Geology and Mineralogy

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GEOLOGICAL SURVEY

STRATIGRAPHY OF THE AREA BETWEEN HERNANDO AND HARDEE COUNTIES, FLORIDA*

By

Keith B. Ketner and Lawrence J. McGreevy

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Trace Elements Investigations Report 524

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STRATIGRAPHY OF THE AREA BETWEEN HERNANDO AND HARDEE COUNTIES, FLORIDA

By Keith B. Ketner and Lawrence J. McGreevy

ABSTRACT

Eocene, Oligocene, Miocene, and Recent rocks are exposed between Hernando and Hardee Counties. Eocene and Oligocene formations are fossiliferous limestones but Miocene rocks are largely unconsolidated sands and clays in which fossils are scarce. Correlation of Miocene strata therefore is necessarily based mainly on lithology and stratigraphic position. Where rocks are altered by weathering, correlation is based on original rather than present gross lithology. Quartz sand was found to be valuable in correlation because it is not affected by weathering.

Rocks in the report area previously mapped as the upper Miocene or lower Pliocene Alachua and Bone Valley formations were found to range from lower to middle Miocene and are assigned to the Tampa and Hawthorn formations. The Citronelle formation of Pliocene or later age apparently does not extend into peninsular Florida. Clayey sand that has been considered as Citronelle equivalent in the report area is late middle Miocene or early upper Miocene in age.

Hardrock phosphate deposits in the area are in lower Miocene beds which are assigned to the Tampa limestone. Hardrock phosphate particles appear to consist of two types: cementation concretions and limestone replacements.

Land-pebble phosphate deposits range in age from middle Miocene to Pleistocene. In the area of this report they are mainly residual deposits of middle Miocene age.

In the report area uranium is confined mainly to lower and middle Miocene rocks with the greatest concentrations in the Hawthorn formation.

INTRODUCTION

Purpose

In 1953 the United States Geological Survey studied formations on the borders of the land-pebble phosphate district for the purpose of placing previous and current stratigraphic and economic studies of the district into a larger geologic setting.

Location of area and sources of data

This report, one of four on the peripheral areas, describes Cenozoic rocks on the northern and eastern edges of the land-pebble phosphate district, including part of the hardrock phosphate belt. Figure 1 and plate 1 show the area studied.

Outcrops and exposures of unconsolidated sands and clays that cover the entire area are poor. However, data were obtained from the following 71 excavations and core holes which extend in a broad belt about 90 miles long between Hernando and Hardee Counties (pl. 1). Site numbers correspond to those in plates 1 to 3 and in the Appendix.

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1. McDonald limestone quarry, sec. 19, T. 22 S., R. 20 E.
2. hardrock phosphate mine, sec. 4, T. 22 S., R. 20 E.
3. hardrock phosphate mine, sec. 18, T. 22 S., R. 21 E.
4. hardrock phosphate mine, sec. 5, T. 23 S., R. 21 E.
5. core hole, NW 1/4 SE 1/4 sec. 22, T. 24 S., R. 21 E.
6. core hole, NE 1/4 NE 1/4 sec. 14, T. 25 S., R. 21 E.
7. core hole, NW 1/4 SE 1/4 sec. 13, T. 25 S., R. 21 E.
8. core hole, SW 1/4 NE 1/4 sec. 19, T. 25 S., R. 22 E.
9. core hole, SW 1/4 SW 1/4 sec 27, T. 25 S., R. 22 E.
10. road-cut, SW 1/4 sec. 35, T. 25 S., R. 22 E.

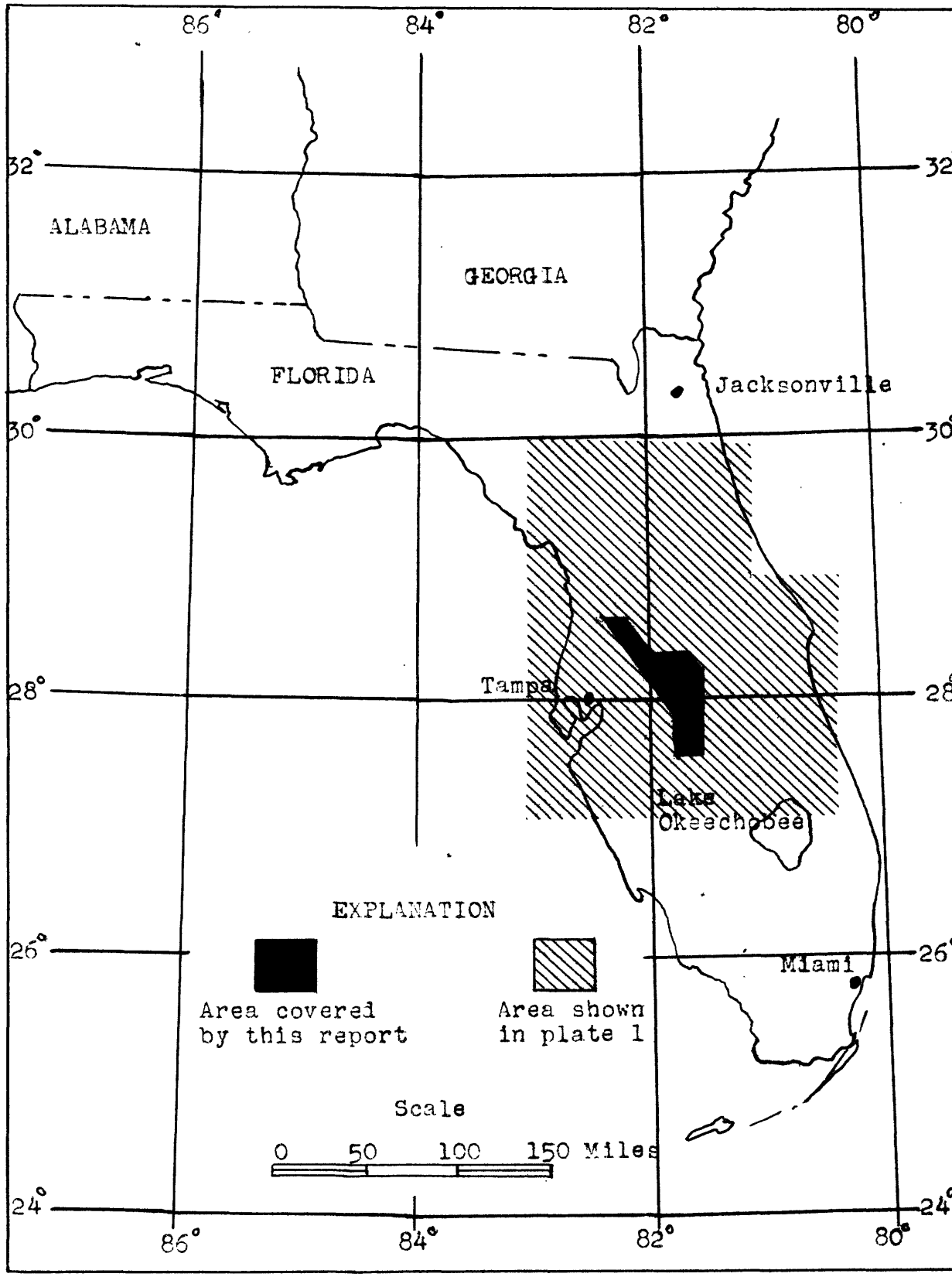

Figure 1.--Index map showing location of area covered by this report.

11. core hole, NW 1/4 NW 1/4 sec. 1, T. 26 S., R. 22 E.

12. core hole, SW 1/4 SW 1/4 sec. 8, T. 26 S., R. 23 E.

13. road-cut, N 1/2 sec. 21, T. 26 S., R. 23 E.

14. core hole, NE 1/4 SW 1/4 sec. 27, T. 26 S., R. 23 E.

15. core hole, NW 1/4 SW 1/4 sec. 1, T. 27 S., R. 23 E.

16. core hole, NE 1/4 SW 1/4 sec. 18, T. 27 S., R. 24 E.

17. core hole, SE 1/4 NW 1/4 sec. 31, T. 27 S., R. 24 E.

18. Saddle Creek land-pebble phosphate mine, sec. 14, T. 28 S., R. 24 E.

19. Tenoroc land-pebble phosphate mine, sec. 35, T. 27 S., R. 24 E.

20. core hole, NE 1/4 SE 1/4 sec. 11, T. 27 S., R. 24 E.

21. core hole, NE 1/4 SW 1/4 sec. 5, T. 25 S., R. 25 E.

22. core hole, SW 1/4 SW 1/4 sec. 7, T. 25 S., R. 25 E.

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25. core hole, SW 1/4 SW 1/4 sec. 21, T. 26 S., R. 25 E.

26. core hole, SW 1/4 sec. 28, T. 26 S., R. 25 E.

27. core hole, NW 1/4 SW 1/4 sec. 6, T. 27 S., R. 25 E.

28. core hole, NE 1/4 NE 1/4 sec. 8, T. 27 S., R. 25 E.

29. core hole, NW 1/4 NW 1/4 sec. 3, T. 27 S., R. 25 E.

30. core hole, NE 1/4 sec. 12, T. 27 S., R. 25 E.

31. core hole, SW 1/4 SW 1/4 sec. 3, T. 27 S., R. 26 E.

32. core hole, NE 1/4 SW 1/4 sec. 7, T. 27 S., R. 27 E.

33. core hole, NE 1/4 NE 1/4 sec. 20 , T. 28 S., R. 25 E.

34. core hole, SE 1/4 NE 1/4 sec. 21, T. 28 S., R. 25 E.

35. core hole, NE 1/4 SE 1/4 sec. 22, T. 28 S., R. 25 E.

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38. core hole, NW 1/4 SE 1/4 sec. 14, T. 28 S., R. 26 E.

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Earlier work

Eldridge (1893), Sellards (1913), Matson (1915), and Vernon (1951) described the geology of the hardrock phosphate belt, and Eldridge (1893), Sellards (1915), Matson (1915), Cathcart (1950), and Cathcart and others (1953) gave detailed accounts of the land-pebble phosphate district. There are no detailed published descriptions of rocks between the two districts.

Field work and acknowledgments

Field work was done mainly in May, August, and September 1953. Cores 3-5/8 inches in diameter were obtained from holes drilled with a truck-mounted core drill. Elevations were determined by the use of topographic maps and aneroid barometers. Rock samples were decomposed in acid, dried, and classified by sieving (size terminology used throughout the report is that of Wentworth, 1922). Median diameters of quartz grains were obtained from cumulative curves of the size class weights.

C. B. Hunt, M. N. Bramlette, F. S. MacNeil, and G. W. Boyes aided in the field examination of mines, and R. G. Petersen and J. B. Cathcart aided in logging of drill cores. F. S. MacNeil made all fossil identifications. James Gilluly, F. S. MacNeil, H. D. Drewes, and Z. S. Altschuler reviewed the manuscript. The second author logged most of the cores on the east edge of the land-pebble phosphate district. The first author takes responsibility for all interpretations but acknowledges the assimilation of ideas from all his professional associates in this work.

This work was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOLOGIC SETTING

The area covered by this report is low and of subdued relief. In the northern part of the area hills rise to 200 feet above sea level, and local relief is more than 100 feet in places. In the central and southern parts of the area, low parallel ridges, trending north-south, produce local relief of less than 100 feet. The prevailing aspect of the entire area is one of low swamplands and savannas drained by sluggish streams and pocked with innumerable sinks. North of Lakeland, the area is drained by the Withlacoochee and Hillsborough rivers; south of Lakeland, by the Peace and Alafia rivers.

A breached, north-south trending elongate dome known as the Ocala Uplift occupies much of peninsular Florida (Vernon, 1951). The report area covers part of the southwestern and southeastern flanks of this uplift.

STRATIGRAPHY

Introduction

Summary of stratigraphy

One of the most salient features of Cenozoic stratigraphy in the area covered by this report and over most of Florida is the prevalence of the general sequence (in descending order):

1. loose sand
2. clayey sand and sandy clay
3. limestone

Table 1. Generalized section of rocks in the area between Hernando and Hardee Counties, Florida.

Series	Generalized lithology of stratigraphic units	Thickness (feet)	Formation names used in this report	
			Northern part of area	Southern part of area
Miocene to Recent	Sand, quartz, loose, massive	0 to 15	Surficial sand	Surficial sand
Late middle to early upper Miocene	Sand, quartz, clayey, micaceous, very fine-grained to medium-grained, brown to white	0 to 80	Not present	Clayey sand
Middle Miocene	Sand, quartz, clayey, fine-grained, brown to gray; interstitial secondary phosphates	0 to 70	Hawthorn formation, sand unit	Hawthorn formation, sand unit
	Sand, quartz and phosphorite, clayey, gray to brown; quartz sand fine-grained, phosphorite nodules range to pebble size	0 to 18	Hawthorn formation, phosphorite unit	Hawthorn formation, phosphorite unit
	Limestone, clayey, sandy; phosphorite nodules range up to pebble size	0 to more than 100	Not present	Hawthorn formation, limestone unit
Lower Miocene	Clay, sandy (very fine-grained), greenish to brown	0 to 25	Tampa limestone, clay unit	Not present
	Limestone, clayey, sandy, yellowish; phosphorite nodules of sand size	0 to 100	Not present	Tampa limestone, limestone unit
	Clay, clay size apatite and clay, sandy, concretionary, white, brown	0 to more than 10	Tampa limestone, phosphorite unit	Not present
Upper Oligocene	Limestone, sandy (very fine-grained)	0 to 125	Suwannee limestone	Not present
Upper Eocene	Limestone, pure	100 to 500	Ocala limestone	Ocala limestone

In the report area, limestone ranges from upper Eocene to middle Miocene. Much of the clayey sand and sandy clay, which ranges in thickness from about 12 feet to more than 125 feet, is phosphatic; and, although nearly all of it is devoid of fossils, it is thought to range from lower to upper Miocene. Surficial loose sand, commonly less than 15 feet thick, is unfossiliferous. In the northern and northeastern parts of the report area, surficial loose sand contains artifacts indicating it is of Recent age there.

