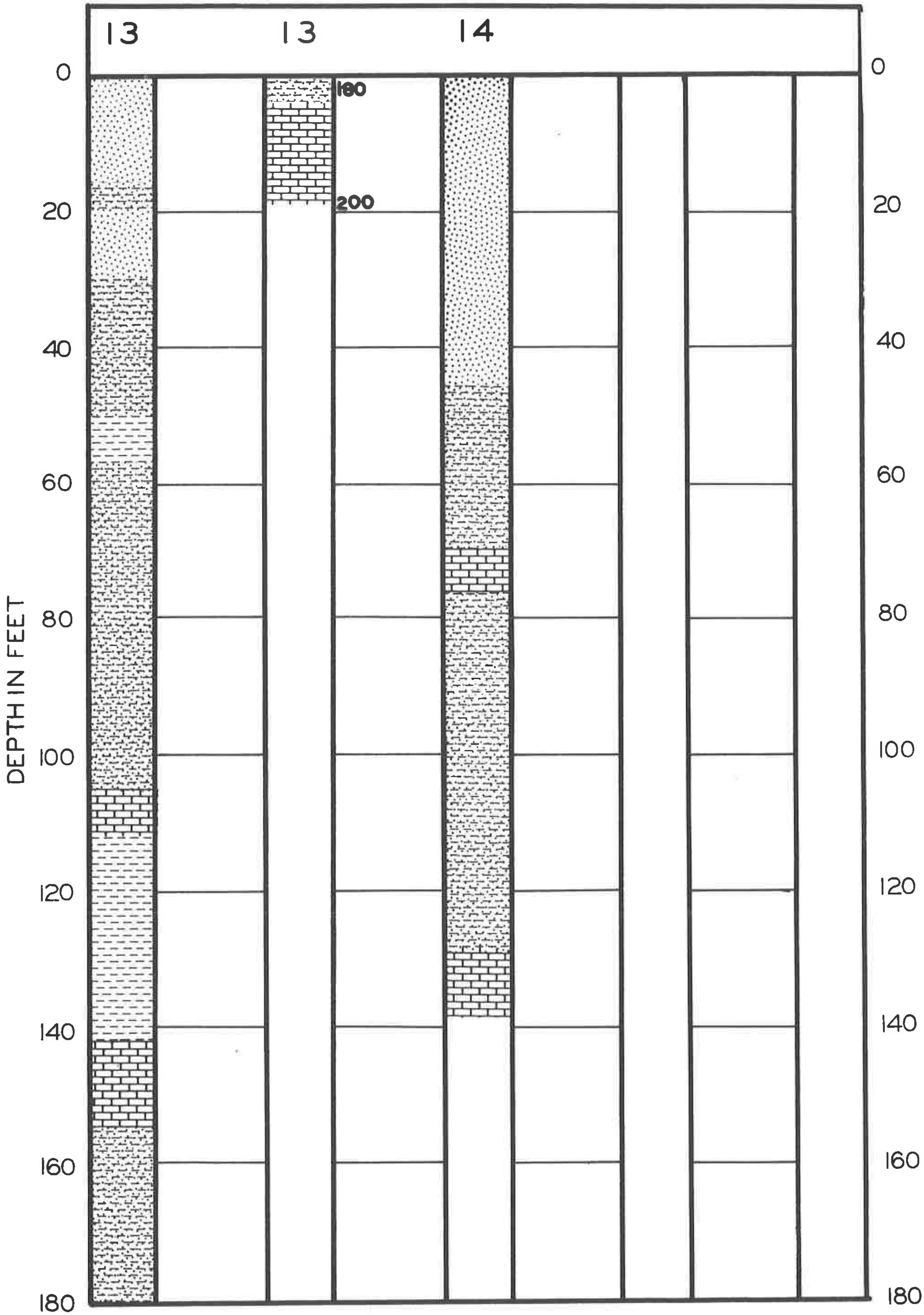
Logs showing lithology of holes.
(Continued)



Logs showing lithology of holes.
(Continued)



Logs showing lithology of holes.
(Continued)



Logs showing lithology of holes.
(Concluded)

ANALYTICAL METHODS AND RESULTS

Physical

After the core has been systematically divided or quartered down to representative samples, the material is put through a series of sieves and the percentage of different sizes is obtained. This gives the percentage of so-called pebble phosphate, intermediary grade, and the amount of sand which will be necessary to process through the flotation machinery in order to recover the phosphorite values.

The pebble phosphate fraction (+16 mesh) was screened into three fractions, +4, -4+8, -8+16, as these fractions usually require different plant processing. Slimes (-150 mesh) were dried and stored. The -16+150 mesh fraction served as the feed for flotation experiments. Current practice in some plants is to divide the flotation feed into 16 x 35 and 35 x 150 size ranges for more efficient flotation.

Heavy Minerals

"Heavy Minerals" were determined for each of the Ec-1 through Ec-14 holes; the results being given in Table II. Of the eleven mineral species shown, only ilmenite, garnet, rutile, and zircon were deemed worthy of mention. Heavy minerals of attention are found in Table III.

Current production may be carried out with "sands" containing as little as four percent heavy minerals by weight. The United States' garnet resources are more than adequate at this time since the New York and Idaho mines have ores containing up to fifteen to twenty percent garnet. Thus, the possibilities of interest in Echols County's deposits are nil. Ilmenite, rutile, and zircon should be considered for possible co-production from phosphate operations where quantity and mining conditions are sufficiently favorable. The "best" hole, Ec-2, at 40 to 50 feet, showed but 1.8 percent of heavy minerals by particle count, or about one percent ilmenite and 0.2 percent zircon. All holes, except Ec-10, Ec-11, Ec-12, and Ec-13 (which were very low) in the northern half of the county showed large tonnages of heavy minerals, but at such low concentrations that mining for heavy minerals alone is not practicable; the concentrations of rutile and zircon being in the 0.02-0.06 percent range.

TABLE II

DEGREE OF CONCENTRATION AND FRACTIONAL PERCENT OF HEAVY MINERAL SPECIES ECHOLS COUNTY, GEORGIA

DEPTH	% HEAVY MINERALS	HORNBLENDE	ILMENITE	EPIDOTE	ZIRCON	STAUROLITE	SILLIMANITE	GARNET	RUTILE	TOURMALINE	KYANITE	OTHER
HOLE NUMBER ONE												
10-15	0.2	-	41	25	9	6	10	4	1	1	1	2
20-25	0.3	-	41	24	9	9	8	4	1	2	1	1
35-40	0.5	Tr	57	13	9	6	4	5	2	2	1	1
40-45	0.5	-	58	2	13	8	3	3	4	6	1	2
55-60	0.5	Tr	61	3	16	6	2	3	4	3	1	1
60-65	0.4	-	57	5	12	11	3	3	4	3	1	1
90-100	0.5	Tr	55	5	18	9	2	4	4	2	1	1
125-130	0.5	Tr	47	3	9	15	7	12	3	4	1	1
HOLE NUMBER TWO												
10-25	0.8	-	41	10	12	8	18	3	4	2	1	1
25-40	0.5	Tr	27	19	9	9	22	5	5	2	1	1
40-50	1.8	-	58	16	9	7	15	4	2	2	1	2
50-70	1.1	-	46	15	9	8	12	4	2	2	1	1
105-130	0.1	-	51	10	15	8	2	6	4	1	1	2
130-145	0.3	Tr	59	14	14	5	5	6	2	2	-	1
145-155	0.2	Tr	41	4	11	15	5	16	2	4	1	1
HOLE NUMBER THREE												
6-21	0.2	-	48	6	12	6	16	3	4	3	1	1
21-47	0.2	-	36	15	12	7	15	8	1	3	1	2
47-61	0.5	-	46	11	7	5	19	6	2	2	1	1
63-70	0.1	-	45	11	11	3	18	1	3	1	1	1
80-90	0.3	-	55	5	11	12	3	7	2	3	1	1
95-110	0.3	Tr	55	7	13	6	3	6	2	6	-	2
110-135	0.1	-	52	7	10	9	8	7	2	2	1	2
HOLE NUMBER FOUR												
0-14	0.1	-	48	5	17	7	10	1	8	3	-	1
14-25	0.4	-	42	10	13	7	18	1	5	3	1	1
25-35	0.2	-	38	23	10	5	14	2	4	3	-	1
35-40	0.3	-	31	26	7	2	21	6	4	2	-	1
40-50	0.1	-	28	24	10	4	17	10	4	2	-	1
50-55	0.2	-	29	26	7	6	17	9	2	3	Tr	1
55-65	0.3	-	41	24	8	4	11	7	2	2	-	1
65-70	0.2	-	33	23	5	5	19	10	1	3	-	1
70-82	0.2	-	38	17	8	4	18	10	1	3	-	1

(Continued)

TABLE II

DEGREE OF CONCENTRATION AND FRACTIONAL
PERCENT OF HEAVY MINERAL SPECIES
ECHOLS COUNTY, GEORGIA
(Continued)

DEPTH	% HEAVY MINERALS	HORNBLENDE	ILMENITE	EPIDOTE	ZIRCON	STAUROLITE	SILLIMANITE	GARNET	RUTILE	TOURMALINE	KYANITE	OTHER
HOLE NUMBER FOUR, Continued												
82-92	0.4	-	27	24	9	5	23	6	1	3	1	1
102-112	0.5	-	21	28	7	7	24	9	1	2	Tr	1
112-122	0.5	-	47	10	12	5	13	7	1	3	1	1
122-132	0.3	-	38	12	14	8	8	15	1	1	1	2
132-150	0.2	-	45	10	16	5	8	6	6	2	1	1
HOLE NUMBER FIVE												
10-25	0.2	-	44	6	10	6	20	6	3	3	1	1
25-55	0.3	-	46	8	7	9	12	11	2	3	1	1
55-80	0.1											
80-95	0.2	-	39	3	17	9	18	4	2	6	1	1
95-105	0.1	-	47	8	9	9	8	12	2	3	1	1
HOLE NUMBER SIX												
10-18	0.2	-	39	6	17	9	11	2	7	5	2	2
18-25	0.2	-	41	5	19	4	15	1	11	3	Tr	1
25-40	0.6	-	28	22	12	5	15	5	7	4	1	1
40-45	0.3	-	22	24	14	4	18	7	6	4	Tr	1
55-60	0.3	-	25	23	9	6	17	5	3	2	1	1
60-75	0.4	-	25	23	10	8	14	11	3	4	1	1
75-90	0.4	-	24	28	8	8	16	11	1	2	1	1
90-110	0.3	-	21	26	13	8	18	6	2	4	1	1
HOLE NUMBER SEVEN												
10-20	0.2	-	42	3	11	6	20	Tr	11	5	1	1
20-30	0.5	-	35	10	19	5	17	4	5	3	1	1
30-65	0.3	-	21	28	11	5	13	12	4	3	1	2
65-85	0.3	-	58	6	7	10	5	5	3	5	1	1
85-130	0.4	-	23	22	11	6	24	6	3	4	Tr	1
160-200	0.2	-	42	7	11	11	13	4	6	4	1	1
HOLE NUMBER EIGHT												
10-15	0.2	-	50	3	17	5	6	1	12	4	1	1
15-35	0.4	-	45	3	14	8	19	Tr	7	2	1	1
35-50	0.5	-	35	26	9	5	8	6	5	3	1	2
50-75	0.3	-	30	24	12	5	18	7	2	1	Tr	1

