STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES

BUREAU OF GEOLOGY
Robert O. Vernon, *Chief*

GEOLOGICAL BULLETIN NO. 52

ANCIENT SEA LEVEL STANDS IN FLORIDA

By
E.C. Pirkle, W.H. Yoho, and C.W. Hendry, Jr.

Published for
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DEPARTMENT
OF
NATURAL RESOURCES

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ERRATA

PAGE	
5	Line 2–Insert comma after (stippled pattern),
7	In body of table, 3rd column, lines 10, 11, 12,–168' should be 268' 168'6" should be 268'6" 170' should be 270'
10	In body of table, 4th column, line 3–4.18 should be 34.18
12	Heading "Insoluble Residue" should be centered over columns "Quartz sand in %" and "Clay (-325 mesh) in %"
13	Same as page 12
21	In heading, following Hawthorn Formation, Miocene delete (elev. 36 ft) In body of table, following Hawthorn Formation, Miocene delete (elev. 41 ft) In body of table, following Crystal River Formation, Eocene–add minus sign (-) before 87 to read (elev. -87 ft.)
22	Line 1–Asterisk goes after table heading In body of table under Finely laminated sands, 4th column, line 4–insert .04
24	Line 1–Asterisk goes after table heading Line 2–Percentage should be percentages
25	End of table–insert "*Sample numbers correspond to those of the detailed log in the appendix."
49	Paragraph after Spl. 7 beginning at asterisk–should be at bottom of page
50	Last line–should be at top of p. 51 before number 29 description
55	Paragraph after Spl. 7 beginning at asterisk–should be at bottom of page

LETTER OF TRANSMITTAL

Bureau of Geology
Tallahassee
June 16, 1970

Honorable Claude R. Kirk, *Chairman*
Department of Natural Resources
Tallahassee, Florida

Dear Governor Kirk:

This report was prepared in cooperation with the University of Florida and is the first of several that will result from a study of the heavy minerals in Florida. It was undertaken to gain a better understanding of the environment of deposition of known heavy mineral deposits. It will enable others to accertain likely areas where these minerals will occur. Since heavy minerals are associated with shore and near-shore features this study of "Ancient Sea Level Stands in Florida" lends itself to this end.

Respectfully yours,

R. O. Vernon, *Chief*

Completed manuscript received
June 16, 1970
Prepared by the Bureau of Geology
Division of Interior Resources
Florida Department of Natural Resources
Tallahassee, Florida

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ACKNOWLEDGMENTS

The writers are indebted to Guy C. Omer of the Physical Sciences Department, University of Florida; Floyd M. Wahl of the Department of Geology, University of Florida; and Robert O. Vernon of the Bureau of Geology, Florida Department of Natural Resources for their cooperation. Most of the analyses presented in the report were run in laboratory space and with facilities provided by the Physical Sciences Department and the Department of Civil Engineering at the University of Florida. The holes through Trail Ridge and the Baywood Promontory were drilled by the Bureau of Geology. The P_2O_5 analyses given in various tables were run by Thornton and Company of Tampa, Florida.

Thomas E. Garnar, C. D. Hewett and the late W. G. Few of the E. I. du Pont de Nemours and Company made significant contributions to the work through stimulating discussions and by providing technical information.

The writers are indebted to Fred Pirkle and Bill Pirkle for their help in the field work and to Justin Hodges and James Hodges for their care and interest in carrying out the drilling assignments necessary for a successful program. Special thanks are extended to Mrs. Phyllis Clarke and Mrs. Bonnie Elferdink for organizing data presented in the report and for typing the manuscript.

To the organizations and individuals aiding in this study, the writers express their deep gratitude. Only the authors, however, should be held responsible for the contents of the report.

ANCIENT SEA-LEVEL STANDS IN FLORIDA

By
E. C. Pirkle, W. H. Yoho,[1] and C. W. Hendry, Jr.[2]

INTRODUCTION

Most sand ridges in interior Florida are considered to be barrier islands, beach ridges or spits formed along ancient shore lines. Different investigators, however, give different elevations to which ancient seas rose and assign different ages for shore lines and shore-line features (Table 1). Most of the elevations of old shore lines presented by various workers have been determined from surface studies, primarily from physiographic evidences. Some attempts have been made to use fossil occurrences (Alt and Brooks, 1965).

Trail Ridge and the Baywood Promontory are two of the most conspicuous ridges in the northern part of peninsular Florida, as shown in figure 1. Recently two holes were drilled through the sediments forming the southern part of Trail Ridge, and one hole was drilled through the sediments of the Baywood Promontory. By means of a specially designed core barrel, almost 100 per cent recovery of cores of loose to slightly consolidated sands composing the ridges was obtained. Detailed analyses were made of these sands and all other sediments penetrated. The writers are not aware of any previous attempts to utilize characteristics revealed by these kinds of data as aids in studying old shore-line elevations or associated sand ridges in Florida. The purpose of this report is to demonstrate the value of these data to the studies of ancient sea-level stands in peninsular Florida.

[1] Department of Physical Sciences and Department of Geology, University of Florida, Gainesville, Florida.
[2] Bureau of Geology, Florida Department of Natural Resources, Tallahassee, Florida.

TABLE 1. MARINE TERRACES IN FLORIDA

Terrace	Elevation	Age
After Cooke (1945)		
Brandywine	270 feet	Aftonian
Coharie	215 feet	Yarmouth
Sunderland	170 feet	Yarmouth
Wicomico	100 feet	Sangamon
Penholoway	70 feet	Sangamon
Talbot	42 feet	Sangamon
Pamlico	25 feet	Wisconsin
After MacNeil (1949)		
Okefenokee	150 feet	Yarmouth
Wicomico	100 feet	Sangamon
Pamlico	25 to 35 feet	Wisconsin
Silver Bluff	8 to 10 feet	Recent
After Vernon (1951)		
Coharie	220 feet	Aftonian
Okefenokee	150 feet	Yarmouth
Wicomico	100 to 105 feet	Sangamon
Pamlico	25 to 30 feet	Wisconsin
After Alt and Brooks (1965)		
	215 to 250 feet	Upper Miocene
	90 to 100 feet	Pliocene
Insignificant stand	70 to 80 feet	Pliocene or Pleistocene
Insignificant stand	45 to 55 feet	Pliocene or Pleistocene
	25 to 30 feet	Pleistocene

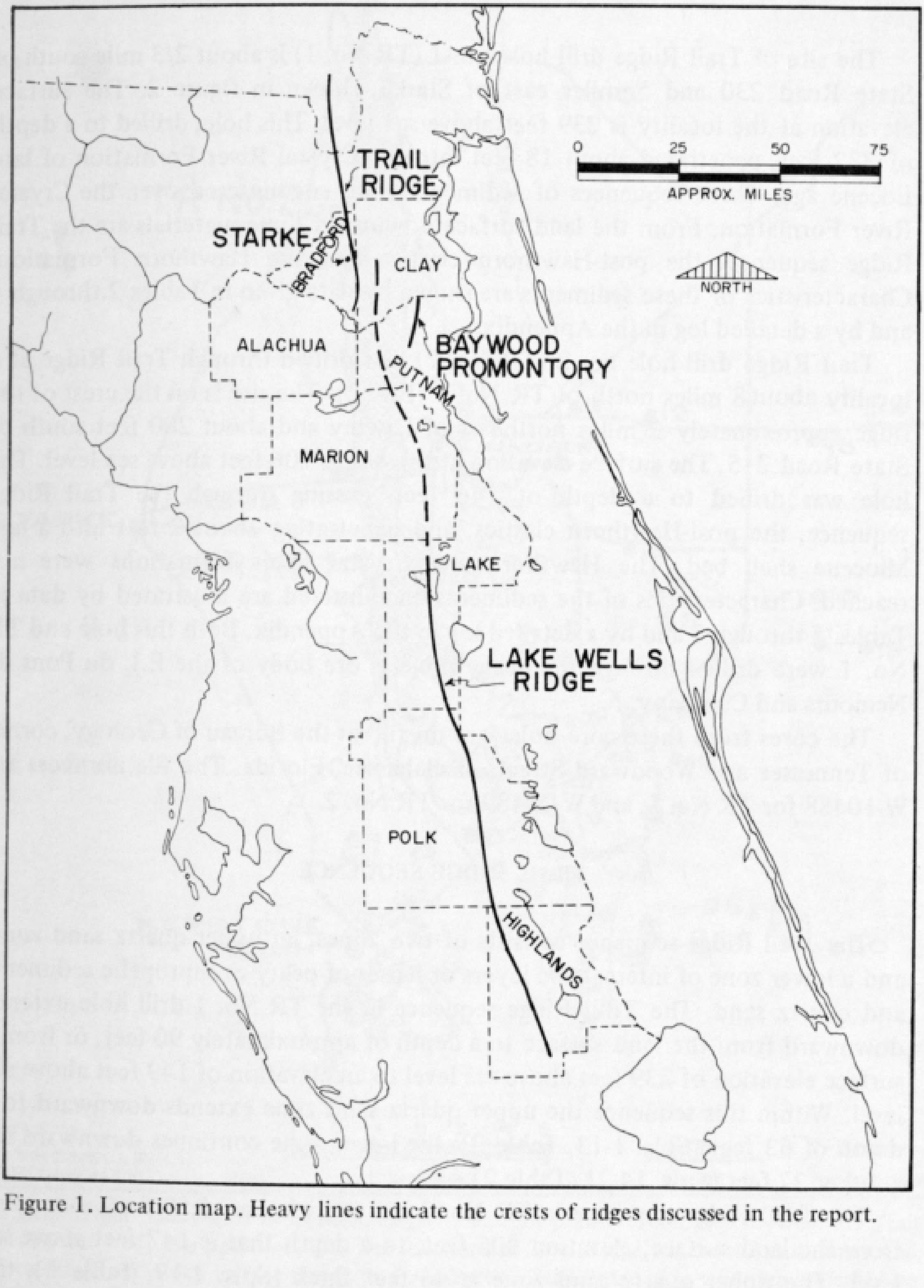

Figure 1. Location map. Heavy lines indicate the crests of ridges discussed in the report.

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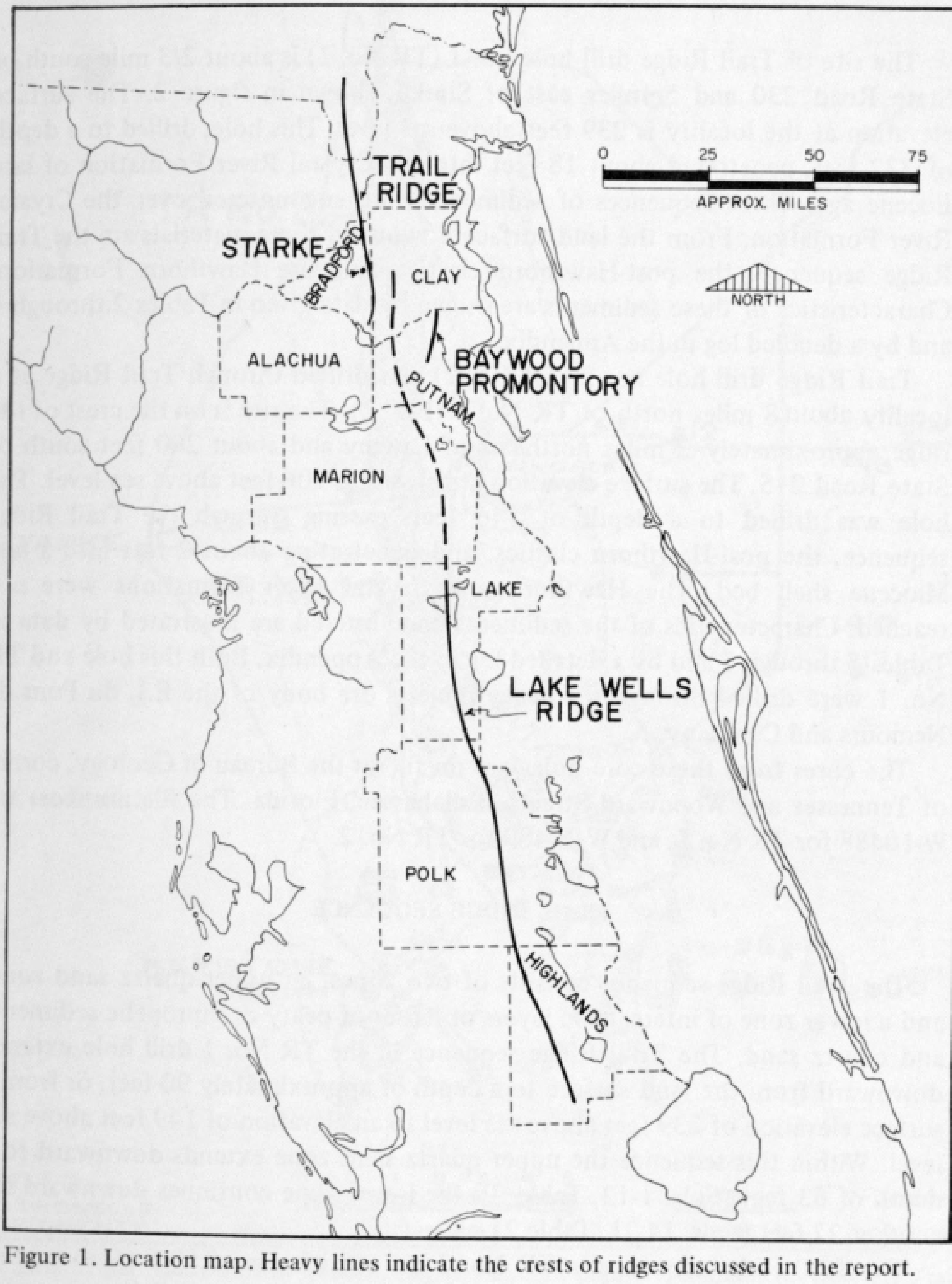

Figure 1. Location map. Heavy lines indicate the crests of ridges discussed in the report.

DESCRIPTIONS OF SEDIMENTS PENETRATED
TRAIL RIDGE DRILL HOLES

The site of Trail Ridge drill hole no. 1 (TR No. 1) is about 2/3 mile south of State Road 230 and 5 miles east of Starke, shown in figure 2. The surface elevation at the locality is 239 feet above sea level. This hole, drilled to a depth of 332 feet, penetrated about 18 feet into the Crystal River Formation of late Eocene age. Three sequences of sediments were encountered over the Crystal River Formation. From the land surface downward these materials are the Trail Ridge sequence, the post-Hawthorn clastics and the Hawthorn Formation. Characteristics of these sediments are shown by data given in Tables 2 through 4 and by a detailed log in the Appendix.

Trail Ridge drill hole no. 2 (TR No. 2) was drilled through Trail Ridge at a locality about 8 miles north of TR No. 1 (Fig. 2). The site is on the crest of the ridge approximately 2 miles northeast of Lawtey and about 200 feet south of State Road 215. The surface elevation at this site is 206 feet above sea level. The hole was drilled to a depth of 146 feet, passing through the Trail Ridge sequence, the post-Hawthorn clastics, and penetrating about 2 feet into a late Miocene shell bed. The Hawthorn and Crystal River formations were not reached. Characteristics of the sediments encountered are illustrated by data in Tables 5 through 7 and by a detailed log in the Appendix. Both this hole and TR No. 1 were drilled through the heavy mineral ore body of the E.I. du Pont de Nemours and Company.

The cores from these core holes are on file at the Bureau of Geology, corner of Tennessee and Woodward Streets, Tallahassee, Florida. The file numbers are W-10488 for TR No. 1, and W-10489 for TR No. 2.

TRAIL RIDGE SEQUENCE

The Trail Ridge sequence consists of two zones, an upper quartz sand zone, and a lower zone of intercalated layers or lenses of peaty or sapropelic sediments and quartz sand. The Trail Ridge sequence in the TR No. 1 drill hole extends downward from the land surface to a depth of approximately 90 feet, or from a surface elevation of 239 feet above sea level to an elevation of 149 feet above sea level. Within this sequence the upper quartz sand zone extends downward to a depth of 63 feet (Spls. 1-13, Table 2); the lower zone continues downward for another 27 feet (Spls. 14-21, Table 2).

The Trail Ridge sequence in TR No. 2 has a thickness of 59 feet, extending from the land surface, elevation 206 feet, to a depth that is 147 feet above sea level. The upper quartz sand zone is 46 feet thick (Spls. 1-17, Table 5); the intercalated layers or lenses of sapropelic sediments and quartz sand of the lower zone have a total thickness of 13 feet (Spls. 18-25, Table 5).