Plate 2 shows a geologic section extending from the hardrock phosphate district in Hernando County to the land-pebble phosphate district in Polk County. It represents the authors' interpretation of stratigraphy derived from field examination of mines, road cuts, and drill cores and from laboratory examination of numerous rock samples. Measured median diameters of quartz sand and percentage of quartz sand content in spot samples and relative radioactivity are shown at appropriate stratigraphic positions. Plate 3 shows a fence diagram of the northeastern and eastern edges of the land-pebble phosphate district. It is based almost entirely on field examination of drill cores.

Nomenclature

Stratigraphy in Florida has been complicated by one or more periods of intense weathering which have profoundly altered some rocks. It is generally agreed that impure limestone and phosphorite have been altered in places to clayey sand and that the clay in the clayey sand, especially near the surface, has been almost entirely removed by ground water leaving a bed of loose sand. However, opinion is divided on the quantitative importance of this alteration in Florida stratigraphy. In one view, some widespread strata consisting of unconsolidated sand and clay are entirely the relatively insoluble residues of impure limestone. In the opposite view, all strata are primary depositional units only slightly modified by weathering. According to still other views apparent lithologic units may be residual in one place and depositional in another. Because of this unsettled state of opinion certain deposits are informally called units in this report to avoid the connotation of primary origin implicit in the terms "formation", "member", "lentil" or "tongue."

Correlation

Because of widely separated exposures and drill holes and rarity of fossils, correlation is difficult. Moreover, where strata can be partly reconstituted by weathering, only original lithology, not present gross lithology, can be used in correlation. In this report, some rocks are subdivided on the basis of general lithologic features into units; but, because a lithologic unit might be derived by weathering from parent material of different lithology, units are grouped into formations on the basis of age, where possible, and of similarity in size of relatively unalterable constituents, mainly quartz sand.

In general, quartz sand increases in average size upward from the rocks of one series to those of the next younger. This is true of Eocene, Oligocene and Miocene limestones in which an abundance of fossils makes age determination certain and appears to be generally true of lower, middle and upper Miocene sands and clays in which fossils are scarce (pl. 2, and W. J. Carr and D. C. Alverson, report in preparation).

Clay content is used in conjunction with quartz sand in some places as an aid in correlation. Although it is susceptible to some redistribution and chemical alteration, clay is stable relative to other common rock components such as carbonate and phosphate.

Uranium is contained in both primary phosphates and their secondary alteration products in the report area (Altschuler and Boudreau, 1949). When primary phosphate, commonly apatite, is decomposed by weathering, enough uranium-bearing secondary phosphate generally is left to indicate the former presence of apatite. Radioactivity in drill holes was measured by means of a gamma-ray logging apparatus. Graphs showing relative radioactivity are given in plate 2 beside drill holes. These graphs were used as an aid in correlation on the assumption that a relatively high degree of radioactivity indicates that apatite is or was, prior to weathering, present in considerable amount.

Unconformities

Where processes of weathering alter a formation to various depths, an apparent unconformity is commonly produced by the irregular contact at the base of the altered rock and by the change of lithology (Sellards, 1910, p. 34). Where the entire parent formation is altered causing the altered rock to lie directly upon a distinctly older formation, the illusion of an unconformity is even more striking. Possible examples are common in the report area. In plate 2, for example, the sand unit of the Hawthorn formation is shown lying on Tampa limestone in some places without the normally intervening phosphorite and limestone units of the Hawthorn formation. Here erosion or nondeposition of the phosphorite and limestone units is not a necessary deduction, they might have been present before weathering altered both to clayey sand.

Eocene series

Ocala limestone

The oldest formation exposed in the report area, Ocala limestone, is of late Eocene age (Cooke, 1945).

Although it underlies the entire Florida peninsula (Cooke, 1945, p. 55), Ocala limestone was encountered in the report area only in the south end of the hardrock phosphate belt in three mines, and on the northeast edge of the land-pebble phosphate district in three drill holes (pls. 2 and 3).

According to Cooke (1945, p. 55) and Vernon (1951, pl. 2) the Ocala is 100 to 500 feet thick in the report area where it lies unconformably (Cooke, 1945, p. 56) on Avon Park limestone of middle Eocene age.

Ocala limestone is soft, friable, porous, and pure. In many places it consists almost entirely of fossils. Its most conspicuous impurity, green or brown clay, is so sparse that the limestone is almost everywhere white. Two samples of Ocala limestone from quarries near the east edge of the south end of the hardrock phosphate belt (pl. 1, nos. 69 and 70) contain 0.12 and 0.04 percent P_2O_5, and 0.45 and 0.14 percent acid-insoluble material, probably quartz silt and clay. Two samples within the hardrock belt (pls. 1 and 2, nos. 2 and 3) contain 0.10 and 0.08 percent P_2O_5, and 0.68 and 0.32 percent acid-insoluble material.

All four samples contain less than 0.1 percent Al_2O_3. Two samples of Ocala from the hardrock district (pls. 1 and 2, nos. 2 and 3), each weighing about seven pounds, yielded no residue of sand size when dissolved in acid. Recognition of Ocala limestone in the area covered by this report is simplified by the extreme purity of the rock and an abundance of fossils of which Lepidocyclina is especially common and diagnostic.

The Ocala limestone surface in the hardrock phosphate belt is deeply weathered as shown by solution features such as sinkholes and pinnacles. The pinnacles, common in hardrock phosphate mines, are 2 to 10 feet thick and generally greater in vertical than in horizontal dimension. Many pinnacles are slickensided indicating that overlying sediments have settled down around them as a result of compaction or differential limestone solution.

The configuration of the surface of the Ocala limestone east of the hardrock phosphate belt contrasts sharply with the configuration within the hardrock belt. East of the hardrock belt the generally flat surface of Ocala is broken, not by pinnacles, but by nearly vertical-sided solution "pipes" 2 to 10 feet in diameter and 10 to 30 feet deep. East of the hardrock belt, clay, probably derived partly from solution of the Ocala, veneers the limestone surface and fills solution pipes and sinkholes. In the hardrock phosphate belt the insoluble residue of Ocala limestone derived from limestone removed by solution above and around the pinnacles doubtless collects in depressions between pinnacles but is not commonly exposed.

The following Eocene fossils were collected from core holes in Ocala limestone:

Plates 1 and 3, no. 25

Chlamys sp. cf. C. spillmani (Gabb)

Tubulostium sp. (coiled worm)

Lepidocyclina ocalana Cushman.

Plates 1 and 3, no. 24

Lepidocyclina, sp. cf. L. pseudomarginata Cushman.

Plates 1, 2, and 3, no. 31

Amusium ocalanum Dall.

Oligocene series

Suwannee limestone

Suwannee limestone, the only formation of Oligocene age in the report area, crops out both in northwest and west-central peninsular Florida (Cooke, 1945, pl. 1). The area of this report covers part of the northeast edge of the southern outcrop area. Suwannee limestone lies unconformably on Ocala limestone (Cooke, 1945, p. 88). In the report area it ranges in thickness from a probable maximum of 125 feet, as known from wells at Zephyr Hills (Carr, W. J. and Alverson, D. C., report in preparation) to the vanishing point in the southern end of the hardrock phosphate belt and on the northeast edge of the land-pebble phosphate district.

Twenty feet of Suwannee limestone is exposed in the McDonald quarry three miles east of Brooksville in Hernando County (pls. 1 and 2, no. 1). The limestone is widely jointed, hard, and dense at the base of the pit, but closely jointed and considerably softer and porous near the top. The top is very irregular, sinkholes are numerous, and the limestone surface between sinkholes is jagged in detail.

In the hardrock phosphate belt, a rubble of Suwannee limestone ranging from pebble to boulder size discontinuously overlies Ocala limestone. The maximum thickness of rubble observed is about 15 feet. Although most of the particles of Suwannee limestone are roughly equidimensional, they are not rounded or polished but clearly show effects of solution such as protruding crystals and fossils, pitting, and fluting. Some are encased in crusts of chert, others contain sponge-like "skeletons" of chert. Some are replaced by apatite. One boulder of Suwannee limestone found (displaced) in a hardrock phosphate mine (pls. 1 and 2, no. 3) is completely replaced by apatite and chert. The following Oligocene fossils were identified in this boulder:

Calliostoma silicatum Mansfield

"Amauropsis", aff. A. burnsii meridionalis Pilsbry Mansfield

Cerithium aff. C. vaginatum Dall

Xenophora sp.

Glycymeris n. sp.? large

Venericardia sp. juvenile

Phacoides hernandoensis Mansfield

Cassidulus gouldii (Bouvé).

Three samples of Suwannee limestone from a limestone quarry and a hardrock mine (pls. 1 and 2, nos. 1 and 3) were found to contain less than 0.2 percent P_2O_5, and less than 0.1 percent Al_2O_3. The principal noncalcareous constituent is very fine-grained, very well sorted quartz sand which constitutes from 1 to 11 percent of the Suwannee limestone in the report area (pl. 2).

In the northern part of the area, Suwannee limestone differs lithologically from Ocala limestone in being dense, coarsely crystalline, tan, and visibly sandy. From Dade City southeastward, however, it more nearly resembles Ocala limestone in being soft, porous, finely crystalline, and white. The characteristics which distinguish Suwannee from Ocala limestone in this area are appreciable quartz sand content in the Suwannee and distinctive fossils. Cassidulus gouldii is a common guide fossil of the formation.

The following Oligocene fossils were collected from a core hole in Suwannee limestone (pls. 1 and 2, no. 12):

Depth, 20 feet

Turritella sp. cf. T. bowenae Mansfield and T. halensis Dall

Depth, 21 to 27 feet

Turritella halensis Dall

Cryoturris ? cf. C. hillsboroughensis Mansfield

Glycymeris suwannensis Mansfield

Divaricella sp.

Pitar sp.

Corbula sp.

Depth, 28 to 33 feet

Turritella sp. cf. T. halensis Dall

Eucrassatella sp. cf. E. paramesus Dall

Chlamys sp. cf. C. brooksvillensis Mansfield

Depth, 34 to 38 feet

Orthaulax hernandoensis Mansfield

Amauropsis ? sp.

Glycymeris suwannensis Mansfield

Chlamys sp. cf. C brooksvillensis Mansfield

Phacoides sp

Chione sp. cf. C. bainbridgenses Dall

Chione sp.

Pitar sp. cf. P. heilprini Mansfield

Depth, 39 to 44 feet

Anatina sp.

Venus sp.

Miocene series

Tampa limestone

Introduction.--The Tampa limestone of this report includes the lower Miocene Tampa limestone as defined by Cooke (1945, p. 111) and lower Miocene strata commonly included in the Alachua formation of Sellards (1914, p. 161). Cooke (p. 114) described the Tampa limestone simply as ". . . fairly hard, dense, light-colored to yellowish limestone . . . . "

Lower Miocene rocks have not previously been recognized in the Alachua formation. In 1910, Sellards (p. 32) applied the term "Dunnellon formation" to " . . . a mixture of material largely residual from several formations . . . " between the underlying limestone and overlying loose surficial sand in the hardrock phosphate belt. Commonly the Dunnellon formation is composed of basal phosphorite overlain successively by clay lenses and "more or less phosphatic light gray sands " (p. 22). Less commonly it contains water-worn chert , conglomerate and interbedded clay, sand, and phosphate rock (p. 23).

In 1914, Sellards (p. 161) retracted the name "Dunnellon formation" and substituted the name "Alachua formation" for the same strata stating that the Dunnellon formation is simply a local variant of the Alachua clays which previously had been briefly mentioned by Dall and Harris in 1892 (p. 127). Dall and Harris cite clay east of the hardrock belt on the old Mixson farm in the center of sec. 29, T. 12 N., R. 19 E., near Williston as an example of Alachua clay. Simpson (1930, p. 175) considers the vicinity of Williston the type locality of the Alachua formation which he describes as follows (p. 173): ". . . sandy clay, or argillaceous sand, generally from 0. to 15 feet in thickness save where it fills local sinkholes of greater depth. When fresh it is gray or greenish, but it is usually weathered and of a bright orange to chocolate red color. It appears not to be phosphatic but to be residual and doubtless in part water laid or reworked clay derived from the older limestone by weathering and solution."

Therefore, the Alachua formation as redefined by Sellards in 1914 is composed, in general, of four stratigraphic units in the hardrock belt and at least two in the adjacent area as shown in figure 2. The Alachua formation is said to be composed of both residual and locally reworked material by both Sellards and Simpson. Sellards (1910, p. 32) and Matson and Clapp (1909, p. 133) suggest the reworked parts are terrestrial rather than marine.