(Continued)

TABLE II

DEGREE OF CONCENTRATION AND FRACTIONAL
PERCENT OF HEAVY MINERAL SPECIES
ECHOLS COUNTY, GEORGIA
(Continued)

DEPTH	% HEAVY MINERALS	HORNBLENDE	ILMENITE	EPIDOTE	ZIRCON	STAUROLITE	SILLIMANITE	GARNET	RUTILE	TOURMALINE	KYANITE	OTHER
HOLE NUMBER EIGHT, Continued												
75-100	0.2	-										
100-135	0.2	-	36	18	9	9	11	10	3	2	1	1
200-220		-	46	10	10	5	17	4	3	4	Tr	1
HOLE NUMBER NINE												
10-20	0.4	-	40	2	11	9	27	Tr	7	3	Tr	1
20-45	0.5	-	36	12	12	6	16	6	7	3	Tr	2
45-65	0.6	-	25	30	11	3	13	8	6	2	1	1
65-85	0.4	-	30	24	12	5	18	7	2	1	Tr	1
85-115	0.2	-	28	21	9	7	15	11	2	5	1	1
HOLE NUMBER TEN												
6-19	0.2	-	41	5	9	6	24	Tr	10	3	1	1
20-40	0.1	-	35	5	11	11	25	1	7	3	1	1
40-45	0.3	-	48	5	5	7	17	11	2	3	1	1
45-55	0.3	-	34	14	10	6	16	12	3	3	1	1
55-65	0.1	-	29	14	14	9	12	15	3	3	Tr	1
HOLE NUMBER ELEVEN												
0-15	0.2	-	56	5	5	5	9	-	8	3	1	1
15-30	0.1	-	53	10	9	3	6	1	5	1	1	1
30-45	0.1	-	41	4	12	12	18	1	4	5	1	2
45-65	0.2	-	41	11	8	8	24	1	3	2	1	1
65-90	0.2	-	34	29	10	6	10	3	4	3	Tr	1
90-105	0.5	-	-	-	-	-	-	-	-	-	-	-
105-135	0.2	-	53	8	9	12	5	3	3	4	1	2
135-180	0.2	-	62	7	4	7	8	4	4	2	1	1
HOLE NUMBER TWELVE												
10-15	0.1	-	52	3	15	9	9	Tr	5	3	3	1
15-30	0.1	-	40	6	16	7	19	1	2	5	3	1
30-45	0.5	-	25	23	10	6	23	5	3	3	1	1
45-75	0.3	-	54	12	8	5	10	4	2	3	1	1
75-95	0.2	-	30	22	5	10	17	9	1	3	1	2
95-125	0.2	-	35	8	6	12	12	18	3	4	1	1
125-145	0.1	-	50	4	8	10	13	6	3	3	2	1
145-175	0.1	Tr	50	6	12	10	4	10	4	2	1	1
175-196	0.1	-	47	16	12	5	4	10	2	2	-	2

(Continued)

TABLE II

DEGREE OF CONCENTRATION AND FRACTIONAL
PERCENT OF HEAVY MINERAL SPECIES
ECHOLS COUNTY, GEORGIA
(Concluded)

DEPTH	% HEAVY MINERALS	HORNBLENDE	ILMENITE	EPIDOTE	ZIRCON	STAUROLITE	SILLIMANITE	GARNET	RUTILE	TOURMALINE	KYANITE	OTHER
HOLE NUMBER THIRTEEN												
15-20	0.2	-	43	1	21	4	11	1	14	2	2	1
20-30	0.1	-	33	9	19	5	13	1	15	2	2	1
35-50	0.2	-	35	9	12	5	27	1	9	1	-	1
50-75	0.3	-	33	18	16	3	18	7	2	1	1	1
75-95	0.1	-	37	8	8	9	12	20	2	2	1	1
95-115	0.1											
115-130	0.2	-	14	26	10	10	26	9	1	2	1	1
130-150	0.2	-	23	22	8	10	16	17	2	2	Tr	1
150-190	0.1											
190-200	0.1	-	35	8	7	18	11	18	1	1	Tr	1
HOLE NUMBER FOURTEEN												
10-25	0.1	-	32	7	18	9	18	1	7	5	1	1
25-40	0.3	-	30	9	16	9	19	2	11	2	1	1
40-45	0.2	-	29	24	8	8	12	10	4	3	1	1
47-57	0.4	-	50	14	6	10	4	11	1	2	Tr	1
62-70	0.2	-	29	24	10	12	8	11	1	3	1	1
70-88	0.4	-	46	6	14	11	4	9	4	4	1	1
80-95	0.4	-	46	9	10	10	5	4	4	5	1	1
95-105	0.4	-	32	12	13	13	11	6	4	6	1	2

TABLE III

HEAVY MINERALS OF ATTENTION

Hole No.	Depth	Percent Heavy Minerals	Ilmenite	Rutile	Zircon	Sillimanite
1	25-150	0.5	57	4		3
	40-100				16	(10-15) 10
2	25-40	0.5	30	5	9	(10-15) 20
	40-50	1.8	58	2	9	
3	47-61	0.5	46	2	7(10)	(6-70) 18
4	14-25	0.4	42	5	13	18
	90-120	0.5	40	12	1	(40-110) 20
5	25-55	0.3	46	2	7	(10-25) 20
6	25-40	0.6	28	7	12	(20-110) 18
7	20-30	0.5	35	5	19	19
8	15-50	0.5	40	5	9	8-19
9	10-85	0.5	35	6	11	(10-20) 27
10	40-55	0.3	40	3	8	20
11		None				
12		None				
13		None				
14	45-105	0.4	45	4	12	(10-40) 18

Chemical

Sample Preparation

All samples were analyzed on a dry basis (≥ 1 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 analysis and treatments performed in metallurgical laboratory processing. Grinding was performed in a micropulverizer, by hand, with porcelain mortar and pestle, and by an electric mortar grinder using an alumina mortar and pestle.

Samples for x-ray fluorescence were dried at 110° C for one hour, cooled in a desiccator, mixed in a carefully weighed ratio of 9.0000 grams of sample to 1.0000 grams of "Dreft" detergent and ground together to -200 mesh size in a Spex mixer-mill. The resulting powder was pressed into pellets for x-ray fluorescence analysis. A hydraulic press was used to mold the powder into a "Spec-cap," Spex Catalog No. 3619. Although wet analysis of the "Dreft" showed 17.5 percent P_2O_5, good agreement was obtained by carefully mixing the same quantity of detergent into both the unknown samples and the standards.

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 ml of concentrated nitric acid and 10 ml of concentrated hydrochloric acid were used to digest 1.0000 or 2.0000 gram portions of sample until red fumes were no longer evolved and the solution became clear. The solution was diluted to 100 ml 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 was discarded or reserved as required for wet chemical phosphorous analysis. The percent acid insoluble residue was calculated from the formula:

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

2. Bone Phosphate of Lime (BPL) - Two methods were used for the phosphate analyses reported.

a. Samples resulting from metallurgical laboratory treatment were prepared by the method described in paragraph 1 (above) and analyzed on Philips Norelco x-ray fluorescence apparatus using a P.E.T. crystal. The apparatus is composed of the following parts: circuit panel model No. 12206; specimen holder, model No. 52388; x-ray generator, model No. 12045; recorder, model No. 52583; sample changer, type 409548/1. Reproducibility of analyses and precision of analyses as estimated from National Bureau of Standards samples included in the sets being examined were less than one percent, based on amount detected.

b. The wet phosphate determinations were 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 in this laboratory is S_0-S-270 Sodium Hydroxide Solution N/2 (Fisher Scientific Company) tested against primary standard grade potassium acid phthalate as each container was opened. Nitric acid, 0.5000 N., was prepared using the standardized sodium hydroxide solution as a secondary standard. To the ammonium molybdate solutions described in the Florida method was added 0.05 gram of dibasic sodium phosphate before storing at least twenty-four hours and filtration just before use in the usual fashion.

Agreement among duplicate samples was within one percent of the phosphate detected. Precision of the method was also within one percent, as estimated from portions of National Bureau of Standards sample 120a, Florida phosphate rock, run as controls among the unknown phosphate samples (34.35 percent as compared to the National Bureau of Standards value of 34.4 percent P_2O_5). No significant difference in results was detected between aliquot portions from the same sample precipitated overnight at room temperature or precipitated for twenty minutes at 50° C. Calculations for a typical 25 ml aliquot portion may be summarized as:

$$\text{Percent } P_2O_5 = \frac{0.5000}{0.3240} \times \frac{1}{\text{Weight of sample}} (\text{ml NaOH}^{*} - \text{ml HNO}_3{}^{*})$$

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

3. Lime - CaO - Excepting Echols 4, which was run by atomic absorption spectrophotometry, all of the CaO determinations reported for Echols County were made with Philips Norelco x-ray fluorescence apparatus using a germanium crystal. Standard samples included several portions of NBS 120a, Florida phosphate rock, and several ore samples which gave reproducible analyses when treated by the gravimetric sulfate method set forth in Methods Used and Adopted by the Association of Florida Phosphate Chemists (1960), page 33. Data points obtained using a germanium crystal were more reproducible than earlier measurements with a P.E.T. crystal. Recent experiments with atomic absorption spectrophotometry indicate better reproducibility than has been obtained with either of the x-ray fluorescence methods. Results for Echols 4 were determined with 1:50 dilutions of the iron solutions described in Section 4 (below).