The lower zone of the Trail Ridge sequence is characterized by layers or lenses of sediments carrying wood and finely-divided organic matter. The upper

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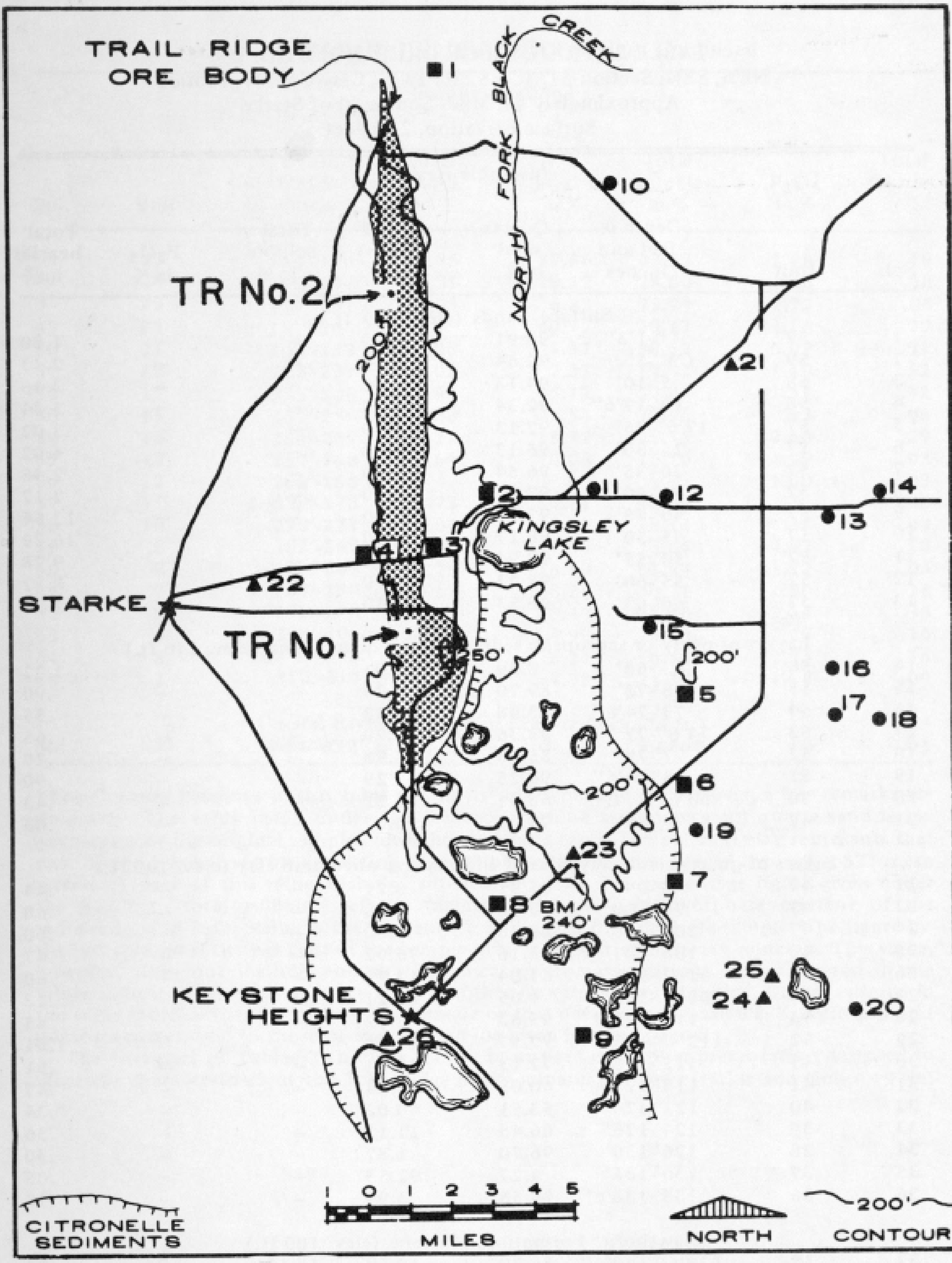

Figure 2 Map study area in western Clay and eastern Bradford counties showing the Trail Ridge Ore body (strippled pattern) the locations of Trail Ridge #1 and #2 drill holes, and localities from which surface samples were collected. Trail Ridge type sands are indicated by squares. Sands of the Baywood Promontory type (sometimes called Atlantic Coast type) are shown by circles. Sites of samples that do not give analyses similar to either the Trail Ridge type or the Baywood Promontory type are indicated by triangles. The 200-foot contour line is shown and the outline of Citronelle sediments as mapped by Clark et al (1964) is given to aid in fixing positions from which the samples were taken, Modified from Pirkle and Yoho (1970).

TABLE 2. TRAIL RIDGE DRILL HOLE NO. 1*

NE¼, SE¼, Section 31, T. 6 S., R. 23 E., Clay County, Florida
Approximately 4½ Miles Southeast of Starke
Surface Elevation, 239 Feet

			Insoluble Residue				
Spl.	Unit	Depth in feet and inches	Quartz sand in %	Clay (-325 mesh) in %	Total soluble in %	P_2O_5 in %	Total heavies in %
Surface Sands (elev. 239 ft.)							
1	59	0-1'3"	95.91	2.89	–	–	1.80
2	59	1'3"-5'	92.64	4.58	–	–	2.43
3	58	5'-10'	94.13	3.16	–	–	3.46
4	58	10'-17'6"	92.34	6.37	–	–	3.34
5	57	17'6"-25'	97.13	1.70	–	–	3.02
6	57	25'-30'	96.13	2.68	–	–	4.02
7	57	30'-35'	96.54	2.39	–	–	2.48
8	57	35'-40'	97.84	1.40	–	–	2.12
9	57	40'-45'	97.31	1.20	–	–	13.54
10	57	45'-50'	98.27	.60	–	–	16.29
11	57	50'-55'	98.94	.14	–	–	9.78
12	57	55'-60'	98.43	.10	–	–	8.82
13	57	60'-63'	98.53	.40	–	–	2.55
Layers of peaty or sapropelic sediments and quartz sand (elev. 176 ft.)							
14	56	63'-68'	8.39	.01	–	–	1.22
15	55	68'-73'	89.70	3.20	–	–	.90
16	54	73'-74'6"	83.98	12.52	–	–	.55
17	53	74'6"-77"	92.36	4.79	–	–	.65
18	52	77'-78"	85.53	11.98	–	–	.70
19	51	78'-80'6"	96.25	2.29	–	–	.90
20	50	80'6"-84'6"	68.91	28.22	–	–	.43
21	49	84'6"-86'	77.65	20.37	–	–	.63
Layers of quartz sand, clayey sand and massive olive-drab clay (elev. 149 ft.)							
22	47	90'-94'	95.91	3.21	–	–	.44
23	47	95'-100'	93.93	4.38	–	–	.60
24	47	100'-106'	89.46	7.80	–	–	.60
25	46	106'-107'	13.16	75.92	–	–	.47
26	45	107'-108'6"	61.04	13.72	–	–	.60
27	44	108'6"-110'	9.05	88.21	–	–	.13
28	43	110'-112'9"	95.63	2.72	–	–	.45
29	42	112'9"-115'	77.57	12.59	–	–	1.01
30	41	115'-118'	72.13	20.14	–	–	.91
31	41	118'-121'	40.05	45.74	–	–	.47
32	40	121'-124'	53.51	40.02	–	–	.34
33	39	124'-126'	86.45	11.12	–	–	.36
34	38	126'-130'	96.70	1.87	–	–	.30
35	37	130'-135'	4.27	92.53	–	–	.05
36	36	135'-138'6"	94.58	3.99	–	–	.78
Hawthorn Formation, Miocene (elev. 100 ft.)							
37	35	138'6"-140'6"	66.29	19.69	13.43	3.06	.24
38	34	140'6"-143'	11.45	3.78	84.69	1.71	.07
39	33	143'-150'	23.17	11.16	65.65	4.34	.11
40	32	150'-155'6"	26.46	13.17	60.22	7.36	.13
41	31	155'6"-156'6"	6.59	5.59	87.82	.88	.02
42	30	156'6"-158'	32.57	7.74	59.61	2.55	.14
43	29	158'-172'	31.30	8.84	59.80	2.52	.10
44	27	175'-180'	66.37	10.19	23.27	4.73	.15
45	26	180'-185'	47.33	6.82	45.68	3.45	.09

TABLE 2. TRAIL RIDGE DRILL HOLE NO. 1 Continued

			Insoluble residue				
Spl.	Unit	Depth in feet and inches	Quartz sand in %	Clay (-325 mesh) in %	Total soluble in %	P_2O_5 in %	Total heavies in %
46	25	185'-190'	47.85	17.56	33.92	1.99	.19
47	24	190'-194'	41.35	29.12	28.00	1.63	.28
48	23	194'-201'6"	17.01	6.83	75.79	1.72	.06
49	22	201'6"-206'	57.95	20.77	20.17	3.16	.20
50	21	206'-212'6"	38.05	5.37	56.52	6.07	.21
51	19	222'-231'	75.03	7.35	17.42	1.40	.52
52	17	237'-240'	46.92	15.17	37.33	1.31	.42
53	15	252'-254'	10.38	9.58	79.96	.63	.06
54	14	254'-257'	55.22	18.77	25.55	2.60	.29
55	13	257'-168'	7.64	76.08	15.10	1.29	.03
56	12	268'-168'6"				1.00	.03
57	11	268'6"-170'	4.73	54.11	40.88	.84	.03
58	10	270'-271'6"	4.84	17.01	78.11	.34	.04
59	8	282'-287'	19.11	7.07	73.66	4.47	.18
60	8	282'-287'	1.75	16.53	81.64	1.72	.03
61	7	287'-290'	10.12	8.28	80.71	1.50	.18
62	6	290'-298'	39.81	10.49	48.46	3.34	.38
63	5	298'-306'6"	21.75	4.90	73.23	2.28	.10
64	3	308'6"-310'	35.17	8.27	56.42	2.93	.16
65	2	310'-314'	23.10	4.78	71.54	1.68	.09
		Crystal River Formation, Eocene (elev.-75 ft.)					
66	1	314'-332'	.24	.20	99.56	.10	.01

*The Column headings in this table are partly self-explanatory. However, a few remarks are necessary. The value listed under the insoluble residue as the per cent quartz sand is the percentage of the original sample consisting of quartz sand. The per cent clay represents that part of the original sample consisting of insoluble sediments that passed through a 325-mesh screen. A part of this value includes silt-size materials. The percentage figure given under the heading "total soluble" reflects mainly carbonate and phosphate content of the sediments. The P_2O_5 value is the percentage of P_2O_5 in the complete sample. The figure in the last column is the per cent of the sample or unit consisting of heavy minerals. This value, however, does not include phosphorite, mica, or iron concretions. Zeros entered in the tables indicate that analyses were made and that no values were obtained. Dashes entered in the table indicate that no analyses were made or that data are not available. Sample and unit numbers correspond to those of the detailed log given in the Appendix.

The first part of Tables 2 through 7 have been used in another presentation designed to illustrate characteristics of the Trail Ridge heavy mineral ore body (Pirkle and Yoho, 1970.)

TABLE 3. TRAIL RIDGE DRILL HOLE NO. 1*
Mechanical Analyses of Quartz Sand Extracted from Sediments

		Per cent quartz sand retained on mesh						
Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
Surface sands								
1	95.91			4.62	61.26	29.99	4.14	.30
2	92.64		.04	3.74	57.69	32.83	5.69	.28
3	94.13		.01	3.86	48.58	43.42	4.03	.26
4	92.34		.06	4.08	59.27	33.81	2.78	.29
5	97.13			4.15	68.17	26.16	1.52	.31
6	96.13			3.43	55.11	37.57	3.89	.29
7	96.54		.08	5.16	72.59	21.20	.97	.31
8	97.84		.02	12.31	70.84	14.72	2.10	.38
9	97.31			.64	53.88	36.13	9.35	.26
10	98.72			.61	48.96	42.02	8.41	.24
11	98.94			1.33	50.27	41.81	6.58	.26
12	98.43			1.35	57.53	36.27	4.85	.28
13	98.53		.02	1.80	70.42	25.75	2.02	.31
Intercalated layers of peaty or sapropelic sediments and quartz sand								
14	8.39			.89	22.80	47.50	28.81	.18
15	89.70			6.89	46.19	27.98	18.95	.26
16	83.98		.09	8.76	51.44	26.79	12.92	.29
17	92.36	.06	.04	3.43	26.85	36.68	32.92	.18
18	85.53		.07	6.70	42.40	33.49	17.34	.24
19	96.25		.08	5.98	38.02	40.61	15.30	.24
20	68.91		.09	12.27	54.27	24.95	8.42	.31
21	77.65		.15	15.72	59.00	20.83	4.30	.33
Intercalated layers of quartz sand, clayey sand and massive olive-drab clay								
22	95.91		.10	12.19	67.46	19.32	.92	.34
23	93.93			3.58	55.15	38.42	2.84	.28
24	89.46		.02	3.51	68.83	18.79	8.85	.33
25	13.16		1.22	2.74	18.87	14.16	63.01	.11
26	61.04			.07	.43	.66	98.85	.09
27	9.05		.44	.66	4.42	15.01	79.47	.09
28	95.63		.92	10.16	45.23	31.15	12.53	.28
29	77.57		.08	.83	7.22	26.22	65.66	.11
30	72.13		.08	1.85	11.82	29.03	57.22	.12
31	40.05		.05	.60	14.67	34.83	49.85	.13
32	53.51		.19	3.18	27.72	39.73	29.18	.18
33	86.45		.37	5.58	45.23	40.90	7.93	.26
34	96.70	.27	.45	7.07	52.78	36.72	2.71	.29
35	4.27		2.34	3.27	29.44	41.59	23.36	.21
36	94.58		.15	3.60	51.02	41.60	3.62	.26
Hawthorn Formation, Miocene								
37	66.29	.09	.15	2.71	19.95	70.57	6.53	.21
38	11.45			2.78	21.53	71.53	4.17	.21
39	23.17		.43	2.41	15.13	73.09	8.94	.19
40	26.46		.38	3.60	24.69	64.11	7.21	.22
41	6.59			3.03	28.48	64.24	4.24	.23
42	32.57		.24	2.24	17.10	76.41	4.00	.21
43	31.30		.50	10.71	34.66	50.85	3.28	.24
44	66.37		.33	13.60	59.22	25.37	1.47	.33
45	47.33	.13	1.81	17.44	55.71	21.34	3.57	.36
46	47.85		.25	3.96	16.31	49.83	29.65	.18
47	41.35	.24	1.35	3.71	5.06	24.43	65.20	.11

TABLE 3. TRAIL RIDGE DRILL HOLE NO. 1 Continued

Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
				Hawthorn Formation, Miocene				
48	17.01		1.29	11.97	41.90	34.98	9.86	.28
49	57.95	.31	2.89	16.37	43.04	21.26	16.13	.33
50	38.05		.74	13.47	61.37	23.37	1.05	.35
51	75.03		.08	.53	8.17	81.93	9.29	.19
52	46.92		.21	2.26	10.51	53.83	33.19	.16
53	10.38			.38	3.08	71.73	24.81	.16
54	55.22			.22	4.81	73.28	21.69	.17
55	7.64		.26	1.05	7.85	43.19	47.64	.13
56								
57	4.73		1.69	3.39	16.95	50.00	27.97	.18
58	4.84			2.06	9.05	53.91	34.98	.15
59	19.11	1.56	8.96	23.44	39.79	19.06	7.19	.41
60	1.75	21.59	3.41	22.73	26.14	11.36	14.77	.49
61	10.12	2.17	1.38	6.11	22.09	17.55	50.69	.12
62	39.81	.25	1.46	15.06	47.14	27.21	8.89	.31
63	21.75			2.30	73.32	21.16	3.22	.35
64	35.17		.11	1.19	67.63	22.79	8.28	.31
65	23.10			1.15	71.54	19.03	8.28	.33
				Crystal River Formation				
66	.24			16.67	25.00	33.33	25.00	.22

*Sample Numbers correspond to those of the detailed log in the Appendix.