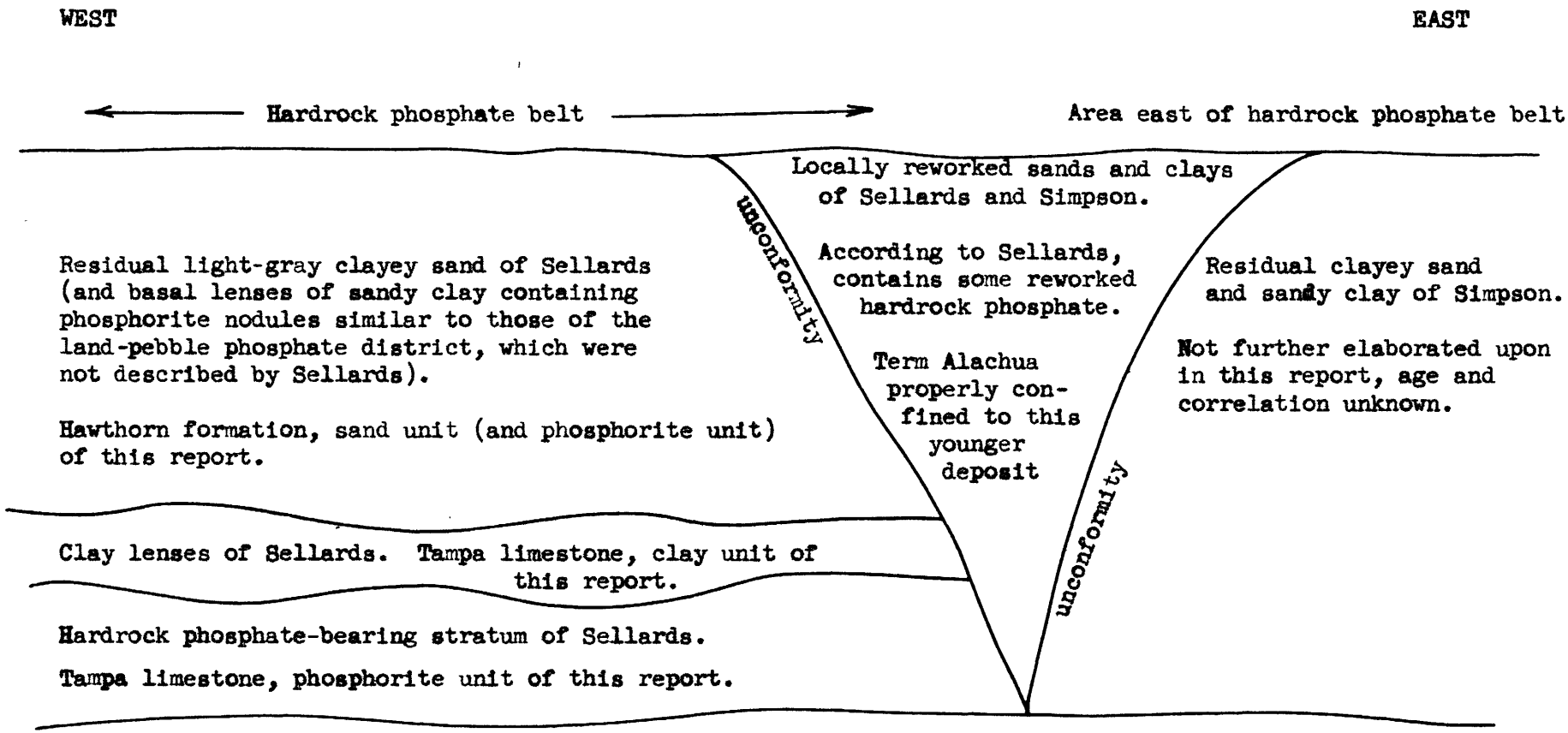


Figure 2.--Diagrammatic east-west section showing strata composing the Alachua formation as redefined by Sellards in 1914.

The Alachua clay of Dall and Harris in the area adjacent to the hardrock belt on the east was not studied and is not further reported upon. The locally reworked part of Sellards' Dunnellon formation in the hardrock belt was not recognized, but his three older strata were observed in abandoned hardrock phosphate mines (pls. 1 and 2, nos. 2, 3, 4) and were encountered in drilling (nos. 5, 6, 7, 8) in the southern end of the hardrock belt.

Of the three older strata observed, the lower two, clay lenses and the hardrock phosphate-bearing stratum, are correlated with lower Tampa limestone of early Miocene age (pl. 2) and in this report are termed the clay and phosphorite units, respectively, of the Tampa limestone. The upper stratum, gray clayey sand together with basal lenses containing nodular phosphorite not mentioned by Sellards, are correlated with Hawthorn limestone of middle Miocene age (pl. 2) and in this report are termed the sand and phosphorite units , respectively, of the Hawthorn formation. The bases of these formational assignments are given below.

Simpson (1930, p. 170) reviewed the evidence of age of the Alachua formation. He studied vertebrate fossils collected from clay of the Alachua on the Mixson farm and from largely unknown stratigraphic positions in various hardrock phosphate mines north of the area of this report and concluded that the Alachua formation is late Miocene or early Pliocene in age.

The discrepancy between the age of the Alachua formation as determined by Simpson and the ages of component strata indicated by the data of this report probably results from diversity of age of the component strata rather than from error. The age assignments of this report are based on marine invertebrate fossils. (See below.) Those of Simpson are based on land vertebrates. It seems probable that the vertebrates studied by Simpson came from the terrestrial "reworked" component of Sellards' Alachua formation whereas in the area of this report only the components said to be residual products of older marine rocks are present.

It is recommended that the term Alachua formation be used only in its original sense, i. e., for deposits of clay of late Miocene or early Pliocene age typified by those on the Mixson farm.

Phosphorite unit.--The lowest unit of Sellards' Dunnellon, or Alachua, formation in the hardrock belt, is here called the phosphorite unit of the Tampa formation. It is the bed which contains hardrock phosphate in the south end of the hardrock phosphate belt.

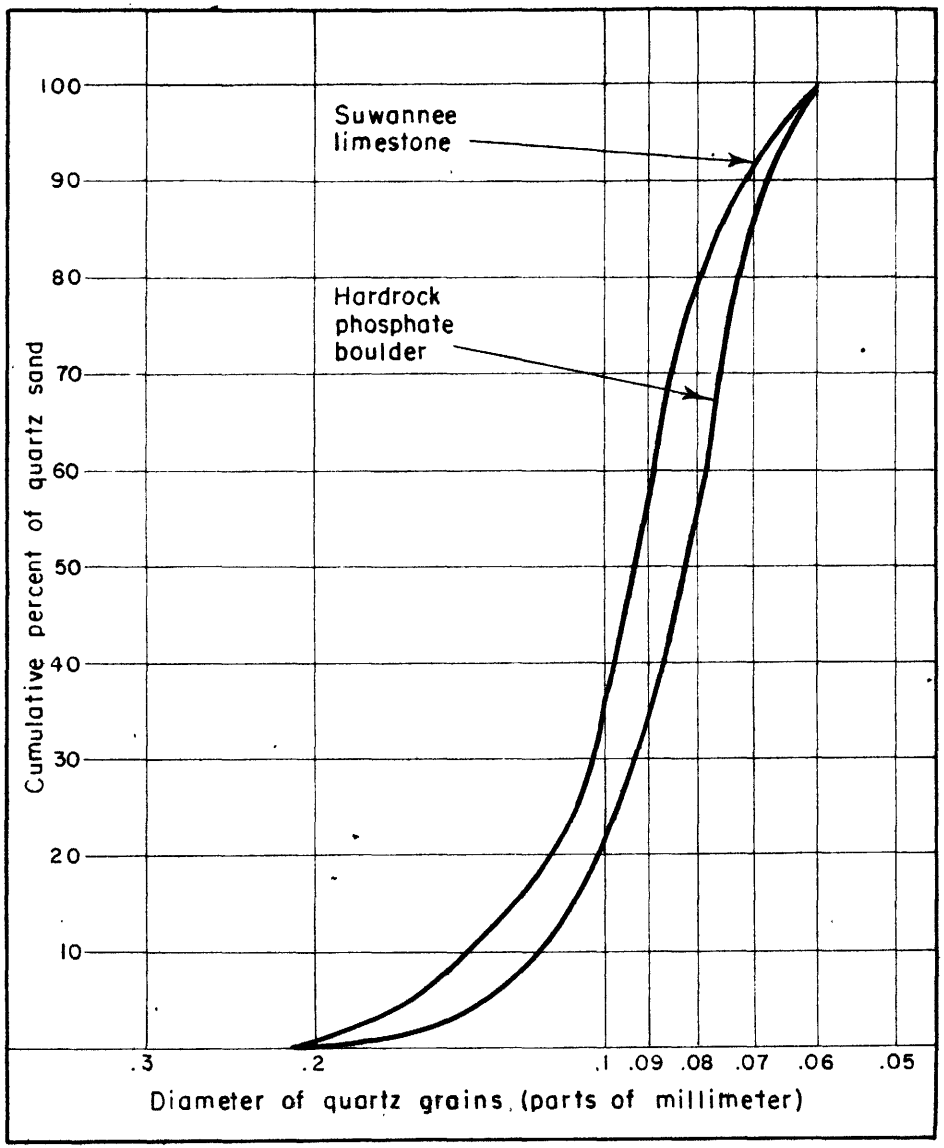
The phosphorite unit extends in a belt 125 miles long and about 10 miles wide between Dade City, Pasco County, and Fort White, Columbia County. It is well exposed in dry weather in three abandoned hardrock phosphate mines near the village of Croom, Hernando County (pls. 1 and 2, nos. 2, 3, 4).

The phosphorite unit of the Tampa limestone consists of a nonbedded, mottled, weakly coherent mixture of clay, very fine- to fine-grained quartz sand, and clay-size particles of white cryptocrystalline apatite or "collophane" in widely variant proportions. Quartz sand content of the phosphorite unit ranges from 2 to over 50 percent in the report area (pl. 2). The southernmost tongue, near Dade City, is more than usually sandy.

Rubble of Suwannee limestone and sand-size to boulder-size concretions of hard apatite known as "hardrock phosphate" are irregularly distributed in the phosphorite unit. Some of the concretions are brown, hard, roughly concentrically laminated, and complexly veined with layered crystalline apatite. They contain minor amounts of clay and quartz sand and have sharp contacts with the soft, sandy apatite and clay matrix. Other concretions, generally white or tan, are more homogeneous in structure with no concentric layering or veins. They are rather sandy and their contacts with the soft matrix are gradational. Angular fragments of both types of concretions are common.

Where the phosphorite unit of the Tampa directly overlies Ocala limestone in the hardrock belt, it is unconformable and, because of the distinct difference in lithology, is probably also unconformable where it overlies Suwannee limestone.

Although the phosphorite unit is unfossiliferous in the report area, it is probably early Miocene in age, being underlain unconformably by limestone of Oligocene age and overlain without apparent unconformity by clay of early Miocene age. Furthermore, quartz sand contained in both the phosphorite and overlying lower Miocene clay unit is nearly identical in size and sorting indicating probably genetic unity (fig. 3 and pl. 2).



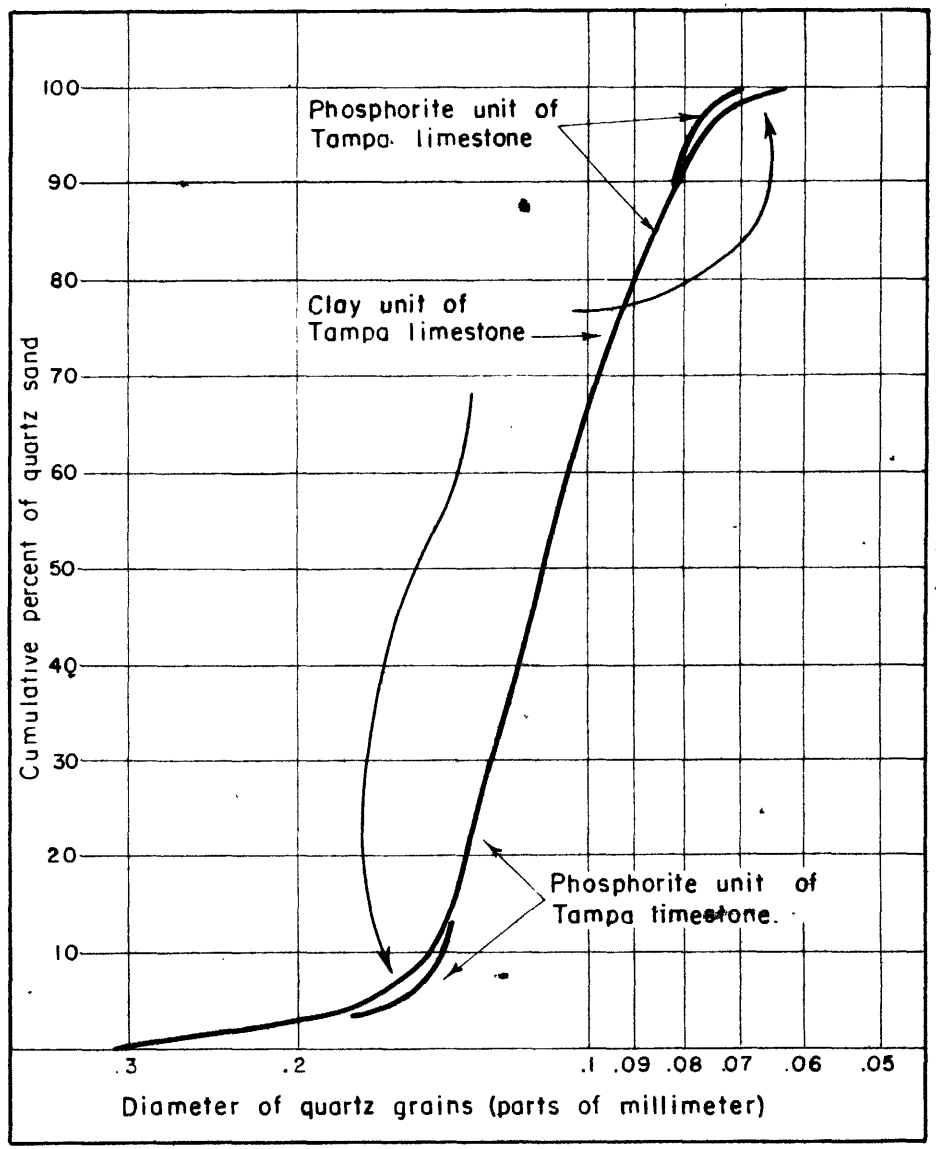


FIGURE 3-CUMULATIVE CURVES COMPARING SIZE AND SORTING OF QUARTZ SAND IN SAMPLES FROM A HARDROCK PHOSPHATE MINE (PLATES 1 AND 2, NUMBER 2)

Limestone unit.--Like Suwannee limestone, Tampa limestone crops out in northwestern and west-central peninsular Florida on the flanks of the Ocala Uplift (Cooke, 1945, p. 114). It underlies the report area only on the north and east edges of the land-pebble phosphate district where it was positively identified in one phosphate mine and in two drill holes (pls. 1, 2, and 3, nos. 19, 37, 38). According to Cooke (1945, p. 114) it is generally less than 100 feet thick in the report area.

Although the stratigraphic relation between the phosphorite unit of the Tampa and the limestone unit of the Tampa is not certainly known, the authors believe the limestone to be younger than the phosphorite. In one exposure (pls. 1 and 2, no. 2) fragments of limestone resembling Tampa limestone overlie the phosphorite unit.

In the Tenoroc mine (pls. 1 and 2, no. 19) it is fossiliferous, yellowish, rather soft, clayey, sandy, and sparsely pebbly. The sand consists of very fine to fine-grained quartz and sand-size to pebble-size rounded, polished phosphorite nodules. The limestone unit of the Tampa elsewhere has not been reported to contain phosphate. The two feet of rock exposed shows no bedding. Tampa limestone at the Tenoroc mine differs lithologically from limestone of the Hawthorn formation exposed in other land-pebble phosphate mines in having a much greater content of well-preserved fossils, and less phosphate.