4. Iron Oxide - Fe_2O_3 - The iron oxide analyses reported for Echols County were performed on a Perkin Elmer Model 303 Atomic Absorption Spectrophotometer. Standards included specially prepared iron solutions NBS 120a, Florida phosphate rock, and several Echols County samples which had given reproducible results when analyzed by the dichromate method set forth in Methods Used and Adopted by the Association of Florida Phosphate Chemists (1960), page 31. As the Fe_2O_3 content of most of the samples was low, variable quantities of iron introduced into the sample by micropulverizer grinding (up to 0.214 percent) and additional iron introduced in the Spex mixer-mill (up to 0.08 percent) were sufficiently large to obscure the exact quantity of Fe_2O_3 in the sample. With few exceptions, the total iron oxide analysis was not sufficiently high to

*The terms "ml NaOH" and "ml HNO_3" refer to the number of milliliters of 0.500 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 phenolphthalien as the indicator.

affect the selection of processing methods. Analyses higher than 1.5 percent Fe_2O_3 were based on samples freshly ground in porcelain or alumina mortars. Measurements were performed on solutions prepared by boiling 0.5000 gram samples with 1:1 hydrochloric acid, dilution to 100 ml with distilled water, and filtration through dry Whatman No. 40 filter paper.

5. Aluminum Oxide (Al_2O_3) - Aluminum oxide was determined by atomic absorption spectrophotometry using the same solutions that had been prepared for iron analyses. Standards included NBS 120a, Florida phosphate rock, solutions prepared from reagent grade aluminum compounds, and Echols County samples which had given reproducible results when analyzed by the "Direct Caustic Method" given in Methods Used and Adopted by the Association of Florida Phosphate Chemists (1960), page 32.

Air, acetylene, and a high temperature nitrous oxide were used in these determinations.

TABLE IV

PERCENT BPL CONTENT OF SOUTHERN RAILWAY SYSTEM HOLES IN ECHOLS COUNTY, GEORGIA

Depth	Hole Number								
	2	15	18	19	21	22	23	24	27
10-15									
15-20									
20-25	-	-	-	-	0.5	1.5	-	-	-
25-30	4.1	0.98	2.1	-	0.5	3.0	-	-	1.4
30-35	14.0	2.50	4.2	-	1.0	1.6	-	-	1.6
35-40	12.2	4.90	4.5	-	1.5	1.7	-	-	6.4
40-45	11.7	5.30	7.2	0.7	3.2	2.1	4.9	-	7.5
45-50	12.4	4.20	6.1	1.7	3.6	2.8	13.1	-	8.2
50-55	12.2	6.10	5.8	0.7	2.8	1.8	13.7	-	-
55-60	12.6	5.00	5.1	0.6	4.2	1.7	-	-	-
60-65	-	5.20	5.1	1.9	-	-	-	6.8	-
65-70	8.7	4.50	5.8	1.7	-	-	-	12.6	-
70-75	5.7	4.10	6.7	-	-	-	-	22.1*	-
75-80	8.1	-	-	-	-	-	-	15.8	-
80-85	9.3	-	-	-	-	-	-	-	-
85-90	8.4	-	-	-	-	-	-	-	-
90-95	21.6	-	-	-	-	-	-	-	-
95-100	6.1	-	-	-	-	-	-	-	-
100-105	8.6	-	-	-	-	-	-	-	-
105-110	11.3	-	-	-	-	-	-	-	-
110-115	8.4	-	-	-	-	-	-	-	-
115-120	6.6	-	-	-	-	-	-	-	-
Surface Elevation	-	170	147	160	141	127	132	151	-

* It was not clear whether this figure was for hole 24 or 27.

Note: 1. Samples are "wash" samples of 5 ft. intervals
2. From Southern Railway System's analytical data

(Continued)

TABLE IV

PERCENT BPL CONTENT OF SOUTHERN RAILWAY SYSTEM HOLES IN ECHOLS COUNTY, GEORGIA
(Continued)

Depth	Hole Number								
	28	34	35	37	38	40	41	43	45
10-15	-	-	-	-	-	-	2.5	-	-
15-20	-	-	-	-	-	-	13.7	-	-
20-25	-	-	-	-	-	10.0	15.7	-	-
25-30	-	-	-	-	-	9.8	10.9	-	25.1
30-35	-	-	-	4.8	-	16.4	12.7	-	25.0
35-40	-	-	-	9.3	-	19.4	15.0	-	24.6
40-45	-	-	-	6.3	2.5	10.7	15.5	-	29.0
45-50	-	5.1	-	7.5	4.5	11.4	14.5	-	32.0
50-55	-	7.9	18.0	-	6.0	14.5	10.3	10.0	36.1
55-60	-	4.6	14.2	-	13.7*	-	13.7	21.9	16.6
60-65	12.8	8.7	18.9	-	-	-	12.9	15.3	19.1
65-70	8.1	8.6	23.2	-	-	-	9.5	17.8	-
70-75	5.6	20.0	-	-	-	-	10.8	15.7	-
75-80	16.6	16.6	-	-	-	-	11.4	18.3	-
80-85	17.5	8.9	-	17.2**	-	-	11.4	-	-
85-90	23.5	-	-	-	-	-	-	-	-
90-95	-	-	-	-	-	-	-	-	-
95-100	-	-	-	-	-	-	-	-	-
100-105	-	-	-	-	-	-	-	-	-
105-110	-	-	-	-	-	-	-	-	-
110-115	-	-	-	-	-	-	-	-	-
115-120	-	-	-	-	-	-	-	-	-
Surface Elevation	170	-	165	170	-	160	147	144	147

*55-57 feet
**80-86 feet

(Continued)

TABLE IV

PERCENT BPL CONTENT OF SOUTHERN RAILWAY SYSTEM HOLES IN ECHOLS COUNTY, GEORGIA
(Continued)

Depth	Hole Number 46	47	48	49	50	54	56	61	62
10-15	-	-	-	-	-	-	-	-	-
15-20	-	-	1.0	-	-	-	-	-	-
20-25	-	3.9	2.6	-	-	-	-	-	-
25-30	-	5.3	3.8	-	-	-	-	-	-
30-35	14.9	4.7	4.2	-	-		-	-	-
35-40	12.9	5.5	9.6	-	-		9.5	-	17.9
40-45	20.0	8.7	9.7	-	-	Max.	14.5	10.7	15.8
45-50	23.2	9.0	17.2	4.7	5.2	of	13.3	15.5	-
50-55	22.0	-	-	7.9	9.8	25.8	-	-	-
55-60	27.7*	-	20.3	9.5	16.1		-	-	23.1
60-65	18.0	21.3	16.1	6.6	19.0		-	-	21.0
65-70	14.2	-	-	8.0	-		-	-	-
70-75	6.6	-	-	13.7	-		8.0	-	-
75-80	-	-	-	9.8	-	-	-	-	-
80-85	-	-	-	-	-	-	13.7	-	-
85-90	-	-	-	-	-	-	20.3	-	-
90-95	-	-	-	-	-	-	-	-	-
95-100	-	-	-	-	-	-	-	-	-
100-105	-	-	-	-	-	-	-	-	-
105-110	-	-	-	-	-	-	-	-	-
110-115	-	-	-	-	-	-	-	-	-
115-120	-	-	-	-	-	-	-	-	-
Surface Elevation	153	156	160	162	162	150	-	-	-

*13.3 was also listed for this interval

(Continued)

TABLE IV

PERCENT BPL CONTENT OF SOUTHERN RAILWAY SYSTEM HOLES IN ECHOLS COUNTY, GEORGIA
(Concluded)

Depth	Hole Number						
	63	68	69	70	72	74	77
10-15	-	-	-	-	-	-	-
15-20	-	-	-	-	-	-	1.4
20-25	-	-	-	9.3	7.9	-	2.6
25-30	-	-	-	12.2	10.3	-	-
30-35	-	2.7	-	12.9	6.6	8.2	-
35-40	5.7	4.0	-	10.4	8.6	8.0	-
40-45	7.3	8.0	Max.	13.3	9.5	9.6	-
45-50	17.8	8.7	of	11.6	7.9	6.3	11.6
50-55	11.5	8.4	20.3	7.8	7.6	9.3	11.8
55-60	-	-	-	-	8.1	-	8.4
60-65	-	-	-	-	-	-	9.8
65-70	-	-	-	-	-	-	9.7
70-75	-	-	-	-	-	-	16.6
75-80	-	-	-	-	-	-	-
80-85	-	-	-	-	-	-	-
85-90	-	-	-	-	-	-	-
90-95	-	-	-	-	-	-	-
95-100	-	-	-	-	-	-	-
100-105	-	-	-	-	-	-	-
105-110	-	-	-	-	-	-	-
110-115	-	-	-	-	-	-	-
115-120	-	-	-	-	-	-	-
Surface Elevation	-	-	-	Not available		-	-

Samples of Hole E-75 were given to Georgia Institute of Technology prior to the initiation of the drilling program. It will be noted that P_2O_5 (reported both as P_2O_5 and BPL) and Fe_2O_3 were determined over a complete range of mesh sizes from 0 to minus 200, and clays for each five foot interval of depth for which the wash samples were obtained. While useful as an indicator of phosphorite distribution, this amount of detail was considered as excessive to the value of the data obtained. "H" refers to the heavy fraction and "L" to the light fraction of a heavy liquid separation, where tetrabromoethane (sp. gr. = 2.9) was being used.