TABLE 4. TRAIL RIDGE DRILL HOLE NO. 1*
Percentages of Selected Heavy Minerals in
1/8 to 1/16 mm Fraction

Spl.	Unit	Leocoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Surface sands			
1	59	27.69	4.62	0.00	0.00
2	59	37.75	6.62	0.00	0.00
3	58	12.97	4.18	0.00	0.00
4	58	8.50	42.81	0.00	0.00
5	57	4.87	53.90	0.00	0.00
6	57	4.95	50.15	0.00	0.00
7	57	8.13	52.19	0.00	0.00
8	57	3.47	63.27	0.00	0.00
9	57	4.20	58.86	0.00	0.00
10	57	4.20	54.95	0.00	0.00
11	57	3.87	52.90	0.00	0.00
12	57	4.47	61.66	0.00	0.00
13	57	5.00	59.33	0.00	0.00
		Intercalated layers of peaty or sapropelic sediments and quartz sand			
14	56	5.36	57.44	0.00	0.00
15	55	16.77	37.97	0.00	.13
16	54	17.84	16.67	0.00	0.00
17	53	9.51	31.60	0.00	0.00
18	52	11.15	34.08	0.00	0.00
19	51	7.28	38.08	0.00	0.00
20	50	11.91	33.86	0.00	0.00
21	49	6.69	52.23	0.00	.82
		Intercalated layers of quartz sand, clayey sand and massive olive-drab clay			
22	47	2.83	52.52	0.00	.92
23	47	2.76	42.64	.31	2.48
24	47	3.33	36.97	.30	1.84
25	46	1.33	44.69	0.00	5.71
26	45	9.90	16.50	.33	3.11
27	44	10.38	28.93	.94	2.30
28	43	2.33	48.84	.66	2.86
29	42	2.46	38.03	.67	3.48
30	41	4.92	44.26	.33	2.99
31	41	5.22	40.59	5.90	3.58
32	40	2.14	45.84	3.49	4.29
33	39	5.99	40.38	.63	3.38
34	38	3.04	43.92	.34	3.62
35	37	1.84	44.49	1.84	3.47
36	36	0.00	45.02	8.23	3.02
		Hawthorn Formation, Miocene			
37	35	0.00	13.65	18.07	5.91
38	34	2.57	24.63	27.57	4.97
39	33	1.27	16.83	21.90	7.48
40	32	.34	14.58	25.76	7.54
41	31	2.78	20.49	16.67	2.59
42	30	.36	17.33	21.66	6.62
43	29	1.97	19.28	20.26	3.19
44	27	2.56	17.57	20.45	5.21
45	26	1.33	16.94	14.29	2.67
46	25	2.65	21.79	7.28	4.68
47	24	2.82	30.70	5.63	5.90
48	23	1.97	27.63	4.61	4.24
49	22	2.58	35.48	1.29	4.24
50	21	2.96	34.87	8.88	2.40

TABLE 4. TRAIL RIDGE DRILL HOLE NO. 1 Continued

Spl.	Unit	Leucoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Hawthorn Formation, Miocene			
51	19	2.72	31.42	7.25	8.52
52	17	2.35	29.71	4.41	6.45
53	15	4.81	28.85	3.21	3.94
54	14	3.45	41.07	5.33	5.45
55	13	3.44	34.73	2.67	4.15
56	12	2.60	42.86	2.60	5.79
57	11	8.55	49.67	.99	4.70
58	10	3.22	48.55	1.93	3.82
59	8	4.53	27.51	1.94	9.65
60	8	7.19	35.25	4.32	7.33
61	7	9.38	38.44	5.63	8.23
62	6	2.72	38.10	2.04	12.54
63	5	2.87	32.80	2.87	12.74
64	3	.98	43.28	.98	10.15
65	2	1.52	25.00	6.06	12.50
		Crystal River Formation, Eocene			
66	1	.72	27.34	1.44	5.92

*Sample and unit numbers correspond to those of the detailed log in the Appendix.

TABLE 5. TRAIL RIDGE DRILL HOLE NO. 2*
NE¼, NW¼, Section 19, T. 5 S., R. 23 E., Clay County, Florida
Approximately 2 Miles Northeast of Lawtey
Surface Elevation, 206 Feet

			Insoluble Residue			
Spl.	Unit	Depth Feet and inches	Quartz sand in %	Clay (-325 mesh) in %	Total soluble in %	Total heavies in %
Surface sands (elev. 206 ft.)						
1	37	0-3'	95.43	3.49	–	2.74
2	37	3'-4'6"	97.17	2.00	–	3.23
3	37	4'6"-7'	90.83	6.88	–	3.07
4	37	7'-9'6"	96.76	2.50	–	4.69
5	37	9'6"-15'	89.53	7.97	–	5.27
6	37	15'-21'	97.74	1.50	–	4.25
7	37	21'-24'6"	95.46	1.79	–	7.08
8	37	24'6"-27'6"	99.90	.10	–	2.67
9	37	27'6"-27'9"	88.25	4.63	–	3.46
10	37	27'9"-28'	99.88	.10	–	1.06
11	37	28'-28'6"	88.66	5.59	–	4.39
12	37	28'6"-30'6"	99.34	.20	–	5.37
13	37	30'6"-33'	98.55	.50	–	4.25
14	37	33'-38'	98.70	.50	–	3.90
15	37	38'-40'6"	98.47	.80	–	2.10
16	37	40'6"-43'6"	95.36	2.70	–	2.24
17	37	43'6"-46'6"	98.58	.60	–	1.63
Intercalated layers of sapropelic sediments and quartz sand (elev. 160 ft.)						
18	36	46'6"-48'9"	92.97	2.79	–	1.90
19	35	48'9"-49'	92.08	3.69	–	.57
20	34	49'-50'	89.35	6.18	–	.49
21	33	50'-51'	88.46	8.29	–	.53
22	32	51'-53'	83.70	14.49	–	.49
23	32	51'-54'	87.00	10.58	–	.73
24	31	54'-56'6"	92.26	5.83	–	.65
25	30	56'6"-59'	95.37	2.31	–	.92
Greenish gray clayey sands and sandy clays (elev. 147 ft.)						
26	29	59'-61'3"	87.78	7.99	–	.71
27	28	61'3"-64'6"	67.51	25.51	–	.74
28	27	64'6"-67'	63.88	28.78	–	.95
29	26	67'-69'6"	58.22	29.15	–	.50
30	25	69'6"-73'9"	24.95	46.72	–	.19
31	24	73'9"-77'6"	40.33	13.06	–	.73
32	23	77'6"-78'	30.06	46.56	–	.67
33	22	78'-80'	31.32	26.69	–	.74
34	21	80'-82'6"	33.33	45.42	–	.49
35	20	82'6"-85'	42.44	37.67	–	.56
36	19	85'-86'	70.33	18.95	–	.69
White to gray sands and clayey sands (elev. 120 ft.)						
37	18	86'-89'	91.61	7.59	–	.36
38	17	89'-93'	93.89	5.41	–	.35
39	16	93'-97'	91.66	7.70	–	.43
40	15	97'-99'	96.65	2.50	–	.10
41	14	99'-99'6"	97.43	1.90	–	.02
42	13	99'6"-101'6"	95.38	3.49	–	.08
Olive-drab to tan clayey sands (elev. 105 ft.)						
43	12	101'6"-106'6"	91.42	7.48	.70	.41

TABLE 5. TRAIL RIDGE DRILL HOLE NO. 5 Continued

Spl.	Unit	Depth in feet and inches	Insoluble Residue: Quartz sand in%	Clay (-325 mesh) in %	Total soluble in %	Total heavies in %
44	11	106'6"-108'6"	85.72	12.57	.80	.35
45	10	108'6"-109'9"	90.27	8.17	1.00	.18
46	9	109'9"-111'	84.23	13.67	1.00	.34
47	8	111'-115'6"	88.02	9.47	1.69	.46
48	7	115'6"-118'	90.71	7.47	1.30	.37
49	6	118'-124'	88.87	7.99	2.20	.44
50	5	124'-129'	92.25	6.81	.50	.50
51	4	129'-134'	90.76	7.68	1.00	.46
52	3	135'6"-142'	89.10	7.70	2.10	.57
53	2	143'-143'3"	23.30	21.60	43.40	.19
		Late Miocene shell marl (elev. 63 ft.)				
54	1	143'3"-145'6"	.95	4.43	94.52	.01

*Sample and unit numbers correspond to those of the detailed log in the Appendix.

TABLE 6. TRAIL RIDGE DRILL HOLE NO. 2*
Mechanical Analyses of Quartz Sand Extracted From Sediments

		Per cent quartz sand retained on mesh						
Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
				Surface sands				
1	95.43		.06	5.92	58.56	28.48	6.48	.29
2	97.17		.08	6.74	57.97	29.21	6.00	.29
3	90.83		.09	6.41	58.46	29.66	5.38	.29
4	96.76		.10	5.97	55.48	33.22	5.23	.29
5	89.53		.09	4.48	56.98	34.69	3.76	.29
6	97.74			3.46	69.29	25.57	1.68	.31
7	95.46		.06	2.65	53.55	37.75	5.99	.26
8	99.90		.12	7.66	73.52	18.19	.52	.34
9	88.25		.23	11.76	63.35	17.87	6.79	.36
10	99.88		.18	12.58	77.82	9.10	.32	.38
11	88.66		.05	3.38	58.52	33.85	4.21	.28
12	99.34		.04	2.92	59.72	35.14	2.17	.27
13	98.55		.04	2.59	57.36	37.97	2.04	.26
14	98.70		.04	2.36	56.06	37.42	4.12	.26
15	98.47		.06	5.40	65.97	26.39	2.18	.29
16	95.36			6.67	62.96	27.52	2.85	.29
17	98.58		.06	7.11	61.03	28.74	3.06	.29
		Intercalated layers of sapropelic sediments and quartz sand						
18	92.97		.06	4.58	32.93	25.81	36.61	.19
19	92.08		.04	3.90	24.39	24.08	47.58	.14
20	89.35		.07	3.48	22.40	23.69	50.36	.12
21	88.46		.07	3.27	18.12	24.44	54.10	.12
22	83.70			.31	2.91	31.13	65.65	.11
23	87.00			.37	1.24	31.09	67.30	.11
24	92.26			.35	5.06	32.56	62.04	.11
25	95.37			.67	14.57	42.98	41.78	.14
		Greenish gray clayey sands and sandy clays						
26	87.78		.09	11.56	52.17	21.57	14.61	.34
27	67.51		.12	9.39	43.22	26.87	20.40	.26
28	63.88		.13	5.91	34.32	38.86	20.78	.22
29	58.22			.86	7.99	40.16	50.99	.12
30	24.95			.56	7.06	34.80	57.58	.12
31	40.33			.15	2.64	55.16	42.05	.14
32	30.06			1.40	15.09	33.58	49.93	.13
33	31.32			.38	11.47	15.50	72.65	.10
34	33.33		.18	1.32	8.42	12.52	77.56	.10
35	42.44		.38	2.74	16.57	24.65	55.67	.12
36	70.33	.17	1.67	8.17	24.74	34.24	31.01	.19
		White to gray sands and clayey sands						
37	91.61		.24	1.53	27.75	65.29	5.19	.21
38	93.89			.73	41.10	53.96	4.22	.24
39	91.66		.07	.72	20.58	71.96	6.68	.21
40	96.65	.58	7.52	24.66	50.57	15.47	1.20	.43
41	97.43	1.15	14.66	46.42	32.02	5.12	.63	.62
42	95.38	.29	4.91	28.43	38.24	26.27	1.86	.40
		Olive-drab to tan clayey sands						
43	91.42	.09	.81	6.79	29.52	56.23	6.57	.23
44	85.72		.16	4.93	24.04	59.18	11.68	.21
45	90.27		.18	21.86	39.35	32.61	6.01	.31
46	84.23		.05	1.02	18.17	64.34	16.42	.21

TABLE 6. TRAIL RIDGE DRILL HOLE NO. 2 Continued

Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
	Olive-drab to tan clayey sands							
47	88.02		.09	.52	6.70	78.96	13.73	.18
48	90.71		.07	1.36	13.01	77.48	8.09	.19
49	88.87		.11	2.43	19.74	71.18	6.54	.21
50	92.25	.09	.24	2.76	19.87	70.90	6.14	.21
51	90.76	.09	.20	2.99	19.49	69.67	7.56	.21
52	89.10	.20	.52	5.27	28.06	59.30	6.64	.22
53	23.30	.34	.34	1.89	11.85	35.02	50.56	.12
	Late Miocene shell marl							
54	.95			4.26	17.02	51.06	27.66	.18

*Sample numbers correspond to those of the detailed log in the Appendix.

TABLE 7. TRAIL RIDGE DRILL HOLE NO. 2*
Percentages of Selected Heavy Minerals in
1/8 to 1/16 mm Fraction

Spl.	Unit	Leucoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Surface sands			
1	37	29.39	11.82	0.00	0.00
2	37	31.89	10.63	0.00	0.00
3	37	22.80	19.22	0.00	0.00
4	37	20.07	25.99	0.00	0.00
5	37	12.12	34.24	0.00	0.00
6	37	2.86	53.33	0.00	0.00
7	37	1.60	57.33	0.00	0.00
8	37	3.50	60.51	0.00	0.00
9	37	2.81	57.50	0.00	0.00
10	37	4.59	56.88	0.00	0.00
11	37	3.89	46.11	0.00	0.00
12	37	3.87	51.19	0.00	0.00
13	37	3.28	53.63	0.00	0.00
14	37	2.78	50.93	0.00	0.00
15	37	2.99	61.13	0.00	0.00
16	37	2.76	61.35	0.00	0.00
17	37	5.18	56.10	0.00	0.00
		Intercalated layers of sapropelic sediments and quartz sand			
18	36	13.73	45.42	0.00	0.00
19	35	36.84	8.23	0.00	0.00
20	34	41.67	6.67	0.00	0.00
21	33	21.18	13.24	0.00	0.00
22	32	12.23	36.55	0.00	0.00
23	32	11.61	37.10	0.00	0.00
24	31	6.12	44.39	0.00	.49
25	30	3.40	36.26	0.00	1.29
		Greenish gray clayey sands and sandy clays			
26	29	11.68	37.80	.69	.71
27	28	6.52	58.07	0.00	.66
28	27	4.85	53.07	.65	1.55
29	26	3.93	53.11	1.31	1.25
30	25	6.89	42.62	3.93	.62
31	24	6.73	54.17	.64	.67
32	23	5.23	48.04	1.31	.59
33	22	7.16	44.70	1.15	.80
34	21	6.71	49.70	.91	1.22
35	20	5.12	51.20	1.81	1.32
36	19	1.95	44.81	1.30	.62
		White to gray sands and clayey sands			
37	18	2.37	54.24	1.02	.27
38	17	1.41	38.59	1.41	.95
39	16	2.85	50.95	.32	.56
40	15	2.26	60.38	1.13	1.62
41	14	1.86	57.62	1.12	1.09
42	13	.95	47.87	.47	1.20
		Olive-drab to tan clayey sands			
43	12	2.56	51.99	.57	4.59
44	11	3.34	49.24	.91	4.99
45	10	2.34	50.50	1.34	3.75
46	9	1.60	47.33	1.07	4.24
47	8	1.79	49.11	.60	2.05
48	7	1.00	60.67	1.00	1.90

TABLE 7. TRAIL RIDGE DRILL HOLE NO. 2 Continued

Spl.	Unit	Leucoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Olive-drab to tan clayey sands			
49	6	2.59	54.05	2.27	3.05
50	5	1.66	47.35	2.98	2.90
51	4	1.23	49.39	4.91	1.64
52	3	.67	41.00	25.67	.80
53	2	3.61	39.16	7.23	.93
		Late Miocene shell marl			
54	1	1.10	26.01	39.83	1.61

*Sample and unit numbers correspond to those of the detailed log in the Appendix.

5 feet of the lower zone in TR No. 1 is a peat layer (Spl. 14, Table 2). Other beds or lenses containing wood debris and finely-divided organic matter at the TR No. 1 site are present at depths of 73 feet to 74 feet 6 inches, 77 feet to 78 feet, and 80 feet 6 inches to 84 feet 6 inches (Table 2). The sediments in the lower zone at the TR No. 2 site contain less wood than the sediments in the lower zone at the TR No. 1 site. Nevertheless sediments containing some wood and finely-divided organic matter are present throughout the lower zone at the TR No. 2 site (Spls. 18-25, Table 5).

POST-HAWTHORN CLASTICS

The post-Hawthorn clastics consist of intercalated layers or lenses of quartz sand, clayey sand and massive olive-green or olive-drab clay. In TR No. 1 these sediments have a thickness of 49 feet, extending from a depth of 90 feet below the land surface to a depth of 139 feet (Spls. 22-36, Table 2). The elevation of the upper surface of these clastics is 149 feet; the elevation of the lower surface is 100 feet. In TR No. 2 the post-Hawthorn clastics have a thickness of 84 feet, extending downward from an elevation of 147 feet to an elevation of 63 feet (Spls. 26-53, Table 5). Characteristics of the post-Hawthorn clastics are illustrated by the logs in the Appendix and by data in Tables 2 through 7.

The massive, olive-green clay contains finely-divided organic matter and small fragments of brown wood. These clays apparently accumulated in a restricted marine environment. At the TR No. 1 site rare marine microfossils were observed in the massive olive-green clay which is present at a depth of 106 feet to 107 feet (Spl. 25, Table 2).

LATE MIOCENE SHELL MARL

At some localities in northern peninsular Florida shell marls of late Miocene age are present at the top of the Hawthorn Formation. Such a shell marl was encountered in the TR No. 2 drill hole (Spl. 54, Table 5). The sediments consist of a mixture of cream to white shells, quartz sand, clay and phosphorite. Many of the shells are broken. Macrofossils, mostly mollusks, and foraminifera are abundant. These late Miocene shell beds are believed to be conformable with the underlying Hawthorn sediments and may be conformable with the overlying post-Hawthorn clastics. Such relationships suggest the possibility that in these areas the upper Hawthorn sediments, the shell beds and the post-Hawthorn clastics may all be late Miocene in age.

HAWTHORN FORMATION

The Hawthorn Formation is marine in origin and is characterized by phosphorite. In the areas of Trail Ridge and the Baywood Promontory, the Hawthorn sediments probably are middle to late Miocene in age. The formation

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HAWTHORN FORMATION

The Hawthorn Formation is marine in origin and is characterized by phosphorite. In the areas of Trail Ridge and the Baywood Promontory, the Hawthorn sediments probably are middle to late Miocene in age. The formation

consists of phosphatic sands, clays and dolomites. In TR No. 1 the Hawthorn Formation overlies the Crystal River Formation unconformably and is 175 feet in thickness, extending from a depth of 139 feet below the land surface to a depth of 314 feet (Spls. 37-65, Table 2). The elevation of its upper surface is 100 feet above sea level. The contact between the Hawthorn Formation and the underlying Crystal River Formation is approximately 75 feet below sea level.