The following lower Miocene fossils were collected from core holes in Tampa limestone:

Plates 1 and 3, no. 37

Turritella tampa Heilprin

Turritella hillsborensis Mansfield

Amauropsis sp.

"Acropsis" sp.

Chlamys crocus (Cooke)

Phacoides sp. cf. P. wacissanus Dall

Plates 1 and 3, no. 38

Venus ? sp.

Sorites sp.

Camerina sp.

Peneroplis sp.

Clay unit.--The second oldest unit of Sellards' Dunnellon or Alachua formation is here called the clay unit of the Tampa limestone.

In the area covered by this report the clay unit extends from Brooksville to Lakeland (pls. 1 and 2, nos. 1 to 15). Reconnaissance indicates it does not extend into the northern end of the hardrock phosphate belt as does the phosphorite unit. This conforms with Sellards' observation (1913, p. 29) that hardrock phosphate is typically associated with clay in the southern part of the hardrock belt, in contrast with that of the northern part. The clay unit of the Tampa continues west of the report area an unknown distance and to the south apparently grades into the limestone unit of the Tampa about where the limestone unit of the Hawthorn formation appears (pl. 2, nos. 15 and 16).

The clay unit ranges in thickness from about 25 feet near Dade City to the vanishing point north and east of the report area.

The clay unit of the Tampa limestone consists of greenish-gray to brown clay containing very well-sorted, very fine-to fine-grained quartz sand (fig. 3 and pl. 2). The proportion of sand ranges from 5 to 80 percent, averaging about 35 percent. Bedding, expressed as various sand-clay ratios, is commonly massive, and contacts between beds are gradational. Veinlets of secondary phosphate are common near the top.

The clay unit overlies the phosphorite unit of the Tampa limestone and Suwannee limestone in the area covered by this report. Its contact with the phosphorite unit is generally gradational, but with Suwannee limestone it is sharp and probably unconformable.

The clay unit (and consequently the underlying phosphorite unit) was transferred from the Alachua formation to the Tampa limestone partly because of its early Miocene age (see below) and partly because of the possibility that it was derived by weathering from Tampa limestone assumed to have been more widespread formerly than now.

Evidence of secondary origin, partly permissive, is as follows: In places (pl. 2, nos. 1, 2, 17) the clay unit is calcareous and contains pitted, softened, irregular particles of limestone lithologically similar to known Tampa limestone to the southwest. When dissolved in acid, Tampa limestone yields a residue of clay and of sand similar in size and sorting to that of the clay unit (W. J. Carr and D. C. Alverson,

report in preparation). The limestone unit contains rather abundant calcareous and siliceous fossils. The clay unit, however, contains only a few siliceous fossils, most of which are partially decomposed to tripoli, implying intensive leaching.

The following marine invertebrate fossils found in the clay unit indicate it to be lower Miocene. Confirmation of this age is found in the age of overlying strata which are middle Miocene in age (see below).

Plate 2, no. 14

Terebra sp.

Knefastia sp. aff. K. brooksvillensis Mansfield

Olivella sp. cf. O posti Dall

Turritella atacta Dall

Architectonica n. sp. ?

Anadara latidentata (Dall)

Chlamys sp. frag.

Cardium (Trachycardium) delphicum Dall

Callocardia sp.

Pitar sp.

Venus sp.

Corbula sp.

Carr and Alverson (report in preparation) collected the following fossils from the clay unit of the Tampa limestone exposed in a road cut 3-1/2 miles southwest of Thonotosassa, Hillsborough County, where Highway 301, passes under the Atlantic Coast Line railroad.

Plate 1, no. 65

Conus sp. cf. C. illiolus Dall

Strombus liocyclas Dall

Latirus sp. cf. L. floridanus Heilprin

Cyrena floridana (Dall)

Venericardia serricosta (Heilprin)

Chione (Chamelaea) nuciformis (Heilprin)

Anomalocardia floridana (Conrad)

The following fossils were found in a matrix of the clay unit of the Tampa limestone by the edge of an excavated pond about 1 mile west of St. Joseph, Pasco County:

Plate 1, no. 63

Trigonocardia alicula Dall

Anomalocardia penita Dall

Hawthorn formation

Introduction.--The Hawthorn formation of this report includes the Hawthorn formation as defined by Cooke (1945, p. 144) and described below, middle Miocene rocks in the hardrock phosphate belt including those generally assigned to the Alachua formation, and middle Miocene rocks in the land-pebble phosphate district including noncalcareous rocks which have not always been distinguished from the Bone Valley formation.

Cooke and Mossom (1929, p. 115) describe the Hawthorn formation as follows:

> "The most persistent component of the Hawthorn formation is white or cream-colored sandy limestone containing brown grains of phosphorite. Rock of this kind is widely distributed in the Peninsula and the northern part of the state, but is rarely seen in natural exposures, for it readily disintegrates into sand. An intermediate product of disintegration is gray or white, very light, pumice-like sandstone, from which the lime and phosphate have been dissolved, leaving smooth, rounded blebs in place of the phosphatic grains."

A stratum intermediate in lithology and stratigraphic position between "sandy limestone" and "pumice-like sandstone" is common on the north edge of the land-pebble district. In this report these three lithologic subdivisions of the Hawthorn formation are called the limestone, phosphorite, and sand units of the Hawthorn formation.

It was explained (p. 22) that the Alachua formation of Sellards is composed of strata ranging from lower Miocene to upper Miocene or lower Pliocene and that parts of the Alachua formation are here assigned to the Tampa and Hawthorn formations.

The term Bone Valley formation in the land-pebble phosphate district, like the Alachua formation in common usage probably includes beds of diverse age and origin although it was not so intended by Matson and Clapp who originally defined the term.

In the early days of phosphate mining, two types of phosphate deposits were recognized in the land-pebble district: river-pebble phosphate and land-pebble phosphate. River-pebble phosphate occupies the channels, floodplains, and estuaries of modern rivers whereas land-pebble phosphate is contained in buried strata not associated with modern streams. Both types generally overlie the limestone unit of the Hawthorn formation. Only the land-pebble deposits are described in this report.

In 1909 Matson and Clapp (p. 138) applied the term Bone Valley gravel to beds containing commercial land-pebble phosphate deposits. They describe the formation as " . . . a fine-grained matrix containing pebbles of phosphate or chert, fragments of bone and other organic remains." Later Sellards (1910, p. 33) assigned associated sand to the formation, referring to it as the Bone Valley formation. He writes: "This formation includes a lower phosphate-bearing member and an upper sand or sandstone member."

At first it was thought that the Bone Valley formation contained all the commercial land-pebble phosphate deposits in the land-pebble district. However, in 1915 Matson (p. 35) noted that phosphate was also mined from parts of the Hawthorn formation below the Bone Valley formation and emphasized that : "the name Bone Valley gravel does not include these older phosphate-bearing beds." (See fig. 4.) MacNeil (1950, p. 105) and Cathcart (1950, p. 140) refer to commercial phosphate deposits in parts of the Hawthorn formation from which the carbonate has been leached. _/ Cathcart states that the leached Hawthorn formation so resembles the overlying Bone Valley formation that the contact is difficult to recognize.

Owing to the similarity of the Bone Valley formation and noncalcareous Hawthorn formation and to the paucity of fossils it is possible that the extent of the noncalcareous or "leached" Hawthorn formation has been underestimated in the land-pebble district. M. N. Bramlette (1953) suggests that noncalcareous Hawthorn formation exceeds the Bone Valley formation as the source of commercial phosphate in the northern part of the district. The data of this report indicate the Bone Valley formation is absent from both the northern and eastern edges of the land-pebble phosphate district.

_/ Lately the word "leached" has come to apply to zones from which apatite, not carbonate, has been leached.

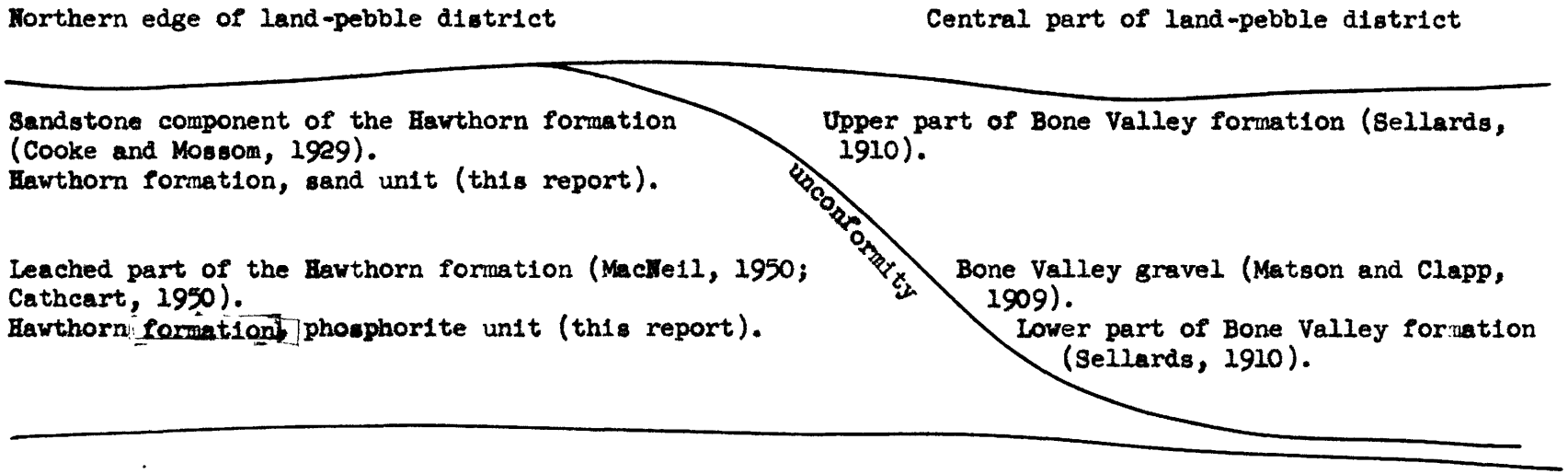


Figure 4.--Diagrammatic north-south section showing the Hawthorn and Bone Valley formations.

Limestone unit. --The limestone (and dolomite) unit of the Hawthorn formation underlies much of northern and southern Florida, but is absent in central peninsular Florida near the crest of the Ocala Uplift.

Typically it contains fine-grained quartz sand, clay, and nodules of phosphorite, mainly apatite, ranging from clay size to cobble size. Phosphorite nodules of sand size and larger are polished and rounded. Many of the larger nodules are aggregates of smaller nodules, quartz sand, and clay. Others consists of limestone cobbles and pebbles encrusted with apatite. Bedding is characteristically massive. Fossils are common although poorly preserved.

According to Carr and Alverson (report in preparation) the limestone unit ranges in thickness from over 100 feet in the central and southern parts of the area covered by this report to the vanishing point in the northern part.

Cooke (1945, p. 145) believes the contact of the Hawthorn formation with the underlying Tampa limestone to be conformable.

The following fossils collected from drill cores show the limestone of sites 39, 40, 43, and 53 (pls. 1 and 3) to be middle Miocene in age, and that of sites 49, 55 and 60 to be probably middle Miocene;

Plates 1 and 3, no. 39

Chlamys sp. cf. C. sayanus Dall

Venericardia sp. frag.

Phacoides ? sp. frag.

Plates 1 and 3, no. 40

Anadara sp.

Chione chipolana Dall

Plates 1 and 3, no. 43

Cardium (Trachycardium) sp. cf. C. plectopleura Gardner

Chlamys sp., probably C. sayanus Dall

Tellina sp.

Plates 1 and 3, no. 53

Chlamys, probably C. sayanus Dall

Plates 1 and 3, no. 49

Anadara sp. fragments

Plates 1 and 3, no. 55

Conus sp.

Anadara sp.

Cardium sp.

? Macrocallista sp.

Plates 1 and 3, no. 60

Crepidula ? sp.

Chlamys sp. frag.

Venerid fragments

Phosphorite unit.--The phosphorite unit of the Hawthorn formation is best known in the land-pebble phosphate district where it constitutes the "matrix" or minable phosphate in places. However, it extends beyond the northern limit of the land-pebble district as lenses and tongues in which the concentration of phosphate is relatively low. It ranges in thickness from about 20 feet to the vanishing point. Although commonly it directly overlies the limestone unit of the Hawthorn formation in the land-pebble district, it overlies Tampa limestone from the northern edge of the district northward. Here a former limestone unit of the Hawthorn formation may have been completely weathered to the phosphorite unit.

The phosphorite unit of the Hawthorn formation, in general, is a poorly bedded mixture of clay and quartz sand containing various proportions of rounded, polished nodules of phosphorite similar to those of the limestone unit. Although most of the quartz sand, which constitutes on the average 30 percent of the rock, is of fine sand size it ranges from very fine- to medium-grained. Phosphorite nodules range much more widely in size.

Judging by carbonate content, the contact between phosphorite and limestone is gradational over a distance of a few inches to six feet, grading upward from phosphatic limestone to calcareous phorphorite and finally to noncalcareous phosphorite.

Lithology of the phosphorite unit varies areally in several respects, notably in size of phosphorite nodules. In general, nodule size of both the phosphorite and limestone units is greatest in the area west of Bartow and least to the east and south of Bartow.

Although no fossils were found in the phosphorite unit in the area of this report, the following silicified fossils were discovered by M. N. Bramlette at the top of the phosphorite unit of the Hawthorn formation in the Sydney mine on the northwest edge of the land-pebble phosphate district:

Plate 1, no. 66

Polystira aff. P. tenagos Gardner

Melongena sp. cf. M sculpturata Dall

Mitrella sp.

Murex sp.

Turritella bicarinata Gardner

Calliostoma harrisii Dall

Calliostoma n. sp.

Glycymeris drymanos grapta Gardner

Chlamys sayanus Dall

Mytilus sp.

Cardita apotega Gardner subsp?

Macrocallista sp.

Callocardia (Agripoma) prosayana dodona? Gardner

Venus cf. V. langdoni Dall

Venus cf. V. prodroma Gardner

Semele cf. S. smithi Dall

They show the underlying phosphorite to be no younger than middle Miocene. Support for this age assignment in the area of this report is found in the age of overlying strata which are middle Miocene and upper Miocene. (See below.)