TABLE V

ANALYSES OF SOUTHERN RAILWAY SYSTEM'S E-75
AS COMPLETED BY GEORGIA TECH

DEPTH = 20-25 feet

MESH	PERCENT OF TOTAL SAMPLE	PERCENT P_2O_5	PERCENT BPL	PERCENT Fe_2O_3
clays	1.0	3.4	7.4	2.2
0-14L	24.7	.04	.09	.49
0-14H	.009	3.5	7.7	7.1
14-20L	10.9	.15	.33	.27
14-20H	.003	2.6	5.7	14.2
20-28L	10.4	.08	.18	.33
20-28H	.01	1.1	.24	15.7
28-35L	12.8	.12	.26	.33
28-35H	.02	.66	1.4	12.5
35-48L	18.1	.13	.28	.51
35-48H	.02	.44	.96	17.2
48-65L	18.4	.51	1.2	.38
48-65H	.04	.37	.81	19.0
65-100L	1.7	1.7	3.7	.57
65-100H	.06	.53	1.2	16.5
100-150L	1.0	3.1	.68	1.1
100-150H	.04	.77	1.7	16.1
150-200L	.04	3.1	.61	1.6
150-200H	.003	.15	.33	16.6
-200L	.08	2.9	6.3	2.8
-200H	5.0×10^{-5}	6.7	14.4	50.1

TOTAL SAMPLE WEIGHT = 568.9 grams

(Continued)

TABLE V

ANALYSES OF SOUTHERN RAILWAY SYSTEM'S E-75
AS COMPLETED BY GEORGIA TECH
(Continued)

DEPTH = 25-30 feet

MESH	PERCENT OF TOTAL SAMPLE	PERCENT P_2O_5	PERCENT BPL	PERCENT Fe_2O_3
clays	.60	4.0	8.7	2.3
0-14L	14.0	.41	.90	.09
0-14H	.02	3.9	8.5	43.1
14-20L	4.9	1.4	3.1	.26
14-20H	.01	10.5	21.9	1.9
20-28L	5.8	.67	1.4	.03
20-28H	.02	11.2	24.4	17.5
28-35L	13.5	.82	1.8	.03
28-35H	.02	14.2	31.0	13.0
35-48L	25.9	.92	2.1	.03
35-48H	.03	14.8	32.4	10.0
48-65L	26.8	1.2	2.6	.16
48-65H	.03	3.7	8.1	13.9
65-100L	6.3	2.7	5.9	.35
65-100H		2.2	4.8	12.8
100-150L	1.0	4.0	8.7	.83
100-150H	.05	1.4	3.1	13.9
150-200L	.40	3.5	7.7	.95
150-200H	.007	18.8	41.0	18.0
-200L	.80	4.3	9.4	2.7

TOTAL SAMPLE WEIGHT = 572.7 grams

(Continued)

TABLE V

ANALYSES OF SOUTHERN RAILWAY SYSTEM'S E-75
AS COMPLETED BY GEORGIA TECH
(Continued)

DEPTH = 30-35 feet

MESH	PERCENT OF TOTAL SAMPLE	PERCENT P_2O_5	PERCENT BPL	PERCENT Fe_2O_3
Clays	.70	4.0	8.7	3.0
0-14L	3.0	5.9	12.9	.67
14-20L	4.2	3.0	6.5	.35
20-28L	11.2	8.9	19.5	.89
28-35L	30.0	4.7	10.3	.35
35-48L	27.4	4.2	9.2	.51
48-65L	18.4	5.0	10.9	.57
65-100L	5.0	5.2	11.4	.57
100-150L	1.2	5.0	10.9	.77
150-200L	.40	4.3	9.4	1.9
-200L	.60	5.3	11.6	2.2

TOTAL SAMPLE WEIGHT = 374.6 grams

(Continued)

TABLE V

ANALYSES OF SOUTHERN RAILWAY SYSTEM'S E-75
AS COMPLETED BY GEORGIA TECH
(Continued)

DEPTH = 35-40 feet

MESH	PERCENT OF TOTAL SAMPLE	PERCENT P_2O_5	PERCENT BPL	PERCENT Fe_2O_3
Clays	.80	5.5	12.0	3.0
0-14L	16.3	5.3	11.6	.54
0-14H	.03	39.6	86.5	1.6
14-20L	12.5	3.2	7.0	.19
14-20H		28.0	61.2	3.9
20-28L	18.3	3.1	6.8	.19
20-28H		27.5	60.0	2.9
28-35L	23.0	2.4	5.3	.10
28-35H		29.0	63.3	3.5
35-48L	16.4	2.7	5.9	.13
35-48H		31.0	67.7	3.6
48-65L	8.8	2.5	5.5	.10
48-65H		28.0	61.1	4.9
65-100L	2.5	2.4	5.2	.29
65-100H	.07	11.6	25.3	10.4
100-150L	.60	3.1	6.9	.67
100-150H	.03	7.9	17.3	11.6
150-200L	.03	3.0	6.6	.83
150-200H	.002	5.5	12.0	8.7
-200L	.01	3.8	8.3	1.6
-200H	2.0×10^{-7}	10.0	21.9	0.0

TOTAL SAMPLE WEIGHT = 585.7 grams

(Continued)

TABLE V

ANALYSES OF SOUTHERN RAILWAY SYSTEM'S E-75
AS COMPLETED BY GEORGIA TECH
(Concluded)

DEPTH = 40-45 feet

MESH	PERCENT OF TOTAL SAMPLE	PERCENT P_2O_5	PERCENT BPL	PERCENT Fe_2O_3
Clays	.80	5.9	12.9	2.8
0-14	21.6	5.3	11.6	.63
14-20L	18.5	9.9	21.6	.82
14-20H		36.0	78.5	2.9
20-28L	24.6	5.6	12.2	.48
20-28H		39.0	85.1	2.4
28-35L	16.5	8.4	18.4	.38
28-35H		33.0	72.0	2.6
35-48L	7.4	4.5	9.8	.38
35-48H		33.0	72.0	1.6
48-65L	3.7	5.6	12.2	.54
48-65H		28.0	61.1	2.9
65-100L	1.3	5.7	12.5	.86
65-100H	.02	24.6	53.7	4.1
100-150L	.60	5.7	12.5	1.1
100-150H	.008	3.2	7.0	8.2
150-200L	.40	5.0	10.9	1.1

TOTAL SAMPLE WEIGHT = 513.2 grams

TABLE VI

SAND BENEFICIATION RESULTS

		TYLER MESH SIZES							FLOTATION RESULTS		
	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER ONE											
Total sand footage	30*										
Dry density lb/cu ft	69.98										
Percent dry weight	100.00	.40	1.60	7.50	70.90	27.00	43.90	19.60	5.20	85.60	9.20
Percent BPL	9.80	53.80	38.20	15.70	5.50	5.70	5.20	23.70	61.60	1.10	1.70
Percent acid insol	82.90	25.10	41.60	88.40	90.80	90.30	91.90	56.70	7.60	96.40	96.40
Percent Fe_2O_3	0.54	0.79	.82	.63	.18	.17	.22	1.71	1.10	.04	.19
Percent Al_2O_3	1.80	1.20	1.10	.50	.28	.24	.37	7.74	1.10	.04	.04
Percent CaO	5.60	37.20	26.40	9.00	2.80	3.20	2.70	11.78	44.44	.75	.50
HOLE NUMBER TWO											
Total sand footage	66*										
Dry density lb/cu ft	68.35										
Percent dry weight	100.00	3.30	1.40	3.00	66.70	8.30	58.40	25.60	6.90	45.40	47.70
Percent BPL	9.80		22.10		8.90	10.60	8.10	8.50	49.20	5.00	4.80
Percent acid insol	78.20		43.00		93.20	84.20	89.10	50.90	30.90	95.00	94.10
Percent Fe_2O_3	.76		1.50		-	.66	.28	1.66	1.00	.26	.23
Percent Al_2O_3	1.70		3.40		-	.44	.20	5.01	.90	.18	.17
Percent CaO	8.00		20.50		5.20	6.60	4.60	12.46	37.70	2.80	2.40

* See Table VII for details

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Continued)

		TYLER MESH SIZES							FLOTATION RESULTS		
	Feed	+40	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER THREE											
Total sand footage	41*										
Dry density lb/cu ft	89.80										
Percent dry weight	100.00	.20	.60	1.50	77.00	12.20	64.80	20.70	2.90	79.50	17.60
Percent BPL	5.90	37.60	38.90	33.20	4.40	4.20	3.30	8.20	70.10	.90	1.10
Percent acid insol	90.00	34.30	43.60	74.10	94.10	94.20	94.10	77.80	4.90	98.90	97.30
Percent Fe_2O_3	.34	4.10	.80	.72	.10	.09	.14	1.04	1.10	.07	.10
Percent Al_2O_3	1.60	1.00	1.40	.47	.18	.18	.19	6.97	1.40	.08	.05
Percent CaO	3.10	28.80	24.40	10.40	2.52	2.18	2.40	4.42	48.60	.69	.65
HOLE NUMBER FOUR**											
Total sand footage	20*										
Dry density lb/cu ft	62.42										
Percent dry weight	100.00	.30	.20	.60	82.70	4.50	78.20	16.20	4.50	66.90	28.60
Percent BPL	8.90	9.60	41.10	41.70	9.33	26.50	8.50	3.45	41.70	.85	15.80
Percent acid insol	79.30	56.10	31.00	40.10	85.20	59.80	86.40	50.90	5.80	96.20	71.60
Percent Fe_2O_3	1.13	20.23	3.66	2.82	.64	2.12	.58	2.99	2.19	.17	.67
Percent Al_2O_3	1.15	3.61	2.00	1.40	.61	1.17	.45	4.40	.95	.06	.38
Percent CaO	15.20	17.20	67.70	57.60	13.50	39.00	12.20	19.39	65.80	3.60	23.80

*See Table VII for details **Results are for matrix only

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Continued)

		TYLER MESH SIZES							FLOTATION RESULTS		
	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER FIVE											
Total sand footage	30*										
Dry density lb/cu ft	76.40										
Percent dry weight	100.00	.10	.30	1.30	80.10	20.80	59.30	18.20	8.80	76.60	14.60
Percent BPL	15.10	66.40	61.20	49.30	11.60	11.80	7.00	27.00	73.20	2.00	14.90
Percent acid insol	78.60	10.80	13.50	33.20	84.80	83.80	87.00	56.00	4.15	99.70	79.20
Percent Fe_2O_3	.50	1.00	.78	.89	.17	.18	.15	1.97	.98	.80	.20
Percent Al_2O_3	1.00	1.40	1.60	1.60	.24	.31	.26	4.14	1.40	.12	.31
Percent CaO	8.70	45.60	44.20	34.90	6.30	6.60	5.90	17.59	48.20	1.30	7.90
HOLE NUMBER SIX**											
Total sand footage	44*										
Dry density lb/cu ft	35.16										
Percent dry weight	100.00										
Percent BPL	3.50										
Percent acid insol	90.80										
Percent Fe_2O_3	.40										
Percent Al_2O_3	1.30										
Percent CaO	3.00										

*See Table VII for details　　**Not processed because of low BPL

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Continued)