The composition or nature of the Hawthorn materials penetrated in TR No. 1 can be summarized in terms of the dominant components of the beds. Of the 175 feet of vertical section of Hawthorn sediments, an aggregate of 62 feet (or 35 per cent of the total thickness) contains more than 50 per cent carbonate, an aggregate of 23 feet (or 13 per cent) contains more than 50 per cent sand, and an aggregate of 12 feet (or 7 per cent) contains more than 50 per cent clay (figures derived from data in Table 2). An aggregate of 77 feet (44 per cent) of the materials consists of mixtures of the various types of clastic sediments and carbonate, with no specific component comprising as much as 50 per cent of the total materials. The percentage of carbonate in sediments can be of interest and should be considered when analyzing land-form development in humid subtropical regions such as Florida.

BAYWOOD PROMONTORY DRILL HOLE

The Baywood Promontory hole was drilled on the crest of the Baywood Promontory in Putnam County about 2½ miles southeast of the town of Florahome. The surface elevation at the site of the hole as determined from the Interlachen Quadrangle map is approximately 210 feet above sea level. Analyses and characteristics of the sediments penetrated in this hole are given in Tables 8 through 10 and in a detailed log presented in the Appendix.

Slightly more than 128 feet of loose quartz sands underlie the ridge crest (Spls. 1-26, Table 8). Beneath these sands are 41 feet of sediments consisting of alternating lenses of fine to very fine quartz sands and massive olive-green or olive-drab clays of the post-Hawthorn clastics (Spls. 27-36, Table 8). These post-Hawthorn clastics lie upon a shell marl of late Miocene age (Spl. 37, Table 8). The shell marl is about 5 feet thick and rests upon 121 feet of phosphatic sands, clays and dolomites of the Miocene Hawthorn Formation (Spls. 38-57, Table 8). The Crystal River Formation of Eocene age lies immediately beneath the Hawthorn sediments (Spl. 58, Table 8).

SURFACE SANDS

The upper 110 feet of sand (Spls. 1-22, Table 8) is massive and is characterized by dark brown to black zones containing a relatively high content of finely-divided organic matter. In addition to the fine organic material, wood debris is present. One log or large limb was encountered from a depth of 60 feet 9 inches to 62 feet 6 inches. A radiocarbon analysis of wood from this log was

consists of phosphatic sands, clays and dolomites. In TR No. 1 the Hawthorn Formation overlies the Crystal River Formation unconformably and is 175 feet in thickness, extending from a depth of 139 feet below the land surface to a depth of 314 feet (Spls. 37-65, Table 2). The elevation of its upper surface is 100 feet above sea level. The contact between the Hawthorn Formation and the underlying Crystal River Formation is approximately 75 feet below sea level.

The composition or nature of the Hawthorn materials penetrated in TR No. 1 can be summarized in terms of the dominant components of the beds. Of the 175 feet of vertical section of Hawthorn sediments, an aggregate of 62 feet (or 35 per cent of the total thickness) contains more than 50 per cent carbonate, an aggregate of 23 feet (or 13 per cent) contains more than 50 per cent sand, and an aggregate of 12 feet (or 7 per cent) contains more than 50 per cent clay (figures derived from data in Table 2). An aggregate of 77 feet (44 per cent) of the materials consists of mixtures of the various types of clastic sediments and carbonate, with no specific component comprising as much as 50 per cent of the total materials. The percentage of carbonate in sediments can be of interest and should be considered when analyzing land-form development in humid subtropical regions such as Florida.

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The composition or nature of the Hawthorn materials penetrated in TR No. 1 can be summarized in terms of the dominant components of the beds. Of the 175 feet of vertical section of Hawthorn sediments, an aggregate of 62 feet (or 35 per cent of the total thickness) contains more than 50 per cent carbonate, an aggregate of 23 feet (or 13 per cent) contains more than 50 per cent sand, and an aggregate of 12 feet (or 7 per cent) contains more than 50 per cent clay (figures derived from data in Table 2). An aggregate of 77 feet (44 per cent) of the materials consists of mixtures of the various types of clastic sediments and carbonate, with no specific component comprising as much as 50 per cent of the total materials. The percentage of carbonate in sediments can be of interest and should be considered when analyzing land-form development in humid subtropical regions such as Florida.

BAYWOOD PROMONTORY DRILL HOLE

The Baywood Promontory hole was drilled on the crest of the Baywood Promontory in Putnam County about 2½ miles southeast of the town of Florahome. The surface elevation at the site of the hole as determined from the Interlachen Quadrangle map is approximately 210 feet above sea level. Analyses and characteristics of the sediments penetrated in this hole are given in Tables 8 through 10 and in a detailed log presented in the Appendix.

Slightly more than 128 feet of loose quartz sands underlie the ridge crest (Spls. 1-26, Table 8). Beneath these sands are 41 feet of sediments consisting of alternating lenses of fine to very fine quartz sands and massive olive-green or olive-drab clays of the post-Hawthorn clastics (Spls. 27-36, Table 8). These post-Hawthorn clastics lie upon a shell marl of late Miocene age (Spl. 37, Table 8). The shell marl is about 5 feet thick and rests upon 121 feet of phosphatic sands, clays and dolomites of the Miocene Hawthorn Formation (Spls. 38-57, Table 8). The Crystal River Formation of Eocene age lies immediately beneath the Hawthorn sediments (Spl. 58, Table 8).

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The upper 110 feet of sand (Spls. 1-22, Table 8) is massive and is characterized by dark brown to black zones containing a relatively high content of finely-divided organic matter. In addition to the fine organic material, wood debris is present. One log or large limb was encountered from a depth of 60 feet 9 inches to 62 feet 6 inches. A radiocarbon analysis of wood from this log was

made by the Radiocarbon Laboratories of the Florida State University. That laboratory determined the apparent age as 31,400 ±500 years (Pirkle and Yoho, 1970). The quartz sands from a depth of 110 feet to 128 feet are finely laminated (Spls. 23-26, Table 8). The laminations are shown by stringers of black heavy minerals.

OLIVE-GREEN CLAYS OF POST-HAWTHORN CLASTICS

Sediments consisting of intercalated layers or lenses of massive olive-green clay and fine to very fine quartz sand begin at a depth of 128 feet and continue to a depth of 169 feet (Spls. 27-36, Table 8). These post-Hawthorn clastics appear almost identical to the post-Hawthorn clastics encountered from a depth of 90 feet to 139 feet in TR No. 1 (Spls. 22-36, Table 2).

In addition to finely-divided organic matter, brown wood and wood fibers are present in the olive-green clays. Wood debris was noted in the clays of Units 32, 30 and 27 (Spls. 27, 29 and 35, Table 8). In addition to wood, leaf impressions were seen in the clays of Unit 27. Furthermore the sediments throughout the interval contain a small amount of pebble-size and sand-size black phosphorite.

LATE MIOCENE SHELL MARL

A late Miocene shall marl is present at the top of the Hawthorn Formation (Spl. 37, Table 8). Green hornblende constitutes approximately 5 per cent of the 1/8 to 1/16 mm fraction of heavy minerals in the bed. This mineral also is relatively abundant in the quartz sand collected immediately over the shell bed (Spl. 36, Table 8). In no other sediments from this drill hole is hornblende an important constituent of the heavy mineral suite, although occasional grains are present, particularly in the sediments of the upper part of the Hawthorn Formation and in the post-Hawthorn clastics. The significance of the green hornblende is not known.

HAWTHORN FORMATION

Of the 107 feet of Hawthorn sediments sampled, an aggregate of about 30 feet (28 per cent) contains more than 50 per cent carbonate, an aggregate of 36 feet (34 per cent) contains more than 50 per cent quartz sand, and an aggregate of 4 feet (4 per cent) contains more than 50 per cent clay (Table 8). In the remainder, a total of approximately 36 feet of the sediments (34 per cent), no one component makes up as much as 50 per cent of the total material. The Hawthorn sediments at this particular locality contain slightly less carbonate than the Hawthorn sediments encountered in the TR No. 1 drill hole.

TABLE 8. BAYWOOD PROMONTORY DRILL HOLE*
SW¼, NW¼, Section 18, T. 9 S., R. 25 E., Putnam County, Florida
Approximately 2½ Miles Southeast of Florahome
Surface Elevation, 210 Feet (Estimate)

Spl.	Unit	Depth feet and inches	Insoluble Residue: Quartz sand in %	Insoluble Residue: Clay (-325 mesh) in %	Total soluble in %	P_2O_5 in %	Total heavies in %
		Loose Surface sands with organic zones (elev. 210 ft.)					
1	34	0-5'	98.14	.90	–	–	.31
2	34	5'-10'	98.65	.10	–	–	.27
3	34	10'-15'	98.13	.30	–	–	.38
4	34	15'-20'	98.67	.40	–	–	.80
5	34	20'-25'	97.13	2.09	–	–	.45
6	34	25'-30'	98.53	.70	–	–	.63
7	34	30'-35'	94.72	4.08	–	–	.58
8	34	35'-40'	96.52	2.29	–	–	.52
9	34	40'-45'	96.35	3.49	–	–	.54
10	34	45'-50'	94.20	5.40	–	–	.50
11	34	50'-55'	96.86	2.19	–	–	.46
12	34	55'-60'	95.58	3.29	–	–	.62
13	34	60'-65'	98.73	.60	–	–	.67
14	34	65'-70'	96.46	1.79	–	–	.42
15	34	70'-75'	96.12	2.29	–	–	.56
16	34	75'-80'	96.00	3.48	–	–	.41
17	34	80'-85'	96.31	2.49	–	–	.52
18	34	85'-90'	94.75	3.88	–	–	.35
19	34	90'-95'	96.01	3.00	–	–	.25
20	34	95'-100'	92.94	5.98	–	–	.30
21	34	100'-105'	95.61	1.80	–	–	.55
22	34	105'-110'	93.88	2.09	–	–	.49
		Finely laminated sands (elev. 100 ft.)					
23	33	110'-114'6"	91.93	2.79	–	–	1.18
24	33	114'6"-120'	96.91	.60	–	–	.88
25	33	120'-125'	94.03	2.69	–	–	.90
26	33	125'-128'3"	95.42	2.29	–	–	1.12
		Intercalated layers of massive olive-drab clay and quartz sand (elev. 81'9")					
27	32	128'3"-129'3"	18.43	76.34	5.17	.98	.39
28	31	129'3"-130'6"	88.63	8.86	2.29	.42	.93
29	30	130'6"-132'	26.86	66.85	6.19	1.09	.39
30	28	141'-145'	90.92	4.59	4.09	.84	.66
31	28	145'-150'	91.55	5.20	2.80	.63	.52
32	28	150'-155'	90.63	5.48	3.49	.74	.72
33	28	155'-160'	87.99	7.29	4.10	1.07	.87
34	28	160'-163'6"	81.90	9.57	7.78	2.16	.74
35	27	163'6"-167'	3.72	86.99	9.21	2.04	.06
36	26	167'-169'	82.27	5.48	9.87	2.80	1.17
		Shell marl, Late Miocene (elev. 41 ft.)					
37	25	169'-174'	38.33	8.37	52.90	4.22	.30
		Hawthorn Formation, Miocene (elev. 36 ft.)					
38	24	174'-187'	60.50	10.05	28.96	2.81	.35
39	23	187'-193'	26.27	5.07	68.52	1.67	.06
40	21	201'-208'6"	1.24	13.77	84.98	.43	.004
41	20	208'6"-213'	42.74	4.79	52.41	1.79	.14
42	18	219'-234'	50.08	19.74	22.53	2.95	.69
43	17	234'-238'	.46	83.01	16.35	1.13	.02
44	16	238'-239'	.43	14.46	85.12	.72	.002

TABLE 8. BAYWOOD PROMONTORY DRILL HOLE Continued

Spl.	Unit	Deepth in feet and inches	Quartz sand in %	Clay (-325 mesh) in %	Total soluble in %	P_2O_5 in %	Total heavies in %
		Hawthorn Formation, Miocene (elev. 36 ft.)					
		Hawthorn Formation, Miocene (elev. 41 ft.)					
45	15	239'-240'	63.70	15.96	20.06	3.30	.14
46	14	240'-241'	17.24	15.20	67.30	2.41	.11
47	13	241'-243'	57.90	17.76	23.64	3.05	.36
48	12	243'-245'	35.67	15.46	48.58	1.19	.47
49	11	245'-248'	63.25	18.80	17.21	2.45	.57
50	10	248'-251'6"	25.63	9.65	64.27	6.74	.21
51	9	251'6"-262'	28.89	17.25	51.74	2.41	.15
52	8	262'-264'6"	53.95	29.21	15.65	2.84	.16
53	7	264'6"-267'	38.66	7.46	53.30	1.20	.08
54	6	267'-274'	20.14	44.61	32.26	3.99	.21
55	5	274'-284'	11.45	4.42	83.75	8.05	.18
56	4	284'-292'6"	37.25	6.87	55.78	3.73	.12
57	3	292'6"-295'	16.64	4.17	79.01	7.18	.06
		Crystal River Formation, Eocene (elev. 87 ft.)					
58	1	297'-302'	.12	.30	99.58	.26	.002

*Sample and unit number correspond to those of the detailed log in the Appendix.

TABLE 9. BAYWOOD PROMONTORY DRILL HOLE

Mechanical Analyses of Quartz Sand Extracted From Sediments

		Per cent quartz sand retained on mesh						
Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
Loose surface sands with organic zones								
1	98.14		.04	.33	9.54	79.64	10.46	.18
2	98.65		.04	.48	12.75	78.02	8.71	.19
3	98.13		.10	.95	13.71	77.85	7.38	.19
4	98.67		.04	.59	10.98	81.31	7.09	.19
5	97.13			.27	9.49	81.58	8.67	.19
6	98.53		.06	.50	11.41	81.51	6.52	.18
7	94.72			.40	11.08	83.18	5.34	.19
8	96.52			.31	13.09	81.88	4.72	.19
9	96.35			.31	11.68	81.87	6.13	.19
10	94.20			.47	13.45	80.42	5.66	.19
11	96.86			.23	10.35	83.36	6.06	.19
12	95.58			.13	7.11	85.73	7.04	.19
13	98.73			.16	7.29	87.40	5.15	.19
14	96.46			.23	8.54	84.15	7.08	.19
15	96.12		.04	.08	4.73	89.00	6.14	.19
16	96.00			.06	2.72	93.90	3.32	.19
17	96.31			.37	14.11	80.40	5.11	.19
18	94.75		.02	.36	14.89	82.14	2.58	.20
19	96.01		.04	.69	23.55	74.40	1.33	.21
20	92.94			.36	13.23	82.78	3.63	.20
21	95.61			.46	12.72	82.60	4.22	.20
22	93.88			.19	11.71	85.40	2.70	.19
Finely laminated sands								
23	91.93			.22	10.42	85.53	3.83	.20
24	96.91			.23	13.24	83.38	3.15	.20
25	94.03			.13	7.62	87.36	4.89	.19
26	95.42			.88	12.38	77.80	8.90	.19
Intercalated layers or lenses of massive olive-drab clay and quartz sand								
27	18.43			.65	11.97	75.94	11.43	.19
28	88.63			.04	1.84	71.12	26.99	.16
29	26.86			.15	3.86	61.66	34.32	.15
30	90.92			.07	.75	56.69	42.49	.14
31	91.55			.02	.28	54.70	44.99	.13
32	90.63			.04	.88	47.27	51.80	.12
33	87.99			.07	1.02	26.57	72.34	.11
34	81.90		.07	.19	4.11	40.43	55.19	.12
35	3.72			1.08	8.60	50.00	40.32	.14
36	82.27		.07	.46	7.81	45.14	46.52	.13
Shell marl, Late Miocene								
37	38.33	.26	1.09	5.93	37.37	43.81	11.54	.24
Hawthorn Formation, Miocene								
38	60.50		1.81	10.00	24.41	50.07	13.72	.23
39	26.27	.91	10.30	24.83	35.43	22.79	5.75	.40
40	1.24			11.48	26.23	55.74	6.56	.23
41	42.74		3.64	29.52	51.56	13.87	1.40	.41
42	50.08		3.07	9.51	21.82	23.89	41.72	.17
43	.46			8.70	13.04	21.74	56.52	.12
44	.43			14.29	42.86	28.57	14.29	.29
45	63.70		1.85	6.74	63.38	14.54	13.50	.34
46	17.24	.58	3.02	7.08	45.71	24.13	19.49	.28

TABLE 9. BAYWOOD PROMONTORY DRILL HOLE Continued

Spl.	Quartz sand in %	10	18	35	60	120	230	Median (diam. mm.)
				Hawthorn Formation, Miocene				
47	57.90	.10	2.34	7.41	36.42	26.15	27.57	.23
48	35.67		2.01	9.84	7.21	45.19	35.74	.16
49	63.25	.13	3.11	13.27	8.43	28.94	46.12	.14
50	25.63	.70	3.57	13.98	31.06	25.47	25.23	.25
51	28.89		.97	6.42	19.32	25.33	47.96	.13
52	53.95	.18	1.03	11.75	42.39	22.69	21.95	.28
53	38.66		.77	11.27	71.86	8.23	7.87	.38
54	20.14	.99	3.96	29.67	15.23	13.16	36.99	.25
55	11.45		1.58	18.07	40.35	11.05	28.95	.31
56	37.25			12.37	78.51	7.76	1.36	.39
57	16.64		.36	3.11	75.15	15.89	5.50	.36
				Crystal River Formation, Eocene				
58	.12				33.33	50.00	16.67	.21

*Sample numbers correspond to those of the detailed log in the Appendix.