Sand unit.--The sand unit of the Hawthorn formation overlies the phosphorite unit of the same formation within the land-pebble phosphate district and the Tampa limestone north of the district (pl. 2).

It is a massive-bedded, clayey sand commonly containing vesicles of the size and shape of phosphorite nodules, especially near the base. Quartz sand, most of which is fine-grained, averages 67 percent of the rock in the area sampled. Veinlets and cement of secondary phosphates are rather common especially toward the base of the unit.

The sand unit ranges in thickness from about 70 feet near Dade City to the vanishing point north and south of Dade City and on the east edge of the land-pebble district where erosion has removed it entirely. Maximum thickness of the sand unit in Florida is unknown but probably does not exceed 100 feet.

Although its contact with the clay unit of the Tampa limestone is not prominent, the sand unit can usually be distinguished in the field on the basis of quartz grain size and clay content. The clay unit of the Tampa contains much more clay and its quartz sand is of finer size. Where the sand unit of the Hawthorn overlies the phosphorite unit of the Hawthorn the upper limit of phosphorite nodules is taken to be the contact. Here the contact is generally gradational owing to partial solution of phosphorite nodules in upper parts of the phosphorite.

Where the sand unit of the Hawthorn formation directly overlies the Tampa limestone the interpretation is possible that pre-existing phosphorite and limestone units have been completely altered to the sand unit.

The sand unit of the Hawthorn formation has undergone severe weathering. It contains secondary phosphates and the upper part is oxidized to red, brown, or orange in places. Mottling, resulting from partial reduction of oxidized rock along clay-filled joints, is common in the upper part. Scarce, siliceous fossils are now composed of fragile white tripoli.

The reasons for assigning the phosphorite and sand units to the Hawthorn formation rather than to the Bone Valley formation are the possibility that both were derived from a formerly thicker and more widespread limestone phase by weathering in place and their middle Miocene age (see below). Weathered zones are customarily put in the same formation as the parent rock.

The mineralogical composition of the three units encourages the interpretation that the phosphorite and sand units may be residua of the limestone unit. Were carbonate removed from the upper part of the limestone unit, a residue similar to the phosphorite unit would be formed. If the next most soluble constituent, apatite, were removed from the upper part of the phosphorite unit or converted to secondary phosphates, a residue similar to the sand unit would be produced. Sellards (1913, p. 52) recognized this process in the hardrock district. The relatively high uranium content of the sand unit is interpreted to indicate a formerly high content of phosphate. Quartz sand, the one major constituent of all three units of the Hawthorn which is not altered by weathering, is similar in size in all three and different from that of beds younger and older than the Hawthorn (pl. 2).

Contacts between units of the Hawthorn formation, such as those between the limestone and phosphorite units and between the phosphorite and sand units, are gradational over a distance ranging from a few inches to several feet. Specifically, the gradational contacts are expressed as 1) a gradual decrease upward in carbonate content at the contact between limestone and phosphorite units; 2) a decrease upward throughout the phosphorite unit in carbonate content of the phosphorite nodules (Ketner, 1952); 3) a gradual decrease in hardness and numbers of phosphorite nodules at the contact of phosphorite and sand units; and 4) presence in the sand unit of vesicles from which phosphate evidently has been dissolved.

Areal variations in vesicle size of the sand unit and nodule size of the phosphorite unit correspond to variations in nodule size of the limestone unit. Where phosphorite nodules in the limestone unit of the Hawthorn formation are relatively large, as at the Bonny Lake mine 4 miles west of Bartow (pl. 1, no. 68), those of the phosphorite unit and the vesicles of the sand unit are large also. Where the nodules in the limestone unit are relatively small, as they are to the south and east of Bartow, nodules in the phosphorite unit and vesicles of the sand unit are relatively small.

Proof that the sand unit of the Hawthorn formation is middle Miocene in age is found in its fossil content and in its stratigraphic position. The following siliceous fossils were found by Carr and Alverson (report in preparation) in the sand unit of the Hawthorn formation in a railroad cut in the town of Kathleen, Polk County, near the area of this report:

Plate 1, no. 64

Ostrea normalis Dall

Chlamys sayanus Dall

Fragments of oysters, probably Ostrea normalis, are abundant in Hawthorn sand exposed in a road cut between Lakeland and Dade City (pls. 1 and 2, no. 13). Ostrea normalis is an index fossil of the middle Miocene. As will be seen below, the sand unit of the Hawthorn is overlain by fossiliferous sand of late middle Miocene or early upper Miocene age in the area of this report. The sand unit is therefore bracketed between middle Miocene Hawthorn limestone and late middle or early upper Miocene sand.

Clayey sand of Miocene age

Introduction.--In 1916, Matson (p. 167) named beds of sand, gravel, and clay on the Gulf Coast of Alabama Citronelle formation and dated them Pliocene on the basis of fossil plants. Later, Cooke and Mosson (1929, p. 180) assigned clayey sands of peninsular Florida to the Citronelle. In 1939, Roy (p. 1553) noted that the fossil plants upon which the age of the Citronelle is established at the type locality underlie the Citronelle formation making it possibly younger than Pliocene. Roy suggests that the name Citronelle be dropped in the type area until detailed mapping clarifes the stratigraphy of surficial deposits on the Gulf Coast. The term, clayey sand, is used in the area of this report for the unit that has previously been considered to be the Citronelle formation.

In peninsular Florida, the formation named Citronelle by Cooke and Mossom and later referred to by Roundy (1941, p. 275), and described by Cooke (1945, p. 229) was penetrated in drill holes on the northeast and east edges of the land-pebble phosphate district. It is different lithologically from the Citronelle formation of the type area in being composed almost entirely of clayey quartz sand. Fossils at the base of the formation near Haines City and east of Fort Meade (see below) show it to be late middle Miocene or early upper Miocene in age and therefore older than the Citronelle formation in its type area. The age is that of the Cancellaria Zone (Cooke and Mossom, 1929, p. 140) of Matson and Clapp's Choctawhatchee marl (1909, p. 114). Cooke (1945, p. 181) names phosphatic limestone beds of this age in Florida "Duplin marl" but because the lithology of the clayey sand is different from the nearest Duplin marl at Rock Spring and Wekiva Spring in Orange County, Fla., and the type locality in North Carolina, the terms "Choctawhatchee marl" and "Duplin marl" are not used in the report area.

The section of the clayey sand revealed by drilling 4 miles northwest of Haines City, Polk County (pls. 1 and 2, no. 32), is typical in thickness and lithology, and contains numerous fossils.

Typical stratigraphic section of the clayey sand, NE1/4NW1/4 sec. 7, T. 27 S., R. 27 E., Polk County, Florida (pls. 1 and 2, no. 32).

Unit and description	Thickness (feet)
Not cored (probably loose sand)	12.0
Clayey sand, coarser-grained unit	
Sand, quartz, medium-grained, silty and clayey (20 percent), gray, lower contact sharp	3.5
Clay, very sandy (fine- to medium-grained quartz) (28 to 62 percent), gray to dark green and brown	9.6
No recovery (probably sand)	1.8
Clayey sand, finer-grained unit	
Sand, quartz, very fine- to fine-grained, silty and clayey (10 to 14 percent), white; coarsens at base and grades into unit below	27.0
Sand, quartz, fine-grained, silty and clayey (11 percent), white; trace of mica	5.6

Clayey sand, finer-grained unit--Continued

	Thickness (feet)
No recovery (probably sand)	6.0
Sand, quartz, very fine-grained, sparse coarse grains, silty and clayey (14 percent), white; trace of mica	4.4
Sand, quartz, fine-grained, some coarse grained, silty and clayey (10 percent), white at top to tan at base; sparse phosphorite nodules of coarse sand size; trace of mica	4.5
Sand, quartz, very fine-grained, silty and clayey (20 percent), bluish gray at top to greenish at base; sparse phosphorite nodules of fine to coarse sand size; trace of mica	8.5
Sand, quartz, very fine-grained, silty and clayey (about 15 percent), green; sparse phosphorite nodules of fine to coarse sand size; trace of mica; abundant calcareous fossils	3.0

Hawthorn formation (?), limestone unit

Limestone, clayey, sandy, soft; carbonate and clay (about 75 percent); black phosphorite nodules of coarse sand size (about 20 percent); quartz sand of fine size (about 5 percent)	0.7

Although the clayey sand may be, in general, coextensive with the Citronelle formation of peninsular Florida as mapped by Cooke (1945, pl. 1), it was found both by Roundy (1941) and the writers to extend farther west than shown by Cooke. In plate 2 (nos. 15, 16, and 17) the clayey sand is shown extending westward as far as the northwest edge of the land-pebble district. Patches of the clayey sand are scattered over the northern part of the land-pebble district where they overlie the sand unit of the Hawthorn formation as in one place in the old Saddle Creek mine (pl. 1, no. 67), or they overlie the phosphorite unit where the sand unit of the Hawthorn formation is absent, as in the Tenoroc mine (pls. 1 and 2, no. 19). As first noted by M. N. Bramlette (1953) phosphorite in parts of the Bonny Lake mine (pl. 1, no. 68) is overlain unconformably by clayey sand which contains both weathered and unweathered phosphorite nodules and slightly indurated fragments of sand of the Hawthorn in the basal part.

Although the clayey sand probably extends southeastward beyond the report area it was not found by Bergendahl (1954) directly south of it. On the southern edge of the report area (pls. 1 and 3, no. 61) there is a suggestion in the form of calcareous phosphatic sand and clay overlying clayey sand that the northernmost edge of certain late Miocene calcareous sands described by Bergendahl overlap the southernmost extension of the clayey sand.

In the report area, the clayey sand is composed of an upper, coarser-grained unit and a lower, finer-grained unit which commonly can be distinguished in the field although the exact position of the contact is uncertain because of blending and interfingering.

Finer-grained unit.--The finer-grained unit of the clayey sand is predominantly massive-bedded, weakly coherent, very fine- to fine-grained clayey sand. White mica, although it constitutes less than one percent of the rock, is a conspicuous component. Quartz sand comprises about 65 percent of the member on the average. In places, especially in the southern part of the area covered by this report, it contains scattered grains and beds of coarse sand making it difficult to distinguish from the coarser-grained unit. Although the member is mainly white or brown, it is partly dark green in the northeast and southeast corners of the report area (pls. 1 and 3, nos. 32, 54, 61, 62). Calcareous late middle or early late Miocene fossils were found in this dark green zone in one drill hole (pls. 1, 2, and 3, no. 32) at a depth of 85 feet and in another (pls. 1 and 3, no 54) at a depth of 64 feet. In places, such as the area just north of Lakeland (pls. 1 and 2, nos. 17, 19, 20), it is a sandy clay, correlative with the more typical clayey sand by means of quartz sand size, mica content, and stratigraphic position. In some places the finer-grained unit of clayey sand contains sparse, rounded, polished sand size to pebble size phosphorite nodules near the base.

The finer-grained unit of the clayey sand ranges in thickness from ninety feet to the vanishing point and averages about 25 feet thick in the report area.

The following calcareous fossils show the finer-grained unit to be late middle Miocene or early late Miocene in age:

Plates 1, 2 and 3, no. 32

Olivella sayana Ravenel

Cancellaria cf. C. tabulata Gardner and Aldrich

Turritella sp. aff. T. alumensis Mansfield

Crepidula sp.

Anadara frags. cf. A. idonea harveyensis Mansfield

Chlamys (Plagioctenium) eboreus subsp., cf. watsonensis Mansfield

Pecten (Pecten) sp.

Venus sp.

Spisula (Hemimactra) delumbis (Conrad)

Plates 1 and 3, no. 54

Anadara sp. fragment (A. propatula ?)

Chlamys sp. fragment

Anomia sp. fragment

Phacoides (Parvilucina) multilineatus (Tuomey and Holmes)

Dosinia sp. fragment

Mulinia orthria Gardner

Coarser-grained unit.--The more coarse-grained unit of the clayey sand is weakly coherent, massive-bedded to thin-bedded, slightly clayey sand. Quartz grains range from very fine sand size to pebble size, but the concentration of pebbles is generally too low to classify as gravel any significant part of the formation. Pebbles are commonly disc-shaped. The median diameter of quartz sand and pebbles in the member as a whole is that of medium-grained sand.

In the area covered by this report, content of quartz sand and pebbles averages about 75 percent in the coarser member. The silt and clay size constituents of the member range in color from white near the base of the member to dark red at the top. However, pockets of white clay a few millimeters in diameter are common in the red upper part. Joints containing dark-gray clay form a network in the upper part of the member. The walls of these joints are commonly bleached to a depth of an inch or two causing the upper part of the member to be mottled. Many quartzite pebbles, which range up to an inch in diameter, are easily friable in the fingers as a result of intergranular weathering.

In the area covered by this report the coarser-grained member which averages about 30 feet thick, ranges from 60 feet thick in the northeast to the vanishing point in the southeast and west.

Recent series

Surficial loose sand covers virtually the entire report area. In general, that in the northern and northeastern parts of the area is of variable thickness, possessing a rolling, dune-like surface and commonly containing particles of charcoal and artifacts, mainly chips of chert. The sand commonly is of finer size than that of the clayey sand or sandy clay on which it lies. The presence of artifacts indicates it is of Recent age.

In the southwestern part of the area, most commonly within the land-pebble phosphate district, surficial loose sand is thinner, more regular in surface configuration and contains no charcoal or artifacts below the top few inches. Its lower contact is commonly gradational in clay content with the bed below. The sand above and below the contact is the same size.

CONCLUSION

Geologic history

Table 2 summarizes, from two widely separated viewpoints, the main geologic events which took place in the area of this report beginning with late Eocene time. The two versions illustrate a common conflict in the interpretation of stratigraphic relations in Florida. The residual view is favored by the authors.

Ocala limestone was folded into an anticline known as the "Ocala Uplift" but whether Suwannee limestone was deposited before, during, or after the folding is indeterminate from the data of this report. Where Suwannee limestone is thin or missing it is not clear whether erosion or nondeposition is the cause.

A ridge on the Ocala surface between Brooksville and Croom (pl. 2, nos. 2, 3, 4) might be the locus of greatest upward displacement in the report area or a ridge formed by pre-Suwannee erosion which may or may not coincide with the structural crest of the uplift.