	Tyler Mesh Sizes								Flotation Results		
	Feed	+40	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER SEVEN											
Total sand footage	42*										
Dry density lb/cu ft	73.01										
Percent dry weight	100.00	.70	.60	1.00	80.20	2.50	77.70	17.50	5.90	69.70	24.40
Percent BPL	7.20	1.50	3.70	7.40	5.50	14.50	4.80	15.30	58.10	.20	5.50
Percent acid insol	80.70	17.60	35.80	53.80	89.20	62.40	71.40	47.90	7.30	96.00	89.40
Percent Fe_2O_3	.79	.96	2.00	2.00	.34	.59	.26	3.06	1.90	.79	.69
Percent Al_2O_3	1.50	1.00	2.80	3.30	.55	1.71	.34	6.51	1.20	.12	.18
Percent CaO	6.80	35.90	34.00	14.20	4.31	13.00	3.60	17.60	44.80	.76	3.60
HOLE NUMBER EIGHT											
Total sand footage	40*										
Dry density lb/cu ft	60.53										
Percent dry weight	100.00	.90	1.20	1.80	74.30	4.40	69.90	21.80	4.70	91.00	4.30
Percent BPL	4.90	1.90	3.30	5.20	4.80	7.10	2.60	5.50	56.20	1.70	5.00
Percent acid insol	87.0	50.10	57.30	66.40	91.90	77.70	92.80	75.20	10.00	95.60	94.00
Percent Fe_2O_3	.72	3.50	1.50	1.50	.27	.72	.68	2.03	2.20	.08	.20
Percent Al_2O_3	1.50	3.60	5.00	4.40	.47	1.45	1.10	2.60	1.20	.11	.20
Percent CaO	4.10	13.10	10.90	9.60	2.91	5.77	2.60	7.68	43.60	.84	2.70

*See Table VII for details

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Continued)

	TYLER MESH SIZES								FLOTATION RESULTS		
	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER NINE											
Total sand footage	65*										
Dry density lb/cu ft	78.07										
Percent dry weight	100.00	2.40	1.60	1.70	66.40	4.60	61.80	27.90	6.20	72.70	21.10
Percent BPL	7.90	7.40	8.30	14.60	8.30	16.40	8.50	6.50	50.30	2.80	14.90
Percent acid insol	71.70	25.80	31.30	27.80	84.20	40.40	86.40	55.20	13.90	95.20	81.70
Percent Fe_2O_3	.85	.48	.82	.66	.53	.23	1.40	.58	1.10	.16	.34
Percent Al_2O_3	.70	.80	1.30	1.30	.36	.39	3.60	1.42	1.20	.30	.53
Percent CaO	10.50	33.40	30.10	32.40	6.57	29.84	5.40	1.42	41.40	1.70	9.40
HOLE NUMBER TEN											
Total sand footage	46*										
Dry density lb/cu ft	101.10										
Percent dry weight	100.00	.10	1.30	5.90	68.50	40.10	28.40	24.20	-	88.90	11.10
Percent BPL	7.40	25.60	14.40	8.10	5.00	5.50	7.90	13.50	-	1.10	22.10
Percent acid insol	85.40	45.20	80.50	88.40	92.20	94.20	90.30	65.80	-	97.50	68.40
Percent Fe_2O_3	.53	.60	.36	.18	.17	.10	.22	1.70	-	.04	.33
Percent Al_2O_3	1.20	1.30	.93	.30	.32	.18	.45	4.01	-	.08	.46
Percent CaO	4.20	16.60	8.20	4.30	2.47	4.03	4.10	4.31	-	.36	13.60

*See Table VII for details

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Continued)

	Feed	TYLER MESH SIZES +4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	FLOTATION RESULTS Concen- trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER ELEVEN**											
Total sand footage	60*										
Dry density lb/cu ft	93.41										
Percent dry weight	100.00										
Percent BPL	.90										
Percent acid insol	96.40										
Percent Fe_2O_3	1.00										
Percent Al_2O_3	.70										
Percent CaO	.10										
HOLE NUMBER TWELVE**											
Total sand footage	35*										
Dry density lb/cu ft	67.47										
Percent dry weight	100.00										
Percent BPL	3.10										
Percent acid insol	93.70										
Percent Fe_2O_3	.50										
Percent Al_2O_3	1.60										
Percent CaO	1.10										

*See Table VII for details **Not processed because of low BPL

(Continued)

TABLE VI

SAND BENEFICIATION RESULTS
(Concluded)

		TYLER MESH SIZES							FLOTATION RESULTS		
	Feed	+4	4x8	8x16	(Flot. feed) 16x150	16x35	35x150	(Slime) -150	Concen-trates	Fatty Acid Tailing	Amine Float
HOLE NUMBER THIRTEEN**											
Total sand footage	20*										
Dry density lb/cu ft	-										
Percent dry weight	100.00										
Percent BPL	8.10										
Percent acid insol	88.50										
Percent Fe_2O_3	.30										
Percent Al_2O_3	.50										
Percent CaO	4.60										
HOLE NUMBER FOURTEEN											
Total sand footage	35*										
Dry density lb/cu ft	89.27										
Percent dry weight	100.00	.40	1.90	9.00	70.50	22.10	48.40	18.20	2.90	89.30	7.80
Percent BPL	5.90	24.30	12.70	4.80	3.70	3.40	5.50	13.70	63.40	.80	12.50
Percent acid insol	91.10	49.20	76.30	89.70	95.40	94.60	89.10	77.90	8.80	97.50	85.70
Percent Fe_2O_3	.41	.51	.69	.70	.75	.11	.13	1.34	.96	.02	.17
Percent Al_2O_3	1.50	1.30	.56	.34	.58	.22	.47	6.46	1.10	.28	.94
Percent CaO	3.30	26.00	9.20	3.30	1.60	2.03	1.90	7.38	44.50	.06	5.20

*See Table VII for details

**Insufficient amount of sample for processing

TABLE VII

SAND INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES

Depth (Feet)	Recovery (Feet)
HOLE NUMBER ONE	
10-35	17.0
125-130	3.0
Total	20.0
HOLE NUMBER TWO	
10-60	36.5
80-90	6.0
170-176	6.0
Total	48.5
HOLE NUMBER THREE	
6-47	21.5
Total	21.5
HOLE NUMBER FOUR*	
49-54	5.0
54-59	5.0
59-64	4.0
64-69	5.0
Total	19.0
HOLE NUMBER FIVE	
25-55	16.5
Total	16.5
HOLE NUMBER SIX	
10-17	5.5
30-35	3.5
68-85	15.5
105-115	3.0
140-145	5.0
Total	32.5

Depth (Feet)	Recovery (Feet)
HOLE NUMBER SEVEN	
41-50	8.0
60-68	6.0
74-79	5.0
105-120	5.0
125-130	1.0
Total	25.0
HOLE NUMBER EIGHT	
10-20	5.0
40-45	4.0
75-90	8.0
95-105	7.0
Total	24.0
HOLE NUMBER NINE	
25-35	8.5
45-85	20.0
95-110	14.0
Total	42.5
HOLE NUMBER TEN	
10-56	38.0
Total	38.0
HOLE NUMBER ELEVEN	
15-50	30.0
55-65	7.5
70-75	2.0
80-90	6.5
Total	46.0

*Matrix interval

(Continued)

TABLE VII

SAND INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES
(Concluded)

Depth (Feet)		Recovery (Feet)
HOLE NUMBER TWELVE		
10-35		13.5
75-85		4.0
	Total	17.5
HOLE NUMBER THIRTEEN		
10-15		4.0
25-30		4.5
115-125		5.0
	Total	13.5
HOLE NUMBER FOURTEEN		
35-70		16.0
	Total	16.0

TABLE VIII

MATRIX DATA FOR GEORGIA TECH HOLES

HOLE NO.	THICKNESS OF OVERBURDEN	THICKNESS OF MATRIX*	PERCENT BPL OF MATRIX	PERCENT BPL OF CONCENTRATE
1	15	30	11.55	61.6
2	40	30	10.25	49.2
3	20	50	8.86	70.1
4	50	20	10.01	41.7
5	25	27	16.30	73.2
6	55	53	7.63	N.A.**
7	30	105	8.25	58.1
8	33	101	5.58	56.2
9	45	62	9.00	50.3
10	43	24	7.50	N.A.
11	100	5	18.50	N.A.**
12	45	51	5.91	N.A.**
13	50	25	6.18	N.A.**
14	40	42	9.01	63.4

*See Table IX
**Beneficiation data not available

TABLE IX

MATRIX INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES

Depth (Feet)	Recovery (Feet)
HOLE NUMBER ONE	
15-26	5.0
26-33	5.5
33-39	4.5
39-43	4.0
43-45	2.0
Total	21.0
HOLE NUMBER TWO	
40-52	4.5
52-56	4.0
56-60	3.0
60-70	8.0
Total	19.5
HOLE NUMBER THREE	
21-23	2.0
23-37	4.0
37-47	3.0
47-54	4.0
54-60	6.0
60-70	2.5
Total	21.5
HOLE NUMBER FOUR	
49-54	5.0
54-59	5.0
59-64	4.0
64-69	5.0
Total	19.0
HOLE NUMBER FIVE	
25-30	5.0
30-40	5.0
40-52	6.5
Total	16.5

Depth (Feet)	Recovery (Feet)
HOLE NUMBER SIX	
55-58	3.0
58-63	5.0
63-68	5.0
68-72	4.0
72-77	5.0
77-83	4.0
83-90	4.5
90-98	5.0
98-108	5.0
Total	40.5
HOLE NUMBER SEVEN	
29-34	4.5
34-45	7.0
45-50	4.5
50-54	4.0
54-65	7.0
65-69	4.0
69-74	5.0
74-79	5.0
79-83	4.0
83-87	4.0
87-92	5.0
92-97	5.0
97-102	5.0
102-110	4.5
110-124	5.5
124-134	2.0
Total	76.0

(Continued)

TABLE IX

MATRIX INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES
(Concluded)

Depth (Feet)	Recovery (Feet)
HOLE NUMBER EIGHT	
33-39	5.0
39-45	5.5
45-50	4.5
50-57	6.0
57-61	4.0
61-68	5.5
68-81	5.5
81-84	1.0
84-99	11.0
99-118	6.5
118-134	12.0
Total	66.5
HOLE NUMBER NINE	
45-47	2.0
47-54	5.0
54-58	0.0
58-65	6.0
65-85	7.0
85-89	1.0
89-97	3.0
97-101	4.0
101-107	6.0
Total	34.0
HOLE NUMBER TEN	
43-47	4.0
47-52	5.0
52-57	5.0
57-62	5.0
62-67	4.0
Total	23.0

Depth (Feet)	Recovery (Feet)
HOLE NUMBER ELEVEN	
100-101	1.0
101-105	4.0
Total	5.0
HOLE NUMBER TWELVE	
45-50	5.0
50-53	3.0
53-55	2.0
55-58	3.0
58-60	2.0
60-63	3.0
63-65	1.0
75-71	6.0
71-77	6.0
77-96	6.0
Total	37.0
HOLE NUMBER THIRTEEN	
50-55	5.0
55-58	3.0
58-65	6.0
65-75	7.0
Total	21.0
HOLE NUMBER FOURTEEN	
40-57	6.0
57-62	0.0
62-70	7.0
70-82	8.0
Total	21.0