TABLE 10. BAYWOOD PROMONTORY DRILL HOLE
Percentage of Selected Heavy Mineral in
1/8 to 1/16 mm Fraction

Spl.	Unit	Leucoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Loose surface sands with organic zones			
1	34	10.96	35.22	11.63	0.00
2	34	17.98	27.13	12.30	.28
3	34	14.52	41.58	5.94	.98
4	34	19.31	25.23	1.25	0.00
5	34	15.03	34.36	.61	0.00
6	34	14.45	32.37	0.00	0.00
7	34	14.24	44.98	0.00	0.00
8	34	13.58	49.07	0.00	0.00
9	34	8.00	47.67	0.00	0.00
10	34	10.66	46.71	0.00	0.00
11	34	6.69	55.32	0.00	0.00
12	34	16.96	33.33	0.00	0.00
13	34	13.44	43.93	0.00	0.00
14	34	18.58	43.34	0.00	0.00
15	34	26.07	29.75	0.00	0.00
16	34	13.89	37.65	0.00	0.00
17	34	27.62	22.54	0.00	0.00
18	34	12.06	43.49	0.00	0.00
19	34	4.67	65.73	0:00	0.00
20	34	3.46	57.23	0.00	2.37
21	34	6.01	49.05	0.00	2.55
22	34	3.85	58.97	1.28	5.57
		Finely laminated sands			
23	33	1.81	59.34	17.17	2.81
24	33	2.75	48.93	15.60	2.19
25	33	1.85	47.08	14.46	3.94
26	33	2.43	50.15	7.90	2.34
		Intercalated layers or lenses of massive olive-drab clay and quartz sand			
27	32	1.23	50.31	12.65	3.45
28	31	2.33	27.57	19.93	2.58
29	30	4.17	41.67	15.38	3.24
30	28	1.27	23.25	26.75	2.26
31	28	2.56	24.92	34.50	1.54
32	28	1.63	30.72	29.41	2.41
33	28	2.98	26.49	33.44	.32
34	28	3.38	35.08	28.92	2.42
35	27	.62	32.20	20.43	1.80
36	26	1.99	27.24	23.92	2.09
		Shell marl, Late Miocene			
37	25	.98	34.43	20.66	1.61
		Hawthorn Formation, Miocene			
38	24	.96	22.68	15.65	3.38
39	23	2.12	34.85	8.48	3.10
40	21	3.93	32.13	8.20	.74
41	20	1.00	35.67	12.67	4.34
42	18	.98	33.44	10.82	4.55
43	17	3.78	28.11	9.19	7.59
44	16	3.96	51.49	1.98	2.97
45	15	2.77	44.31	2.46	5.71
46	14	4.30	46.03	1.99	5.48
47	13	2.33	42.52	3.32	4.24
48	12	2.97	49.26	.30	3.10

TABLE 10. BAYWOOD PROMONTORY DRILL HOLE Continued

Spl.	Unit	Leucoxene in %	Ilmenite in %	Epidote in %	Garnet in %
		Hawthorn Formation, Miocene			
49	11	5.36	53.00	1.58	6.98
50	10	2.45	50.35	1.05	6.94
51	9	1.52	35.67	1.52	7.16
52	8	2.11	46.22	2.11	5.31
53	7	3.95	34.21	3.95	4.87
54	6	4.61	39.17	2.23	7.38
55	5	2.61	46.08	1.31	5.72
56	4	1.82	39.27	1.09	9.38
57	3	0.00	27.86	2.14	14.59
		Crystal River Formation, Eocene			
58	1	0.00	34.88	0.00	6.67

made by the Radiocarbon Laboratories of the Florida State University. That laboratory determined the apparent age as 31,400 ±500 years (Pirkle and Yoho, 1970). The quartz sands from a depth of 110 feet to 128 feet are finely laminated (Spls. 23-26, Table 8). The laminations are shown by stringers of black heavy minerals.

OLIVE-GREEN CLAYS OF POST-HAWTHORN CLASTICS

Sediments consisting of intercalated layers or lenses of massive olive-green clay and fine to very fine quartz sand begin at a depth of 128 feet and continue to a depth of 169 feet (Spls. 27-36, Table 8). These post-Hawthorn clastics appear almost identical to the post-Hawthorn clastics encountered from a depth of 90 feet to 139 feet in TR No. 1 (Spls. 22-36, Table 2).

In addition to finely-divided organic matter, brown wood and wood fibers are present in the olive-green clays. Wood debris was noted in the clays of Units 32, 30 and 27 (Spls. 27, 29 and 35, Table 8). In addition to wood, leaf impressions were seen in the clays of Unit 27. Furthermore the sediments throughout the interval contain a small amount of pebble-size and sand-size black phosphorite.

LATE MIOCENE SHELL MARL

A late Miocene shall marl is present at the top of the Hawthorn Formation (Spl. 37, Table 8). Green hornblende constitutes approximately 5 per cent of the 1/8 to 1/16 mm fraction of heavy minerals in the bed. This mineral also is relatively abundant in the quartz sand collected immediately over the shell bed (Spl. 36, Table 8). In no other sediments from this drill hole is hornblende an important constituent of the heavy mineral suite, although occasional grains are present, particularly in the sediments of the upper part of the Hawthorn Formation and in the post-Hawthorn clastics. The significance of the green hornblende is not known.

HAWTHORN FORMATION

Of the 107 feet of Hawthorn sediments sampled, an aggregate of about 30 feet (28 per cent) contains more than 50 per cent carbonate, an aggregate of 36 feet (34 per cent) contains more than 50 per cent quartz sand, and an aggregate of 4 feet (4 per cent) contains more than 50 per cent clay (Table 8). In the remainder, a total of approximately 36 feet of the sediments (34 per cent), no one component makes up as much as 50 per cent of the total material. The Hawthorn sediments at this particular locality contain slightly less carbonate than the Hawthorn sediments encountered in the TR No. 1 drill hole.

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In addition to finely-divided organic matter, brown wood and wood fibers are present in the olive-green clays. Wood debris was noted in the clays of Units 32, 30 and 27 (Spls. 27, 29 and 35, Table 8). In addition to wood, leaf impressions were seen in the clays of Unit 27. Furthermore the sediments throughout the interval contain a small amount of pebble-size and sand-size black phosphorite.

LATE MIOCENE SHELL MARL

A late Miocene shall marl is present at the top of the Hawthorn Formation (Spl. 37, Table 8). Green hornblende constitutes approximately 5 per cent of the 1/8 to 1/16 mm fraction of heavy minerals in the bed. This mineral also is relatively abundant in the quartz sand collected immediately over the shell bed (Spl. 36, Table 8). In no other sediments from this drill hole is hornblende an important constituent of the heavy mineral suite, although occasional grains are present, particularly in the sediments of the upper part of the Hawthorn Formation and in the post-Hawthorn clastics. The significance of the green hornblende is not known.

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HEAVY MINERALS IN SEDIMENTS

In Tables 4, 7 and 10 the percentages for certain selected heavy minerals are given for the 1/8 to 1/16 mm fraction of sediments. Ilmenite and leucoxene are included in the tables because these are important ore minerals of titanium. Furthermore, leucoxene is a weathering product of ilmenite and can be of interest in problems concerning geological history. Epidote and garnet are given because these two heavy minerals are relatively easily destroyed through weathering in humid subtropical climates and are of interest in problems of correlation.

TRAIL RIDGE DRILL HOLES

A number of features of the distribution of heavy minerals are evident from an examination of the data in Tables 4 and 7. Ilmenite is relatively abundant in the upper sand zone of the Trail Ridge sequence (Spls. 1-13, Table 4; Spls. 1-17, Table 7). Although not recorded in these tables, zircon likewise is relatively abundant in these upper sands. This increase in ilmenite and zircon should be expected. As the quantity of heavy minerals increases in sediments, heavy minerals that have the highest specific gravities tend to be concentrated at the expense of heavy minerals with lower specific gravities (Martens, 1935, p. 1585).

A conspicuous feature of the heavy mineral distribution is the occurrence of epidote and garnet. Epidote is completely absent in the sediments of the Trail Ridge sequence (Spls. 1-21, Table 4; Spls. 1-25, Table 7). The mineral is present in varying amounts in almost all of the materials penetrated beneath the Trail Ridge sequence (Tables 4 and 7). At the site of TR No. 1 there is a sharp increase in epidote in the upper 45 to 50 feet of the Hawthorn Formation (Spls. 37-45, Table 4). At the TR No. 2 locality the amount of epidote increases markedly in the late miocene shell bed and in the immediately overlying sediments of the post-Hawthorn clastics (Spls. 52-54, Table 7). A sharp increase in epidote in the upper sediments of the Hawthorn Formation and in late Miocene shell beds has been recorded for other localities in northern peninsular Florida (Pirkle et al., 1965, p. 14 and p. 18).

Garnet is almost totally absent in the Trail Ridge sequence of sediments (Spls. 1-21, Table 4; Spls. 1-25, Table 7). This mineral is present, however, in all of the sediments of the post-Hawthorn clastics, the late Miocene shell marl, and the Hawthorn Formation (Spls. 22-65, Table 4; Spls. 26-54, Table 7). At the site of TR No. 1 there is an increase in garnet in the lower 30 feet of the Hawthorn Formation (Spls. 59-65, Table 4).

The distribution of leucoxene is intriguing. In the Trail Ridge drill holes the amount of this mineral is relatively high from the land surface to a depth of about 10 to 15 feet (Spls. 1-3, Table 4; Spls. 1-5, Table 7). The high content of leucoxene with a corresponding low content of ilmenite indicates that ilmenite has been weathered *in situ* to give much of the leucoxene. Similar relationships

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between ilmenite and leucoxene are present in the upper part of the lower zone of the Trail Ridge sequence (Spls. 18-23, Table 7). The relatively high content of leucoxene with a corresponding low content of ilmenite suggests that the lower zone of the Trail Ridge sequence accumulated in a subaerial environment or was exposed to such an environment before the deposition of the overlying quartz sand zone.

BAYWOOD PROMONTORY DRILL HOLE

Table 10 gives data for the four selected heavy minerals extracted from the 1/8 to 1/16 mm size fraction of sediments from the Baywood Promontory drill hole. In the first 90 feet of sediments the content of leucoxene is relatively high (Spls. 1-18, Table 10). None of the sediments underlying these upper 90 feet of sands contains nearly as much leucoxene. Furthermore from the land surface to a depth of about 12 or 15 feet the sands contain substantial epidote and a trace of garnet (Spls. 1-3, Table 10). The problems raised by the presence of epidote in the upper sands at this site have not been solved.

The finely-laminated sands from 110 feet to 128 feet contain a relatively high amount of epidote (Spls. 23-26, Table 10). This high content of epidote continues downward through the intercalated layers of olive-green clay and quartz sand (Spls. 27-36, Table 10), through the late Miocene shell marl (Spl. 37, Table 10) and well into the upper part of the Hawthorn Formation (Spls. 38-43, Table 10). The heavy mineral distribution is consistent with the possibility that the upper Hawthorn sediments, the late Miocene shell marl and the post-Hawthorn clastics are closely related, and may, in fact, all be late Miocene in age.

The cores from this core hole are on file at the Bureau of Geology, Tallahassee, Florida. The file number is W-8400.

RIDGES IN STUDY AREA

The quartz sand in the upper sand zone of the Trail Ridge sequence is characterized by its uniform size distribution (Spls. 1-13, Table 3; Spls. 1-17, Table 6). In fact, this uniform size distribution is one of the most striking features of these Trail Ridge sands. In general from about 50 to 70 per cent of the quartz sand is medium in size (+60 mesh to -35 mesh, 1/4 to 1/2 mm), and approximately 25 to 40 per cent of the sand is fine (+120 mesh to -60 mesh, 1/8 to 1/4 mm). The size of the quartz sand composing the Baywood Promontory is markedly different. The Baywood Promontory sands are very high in the fine fraction (+120 mesh to -60 mesh). Approximately 80 to 90 per cent of the total sand is this size (Spls. 1-26, Table 9).

Certainly the sands making up Trail Ridge and the Baywood Promontory are very different. Such a pronounced difference indicates the possibility that these ridges formed along different shore lines. If these ridges formed along different

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Certainly the sands making up Trail Ridge and the Baywood Promontory are very different. Such a pronounced difference indicates the possibility that these ridges formed along different shore lines. If these ridges formed along different

shore lines, it seems plausible that some of the other ridges and sand hills in the area would be related to the shore line along which the sands of Trail Ridge accumulated, and other sand hills and ridges would be related to the shore line along which the sands of the Baywood Promontory accumulated. Furthermore, the sand-size distribution of the quartz grains might be an aid in recognizing and distinguishing the different sand hills and ridges. Sand samples, therefore, were collected through the study area and analyzed (Fig. 2).

The results of these analyses reveal that there are, in fact, two distinct sets of ridges in the study area (Pirkle and Yoho, 1970). One set occurs along the western side of the area of Citronelle outcrop and tends to wrap around and to partly cover the northern end of the outcrop area. These ridges and hills are composed of sand of the Trail Ridge type. The second set of ridges is present along the eastern side of the Citronelle area of outcrop. The sands of these ridges are similar to the sands of the Baywood Promontory. The valley followed by the North Fork of Black Creek separates the Trail Ridge type to the west from the Baywood Promontory type to the east. At some sites around the northern end the area of Citronelle outcrop, sand hills and ridges of the Baywood Promontory type appear to truncate sand hills and ridges of the Trail Ridge type. Therefore the ridges of the Baywood Promontory type apparently are younger than ridges and sand hills of the Trail Ridge type, thus giving more reason to believe that these two sets of ridges might be genetically related to different shore lines. Additional considerations of the data given for the Trail Ridge drill holes and for the Baywood Promontory drill hole lend further insights into the occurrences and characteristics of the sand hills and ridges.

TRAIL RIDGE

The base of the Trail Ridge sequence is approximately 149 feet above present sea level in TR No. 1 (Table 2) and 147 feet in TR No. 2 (Table 5). The break is distinct. In addition to a change in the nature of the sediments, there is a change in the nature of the heavy mineral suites. The almost total absence of epidote and garnet in the sediments of the Trail Ridge sequence and the presence of these minerals in almost all of the materials underlying the Trail Ridge sequence presents a problem. Either the minerals were never deposited in the Trail Ridge sediments, or the minerals were deposited with the sediments and later destroyed through weathering. If the epidote and garnet have been removed from the Trail Ridge sequence by weathering *in situ,* the break between the Trail Ridge sequence and the underlying post-Hawthorn clastics might not be of major stratigraphic importance. On the other hand, if epidote was never deposited in the sediments of the Trail Ridge sequence, the implications of the stratigraphic break between the Trail Ridge sequence and the underlying post-Hawthorn clastics would be more far-reaching.

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Of interest to the problem is the fact that epidote is not present in the peaty and sapropelic sediments of the lower zone of the Trail Ridge sequence (Spls.

14-21, Table 4; Spls. 18-25, Table 7). Apparently epidote was never deposited in the sediments, or if deposited was destroyed by weathering while the sediments were accumulating. If the sediments of the lower zone of the Trail Ridge sequence had been subjected to severe weathering under subtropical conditions during post-depositional time, it seems reasonable to assume that the wood and other organic matter so common in that lower part of the Trail Ridge sequence would have been destroyed. Perhaps it could be argued that because of the presence of organic matter, acids formed during post-depositional times and played a role in leaching out epidote and garnet from the peaty and sapropelic sediments of the Trail Ridge sequence. However, the question could then be asked why acids did not form and leach out epidote and garnet from the olive-green clays and quartz sands of the post-Hawthorn clastics immediately underlying the Trail Ridge sequence. The olive-green clays and clayey sands carry wood and finely-divided organic matter. There is no reason to believe that beds of fine sand and other large parts of the post-Hawthorn clastics are less permeable to the movements of ground water than are large parts of the peaty and sapropelic sediments present in the lower zone of the Trail Ridge sequence.

It must be concluded that the break between the Trail Ridge sequence and the underlying sediments is characterized by original differences in the sediments. Also the break is characterized by differences in the heavy mineral suites. This break is at an elevation of about 150 feet above present sea level.

BAYWOOD PROMONTORY

The Baywood Promontory is underlain by a thick section of quartz sand. There is a sharp break at a depth of 110 feet beneath the ridge crest. This depth is at an elevation of approximately 100 feet above present sea level. The loose sands underlying the break are finely laminated in contrast to the massive character of the overlying sands. In addition, the heavy mineral suites are different. The finely-laminated sands are characterized by a relatively high content of epidote (Spls. 23-26, Table 10). It is significant that there is a sharp change in the heavy mineral suites and in the sedimentary features at the same depth. It is also significant that there is no change in the size of the quartz sand, thus indicating that the sand-size distribution of the quartz grains is not the controlling factor in the presence or absence of epidote.