Table 2. Geologic history in the area between Hernando and Hardee Counties, Florida, from the viewpoints of the depositionalist and the residualist.

Epoch	The depositional view	The residual view
Pleistocene and Recent	Deposition of loose sand nearly everywhere at the surface, some residual sand admitted	Conversion, by weathering, of Miocene clayey sand to loose sand nearly everywhere at the surface, some depositional sand admitted
Late late Miocene and Pliocene	Erosion (deposition of Bone Valley formation nearby)	
Late middle Miocene or early late Miocene	Deposition of clayey sand	
	Erosion	
Middle Miocene	Deposition of Hawthorn formation as: clayey sand, phosphorite, limestone	Deposition of Hawthorn formation as limestone, later partly altered to phosphorite and clayey sand by weathering probably mainly before burial
	Erosion (?)	
Early Miocene	Deposition of Tampa limestone as: sandy clay, limestone and phosphorite	Deposition of Tampa limestone as limestone and phosphorite both of which were later partially altered to sandy clay either before or after burial
	Erosion (Cooke, 1945)	
Oligocene	Deposition of Suwannee limestone	
	Erosion (Cooke, 1945)	
Eocene	Deposition of Ocala limestone subsequently arched to produce Ocala Uplift	

Although some folding of the Tampa limestone and Hawthorn formation may or may not have taken place, it appears that the clayey sand was unaffected. Plate 3 shows the clayey sand to be essentially horizontal in an area where Vernon (1951, pl. 2) shows the Ocala Uplift to have hundreds of feet of structural relief. The Ocala Uplift is therefore older than late Miocene.

Although the Tampa limestone might have been deposited as three lithologically distinct members, it appears equally probable, in the absence of positive evidence, that it originally consisted of limestone and phosphorite units and that the clay unit was produced through removal of carbonate from the limestone and removal of phosphate from the phosphorite by weathering. It is not likely that the phosphorite unit is a secondary product resulting from removal of carbonate from phosphatic limestone because, unlike the clay unit, the phosphorite unit is not known to contain remnants of Tampa limestone even where it underlies the clay unit which does contain them (pls. 1 and 2, no. 2) and because the limestone unit of the Tampa limestone is not known to contain phosphate similar to that of the phosphorite unit, i. e., clay-size, white apatite.

The Hawthorn formation, too, might have been deposited as three separate members, but it appears probable from evidence given previously that the three-fold stratification is a result of the weathering of a formerly thicker and more widespread limestone unit. The view that the phosphorite and clay units of the Hawthorn are primary depositional units (Altschuler, written communication) is based partly on differences in the proportions and properties of minerals among the three units which allegedly make the derivation of one unit from another by weathering impossible and partly on differences in bedding characteristics between the three units. This opposition of views results from differences in the degree of significance attributed to each of opposing lines of evidence. It will be overcome only by increased knowledge.

If the phosphorite and sand units of the Hawthorn formation are residues, much of the weathering which produced them must have taken place prior to burial by the clayey sand, i. e., before the end of Miocene time: 1.) The white and green colors, unweathered phosphorite nodules, and calcareous fossils of the lower part of the clayey sand testify that post-Miocene weathering which affected the upper part of the formation probably did not extend deep enough to convert the underlying limestone unit of the Hawthorn

to phosphorite and sand; 2.) the clayey sand appears to lie upon a surface of the Hawthorn formation produced by partial erosion of pre-existing upper units of the Hawthorn formation. The sand, phosphorite, and limestone units of the Hawthorn formation are overlain directly at one place or another by the clayey sand (pls. 1 and 2, nos. 16, 30, and 32). In itself, this does not prove erosion because full development of the sand and phosphorite units might have been prevented in places by deep burial during weathering. Additional evidence of erosion is indicated, however, in plate 2 (nos. 16, 17, 20, 29, 30, and 31) where gamma-ray logs show prominent maxima of radioactivity at the top of the phosphorite unit. Where such maxima within the phosphorite are greatest at the top they are generally interpreted as indicating secondary enrichment in uranium derived from overlying uraniferous clayey sand. Although the sand unit of the Hawthorn is still relatively radioactive after contributing uranium to underlying phosphorite (pl. 2, no. 16), the clayey sand shows no evidence of having contained sufficient uranium to produce the enrichment shown in plate 2 at the top of the phosphorite. It is therefore reasoned that erosion of the sand unit of the Hawthorn formation preceded deposition of the clayey sand in places.

Were the upper Miocene or lower Pliocene Bone Valley formation present in the area of this report, it would be expected from its age to overlie the sand unit of the Hawthorn formation and probably overlie the clayey sand. Only if it overlay the phosphorite or limestone units of the Hawthorn formation directly would there be danger of mistaking it for part of the Hawthorn. Whereas this is possible, the authors find no evidence of it and conclude the Bone Valley formation is not present in the area.

In the northern and northwestern parts of the area surface configuration of Recent surficial sand containing charcoal and artifacts in many places is dune-like; this, together with the absence of marine or fresh water fossils, suggests that the loose sand is a wind deposit. These deposits are now stable as shown by their cover of trees, indicating a probable change in climate in Recent time.

In the southwestern part of the area, loose surficial sand is probably derived from clayey sand, such as that which it overlies, by removal of clay in the weathering process (Sellards, 1912, p. 22). This is indicated by the absence of charcoal and artifacts, the gradational nature of its contact with underlying clay and clayey sand, and the similarity of its quartz grain size with that of the underlying clayey sand.

Origin of hardrock phosphate

The problem of origin of hardrock phosphate is two fold, consisting of the origin of the phosphorite unit of the Tampa limestone as a stratigraphic unit and of the origin of scattered commercial "hardrock phosphate" within the phosphatic stratum.

Without discriminating between hardrock phosphate and its soft phosphatic matrix, Sellards (1913, p. 53) theorized that the phosphorite unit of the Tampa limestone (the lowest part of his Dunnellon or Alachua formation) was the product of limestone replacement and cavity filling by phosphate derived from overlying weathered phosphatic rocks. The grain size and abundance of quartz sand contained in the phosphorite at the south end of the hardrock phosphate belt indicate that if Sellards' hypothesis is true, the phosphatic stratum as a whole could not result from replacement of either the Ocala limestone or the limestone unit of the Hawthorn formation because the phosphorite contains quartz sand, of which there is none in the Ocala and which is of finer size than that of the Hawthorn formation.

It is possible that the phosphorite unit as a whole could result from replacement of Suwannee limestone, but this is unlikely because the concentration of sand and clay is much greater in the phosphorite than in Suwannee limestone (pl. 2); and, in general, the sand of the phosphorite unit is less well sorted than that of Suwannee limestone (fig. 3). However, grain size and sorting of quartz sand in the phosphorite unit of the Tampa limestone are similar to that of the clay unit indicating the possibility of replacement (fig. 3 and pl. 2).

The secondary phosphate of known cavity fillings such as veins is characteristically crystalline, anisotropic, layered, and hard. However, most Tampa phosphorite is cryptocrystalline, isotropic, largely structureless, and soft indicating that is a primary deposit and not a secondary replacement of limestone.

The scattered hard concretions within the phosphorite unit of the Tampa, some of which constitute commercial phosphate, were probably formed in the following two ways originally described by Sellards (1913, p. 61).

Hardrock phosphate concretions in the southern part of the hardrock belt fall into two general classes (see above p. 23). The white, sandy concretions of uniform structure are a combination of cryptocrystalline and crystalline phosphate in which the crystalline variety acts as a cement. This type is evidently formed in place by slight solution and redeposition of phosphate about scattered centers; concretions thus formed are of questionable commercial value because of their high quartz sand content inherited from the parent material.

The brown, hard, veined, and layered concretions are composed mainly of crystalline, birefringent phosphate. The extreme purity of many concretions of this type indicates that reconcentration has taken place since primary deposition.

It is probable that the pure, brown, layered concretions which undoubtedly constitute the best commercial hardrock phosphate are limestone replacements or cavity fillings. At the southern end of the hardrock belt they are probably replacements of Suwannee limestone as evidenced by the similarity to Suwannee limestone in size, sorting, and amount of contained quartz sand (fig. 2). As mentioned above (p. 17), one boulder replaced by phosphate and chert was identified as Suwannee by fossils preserved in the chert.

Particles of Suwannee limestone and of hardrock phosphate, some of which are probably Suwannee limestone replaced by phosphate, are dispersed in the phosphorite unit of the Tampa. Whether limestone or phosphatized limestone particles became incorporated into the phosphorite unit of the Tampa at the time of deposition or were subsequently intermixed with overlying Tampa as a result of unequal setting is not known.

Origin of land-pebble phosphate

The authors believe that phosphate is commercially extracted from the residual phosphorite of the Hawthorn formation in the area of this report. The evidence afforded by vertebrate fossils found in mines in other parts of the land-pebble district such as those described by Simpson (1930) indicates phosphate was, and probably still is, mined from the Bone Valley formation of late Miocene or Pliocene age. The considerable proportion of phosphorite in the lower parts of the clayey sand indicates it might contain commercial phosphorite in places. The first author and C. H. Gray found teeth of the early Pleistocene horse, Plesippus, in cross-bedded phosphorite of possible commercial grade overlying commercial phosphorite of the Hawthorn formation in the Achan phosphate mine near Pierce, Polk County. Therefore, it is concluded that the origins of land-pebble phosphate deposits are diverse. The superficial similarity of most of them is probably brought about in part by weathering.

Uranium

Gamma-ray logs shown beside drill holes in plate 2 indicate that uranium, like phosphate, is slightly concentrated in Miocene rocks of the entire report area although highest concentrations appear to be within the land-pebble district.

Stratigraphically, uranium is concentrated in the lower part of the sand unit and upper part of the phosphorite unit of the Hawthorn formation where, according to current interpretation, it is precipitated from solutions carrying it downward from the upper part of the formation.

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APPENDIX

This appendix contains field descriptions of stratigraphic sections obtained from exposures and drill cores. Grain-size terminology of these descriptions is that of Wentworth (1922). Comparison of measured grain size of selected samples from exposures and drill cores (pl. 2) with field descriptions shows field estimates of grain size to be commonly in error. However, in spite of inaccuracy in absolute size, the field estimates record changes in relative size from bed to bed at a single site and permit correlation from site to site.

The term "clay" means material of clay size, but in the absence of a preceding adjective it can also be taken without danger of error in most cases, to mean the clay minerals. "Phosphatic clay" means clay size phosphorite. "Sand" means quartz of sand size but "phosphatic sand" is sand composed partly of sand size quartz and partly of sand size phosphorite nodules.

Quantitative terms used are intended to have precise meanings as follows:

trace	= less than 0.1 percent
sparse	= 0.1 to 1.0 percent
very slight	= 1.0 to 5.0 percent
slight	= 5.0 to 10.0 percent
abundant	= 10.0 to 20.0 percent
very abundant	= greater than 20.0 percent

An unmodified constituent name such as "clayey" or "sandy" generally means that the constituent is estimated to comprise 10.0 to 20.0 percent of the rock.

Site no. 1

Stratigraphic section in McDonald limestone quarry, sec. 19, T. 22 S., R. 20 E., Hernando County, Florida

Formation and description	Thickness (feet)
Colluvium	
Sand, colluvial, fine-grained clayey (20 percent), massive, brown, iron-cemented and phosphate-cemented concretions of sandstone near base	10
Hawthorn formation, sand unit	
Sand, fine-grained, clayey (25 percent), massive, light gray mottled with brown, joints filled with clay	7
Clay, sandy (fine-grained, 20 percent), massive, green	1
Sand, very fine-grained to fine-grained, clayey (50 percent), massive, gray mottled with brown, joints filled with clay, veinlets of secondary phosphate	2
Tampa limestone, clay unit	
Clay, sandy (very fine-grained to fine-grained, 20 percent), massive, brown	3
Clay, sandy (very fine-grained to fine-grained, 30 percent), greenish gray, massive, contains weathered limestone and silicified limestone near base	3
Suwannee limestone	
Limestone weathered and partly silicified near top, slightly sandy (very fine-grained).	exposed 15

Site no. 2

Stratigraphic section in a hardrock phosphate pit in sec. 4, T. 22 S., R. 20 E., Hernando County, Florida

Formation and description	Thickness (feet)
Surficial sand	
Sand, fine-grained, massive, light brown	4
Hawthorn formation, sand unit	
Sand, fine-grained, clayey (30 percent), massive, light gray, mottled with brown in lower part	3
Tampa formation, clay unit	
Clay, sandy (very fine-grained, 40 percent), massive, brown	2
Clay, sandy (very fine-grained, 20 percent), massive light gray mottled with brown, scattered fragments of weathered limestone and silicified limestone, partially cemented with secondary phosphates	2

Site no. 2.--Continued

Formation and description	Thickness (feet)
Tampa formation, phosphorite unit	
Phosphatic clay, sandy (very fine-grained, 10 percent), massive, white to light brown, very porous	5
Covered	about 5
Suwannee limestone	
Mainly silicified (not in place)	
Ocala limestone	
Limestone, white, pure, soft, porous	

Site no. 3

Composite stratigraphic section in a hardrock phosphate pit in sec. 18, T. 22 S., R. 21 E., Hernando County, Florida.