TABLE X

CLAY INTERVAL ANALYSES

HOLE NO.	CLAY INTERVAL	DRY DENSITY lb/cu ft	PERCENT BPL	PERCENT ACID INSOLUBLE	PERCENT Fe_2O_3	PERCENT Al_2O_3	PERCENT CaO
1	90	60.09	3.3	86.1	1.6	3.4	4.2
2	95	44.75	2.8	64.0	1.4	2.9	9.1
3	79	46.37	4.6	74.7	2.2	4.3	4.9
4	46	59.43	4.2	88.8	1.5	2.8	2.9
5	75	41.62	4.6	66.1	1.5	2.7	10.0
6	73	53.98	6.3	72.5	1.3	2.2	8.8
7	133	60.09	3.1	67.0	1.3	2.7	7.7
8	55	56.70	2.0	84.9	0.8	2.9	3.5
9	25	55.38	3.1	81.1	1.2	1.7	6.0
10	11	76.48	1.1	93.6	0.4	0.8	0.9
11	105	37.80	2.0	76.5	0.7	2.6	4.5
12	145	45.70	2.4	71.9	1.0	2.3	7.4
13	135	63.74	3.3	73.0	0.5	0.8	7.2
14	75	43.65	0.7	73.7	1.2	3.5	5.3

TABLE XI

CLAY INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES

Depth (Feet)	Recovery (Feet)
HOLE NUMBER ONE	
35-125	69.0
Total	69.0
HOLE NUMBER TWO	
60-80	12.0
95-170	45.0
Total	57.0
HOLE NUMBER THREE	
47-65	11.0
75-136	31.0
Total	42.0
HOLE NUMBER FOUR	
14-50	34.0
55-60	5.0
80-85	1.5
Total	40.5
HOLE NUMBER FIVE	
10-25	15.0
65-125	44.5
Total	59.5
HOLE NUMBER SIX	
17-30	6.0
35-58	21.5
60-67	7.0
100-105	3.0
125-140	6.0
160-170	7.5
Total	51.0

Depth (Feet)	Recovery (Feet)
HOLE NUMBER SEVEN	
10-41	30.0
50-60	8.0
68-74	6.0
79-105	17.5
158-190	22.5
197-225	16.0
Total	100.0
HOLE NUMBER EIGHT	
20-40	16.5
45-75	24.0
90-95	3.5
Total	44.0
HOLE NUMBER NINE	
10-25	11.5
35-45	10.0
Total	21.5
HOLE NUMBER TEN	
56-67	10.0
Total	10.0
HOLE NUMBER ELEVEN	
10-15	5.0
50-55	3.0
65-70	3.0
75-80	3.0
90-165	63.0
170-180	3.0
Total	80.0

(Continued)

TABLE XI

CLAY INTERVALS AND RECOVERY
OF GEORGIA TECH HOLES
(Concluded)

Depth (Feet)		Recovery (Feet)
HOLE NUMBER TWELVE		
35-75		39.0
90-195		59.5
	Total	98.5
HOLE NUMBER THIRTEEN		
15-25		0.0
30-90		46.0
125-150		14.5
155-195		27.0
	Total	87.5
HOLE NUMBER FOURTEEN		
10-35		13.5
80-130		37.0
	Total	50.5

Analytical Methods and Results, Continued

The following diagrams, Figure 17, represent a vertical plot of depth (10-100 feet) for each hole, with the shaded area indicating interval of core recovery (95-98 percent) and the blank areas, intervals of core lost.

Horizontally, the diagrams show percent by weight of BPL and percent by particle count of phosphorite. Compositions of phosphorite vary widely, hence percentage by particle count should not be relied upon for BPL content. Solid lines represent BPL, determined chemically for the interval of hole over which a collective sample was made. Dashed lines represent phosphorite determined by particle count.

Compositions plotted over "blank" areas indicating lost core are on the basis of wash samples.

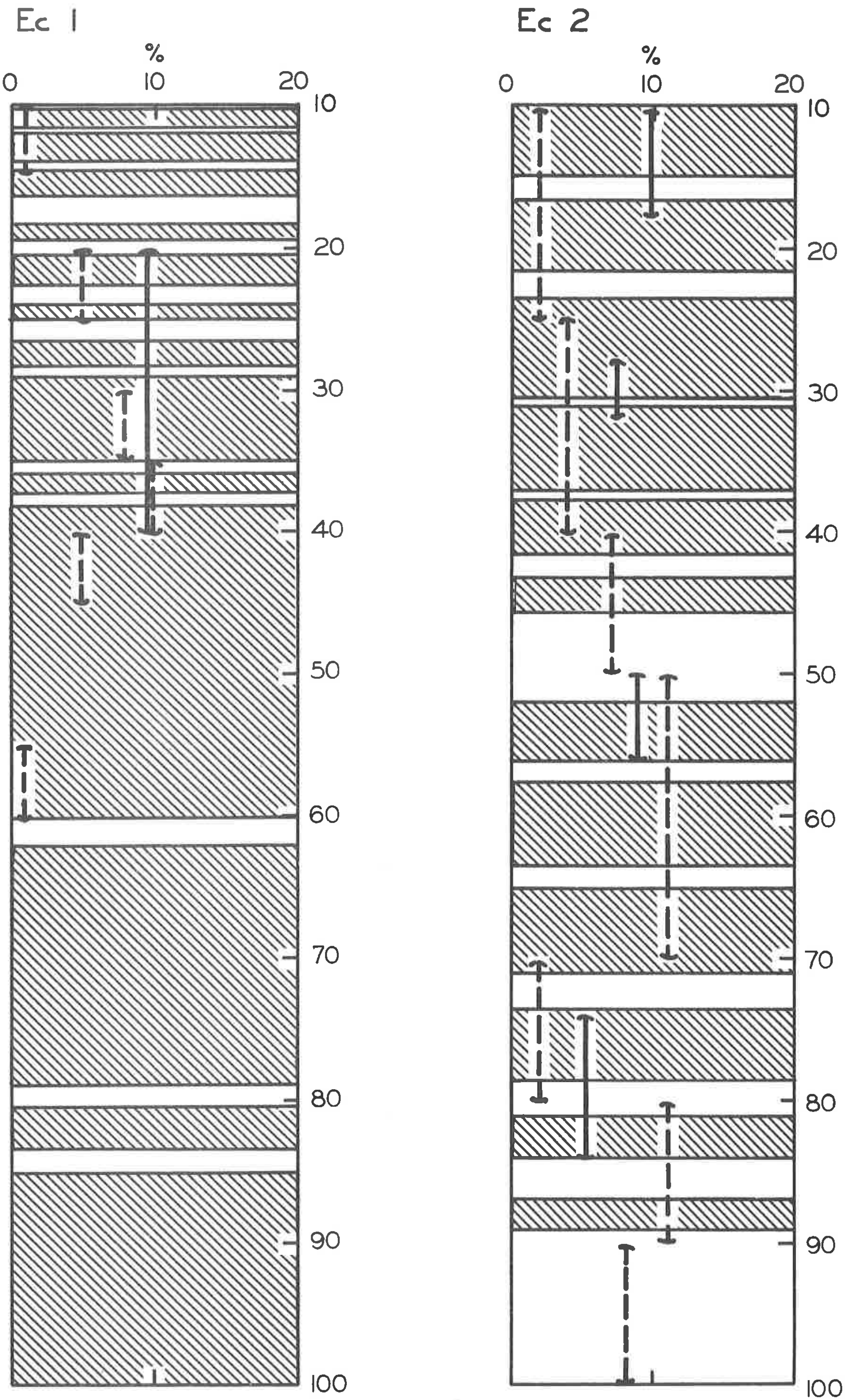
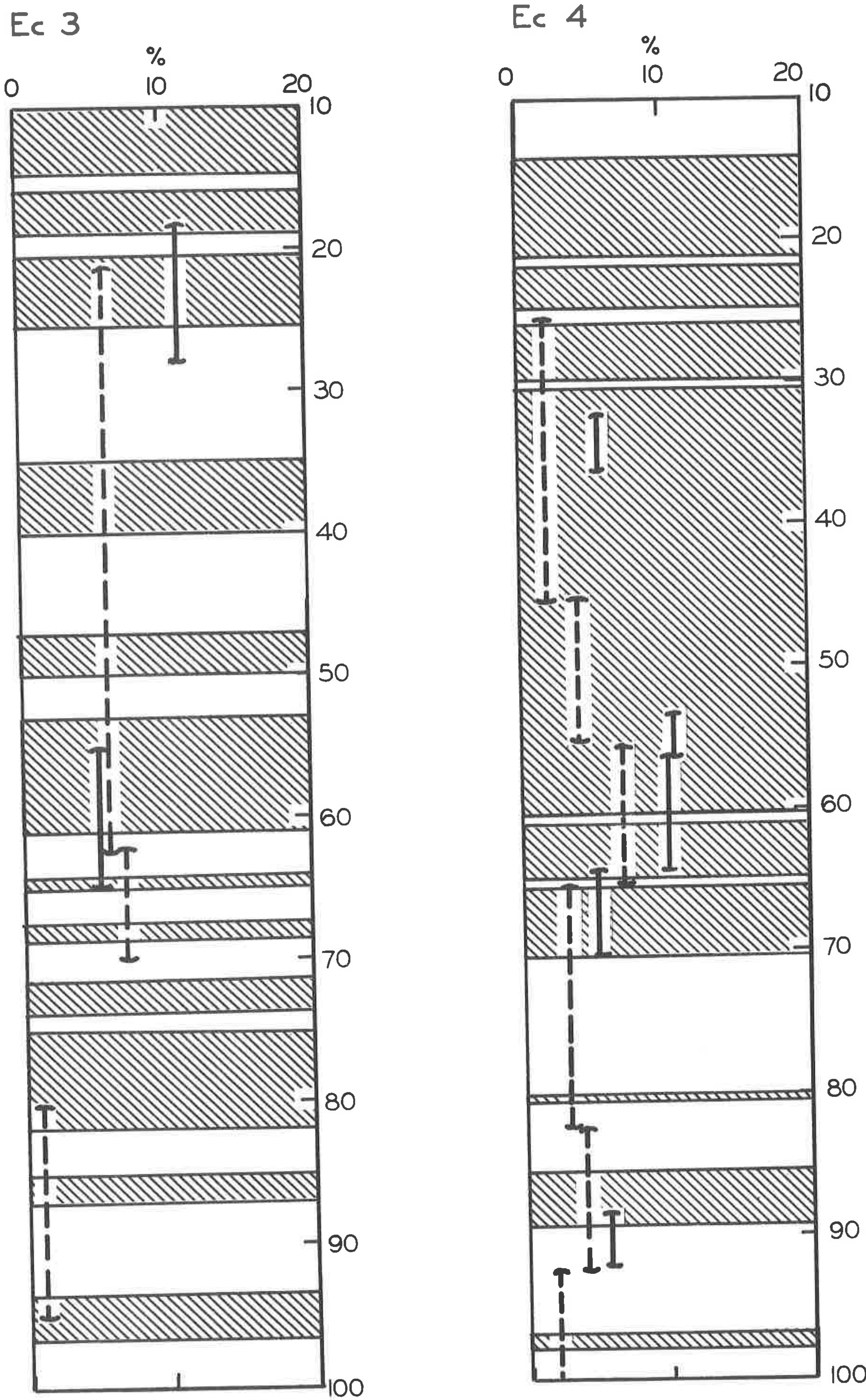
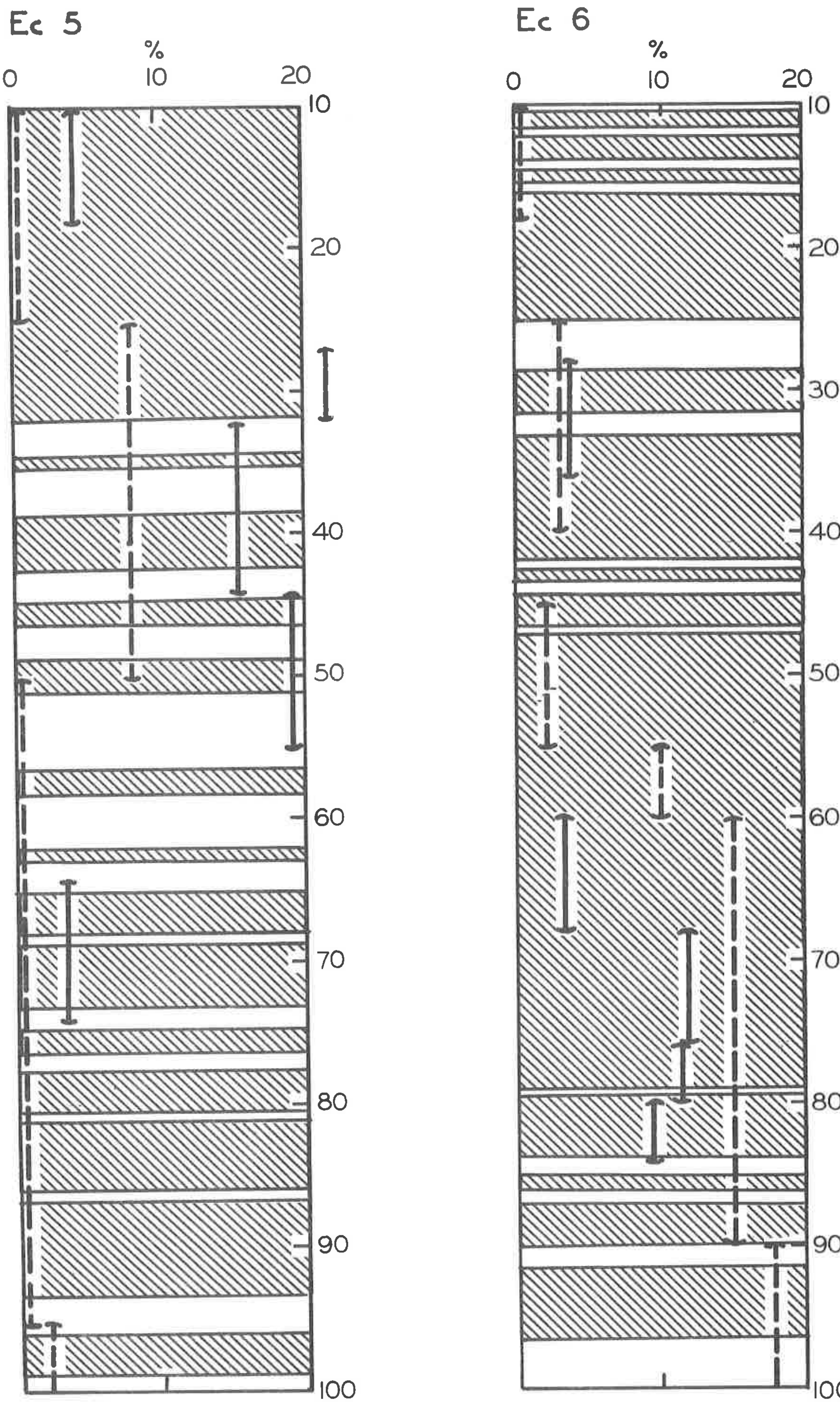