The break at a depth of 110 feet (elevation 100 feet) is important. Suppose, for example, that the sediments from the land surface downward through the olive-green clay portion of the post-Hawthorn clastics (or the upper 169 feet of the sediments) are alternating terrestrial, shore-line, and lagoonal deposits laid down along a fluctuating coast line. In such a case the massive surface sands might be wind-blown or beach ridge deposits that pass downward into lagoonal or marine sediments. The depth at which the massive sands pass downward into lagoonal or other marine sediments would correlate with the changes in sedimentary features and heavy mineral suites. The depth at which these changes take place is at an elevation of approximately 100 feet above present sea level.

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The Baywood Promontory is underlain by a thick section of quartz sand. There is a sharp break at a depth of 110 feet beneath the ridge crest. This depth is at an elevation of approximately 100 feet above present sea level. The loose sands underlying the break are finely laminated in contrast to the massive character of the overlying sands. In addition, the heavy mineral suites are different. The finely-laminated sands are characterized by a relatively high content of epidote (Spls. 23-26, Table 10). It is significant that there is a sharp change in the heavy mineral suites and in the sedimentary features at the same depth. It is also significant that there is no change in the size of the quartz sand, thus indicating that the sand-size distribution of the quartz grains is not the controlling factor in the presence or absence of epidote.

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It must be recognized, however, that it would be difficult to account for the lack of epidote in the sands of dunes and ridges that accumulated on the landward side of a shore line along which epidote was common. Studies along present-day sea coasts show that all of the various kinds of heavy minerals common along shore lines are deposited in the sand dune areas landward from the shore lines. In fact, some of the lighter heavy minerals are more concentrated in the sand dune areas (Gillson, 1959, P. 425).

Actually a case can be built that the laminated quartz sands, which begin at a depth of 110 feet, and the underlying olive-green clays and quartz sands of the post-Hawthorn clastics are older than the massive surface sands making up the Baywood Promontory and are separated from those upper massive sands by a significant stratigraphic interval. The heavy mineral distribution is consistent with this possibility. Furthermore the olive-green or olive-drab clays, the late Miocene shell beds and the Hawthorn materials contain black phosphorite and small amounts of feldspar. These minerals are almost totally absent in the massive surface sands. It is evident that the break between the massive surface sands and the underlying sediments is one along which there is a change in sedimentary features and a change in heavy mineral suites. This break is at an elevation of approximately 100 feet above present sea level, an elevation given by numerous workers for one of the ancient sea-level stands.

ELEVATIONS OF SEA-LEVEL STANDS

If these breaks at 150 feet and 100 feet above present sea level do represent elevations at which terrestrial or beach sediments pass downward into lagoonal, deltaic or marine materials, a question still remains as to whether the elevations represent the highest elevations of sea-level rises recorded in the area. A fuller understanding of this problem requires the consideration of another ridge, the Lake Wales Ridge (Fig. 1).

The Lake Wales Ridge is present in central peninsular Florida. It trends in a generally north-south direction (slightly northwest-southeast) dividing the peninsula into two nearly equal parts. The ridge is underlain by Citronelle sediments which usually rest on the Hawthorn Formation. The Citronelle materials consist of mixtures of quartz sand, quartz granules and kaolinitic clay. Locally quartz or quartzite pebeles are abundant. In some areas much of the Lake Wales Ridge has been destroyed by erosion. Nevertheless, in such areas the characteristic Citronelle sediments may indicate the former presence of the ridge.

The Lake Wales Ridge is older than Trail Ridge or the Baywood Promontory (Pirkle et al., 1963, p. 128-135). Citronelle sediments making up much of the Lake Wales Ridge have been dated as late Miocene by Ketner and McGreevy (1959, p. 49). This date is based on occurrences of invertebrate fossils. Trail Ridge, on the other hand, cannot be older than Pliocene (Pirkle and Yoho, 1970), and the Baywood Promontory is still younger than Trail Ridge.

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Therefore, within the study area the older Lake Wales remnant, revealed by the presence of the characteristic Citronelle sediments, occupies a central position (Fig. 2). It is flanked on the west by Trail Ridge, and it is flanked on the east by Baywood Promontory. The seas along whose shore lines Trail Ridge and the Baywood Promontory formed must have encroached on the older Lake Wales remnant.

PRESENT INTERPRETATION

The stratigraphic position and age of the post-Hawthorn clastics underlying Trail Ridge and the Baywood Promontory are critical in arriving at the correct interpretation of the ridges. Suppose, for example, that the post-Hawthorn clastics are late Miocene in age. Trail Ridge and the Baywood Promontory could then be interpreted as beach ridges formed where seas reached their highest advances during encroachment on the Lake Wales remnant. If, on the other hand, the post-Hawthorn clastics are lagoonal materials genetically related to the same shore lines along which Trail Ridge formed and along which the sands of the Baywood Promontory accumulated, it could be concluded that the ridges formed during standstills of regressing seas.

Although unquestioned conclusions cannot be drawn, the writers believe that the olive-green clays and fine to very fine quartz sands of the post-Hawthorn clastics are more closely related to the late Miocene shell beds than to the overlying surface sands, and that the Baywood Promontory and the southern part of Trail Ridge formed as beach ridges.

The Baywood Promontory, therefore, could be interpreted as a beach ridge formed along a "100-foot shore line" at a time the 100-foot seas reached their highest encroachment on the Lake Wales remnant. This interpretation would be consistent with conclusions drawn by numerous investigators from a study of surface topography, and a vertical section through the Baywood Promontory would give a valid height which would approximate the elevation to which the ancient 100-foot seas rose.

The interpretation of Trail Ridge, however, is more complicated, and conclusions drawn from a consideration of the sediments underlying the ridge are not as easily fitted to conclusions that have been drawn from studies of surface features. For example, various interpretations can be given to the sediments of the lower sapropelic zone of the Trail Ridge sequence. In fact a case can be made that the Trail Ridge seas rose to elevations higher than 150 feet above present sea level and may have covered the Lake Wales remnant. Although the southern part of Trail Ridge is believed to be a beach ridge formed along the flanks of the Lake Wales remnant, sufficient data are not available to establish whether that southern part of the ridge formed during encroachment by the "Trail Ridge seas" onto the Lake Wales remnant or during a standstill of a regressing "Trail Ridge sea." Vertical sections through Trail Ridge at the sites of the drill holes would give elevations at which beach ridge sands pass downward

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It can be concluded that the types of data presented in this report are invaluable in studying ridges formed along the shore lines of ancient seas. Although data from the drill holes are insufficient to allow undisputed interpretations, the value of the approach as a support to studies based on surface topography is demonstrated, and it becomes clear that with more and more of these types of data, a better understanding of sand ridges and ancient sea-level stands will evolve.

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APPENDIX

Trail Ridge Drill Hole No. 1*
NE¼, SE¼, Section 31, T. 6 S., R. 23 E., Clay County, Florida
Approximately 4½ Miles Southeast of Starke
Surface elevation - 239 Feet
E.C. Pirkle, W.H. Yoho, Charles W. Hendry, Jr.

Unit	Description	Thickness In Feet and Inches

Surface Sands

59. Quartz sand, medium to fine. The upper 1 foot 3 inches of this unit is white. Present beneath this upper 1 foot 3 inches is a 6-inch brown zone which grades downward into white and gray sand . . . . . 5' 0" (From 0' to 5')

Spl. 1 – Channel sample of upper 1 foot 3 inches.
Spl. 2 – Channel sample of lower 3 feet 9 inches.

58. Dark brown to black organic zone. Quartz sand containing finely-divided organic matter.
Quartz sand is medium to fine.
The lower 6 inches of this unit is very hard (hardpan) . . . . . 12' 6" (From 5' to 17'6")

Spl. 3 – Channel sample of upper 5 feet of unit.
Spl. 4 – Channel sample of lower 7 feet 6 inches of unit.

57. Quartz sand, fine to coarse. Moderate brown.
Stringers and small lenses of darker sediments are present through the sands. Some of the dark stringers are black from the presence of concentrations of heavy minerals. Other dark streaks are black from the presence of concentrations of finely-divided organic matter.
The moderate brown color is somewhat uniform throughout this part of the surface sands.
Bedding features are revealed by the dark streaks of heavy minerals and organic matter. Horizontal bedding was noted at a depth of 9 feet below the upper surface of the unit. Highly inclined bedding was conspicuous in the interval from 38 feet to 45 feet 6 inches below the upper surface of the unit.
The sediments from the land surface to a depth of 63 feet are mined for their heavy mineral content . . . . . 45' 6" (From 17'6" to 63')

*This hole was drilled by the Bureau of Geology, Florida Department of Natural Resources, under the active supervision of Charles W. Hendry, Jr. The drilling was completed May 23, 1968. Analyses of the samples are given in Tables 2 through 4.

A series of channel samples of the unit was taken at the following depths below the land surface.

Spl. 5 – Channel sample from 17 feet 6 inches to 25 feet below land surface (upper 7 feet 6 inches of Unit 57).
Spl. 6 – Sample from depth of 25 to 30 feet below land surface.
Spl. 7 – 30 to 35 feet.
Spl. 8 – 35 to 40 feet.
Spl. 9 – 40 to 45 feet.
Spl. 10 – 45 to 50 feet.
Spl. 11 – 50 to 55 feet.
Spl. 12 – 55 to 60 feet.
Spl. 13 – 60 to 63 feet below land surface (lower 3 feet of Unit 57).

Intercalated Layers of Peaty or Sapropelic Sediments and Quartz Sand

56. "Peat" layer. Black to brown.
Approximately 92 per cent by weight of this unit is woody material.
The quartz sand mixed with the woody material is very fine to medium . . . . 5' 0"
(From 63' to 68')

Spl. 14 – Channel sample of peat layer.

55. Quartz sand, medium to very fine. White, to light brown, to gray with black mottling.
In the upper 1 foot of this unit (just below the overlying wood layer) the sand is very fine . . . . 5' 0"
(From 68' to 73')

Spl. 15 – Channel sample of Unit 55.

54. Black organic zone. Quartz sand with wood and finely-divided organic matter.
This interval differs from Unit 56 in being mainly quartz sand with some wood, whereas Unit 56 is mainly wood with some sand.
As a result of techniques used in treating these sediments, a part of the value listed in Table 2 under the clay fraction of this unit consists of finely-divided organic matter. Likewise, the clay fraction for Units 52 and 50 (Spls. 18 and 20) contains finely-divided organic matter.
Quartz sand is medium to very fine . . . . 1' 6"
(From 73' to 74' 6")

Spl. 16 – Channel sample of black organic zone.

53. Quartz sand, very fine to medium. White with some black mottling . . . . 2' 6"
(From 74' 6" to 77')

Spl. 17 – Channel sample of sand of Unit 53.

52. Black organic zone. Quartz sand with wood and finely-divided organic matter.
This unit is similar to Unit 54.
Quartz sand is medium to very fine . . . . 1' 0"
(From 77' to 78')

Spl. 18 – Channel sample of Unit 52.

51. Quartz sand, medium to very fine. White with black mottling . . . . 2' 6"
(From 78' to 80' 6")

Spl. 19 – Channel sample of Unit 51.

50. Black to brown organic zone. Quartz sand with wood and much finely-divided organic material.
This unit is similar to Units 54 and 52.
Quartz sand is fine to coarse . . . . 4' 0"
(From 80'6" to 84'6")

Spl. 20 – Channel sample of Unit 50.

49. Clayey quartz sand. Quartz sand is fine to coarse. Gray.
This layer underlies the peaty sediments of the section . . . . 1' 6"
(From 84'6" to 86')

Spl. 21 – Channel sample of the clayey sand.

48. No recovery . . . . 4' 0"
(From 86' to 90')

Intercalated Layers or Lenses of Quartz Sand, Clayey Sand and Massive Drab Clay

47. Quartz sand, fine to coarse, Brown.
Approximately 10 feet beneath the upper surface of the unit the color becomes darker with some black mottling.
The bottom 6 inches of the unit is characterized by a marked increase in clay . . . . 16' 0"
(From 90' to 106')

Spl. 22 – Channel sample of upper 4 feet of unit.
Spl. 23 – Channel sample of interval from 4 feet to 9 feet beneath upper surface of unit (depth of 95 to 100 feet below land surface).
Spl. 24 – Channel sample of lower 6 feet of unit.

46. Sandy Clay. Drab to olive. Massive.
Rare Marine micofossils are present.
Quartz sand is very fine to medium . . . . 1' 0"
(From 106' to 107')

Spl. 25 – Channel sample of the massive drab clay.

45. Clayey quartz sand. White.
Almost 99 per cent of the quartz sand in this unit is very fine.
The fraction of sediments that passed through the 230-mesh screen and was retained on the 325-mesh screen is relatively high. This fraction of sediments is not recorded in Table 2 for this unit or for any of the other units . . . . 1' 6"
(From 107' to 108'6")

Spl. 26 – Channel sample of the fine sand.

44. Clay, sandy. Drab to olive. Massive. Similar to Unit 46.
Quartz sand is very fine to fine . . . . 1' 6"
(From 108'6" to 110')

Spl. 27 – Channel sample of the drab clay.

43. Quartz sand, very fine to coarse. Loose. White to light gray . . . . 2' 9"
(From 110' to 112'9")

Spl. 28 – Channel sample of Unit 43.

42. Clayey quartz sand. White to light gray. Quartz sand is very fine to fine.
Borings are present in the sediments . . . . 2' 3"
(From 112'9" to 115')

Spl. 29 – Channel sample of the clayey sand.

41. Stringers and small lenses of fine white quartz sand intercalated with stringers and small lenses of drab clay.
The sediments are characterized by conspicuous laminations which give the unit a varved appearance.
In the upper 3 feet the stringers and small lenses of quartz sand are more abundant.
In the lower 3 feet the clay stringers and clay lenses are more abundant. The lower foot is mainly massive drab clay.
The quartz sand is very fine to medium . . . . 6' 0"
(From 115' to 121')

Spl. 30 – Channel sample of upper 3 feet of unit.
Spl. 31 – Channel sample of lower 3 feet of unit.

40. Clayey quartz sand. Drab to olive. Has a massive appearance.
The quartz sand is very fine to medium . . . . 3' 0"
(From 121' to 124')

Spl. 32 – Channel sample of the drab clayey sand of Unit 40.

39. Clayey quartz sand. Quartz sand is medium to fine. Gray.
Clay is disseminated throughout the unit.
This unit contains more clay than underlying unit . . . . 2' 0"
(From 124' to 126')

Spl. 33 – Channel sample of Unit 39.

38. Quartz sand. Loose. Medium to fine. White to light gray . . . . 4' 0"
(From 126' to 130')

Spl. 34 – Channel sample of loose sand.

37. Clay. Drab to olive to black. Massive.
Upper 2 feet of clay is drab and is similar to units 46 and 44. The clay in the lower 3 feet is black.
Quartz sand present in the unit is medium to very fine . . . . 5' 0"
(From 130' to 135')

Spl. 35 – Channel sample of clay.

36. Quartz sand, medium to fine. Horizontally laminated.
Some black mottling . . . . 3' 6"
(From 135' to 138'6")

Spl. 36 – Channel sample of sand of Unit 36.

Hawthorn Formation – Miocene

35. Clayey quartz sand. Some stringers and small lenses of drab clay are present in the unit.
The upper 6 inches of this unit have a relatively high content of the drab clay.
Sand-size black phosphorite is common. Pyrite is present.
Quartz sand is fine to medium . . . . 2' 0"
(From 138'6" to 140'6")

Spl. 37 – Channel sample of Unit 35.

34. Sandy dolomite. Cream to pale yellow and buff. Moderately hard.
A few grains and small pebbles of black phosphorite are present in the dolomite.
Occasional impressions of marine mollusks.
The quartz sand is fine to medium . . . . 2' 6"
(From 140'6" to 143')

Spl. 38 – Chips selected from all parts of the unit.

33. Sandy and clayey dolomite. Cream to light tan to buff. Soft.
Sand-size grains and small pebbles of black phosphorite are present in the unit. A few of the phosphate particles are brown. The small phosphate pebbles are more common in the upper 3 feet of the unit.
The quartz sand is fine to medium . . . . 7' 0"
(From 143' to 150')

Spl. 39 – Channel sample of unit.

32. Mixture of carbonate, quartz sand, clay and phosphorite. Gray. Soft.
In the upper 2 feet 6 inches of the unit there is an increase in small pebble and sand-size black phosphorite. Some phosphate particles are brown.
Quartz sand is fine to medium . . . . 5' 6"
(From 150' to 155'6")

Spl. 40 – Channel sample of Unit 32.

31. Dolomite, Sandy and clayey. Gray. Hard.
Fossil impressions of marine mollusks.
A few sand-size grains of shiny black phosphorite.
The quartz sand is fine to medium . . . . 1' 0"
(From 155'6" to 156'6")

Spl. 41 – Selected chips representative of unit.