Formation and description	Thickness (feet)
Surficial sand	
Sand, fine-grained, massive, light brown, trace of charcoal	5 to 15
Hawthorn formation, sand unit	
Sand, fine-grained, clayey (15 percent), massive, mottled white, light gray, and orange	5 to 15
Sand, fine-grained, very clayey (40 percent), massive, gray to brown	3
Hawthorn formation (?), phosphorite unit	
Clay, sandy (fine-grained, 25 percent), massive, light green, trace of rounded and polished phosphorite nodules	0 to 5
Tampa formation, clay unit	
Clay, sandy (very fine-grained, 20 percent), massive, green	0 to 5
Tampa formation, phosphorite unit	
Phosphatic clay, sandy (very fine-grained, 25 percent), massive, white and tan	about 6
Suwannee limestone	
Limestone, sparsely sandy (very fine-grained, 3 percent), tan, visibly crystalline, dense, rubbly	0 to 10
Ocala limestone	
Limestone, white, pure, soft, porous	

Site no. 4

Stratigraphic section in a hardrock phosphate pit in sec. 5, T. 23 S., R. 21 E., Hernando County, Florida

Formation and description	Thickness (feet)
Surficial sand	
Sand, fine-grained, massive, light brown	4
Hawthorn formation, sand unit	
Sand, fine-grained, clayey (25 percent), massive, white mottled with brown .	6
Tampa formation, clay unit	
Clay, sandy (very fine-grained, 30 percent), massive, light greenish gray mottled with brown	6
Tampa formation, phosphorite unit	
Phosphatic clay, sandy (very fine-grained, 10 percent), white	1
Covered	
Ocala limestone	
White, pure, soft, porous (not in place)	

Site no. 5
(originally line 17, hole 11)

Lithologic log of core from NW 1/4SE1/4 sec. 22, T. 24 S., R. 21 E., Pasco County, Florida

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 11'6"	Sand, fine, clayey, white.
11'6" - 23'6"	Clay, very sandy at top to sandy at base, greenish gray at top, mottled with brown at base.
23'6" - 25'8"	Clay, sandy, white and brown mottled, contains numerous large chert concretions and irregular pockets of soft white phosphatic clay some of which are cemented with secondary phosphate, forming hard white sandy concretions of granule size.
25'8" - 26'0"	Limestone, slightly sandy, soft, white and tan. Reacts strongly to chemical phosphate test but no phosphorite nodules visible.
26'0" - 30'0"	Limestone, slightly sandy, tan, moderate phosphate reaction to chemical test.

Site no. 6
(originally line 17, hole 10)

Lithologic log of core from NE 1/4 NE1/4 sec. 14, T. 25 S., R. 21 E., Pasco County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 12'0"	Sand, fine to medium, clayey to very clayey, dark brown and brown mottled.
12'0" - 29'0"	Sand, fine clayey, mottled brown and gray at top to tan at base.
29'0" - 47'0"	Sand, fine, clayey to slightly clayey, mottled tan and light gray.
47'0" - 68'0"	Sand, fine, very slightly to slightly clayey, light gray.
68'0" - 78'0"	No recovery.
78'0" - 80'0"	Clay, very sandy (medium to coarse), brown, contains sandy concretions cemented with secondary phosphate and containing veinlets of wavellite.
80'0" - 82'5"	Clay, very slightly sandy, brown.
82'5" - 87'0"	Clay, sandy and pebbly, brown. Abundant rounded polished phosphorite nodules of sand size to small pebbly size, white to tan, at top. Few phosphorite nodules but many sandy concretions cemented with secondary phosphate in lower part.
87'0" - 89'0"	Sand, fine to medium, very clayey, brown to black.
89'0" - 105'0"	Sand, fine, very clayey, mottled tan and light gray.
105'0" - 111'0"	No recovery.
111'0" - 114'6"	Clay, very sandy, greenish-gray to brown. Contains pockets of soft, white, sandy, clay-size apatite, some of which are cemented with secondary phosphates.
114'6 - 116'1"	Phosphatic clay, slightly sandy, white. Partly friable, non-plastic, white, slightly sandy, clay size phosphorite similar to matrix in hardrock phosphate district. Partly hard, brown, and encrusted with secondary phosphate, similar to commercial hardrock phosphate.
116'1 - 134'9"	No recovery.
134'9" - 138'7"	Only 6 inches recovered. Clay, very sandy, greenish-gray and brown (possibly caved from above).
138'7" - 144'3"	Only 6 inches recovered. Limestone, fossiliferous, slightly sandy, white.

Site no. 7
(originally line 17, hole 9)

Lithologic log of core from NW 1/4 SE 1/4 sec. 13, T. 25 S., R. 21 E. Pasco County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 18'6"	Sand, fine to medium, slightly clayey, dark red-brown.
18'6" - 22'4"	Sand, fine to medium, clayey, brown. Wavellitic concretions at 20 feet.
22'4" - 30'5"	Sand, fine to medium, clayey, mottled and banded brown and gray.
30'5" - 48'0"	Clay, very slightly sandy at top to very sandy at bottom, greenish-gray.
48'0" - 51'0"	Sand, fine, very slightly clayey, light gray.
51'0" - 52'9"	Sand, fine, clayey, light greenish-gray.
52'9" - 61'0"	Clay, very slightly sandy to sandy, greenish-gray at top, white in middle, and brown and green at base. The white part gives strong phosphatic reaction to chemical test.
61'0" - 67'0"	Clay, slightly sandy to very sandy, brown and white. White material is strongly phosphatic and contains indurated, probably siliceous, fossiliferous concretions.
67'0" - 67'11"	Limestone, very slightly sandy, white, soft.

Site no. 8
(originally line 17, hole 8)

Lithologic log of core from SW 1/4NE1/4 sec. 19, T. 25 S., R. 22 E., Pasco County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 13'0"	Poor recovery. Sand, fine to medium, very slightly clayey, reddish brown.
13'0" - 21'0"	Sand, fine to medium, clayey, mottled tan and gray.
21'0" - 64'5"	Sand, fine, very slightly clayey to clayey, white. Poor recovery between 26 and 32 feet, and between 56 and 64 feet.

Site no. 8.--Continued.

Depth in feet and inches	Description
64'5" - 65'5"	Sand, medium, very clayey, brown, abundant wavellite-cemented concretions.
65'5" - 71'5"	Clay, very slightly sandy, yellowish-brown.
71'5" - 73'0"	Sand, fine to medium, very clayey, brown.
73'0" - 91'6"	Poor recovery. Sand, fine, clayey to very clayey, mottled gray and brown, some wavellite-cemented concretions.
91'6" - 92'2"	Clay, very slightly sandy, yellowish-brown.
92'2" - 95'5"	Clay, sandy to very sandy, mottled brown and black.
95'5" - 96'3"	Phosphatic clay, slightly sandy, white, mainly apatite.
96'3" - 99'0"	Clay, slightly sandy, brown.
99'0" - 100'0"	Phosphatic clay, slightly sandy, partially cemented, hard, white, mainly apatite.
100'0" - 101'0"	Clay, very sandy, banded tan, gray, and white.
101'0" - 101'3"	Limestone, slightly sandy, clayey, mottled white and tan, soft.

Site no. 9
(originally line 17, hole 7)

Lithologic log of core from SW 1/4 SW 1/4 sec. 27, T. 25 S., R. 22 E., Pasco County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 7'0"	Clay, very sandy, gray.
7'0" - 10'0"	Sand, fine to medium, clayey, gray and tan.
10'0" - 14'0"	No recovery.
14'0" - 19'6"	Partially silicified limestone, white, fossiliferous.

Site no. 10

Stratigraphic section in a road-cut in SW 1/4 sec. 35, T. 25 S., R. 22, E., Pasco County, Florida.

Formation and description	Thickness (feet)
Hawthorn formation, sand unit	
Sand, fine, clayey, brown, massive	2
Hawthorn formation, phosphorite unit	
Phosphatic sand, pebbly, clayey, gray, massive	4

Site no. 11
(originally line 17, hole 6)

Lithologic log of core from NW 1/4 NW1/4 sec. 1, T. 26 S., R. 22 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 6'10"	Sand, medium, clayey to very clayey, mottled gray and brown.
6'10" - 9'0"	Clay, sandy at top to very sandy at base, a few siliceous concretions.
9'0" - 12'6"	Sand, fine, clayey at top to very clayey at base, greenish-gray, siliceous fossil fragments.
12'6" - 15'3"	Clay, slightly sandy, gray, upper contact gradational.
15'3" - 16'6"	No recovery.
16'6" - 17'0"	Sand, fine to medium, clayey.
17'0" - 26'4"	Limestone, white, soft, fossiliferous.

Site no. 12
(originally line 17, hole 5)

Lithologic log of core from SW 1/4 SW 1/4 sec. 8, T. 26 S., R. 23 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 6'0"	Sand, medium, very clayey, mottled gray and brown. Sparse nodules, possibly phosphorite but much weathered.

Site no. 12.--Continued.

Depth in feet and inches	Description
6'0" - 9'6"	Sand, fine to coarse, very clayey, white and greenish-gray, many hard concretionary aggregates of sand and white clay- not calcareous, probably siliceous. A few poorly preserved siliceous fossils.
9'6" - 10'2"	Sand, medium, slightly clayey, tan.
10'2" - 12'0"	No recovery.
12'0" - 14'0"	Sand, medium, very clayey, greenish-gray.
14'0 - 15'8"	Clay, sandy to very sandy, greenish-brown. Siliceous concretions at 14 feet, also silicified invertebrate fossils.
15'8" - 17'0"	No recovery.
17'0" - 19'4"	Sand, fine, slightly clayey to very slightly clayey, greenish-gray.
19'4" - 44'8"	Limestone, white, soft, fossiliferous, very slightly sandy.

Site no. 13

Stratigraphic section in a road-cut in N 1/2 sec. 21, T. 26 S., R. 23 E., Polk County, Florida.

Formation and description	Thickness (feet)
Hawthorn formation, sand unit	
Sand, fine, gray, clayey, contains abundant fragments of silicified oyster shells (Ostrea normalis ?)	3

Site no. 14
(originally line 17, hole 4)

Lithologic log of core from NE 1/4 SW 1/4 sec. 27, T. 26 S., R. 23 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 7'2"	No recovery.
7'2" - 9'9"	Sand, medium, clayey, dark gray.
9'9" - 12'0"	No recovery.

Site no. 14.--Continued.

Depth in feet and inches	Description
12'0" - 14'3"	Sand, medium, clayey, bluish-gray.
14'3" - 15'8"	No recovery.
15'8" - 21'4"	Clay, very slightly sandy, blue to greenish-brown much secondary silica.
21'4" - 22'4"	Sand, fine to medium, clayey to very clayey, greenish-gray, abrupt lower contact.
22'4" - 23'0"	Clay, very slightly sandy, blue.
23'0" - 26'0"	No recovery.
26'0" - 28'0"	Clay, very slightly sandy to slightly sandy, blue. Chert at 28 feet; chert looks like silicified limestone.
28'0" - 31'5"	No recovery.
31'5" - 33'5"	Clay, slightly sandy, bluish-green, large chert nodules, slightly calcareous.

Site no. 15
(originally line 17, hole 3)

Lithologic log of core from NW 1/4 SW 1/4 sec. 1, T. 27 S., R. 23 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 6'7"	Sand, fine to medium, loose, tan, poor recovery.
6'7" - 20'0"	Sand, medium, clayey, black at top, brown in middle, gray at base.
20'0" - 22'0"	No recovery.
22'0" - 23'0"	Sand, medium, clayey to very clayey, greenish-gray.
23'0" - 29'0"	Phosphatic sand, fine to pebbly, very clayey especially at base, green. Clay increases downward. Quartz sand, fine, 50 percent. Clay, 30-40 percent. Phosphorite nodules, medium sand size to pebble size, tan, 10-20 percent.

Site no. 15.--Continued.

Depth in feet and inches	Description
29'0" - 31'0"	Clay, sandy, slightly pebbly, green clay content increases downward. Clay, 50-80 percent. Quartz sand, fine, 20-50 percent. Phosphorite nodules, sand size to pebbly size, tan, 5 percent.
31'0" - 33'5"	Clay, very slightly sandy at top to very sandy at base, green, trace of tan phosphorite nodules at top. Quartz sand very fine.
33'5" - 35'0"	No recovery.
35'0" - 41'0"	Clay, very sandy, green, quartz sand very fine, almost 50 percent, trace fine phosphorite nodules at 37 feet.
41'0" - 43'0"	Clay, very slightly sandy, dark green, quartz sand very fine. Black chert concretion at top.
43'0" - 43'9"	Sand, very fine to fine, very clayey, greenish-gray, slightly calcareous.
43'9" -	Limestone, very slightly sandy, white, soft.

Site no. 16
(originally line 17, hole 2)

Lithologic log of core from NE 1/4 SW 1/4 sec. 18, T. 27 S., R. 24 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 8'0"	Sand, medium, light brown, loose.
8'0" - 9'0"	Sand, medium, slightly clayey to clayey, mottled light brown and gray.
9'0" - 14'0"	No recovery.
14'0" - 15'0"	Sand, fine to medium, slightly clayey, mottled tan and gray.
15'0" - 21'0"	Poor recovery. Sand, fine, very slightly clayey to slightly clayey, gray.
21'0" - 27'0"	Poor recovery. Sand, fine, very slightly clayey, mottled brown, and gray.

Site no. 16.--Continued.

Depth in feet and inches	Description
27'0" - 34'0"	Fair recovery. Sand, fine, very slightly clayey, mottled brown and gray.
34'0" - 37'0"	Clay, brown at top, greenish-gray at base, trace of very fine sand in lower part.
37'0" - 41'0"	Phosphatic sand, medium to coarse, very clayey, greenish-gray. Both quartz and phosphorite nodules range from medium sand to coarse sand size. Phosphorite nodules tan.
41'0" - 43'0"	Clay, gray, sparse medium sand composed of both quartz and phosphorite nodules.
43'0" - 43'10"	Phosphatic sand, medium to coarse, clayey, brown. Quartz sand, medium to coarse, 70 percent. Clay, 20 percent. Phosphorite nodules medium to coarse sand size, brown, 10 percent.
43'10" - 45'0"	No recovery.
45'0" - 47'6"	Clay, sandy, pebbly, greenish-gray. Clay 60 percent. Quartz sand, medium, 20 percent. Phosphorite nodules, medium sand to pebble size, dark brown, tan, 20 percent.
47'6" - 48'6"	Phosphatic sand, medium to very coarse, very clayey, greenish-gray, slightly calcareous. Quartz sand, medium, 50 percent. Clay, 30 percent. Phosphorite, medium to very coarse sand size, black, brown, 20 percent.
48'6" - 52'0"	Clay, very calcareous, very sandy, tan. Calcareous clay, 60 percent. Quartz sand, medium, 30 percent. Phosphorite nodules, medium to very coarse sand size, black, brown, 10 percent.
52'0" - 52'10"	Limestone, soft, very sandy, white. Lime, 60 percent. Quartz sand, medium 30 percent. Phosphorite nodules, medium to very coarse sand size, black, brown, 10 percent.