Figure 17. Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)

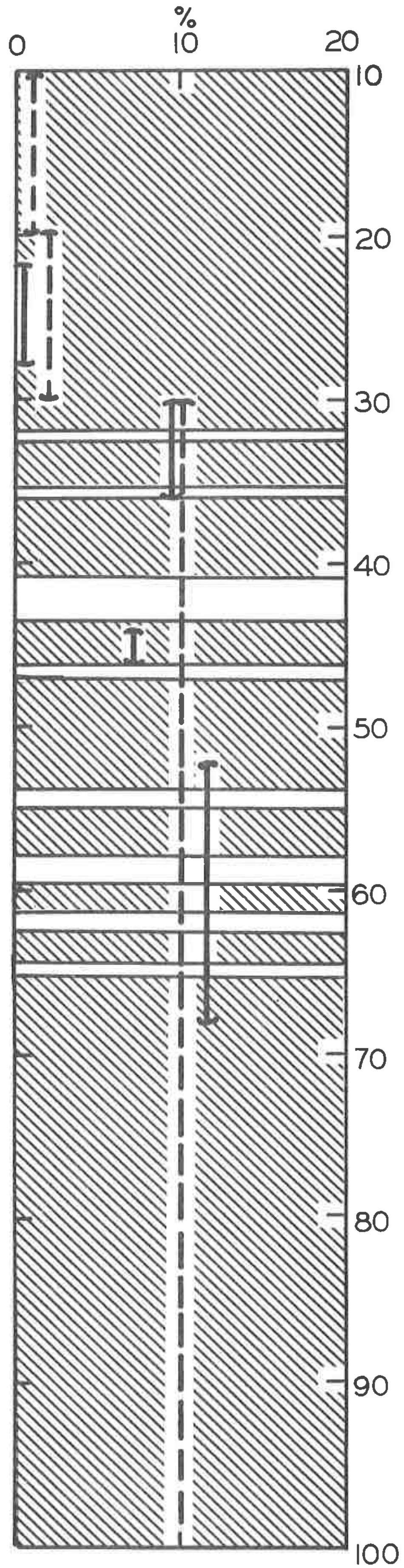


Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)

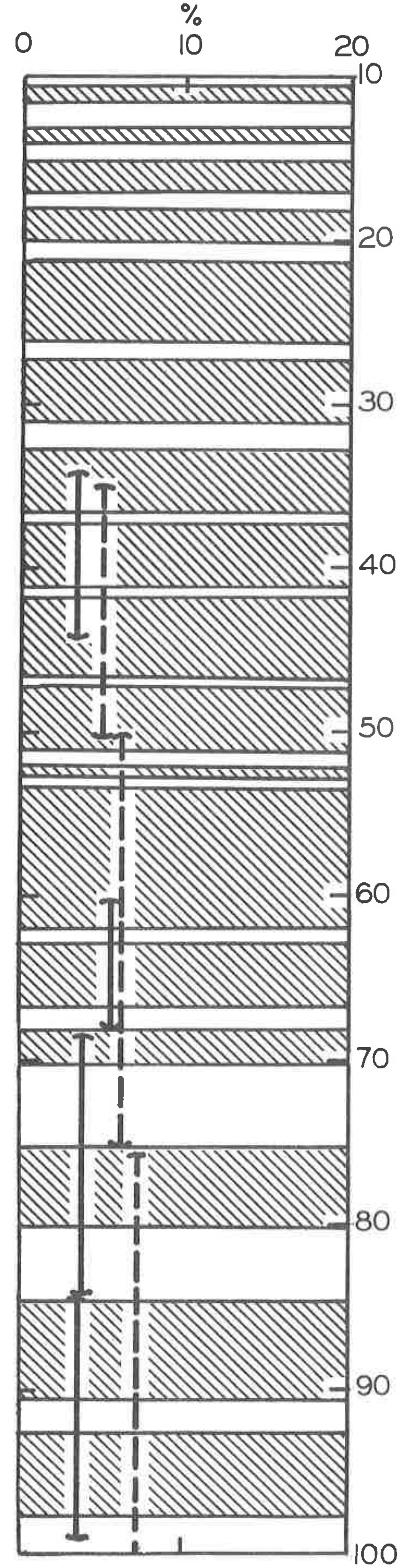


Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)