30. Mixture of carbonate, quartz sand and clay. Gray.
A few small pebbles and sand-size grains of black phosphorite.
From the upper surface of the Hawthorn Formation (Unit 35) through this unit, there has been no real concentration of pebble-sized phosphorite. Most of the phosphorite has been concentrate–or sand-size.
The quartz sand is fine to medium . . . . 1' 6"
(From 156'6" to 158')

Spl. 42 – Channel sample of Unit 30.

29. Mixture of carbonate, quartz sand and clay. Gray. Hard.
A few small black pebbles of phosphorite disseminated through unit.
Impressions of marine mollusks are present. These fossils are especially abundant in the interval from 165 feet to 167 feet. There the rock has a high carbonate content and is a mass of fossil impressions.
The quartz sand is fine to coarse . . . . 14' 0"
(From 158' to 172')

Spl. 43 – Sample of chips selected throughout unit.

28. No recovery . . . . 3' 0"
(From 172' to 175')

27. Clayey quartz sand, dolomitic. Dark gray. Soft.
An increase in clastics from overlying sediments and a decrease in carbonate.
Common black, shiny, sand-size grains of phosphorite.
Quartz sand is fine to coarse . . . . 5' 0"
(From 175' to 180')

Spl. 44 – Channel sample of sediments.

26. Mixture of quartz sand, carbonate and clay. Cream to light tan. Hard.
The unit contains common sand-size particles and small pebbles of black phosphorite.
The quartz sand is fine to coarse . . . . 5' 0"
(From 180' to 185')

Spl. 45 – Selected chips representative of unit.

25. Mixture of quartz sand, carbonate and clay. Gray. Lithified.
Black phosphorite of sand size is present.
The quartz sand is very fine to medium . . . . 5' 0"
(From 185' to 190')

Spl. 46 – Channel sample of unit.

24. Mixture of quartz sand, clay and carbonate. Gray. Lithified.
A few small pebbles and sand-size particles of black, shiny phosphorite.
Quartz sand is very fine to fine . . . . 4' 0"
(From 190' to 194')

Spl. 47 – Channel sample of unit.

23. Sandy dolomite, clayey. Gray. Hard. Mollusk-bored.
The mollusk borings are filled with clay and black phosphorite.
The quartz sand is fine to coarse . . . . 7' 6"
(From 194' to 201'6")

Spl. 48 – Sample of selected chips.

22. Clayey quartz sand, dolomitic. Dark gray to olive. Soft.
Black pebble-size and sand-size phosphorite is common. There is an increase in pebble-size phosphorite in the interval from 201 feet to 202 feet 6 inches.
The quartz sand is coarse to very fine . . . . 4' 6"
(From 201'6" to 206')

Spl. 49 – Channel sample of Unit 22.

21. Mixture of carbonate, quartz sand, clay and phosphorite. Light gray to tan to cream. Hard.
Small black pebbles and sand-size grains of phosphorite are abundant. There are a few small pebbles of cream to light gray phosphorite.
Impressions of marine mollusks.
Quartz sand is fine to coarse . . . . 6' 6"
(From 206' to 212'6")

Spl. 50 – Selected chips representative of unit.

20. No recovery. It is believed that the dominant type of sediment within this unit is fine quartz sand . . . . 9' 6"
(From 212' 6" to 222')

19. Quartz sand, clayey and dolomitic. The quartz sand is fine. Light gray. Soft.
Sand-size shiny black phosphorite is present . . . . 9' 0"
(From 222' to 231')

Spl. 51 – Channel sample of Unit 19.

18. No recovery . . . . 6' 0"
(From 231' to 237')

17. Mixture of quartz sand, carbonate and clay. Gray. Moderately hard.
Small pebbles and sand-size grains of black phosphorite are present.
The quartz sand is very fine to medium . . . . 3' 0"
(From 237' to 240')

Spl. 52 – Channel sample of unit.

16. No recovery. Believed to be fine quartz sand . . . . 12' 0"
(From 240' to 252')

15. Sandy dolomite, clayey. Tan to light gray. Hard.
Very little phosphorite is present in this unit.
The quartz sand is fine to very fine . . . . 2' 0"
(From 252' to 254')

Spl. 53 – Sample of selected chips.

14. Clayey and dolomitic quartz sand. Gray.
Fine black phosphorite is present.
The quartz sand is fine to very fine . . . . 3' 0"
(From 254' to 257')

Spl. 54 – Channel sample of Unit 14.

13. Clay sandy and dolomitic. Dark green. Soft.
In the interval from 257 feet 6 inches to 258 feet megascopic secondary dolomite crystals have formed in the sediments. Also secondary dolomite crystals are present from 262 feet to 263 feet.
The quartz sand is very fine to fine . . . . 11' 0"
(From 257' to 268')

Spl. 55 – Channel sample of the dark green clay.

12. Hard massive clay, silicified. Fine-grained Gray.
No visible grains of phosphorite.
Similar in appearance to the blocky, silicified clay exposed locally at the Devil's Mill Hopper in Alachua County . . . . 0' 6"
(From 268' to 268'6")

Spl. 56 – Chips representative of the silicified clay.

11. Dolomitic clay. Dark green. Soft.
No phosphorite was noted in this unit.
The quartz sand is very fine to medium . . . . 1' 6"
(From 268' 6" to 270')

Spl. 57 – Channel sample of Unit 11.

10. Clayey dolomite. Fine-grained. Lithified. Moderately hard.
No phosphorite was noted in the sediments.
The quartz sand is fine to very fine . . . . 1' 6"
(From 270' to 271'6")

Spl. 58 – Channel sample of unit.

9. Very little recovery. The sediments of this unit are soft and are a mixture of quartz sand and dark green clay with some black phosphorite (sand-size and small pebble-size) . . . . 10' 6"
(From 271'6" to 282')

8. Clayey dolomite. Fine-grained. Light gray to dark gray. Hard.
The upper part of the dolomite is riddle with solution channels. These channels are filled with mixtures of limestone fragments, quartz sand and shiny sand-size grains and small pebbles of black phosphorite. Some of the limestone fragments are mollusk-bored. This unit is similar to Unit 1 at Brooks Sink, Bradford County (Pirkle et al., 1965, p. 46).
The quartz sand is coarse to very fine. Quartz granules are present . . . . 5' 0"
(From 282' to 287')

Spl. 59 – Sample of sediments filling solution channels.
Spl. 60 – Sample of the dolomite.

7. Sandy dolomite, clayey. Gray. Hard.
There are a few black sand-size grains of phosphorite in the unit. There is an increase in the amount of quartz sand and fine phosphorite in the lower foot of the sediments.
Impressions of marine mollusks.
The quartz sand is very fine to medium. Quartz granules are present.
The unit grades into the underlying unit . . . . 3' 0"
(From 287' to 290')

Spl. 61 – Sample of selected chips.

6. Mixture of carbonate, quartz sand, clay and phosphorite. Gray. Hard.
Shiny black phosphate particles are common.
In the interval from 295 feet to 297 feet there is an apparent increase in carbonate, and numerous mollusk impressions are present.
The quartz sand is fine to coarse. Some quartz grains are rice-size . . . . 8' 0"
(From 290' to 298')

Spl. 62 – Sample representative of unit.

5. Sandy dolomite. Gray. Hard and tough. Fragments of mollusk-bored limestone are present.
There is an increase in quartz sand beginning at a depth of approximately 300 feet.
Some sand-size cream, tan and brown grains of phosphorite are disseminated through the unit. This is the first unit down from the upper surface of the Hawthorn Formation in which cream to brown phosphorite is more abundant than black phosphorite.
The quartz sand is medium to fine . . . . 8' 6"
(From 298' to 306'6")

Spl. 63 – Sample of chips representative of unit.

4. No recovery . . . . 2' 0"
(From 306'6" to 308'6")

3. Mixture of carbonate, quartz sand, clay and sand-size phosphorite. The upper 3 inches of this unit is dark gray. The lower part of the unit is light gray. Moderately hard.
   Quartz sand is medium to fine . . . . 1' 6"
   (From 308'6" to 310')

   Spl. 64 – Selected chips from Unit 3.

2. Sandy dolomite Gray. Dense.
   There are a few black grains of phosphorite present in the dolomite.
   The quartz sand is medium to fine . . . . 4' 0"
   (From 310' to 314')

   Spl. 65 – Representative chips of the dolomite.

Crystal River Formation – Eocene

1. Limestone. White to cream.
   A cavity from 314 feet to 315 feet is present at the top of this limestone. The limestone is more than 99 per cent carbonate . . . . 18' 0"
   (From 314' to 332')

   Spl. 66 Channel sample of Unit 1.

Total depth of drill hole . . . . 332' 0"

Trail Ridge Drill Hole No. 2*
NE¼, NW¼, Section 19, T. 5 S., R. 23 E., Clay County, Florida
Approximately 2 Miles Northeast of Lawtey
Surface Elevation – 206 Feet
E. C. Pirkle, W. H. Yoho, Charles W. Hendry, Jr.

Unit	Description	Thickness In Feet and Inches

Surface Sands

37. Loose quartz sand, fine to coarse. Light brown, to moderate brown, to dark brown. Black zones with a relatively high content of finely-divided organic matter are present from 4 feet 6 inches to 7 feet and from 9 feet 6 inches to 15 feet.
The interval from 9 feet 6 inches to 15 feet is very sapropelic with abundant wood from 12 feet to 15 feet. Other sapropelic zones are present at depths of 27 feet 9 inches, 28 feet to 28 feet 6 inches and from 40 feet 6 inches to 43 feet 6 inches.
There is very little visible bedding. However faint stratification, some slightly inclined from the horizontal, is present in the interval from 30 feet 6 inches to 38 feet . . . . 46' 6"
(From 0' to 46'6")

Channel samples were taken at the following depths below the land surface.

Spl. 1 – Channel sample from land surface to a depth of 3 feet. Gray sand.
Spl. 2 – Channel sample from 3 feet to 4 feet 6 inches. Tan sand.
Spl. 3 – Channel sample from 4 feet 6 inches to 7 feet. Black sand.
Spl. 4 – Channel sample from 7 feet to 9 feet 6 inches. Gray sand.
Spl. 5 – Channel sample from 9 feet 6 inches to 15 feet. Black sapropelic sand with abundant wood from 12 feet to 15 feet.
Spl. 6 – Channel sample from 15 feet to 21 feet. Light brown sand.
Spl. 7 – Channel sample from 21 feet to 24 feet 6 inches. Brown sand.

*This hole was drilled by the Bureau of Geology, Florida Department of Natural Resources, under the immediate supervision of Charles W. Hendry, Jr. The drilling was completed in June, 1968. Analyses of the samples are given in Tables 5 through 7.

Spl. 8 – Channel sample from 24 feet 6 inches to 27 feet 6 inches. Light brown sand.
Spl. 9 – Channel sample from 27 feet 6 inches to 27 feet 9 inches. Dark brown sand with an increase in clay.
Spl. 10 – Channel sample from 27 feet 9 inches to 28 feet. Medium brown sand with a ¼-inch sapropelic zone at 27 feet 9 inches.

Spl. 11 – Channel sample from 28 feet to 28 teet 6 inches. Dark brown sand, sapropelic.
Spl. 12 – Channel sample from 28 feet 6 inches to 30 feet 6 inches. Medium-dark brown sand.
Spl. 13 – Channel sample from 30 feet 6 inches to 33 feet. Dark brown sand.
Spl. 14 – Channel sample from 33 feet to 38 feet. Medium-dark brown sand.
Spl. 15 – Channel sample from 38 feet to 40 feet 6 inches. Light brown sand.
Spl. 16 – Channel sample from 40 feet 6 inches to 43 feet 6 inches. Dark brown sand, slightly sapropelic.
Spl. 17 – Channel sample from 43 feet 6 inches to 46 feet 6 inches. Medium dark brown sand.

Intercalated Layers of Sapropelic Sediments and Quartz Sand

36. Quartz Sand. Very fine to medium. Light brown . . . . 2' 3"
(From 46'6" to 48'9")

Spl. 18 – Channel sample of the light brown quartz sand.

35. Quartz sand. Very fine to medium. Dark brown to black. Sapropellic . . . . 0' 3"
(From 48'9" to 49')

Spl. 19 – Channel sample of the quartz sand.

34. Quartz sand, clayey. Quartz is very fine to medium. Dark brown . . . . 1' 0"
(From 49' to 50')

Spl. 20 – Channel sample of Unit 34.

33. Quartz sand, clayey. Quartz is very fine to medium. Black. Soft and highly sapropelic . . . . 1' 0"
(From 50' to 51')

Spl. 21 – Channel sample of unit.

32. Clayey sand. Quartz sand is very fine to fine. Dark brown . . . . 3' 0"
(From 51' to 54')

Spl. 22 – Channel sample from 51 to 53 feet.
Spl. 23 – Channel sample of all of Unit 32.

31. Quartz sand, clayey. Quartz is very fine to fine. Dark brownish gray . , ... 2' 6"
(From 54' to 56'6")

Spl. 24 – Channel sample of Unit 31.

30. Quartz sand. Very fine to medium. Light brown with interval from 58 feet 3 inches to 59 feet almost white . . . . 2' 6"
(From 56' 6" to 59')

Spl. 25 – Channel sample of the quartz sand.
Greensih gray clayey sands and sandy clays

29. Sand, clayey. Quartz sand is very fine to coarse. The clay in the interval from 59 feet through 86 feet. (Units 29 - 19; Spls. 26 - 36) is greenish-gray to gray. Upon exposure to the air the clay color changes to tan or brown. Black spots high in organic matter (some showing wood fibers) are present in the sediments and are especially conspicuous in the interval from approximately 61 feet to 74 feet.
Sapropelic from 59 feet to 60 feet . . . . 2' 3"
(From 59' to 61' 3")

Spl. 26 – Channel sample of Unit 29.

28. Clayey sand. Sand is medium to very fine. Tan to gray . . . . 3' 3"
(From 61' 3" to 64'6")

Spl. 27 – Channel sample of the clayey sand.

27. Clayey sand. Sand is medium to very fine. This clayey sand cuts like cheese and oxidizes to tan upon exposure to the air.
Wood is present . . . . 2' 6"
(From 64'6" to 67')

Spl. 28 – Channel sample of Unit 27.

26. Clayey sand. Sand is very fine Gray to tan. The quartz sand in this unit is much finer than the quartz sand in the overlying unit . . . . 2' 6"
(From 67' to 69'6")

Spl. 29 – Channel sample of the clayey sand of Unit 26.

25. Mixture of clay, sand and silt. The quartz sand is very fine to fine. Gray.
The value of the -230 to +325-mesh fraction of these sediments, and the underlying sediments through Unit 19 (Spl. 36), is relatively high. This fraction consists of quartz and is not recorded in any of the tables. The amount of the fraction can be approximately determined from Table 5 by calculating the per cent of the sediments not represented by the combined value of the columns for quartz sand and clay (-325 mesh) . . . . 4' 3"
(From 69'6" to 73'9")

Spl. 30 – Channel sample of Unit 25.

24. Mixture of silt, quartz sand and clay. Quartz sand is fine to very fine. Gray color changes to light tan upon exposure to air . . . . 3' 9"
(From 73'9" to 77'6")

Spl. 31 – Channel sample of Unit 24.

23. Mixture of clay, quartz sand and silt. Quartz sand is very fine to medium. Gray. The clay turns tan upon exposure to air . . . . 0' 6"
(From 77'6" to 78')

Spl. 32 – Channel sample of Unit 23.

22. Mixture of silt, quartz sand and clay. Quartz sand is very fine to medium. Gray.
Faint horizontal bedding is visible from 79 feet to 80 feet . . . . 2' 0"
(From 78' to 80')

Spl. 33 – Channel sample of sediments in Unit 22.

21. Mixture of clay, quartz sand and silt. Quartz sand is very fine to fine. Gray . . . . 2' 6"
(From 80' to 82'6")

Spl. 34 – Channel sample of Unit 21.

20. Mixture of quartz sand, clay and silt. Quartz sand is very fine to medium. Gray when fresh; tan where exposed to air.
Inclined bedding visible at 84 feet . . . . 2' 6"
(From 82'6" to 85')

Spl. 35 – Channel sample of Unit 20.

19. Clayey sand. Quartz sand is very fine to medium. Gray to tan . . . . 1' 0"
(From 85' to 86')

Spl. 36 – Channel sample of the clayey sand.

White to Gray Sands and Clayey Sands

18. Quartz sand, clayey. Quartz sand is fine to medium. Cream.
The units making up the interval from 86 feet to 101 feet 6 inches (Units 18-13; Spls. 37-42) do not have the high content of very fine sand and silt characteristic of the overlying interval (Units 29-19; Spls. 26-36) . . . . 3' 0"
(From 86' to 89')

Spl. 37 – Channel sample of Unit 18.

17. Quartz sand, clayey. Quartz sand is fine to medium. Tan to cream.
Slightly micaceous . . . . 4' 0"
(From 89' to 93')

Spl. 38 – Channel sample of sediments of Unit 17.

16. Quartz sand, clayey. Quartz sand is fine to medium. Tan to light gray.
Micaceous . . . . 4' 0"
(From 93' to 97')

Spl. 39 – Channel sample of Unit 16.

15. Quartz sand. Coarse to fine. Gray . . . . 2' 0"
(From 97' to 99')

Spl. 40 – Channel sample of the quartz sand.

14. Quartz sand. Medium to very coarse. Light gray.
A layer, ½-inch in thickness, of massive gray clay is present at the base of these coarse sediments . . . . 0' 6"
(From 99' to 99'6")

Spl. 41 – Channel sample of the quartz sand.

13. Quartz sand. Coarse to fine. Gray. Contains a few irregular masses of clay. Micaceous.
Bedding is not distinct, but some faint cross-bedding is present in the interval from 100 feet 6 inches to 101 feet 6 inches . . . . 2' 0"
(From 99'6" to 101'6")

Spl. 42 – Channel sample of the quartz sand.

Drab to Tan Clayey Sands

12. Quartz sand, clayey. Quartz sand is fine to medium. Mottled gray and tan.
Most of the interval from 101 feet 6 inches downward to the late Miocene shell marl at a depth of 143 feet 3 inches is characterized by tan to drab clay. There are occasional stringers of massive drab clay present in the sediments . . . . 5' 0"
(From 101'6" to 106'6")

Spl. 43 – Channel sample of Unit 12.

11. Clayey sand. Quartz sand is medium to very fine. Tan to gray . . . . 2' 0"
(From 106' 6" to 108'6")

Spl. 44 – Channel sample of clayey sand.

10. Quartz sand, clayey. Quartz sand is fine to coarse. Dark gray with some black mottling. Small lenses and stringers of white sand cut the sediments . . . . 1' 3"
(From 108'6" to 109'9")

Spl. 45 – Channel sample of sediments.

9. Clayey sand. Quartz sand is medium to very fine.
Tan to brown . . . . 1' 3"
(From 109'9" to 111')

Spl. 46 – Channel sample of clayey sand.

8. Quartz sand, clayey. Quartz sand is fine to very fine.
Drab to tan . . . . 4' 6"
(From 111' to 115'6")

Spl. 47 – Channel sample of Unit 8.

7. Quartz sand, clayey. Quartz sand is fine to medium.
Drab to tan . . . . 2' 6"
(From 115'6" to 118')

Spl. 48 – Channel sample of sediments of Unit 7.

6. Quartz sand, clayey. Quartz sand is fine to medium.
Drab to tan . . . . 6' 0"
(From 118' to 124')

Spl. 49 – Channel sample of Unit 6.

5. Quartz sand, clayey. Quartz sand is fine to medium.
Drab to tan . . . . 5' 0"
(From 124' to 129')

Spl. 50 – Channel sample of Unit 5.

4. Quartz sand, clayey. Quartz sand is fine to medium.
Drab to tan. Has a mottled appearance . . . . 5' 0"
(From 129' to 134')

Spl. 51 – Channel sample of Unit 4.

3. Quartz sand, clayey. Quartz sand is fine to medium.
Drab to dark gray. Gets darker, almost black, at depth of 141 feet.
Occasional marble-size masses of gray clay that change rapidly to a tan color on exposure to air.
The interval from 134 feet to 135 feet 6 inches was not sampled . . . . 6' 6"
(From 135' 6" to 142')

Spl. 52 – Channel sample of sediments of Unit 3.

2. Mixture of carbonate, quartz sand and clay. Gray to almost black. Light gray just over contact with underlying shell marl. The gray colors change to light tan to brown upon exposure to the air.
There was no recovery of sediments from a depth of 142 feet to 143 feet . . . . 0' 3"
(From 143' to 143'3")

Spl. 53 – Channel sample of Unit 2.

Late Miocene Shell Marl

1. Fossiliferous late Miocene shell bed . . . . 2' 3"
(From 143'3" to 145'6")

Spl. 54 – Channel sample of the late Miocene shell marl.

Total depth of drill hole . . . . 145'6"

Baywood Promontory Drill Hole
SW¼, NW¼, Section 18, T. 9 S., R. 25 E., Putnam County, Florida
Approximately 2½ Miles Southeast of Florahome
Surface Elevation - 210 Feet (Estimate)
E. C. Pirkle, W. H. Yoho, Charles W. Hendry, Jr.

Unit	Description	Thickness In Feet and Inches

Surface Sands

34. Quartz sand, loose. These thick surface sands are characterized by numerous dark brown to black zones containing a relatively high content of finely-divided organic matter. Some of the black zones are very hard and are referred to locally as "hardpan." The sand zones are white, pale yellow, brown and gray. Locally the sands have a black mottling.

A tree trunk or large limb was encountered at a depth of 60 feet 9 inches. The sample from that depth to a depth of 62 feet 6 inches is entirely wood. Fragments of wood were noted in sediments of other intervals. For example, wood fragments, including one fragment 6 inches long, were present from 70 feet 6 inches to 77 feet.

The quartz sand is medium to very fine. More than 75 per cent of the sand falls into the fine size fraction (-¼ mm to 1/8 mm) . . . . 110' 0"
(From 0' to 110')

A series of 5-foot channel samples was taken from the land surface to the base of the unit. The samples were labeled Spl. 1 (0 to 5 feet), Spl. 2 (5 to 10 feet), etc., through Spl. 22 (105 to 110 feet).

Spl. 1 – Channel sample from land surface to depth of 5 feet.
Spl. 2 – Channel sample from 5 to 10 feet.
Spl. 3 – 10 to 15 feet.
Spl. 4 – 15 to 20 feet.
Spl. 5 – 20 to 25 feet.
Spl. 6 – 25 to 30 feet.
Spl. 7 – 30 to 35 feet.

*This hole was drilled by the Bureau of Geology, Department of Natural Resources, under the active supervision of Charles W. Hendry, Jr. The drilling was completed April 25, 1968. Analyses of samples are given in Tables 8 through 10.

Spl. 8 – 35 to 40 feet.
Spl. 9 – 40 to 45 feet.
Spl. 10 – 45 to 50 feet.
Spl. 11 – 50 to 55 feet.
Spl. 12 – 55 to 60 feet.
Spl. 13 – 60 to 65 feet.
Spl. 14 – 65 to 70 feet.
Spl. 15 – 70 to 75 feet.
Spl. 16 – 75 to 80 feet.
Spl. 17 – 80 to 85 feet.

Spl. 18 – 85 to 90 feet.
Spl. 19 – 90 to 95 feet.
Spl. 20 – 95 to 100 feet.
Spl. 21 – 100 to 105 feet.
Spl. 22 – 105 to 110 feet.

Finely Laminated Surface Sands

33. Quartz sand, loose but firm. Sand fine to medium.
Have lost organic zones so characteristic of overlying sands.
Fine laminations are shown throughout the zone by stringers of black heavy minerals.
The upper 4 feet 6 inches of the unit are banded dark and medium brown.
Beneath the upper banded zone are 5 feet 6 inches of light gray or greenish gray sediments. Cross bedding is shown in these sediments by stringers of heavy minerals.
Below the 5 feet 6 inches of light greenish gray sediments is an interval, 1 foot 6 inches in thickness, of tan to light brown sediments.
The lower 6 feet 9 inches of the unit is light greenish gray . . . . 18' 3"
(From 110' to 128'3")

Spl. 23 – Channel sample from 110 feet to 114 feet 6 inches.
Spl. 24 – Channel sample from 114 feet 6 inches to 120 feet.
Spl. 25 – Channel sample from 120 feet to 125 feet.
Spl. 26 – Channel sample from 125 feet to 128 feet 3 inches.

Intercalated Layers or Lenses of Drab Clay and Quartz Sand

32. Sandy clay. Dark drab olive green. Massive.
Wood fragments and wood fibers are common in the clay.
The quartz sand is medium to very fine . . . . 1' 0"
(From 128'3" to 129'3")

Spl. 27 – Channel sample of the drab clay.

31. Sand, clayey. Quartz sand is fine to very fine.
Light gray . . . . 1' 3"
(From 129'3" to 130'6")

Spl. 28 – Channel sample of Unit 31.

30. Sandy clay. Dark drab olive green. Massive.
This clay is like the clay in Unit 32. Brown wood and brown wood fibers are present throughout the interval. One wood layer is ½ inch thick.
The quartz sand is fine to very fine . . . . 1' 6"
(From 130'6" to 132')

Spl. 29 – Channel sample of the drab olive clay.

29. No recovery. Probably fine quartz sand . . . . 9' 0"
(From 132' to 141')

28. Sand, clayey, Quartz sand is very fine to fine. Various shades of white to light green. Micaceous.
Clay content increases with depth.
Rare fragments of mollusk shells. These are marine shell fragments. They are fresh in appearance.
A few sand-size black particles of phosphorite are present in the lower part of the unit . . . . .22' 6"
(From 141' to 163'6")

Spl. 30 – Channel sample from 141 feet to 145 feet.
Spl. 31 – Channel sample from 145 feet to 150 feet.
Spl. 32 – Channel sample from 150 feet to 155 feet.
Spl. 33 – Channel sample from 155 feet to 160 feet.
Spl. 34 – Channel sample from 160 feet to 163 feet 6 inches.

27. Clay. Dark drab olive green. Massive.
This clay is similar to the clay in units 30 and 32.
Wood fragments, wood fibers and a few leaf impressions are present in the clay.
Rare sand-size particles of black phosphorite.
Quartz sand is fine to very fine . . . . 3' 6"
(From 163'6" to 167')

Spl. 35 – Channel sanple of the drab clay.

26. Sand, clayey. Quartz sand is very fine to fine. Gray to light green.
Rare fragments of mollusk shells.
A few small pebbles and sand-size particles of black phosphorite . . . . 2' 0"
(From 167' to 169')

Spl. 36 – Channel sample of Unit 26.

Shell Marl – Late Miocene

25. Mixture of shells, quartz sand, clay and phosphorite. Light olive green.
Abundant broken fragments of macrofossils and abundant foraminiferia. Most of the larger shells are cream to white. Many of the foraminiferia shells are transparent and clear.
Small pebbles and sand-size particles of black phosphorite are common, especially in the upper 4 or 5 inches of the unit.
The quartz sand is coarse to very fine . . . . 5' 0"
(From 169' to 174')

Spl. 37 – Channel sample of the shell marl.

Hawthorn Formation – Miocene

24. Quartz sand in a calcareous and clayey matrix.
Olive to grayish green.
The quartz sand is very fine to coarse.
Black sand-size phosphorite is present . . . . .13' 0"
(From 174' to 187')

Spl. 38 – Channel sample of Unit 24.

23. Dolomite. Lithified. Light yellowish orange. Firm but soft.
Quartz sand is disseminated through the dolomite. The quartz sand is fine to very coarse.
A few small black pebbles and shiny sand-size particles of phosphorite . . . . . . 6' 0"
(From 187' to 193')

Spl. 39 – Channel sample of the sandy dolomite.

22. No recovery. Probably soft calcareous sediments . . . . 8' 0"
(From 193' to 201')

21. Dolomite. Very light grayish green. Firm but soft.
There is only a very little quartz sand or phosphorite in the dolomite. The quartz sand that is present is fine to coarse.
Clay is present in the dolomite . . . . 7' 6"
(From 201' to 208'6")

Spl. 40 – Channel sample of the clayey dolomite.

20. Mixture of carbonate, quartz sand, and clay. Greenish gray. Slightly indurated.
Shiny black sand-size grains of phosphorite are common.
The quartz sand is coarse to fine . . . . 4' 6"
(From 208'6" to 213')

Spl. 41 – Channel sample of Unit 20.

19. No recovery. Probably soft calcareous sediments . . . . 6' 0"
(From 213' to 219')

18. Quartz sand in a clayey and calcareous matrix. Olive green Firm.
The quartz sand is very fine to medium.
A lense of hard, dense light green dolomite is present at a depth of 227 feet. This dolomite is 1 foot in thickness and is mollusk-bored.
Sand-size grains of shiny black phosphorite are common. A small amount of the phosphorite is brown . . . . .15' 0"
(From 219' to 234')

Spl. 42 – Channel sample of Unit 18.

17. Clay. Olive green. Massive. Firm. The clay is slightly dolomitic.
There is only a minute amount of quartz sand or sand-size phosphorite in the clay. However there are a few small black pebbles of phosphorite visible in the sediments.
The quartz sand is very fine to medium . . . . 4' 0"
(From 234' to 238')

Spl. 43 – Channel sample of the clay.

16. Dolomite. Light green. Very firm.
The dolomite contains some insoluble clay.
Only a very small amount of quartz sand is present in the dolomite. This sand is very fine . . . . 1' 0"
(From 238' to 239')

Spl. 44 – Channel sample of the clayey dolomite.

15. Quartz sand in a clayey and calcareous matrix. Olive green.
The quartz sand is medium to very fine.
There are a few tan to light brown sand-size particles of phosphorite and a few small black phosphate pebbles . . . . 1' 0"
(From 239' to 240')

Spl. 45 – Channel sample of the olive green clayey sand.

14. Dolomite with included quartz sand and clay. Light gray.
Small black pebbles of phosphorite.
The quartz sand is medium to very fine . . . . 1' 0"
(From 240' to 241')

Spl. 46 – Channel sample of the dolomite.

13. Quartz sand in a matrix of clay and carbonate. Gray to olive green.
The quartz sand is medium to very fine.
Small pebbles of brown phosphorite and brown and black sand-size phosphate particles are present . . . . 2' 0"
(From 241' to 243')

Spl. 47 – Channel sample of Unit 13

12. Mixture of carbonate, quartz sand and clay.
Dark olive green. Very firm.
Sand-size grains of phosphorite are present. Most of these grains are shiny black; a few are brown.
Quartz sand is very fine to fine . . . . 2' 0"
(From 243' to 245')

Spl. 48 – Channel sample of the sediments of Unit 12.

11. Quartz sand with a matrix of clay and carbonate.
Dark olive green.
The quartz sand is very fine to fine and coarse.
A few black sand-size particles of phosphorite . . . . 3' 0"
(From 245' to 248')

Spl. 49 – Channel sample of the clayey sand.

10. Mixture of carbonate, quartz sand, clay, and phosphorite. Light gray to dark greenish gray.
Small black pebbles and sand-sized grains of phosphorite are common.
The quartz sand is very fine to coarse . . . . 3' 6"
(From 248' to 251'6")

Spl. 50 – Channel sample of Unit 10.

9. Mixture of carbonate, quartz sand and clay. Lithified. Finely crystalline. Light Green.
Fossil impressions of marine mollusks.
Sand-size particles of black phosphorite are present.
The quartz sand is very fine to medium . . . . .10' 6"
(From 251'6" to 262')

Spl. 51 – Channel sample of the mixture of carbonate, quartz sand and clay.

8. Quartz sand in a matrix of clay and carbonate. Dark olive green. Soft.
The quartz sand is very fine to coarse.
Small pebbles and sand-size phosphate particles are common. These particles are various shades of black, brown and white . . . . 2' 6"
(From 262' to 264'6")

Spl. 52 – Channel sample of the clayey sand.

7. Dolomite. Light green, hard, crystalline. Very sandy. Clayey.
Occasional sand-size particles of black and brown phosphorite.
Quartz sand is medium to coarse . . . . 2' 6"
(From 264'6" to 267')

Spl. 53 –Channel sample of the sandy dolomite.

6. Mixture of clay, carbonate, quartz sand and phosphorite. Dark olive green. Lithified.
Small blocks or fragments of almost pure greenish clay are present in the sediments.
Small pebbles and sand-size particles of phosphorite are present. These particles are brown, cream and black.
Quartz sand is very fine to coarse . . . . 7' 0"
(From 267' to 274')

Spl. 54 – Channel sample of Unit 6.

5. Dolomite. Dark yellow gray. Soft to hard, but dominantly hard. Dense and very finely crystalline.
Quartz sand is disseminated through the dolomite. The sand is very fine to coarse.
Many fossil impressions of marine mollusks. Some vugs and macrofossil molds are filled with sand and phosphorite.
White, tan and black sand-size grains of phosphorite are abundant. Some small tan and black phosphate pebbles are present . . . . . .10' 0"
(From 274' to 284')

Spl. 55 – Channel sample of the sandy dolomite.

4. Mixture of carbonate, quartz sand, clay and phosphorite. Gray. Very finely crystalline.
Most of the phosphorite is sand-size. Many of the grains are shiny black, but some grains are brown and tan. Minor amounts of small black, brown and gray phosphate pebbles.
Quartz sand is medium to coarse . . . . 8' 6"
(From 284' to 292'6")

Spl. 56 – Channel sample of Unit 4.

3. Dolomite. Light yellow gray. Very finely crystalline. Hard.
Quartz sand is present in the dolomite. This sand is medium to fine.
Phosphorite is abundant. Pebbles are black, brown, tan and cream. Pebble-size phosphorite is more abundant in this basal unit than in the overlying unit . . . . 2' 6"
(From 292'6" to 295')

Spl. 57 – Channel sample of the sandy dolomite.

2. No recovery. Possibly soft clay and carbonate . . . . 2' 0"
(From 295' to 297')

Crystal River Formation – Eocene

1. Limestone. Fossiliferous, cream-colored.
Very pure.
Very microfossiliferous, porous and permeable . . . . 5' 0"
(From 297' to 302')

Spl. 58 – Channel sample of Unit 1.

Total depth of drill hole . . . . 302' 0"