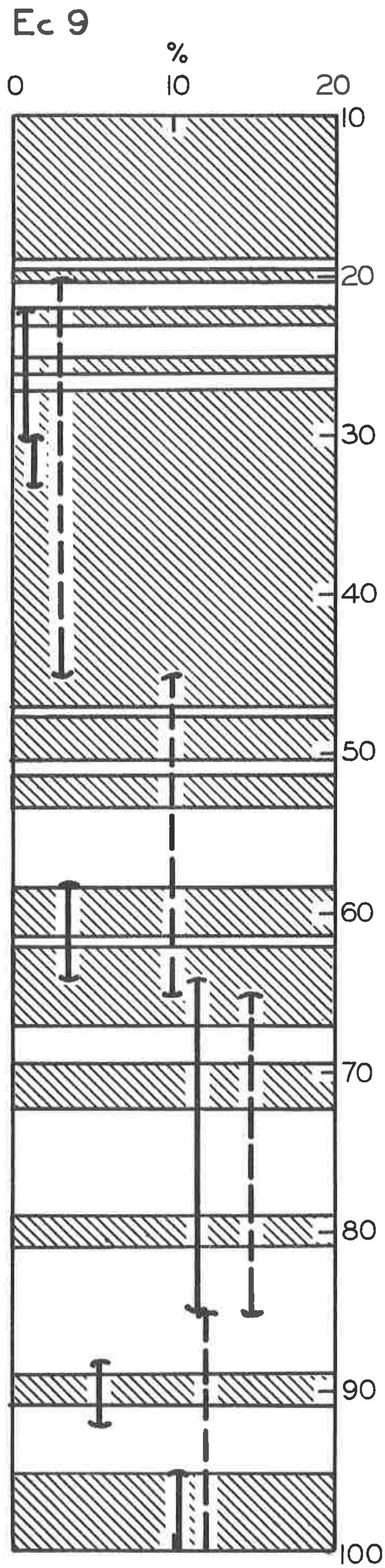
Ec 7

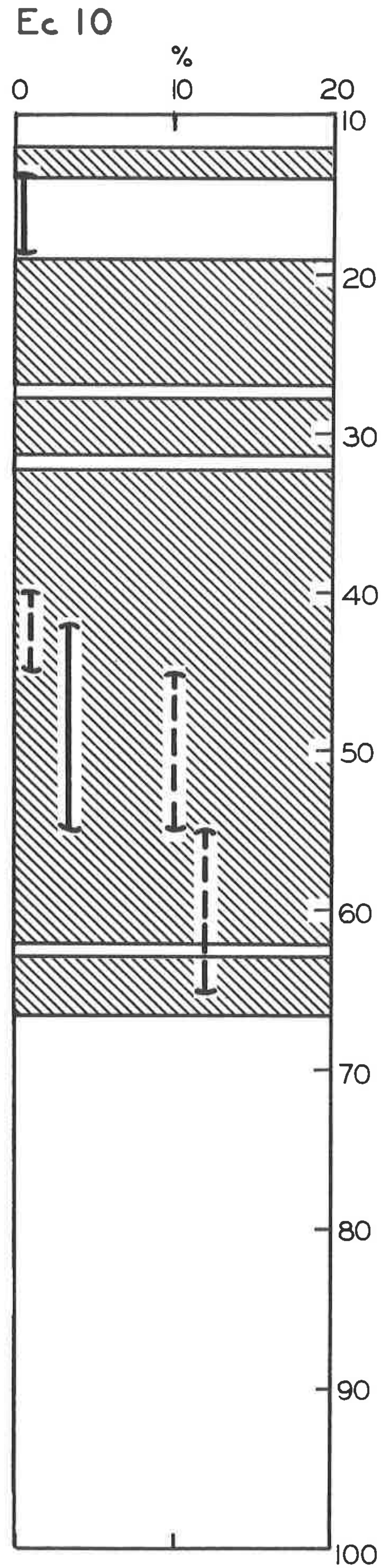


Ec 8

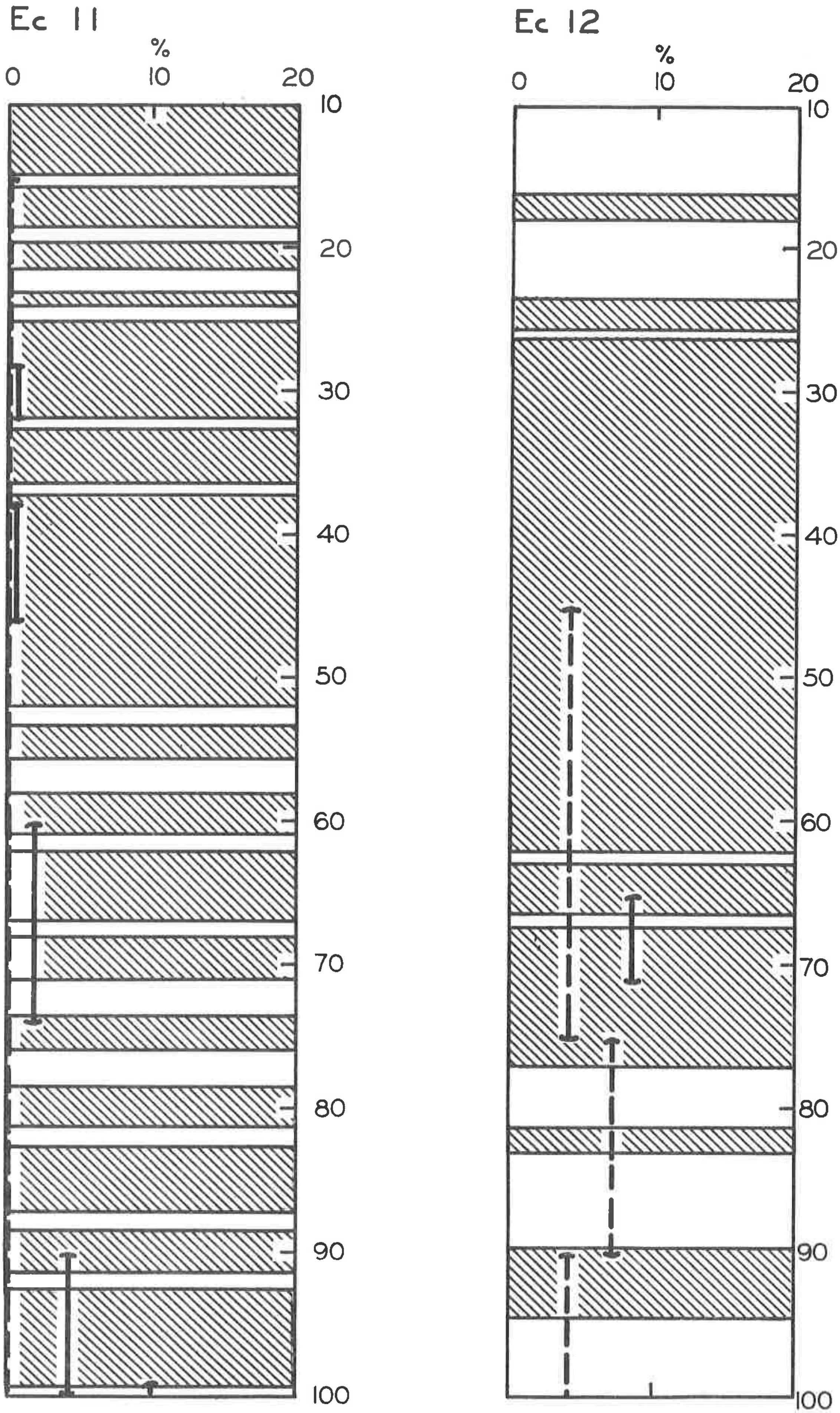


Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)

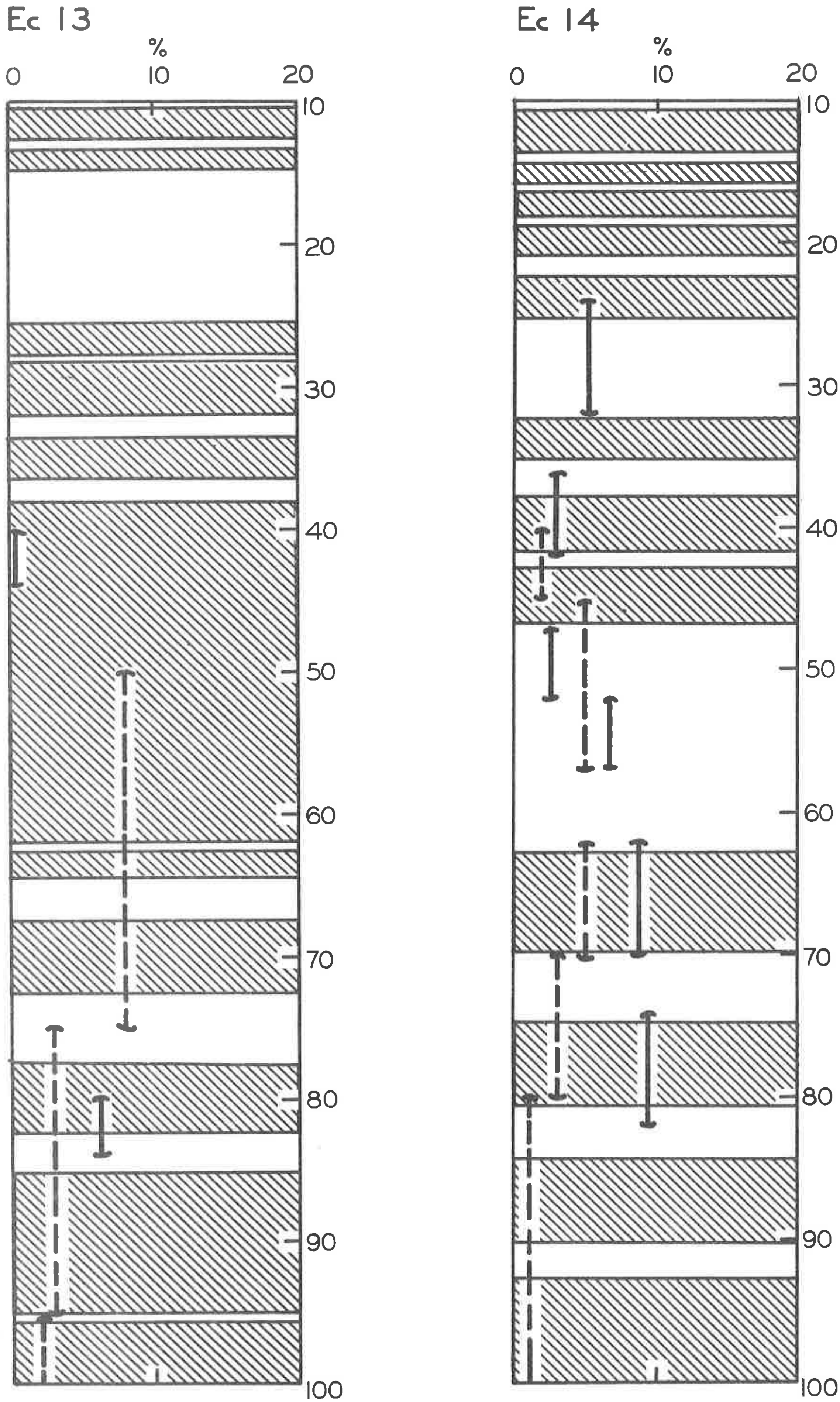




Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)



Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Continued)



Diagrams of core recovery by feet for first 100 feet vs
Percent BPL (by weight) vs
Percent phosphorite (particle count).
(Concluded)

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.

GLOSSARY (Continued)

Tailings . . . . Quartz sand, -1 mm + 0.1 mm in size. Separated from phosphate particles by flotation.