Site no. 17
(originally line 18, hole 1)

Lithologic log of core from SE 1/4 NW 1/4 sec. 31, T. 27 S., R. 24 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 5'7"	Sand, fine grain, tan to dark brown.
5'7" - 12'10"	Sand, fine grain, very slightly clayey, light gray to white.
12'10" - 14'8"	No recovery.
14'8" - 15'10"	Same as 5'7" - 12'10" but slightly grayer in color.
15'10" - 18'7"	Sand, medium grain, slightly clayey, light gray-brown.
18'7" - 23'0"	Sand, clayey, light brown.
23'0" - 31'0"	Phosphatic sand, clayey, gray-white, 5-10 percent light brown and white phosphorite nodules, sand to pebble size.
31'0" - 36'1"	Clay, slightly sandy, slightly calcareous, mottled light and dark brown, 3-10 percent fine sand to fine pebble size brown and white phosphorite nodules.
36'1" - 37'10"	No recovery.
37'10" - 45'2"	Same as 31'0" - 36'1" with one highly calcareous layer from 38'0" to 39'0". Phosphorite content quite variable.

Site no. 18

Stratigraphic section in Saddle Creek land-pebble phosphate mine, sec. 14, T. 28 S., R. 24 E., Polk County, Florida.

Formation and description	Thickness (feet)
Surficial sand	
Sand, massive, gray, loose, contains black organic material	4
Hawthorn formation, sand unit	
Sand, clayey, massive, gray, weathered phosphorite nodules at base . . .	6
Hawthorn formation, phosphorite unit	
Phosphatic sand, clayey, pebbly, greenish-gray massive to thin bedded . .	9

Site no. 18.--Continued.

Formation and description		Thickness (feet)
Hawthorn formation, limestone unit		
Limestone, phosphatic, clayey, sandy, pebbly, massive, bedded, bluish gray, soft		2
Tampa (?) formation, limestone unit		
Limestone, slightly phosphatic, clayey, sandy, pebbly, thin-bedded, bluish gray, hard, fragmental, contains numerous clay balls	exposed	6

Site no. 19

Stratigraphic section in Tenoroc land-pebble phosphate mine, sec. 35, T. 27 S., R. 24 E., Polk County, Florida.

Formation and description		Thickness (feet)
Surficial sand		
Sand, massive, gray, loose		1
Clayey sand		
Sand, medium, massive, mottled brown and gray, slightly clayey		7
Sand, very fine, massive, white, slightly clayey, micaceous		3
Clay, sandy, thin-bedded in part, gray, micaceous		3
Hawthorn formation, phosphorite unit		
Phosphatic sand, fine to massive bedded, clayey, pebbly		9
Hawthorn (?) formation, limestone unit		
Limestone, clayey, sandy, pebbly, phosphatic, (not in place)		?
Tampa formation, limestone unit		
Limestone, massive, phosphatic, clayey, sandy, soft, yellow	exposed	2

Site no. 20
(originally line 17, hole 1)

Lithologic log of core from NE 1/4 SE 1/4 sec. 11, T. 27 S., R. 24 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 5'0"	Not cored
5'0" - 8'2"	Sand, medium to coarse, clayey, gray, red mottling at base.
8'2" - 10'5"	Sand, fine, clayey at top to very clayey at base, mottled red and gray at top, gray at base.
10'5" - 12'0"	No recovery.
12'0" - 12'5"	Clay, sandy to very sandy, brown and gray.
12'5" - 16'0"	Sand, fine, clayey to very clayey, gray.
16'0" - 19'0"	No recovery.
19'0" - 25'0"	Clay, very slightly sandy at top to slightly sandy at base, green and brown mottled. Slight nodular phosphorite and secondary phosphorite at 22-25 feet.
25'0" - 28'0"	Phosphatic sand, fine to granule, very clayey, clay especially abundant in upper part, quartz sand fine to medium 60 percent; clay 30 percent; phosphorite nodules medium sand to granule size, tan, brown, 10 percent.
28'0" - 33'0"	Clay, sandy to very sandy, mottled green and brown, sparse phosphorite sand.
33'0" - 33'3"	Clay, calcareous, sandy, tan.
33'3" - 39'3"	Phosphatic sand, medium, clayey, brownish-gray. Quartz sand, medium, 70 percent; clay, 20 percent; phosphorite, medium, tan, 10 percent.
39'3" - 39'4"	Phosphatic sand, medium, clayey, brownish-gray, slightly calcareous. Quartz sand, medium 60 percent; clay, 20 percent; phosphorite nodules, medium, tan, 10 percent.

Site no. 21
(originally line 16, hole 5)

Lithologic log of core from NE 1/4 SW 1/4 sec. 5, T. 25 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored
4'0" - 6'9"	Sand, fine to very coarse grain, slightly clayey, light brown.
6'9" - 12'11"	Sand, fine to coarse grain, slightly clayey, sparse mica.
12'11" - 34'9"	Sand, fine to medium grain, slightly clayey, sparse mica, sparse heavy minerals.
34'9" - 35'5"	No recovery.
35'5" - 36'6"	Clay, sparsely sandy, blue-green.
36'6" - 39'2"	No recovery.
39'2" - 42'5"	Clay, sandy, light gray-green, slightly calcareous, 5-10 percent fine sand to pebble size black phosphorite nodules.
42'5" - 44'1"	Clay, sandy, calcareous, light gray-tan, sparse fine sand to granule size black phosphorite nodules.

Site no. 22
(originally line 16, hole 4)

Lithologic log of core from SW 1/4 SW 1/4 sec. 7, T. 25 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 8'0"	No recovery.
8'0" - 12'0"	Sand, medium to coarse, tan.
12'0" - 33'4"	Sand, medium to coarse, clayey, brown at top, mottled red-brown and brown in lower part.
33'4" - 38'5"	Sand, coarse, clayey, mottled pink and gray.
38'5" - 40'0"	Sand, medium, clayey, tan.
40'0" - 44'0"	Sand, coarse, slightly clayey, gray, poor recovery.

Site no. 22.--Continued.

Depth in feet and inches	Description
44'0" - 57'0"	Sand, medium to coarse, light pinkish brown, poor recovery.
57'0" - 65'0"	No recovery.
65'0" - 74'5"	Sand, fine, slightly clayey at top grading to very clayey at base, sparse mica in lower half, mottled brown and light gray, a few quartz granules at base.
74'5" - 82'11"	Clay, sparse quartz sand, green.
82'11" - 87'0"	Sand, medium, clayey, brown.
87'0" - 90'0"	Phosphatic sand, medium, clayey at top to very clayey at base, greenish-gray. Quartz sand, medium, 60 percent. Phosphorite nodules medium to coarse sand size, soft and white at top, tan at base, 5 percent.
90'0" - 99'5"	Clay, slightly sandy at top to very sandy at base, mottled greenish-brown and brown, quartz sand is fine to medium size.
99'5" - 102'0"	Clay, sparsely sandy, green.
102'0" - 106'0"	No recovery.
106'0" - 110'11"	Sand, medium, very clayey, mottled brown and greenish-gray. Pocket of white material at 110'6" resembles phosphatic clay but might be cement used by driller to seal drill hole wall.
	Hole not drilled to bedrock.

Site no. 23
(originally line 16, hole 3)

Lithologic log of core from NW 1/4 NE 1/4 sec. 32, T. 25 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 11'0"	Sand, medium at top to coarse at base, clayey, mottled brown and gray at top, light gray at base.
11'0" - 13'0"	Sand, fine to medium, clayey, white.
13'0" - 18'0"	Poor recovery, sand, coarse, clayey, light gray.

Site no. 23.--Continued.

Depth in feet and inches	Description
18'0" - 35'6"	Sand, fine, poorly sorted near top where some coarse grains occur. Clayey at top to slightly clayey at base, light gray, traces of mica.
35'6" - 37'5"	Phosphatic sand, medium to coarse, pebbly, clayey, medium gray. Quartz sand, medium to granule 60 percent. Phosphorite nodules, medium to pebble, brown and black, 20 percent. Clay 20 percent.
37'5" - 39'0"	Clay, very slightly sandy, very slightly phosphatic, dark greenish-brown. Phosphorite nodules medium sand size, brown, black, 5 percent. Quartz sand, 5 percent.
39'0" - 39'5"	Phosphatic sand, medium, clayey, bluish and greenish-gray. Quartz sand, fine to medium, 60 percent. Phosphorite nodules, medium to coarse sand size, tan, brown, black, 20 percent. Clay, 20 percent.
39'5" - 40'0"	Limestone, clayey, sandy, phosphatic, tan (some parts hard and free of sand). Quartz sand, fine to medium, 20 percent. Phosphorite nodules, medium to coarse sand size, tan, brown, black, 10 percent.

Site no. 24
(originally line 16, hole 2)

Lithologic log of core from NW 1/4 sec. 21, T. 26 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 6'8"	No recovery.
6'8" - 10'5"	Sand, medium to coarse, brownish-black from organic matter.
10'5" - 14'4"	Sand, coarse, clayey, medium gray at top to black at 14 feet.
14'4" - 16'10"	No recovery.
16'10" - 26'2"	Sand, medium at top grading to coarse at base, clayey, medium gray.
26'2" - 29'5"	Sand, fine, clayey, medium gray, poorly sorted, over 1 percent mica.

Site no. 24.--Continued.

Depth in feet and inches	Description
29'5" - 50'7"	Sand, very fine to fine, slightly clayey, about 1 percent mica in places, medium gray at top to light gray at base.
50'7" - 56'5"	Clay, very sandy, dark greenish-gray. Clay, 60 percent. Quartz sand, fine to coarse decreasing in abundance downward and increasing in grain size downward, 30 percent. Phosphorite nodules, medium sand size to granule size, brown to tan, very light tan and soft at top, increasing in abundance and size downward, 5-10 percent.
56'5" - 59'10"	Clay, very sandy, dark green. Clay, 60 percent. Quartz sand, fine, 30 percent. Phosphorite nodules, medium sand size, brown, 5-10 percent.
59'10" - 62'10"	No recovery.
62'10" - 68'1"	Limestone, soft, medium gray, abundant fossil particles.

Site no. 25
(originally line 16, hole 1 1/2)

Lithologic log of core from SW 1/4 SW 1/4 sec. 21, T. 26 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 5'4"	Not cored.
5'4" - 14'3"	Sand, fine to medium grain, brown to black.
14'3" - 39'0"	Sand, medium to coarse grain, sparsely clayey, light brown.
39'0" - 58'6"	Sand, fine to medium grain, slightly clayey, white to light gray, bottom contact gradational over 1 foot.
58'6" - 71'7"	Phosphatic sand, clayey, slightly calcareous, dark gray; 5-10 percent black and brown, fine sand size to pebble size phosphorite nodules.
71'7" - 76'3"	Clay, very calcareous, light gray.

Site no. 26
(originally line 16, hole 1)

Lithologic log of core from SW 1/4 sec. 28, T. 26 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 4'0"	Not cored.
4'0" - 11'0"	Sand, medium, tan.
11'0" - 16'0"	Sand, medium, clayey to very clayey, mottled red-brown and brown.
16'0" - 21'3"	No recovery.
21'3" - 28'5"	Sand, medium, clayey but decreasing in clay content downward, mottled red-brown and white.
28'5" - 41'3"	No recovery.
41'3" - 44'6"	Sand, coarse, slightly clayey, white.
44'6" - 45'6"	Sand, medium to coarse, slightly clayey, white.
45'6" - 47'6"	Sand, coarse to very coarse, very slightly clayey, white.
47'6" - 47'9"	Sand, fine to medium, slightly clayey, white.
47'9" - 49'0"	Sand, coarse to very coarse, slightly clayey, white.
49'0" - 54'3"	No recovery
54'3" - 55'4"	Sand, medium to coarse, slightly clayey, white.
55'4" - 58'0"	No recovery.
58'0" - 59'0"	Sand, fine to medium, slightly clayey, white.
59'0" - 62'6"	No recovery.
62'6" - 63'6"	Sand, medium, very slightly clayey, white.
63'6" - 74'10"	No recovery.
74'10" - 76'3"	Sand, fine, very slightly clayey, white.
76'3" - 82'0"	No recovery.
82'0" - 85'0"	Clay, sandy, pebbly, greenish-gray, calcareous at base. Calcareous, clay, 70 percent. Phosphorite nodules of sand, granule, and pebble sizes, tan to brown, 20 percent. Quartz sand, medium 10 percent.

Site no. 27
(originally line 15, hole 1)

Lithologic log of core from NW 1/4 SW 1/4 sec. 6, T. 27 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 8'10"	Not cored.
8'10 - 17'10"	Sand, fine to medium grain, clayey to very clayey in places, brown at top to tan at bottom, trace of muscovite.
17'10" - 18'11"	No recovery.
18'11" - 24'6"	Sand, fine to medium grain (graded bedding, thicknesses highly variable), slightly clayey in some beds to very clayey in others, tan, contains sparse muscovite, bottom contact gradational over 8 inches.
24'6" - 25'5"	Clay, very sandy (coarse grain to mostly fine grain), tan, abundant small clay pebbles - some partially phosphatized, 15-20 percent coarse grain to mostly pebble size white phosphorite nodules (sparse soft, mostly hard), bottom contact sharp.
25'5" - 28'4"	Clay, sparsely sandy (fine grain), light green with abundant streaks and patches of light yellow-brown, sparse fine grain white phosphorite (?) nodules.
28'4" - 28'8"	No recovery.
28'8" - 29'4"	Phosphatic sand, clayey 40 percent, medium to coarse, brown and gray mottled. Quartz sand medium size; 20 percent phosphorite, medium to coarse sand size, tan, brown.
29'4" - 31'3"	Clay, slightly sandy, brown, calcareous; sparse phosphorite nodules of sand and granule size.
31'3" - 32'0"	No recovery.
32'0" - 35'5"	Clay, calcareous, sandy, brown, massive. Clay 50 percent. Quartz sand, medium, 30 percent. Phosphorite nodules, medium sand to granule size, tan and brown, 20 percent.
35'5" - 36'6"	Limestone, sandy, tan, soft. Lime and clay 30 percent. Phosphorite nodules, medium sand to granule size, tan, gray, 10 percent. Quartz sand, medium, 10 percent.

Site no. 28
(originally line 15, hole 2)

Lithologic log of core from NE 1/4 NE 1/4 sec. 8, T. 27 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 6'5"	Sand, loose, fine, tan.
6'5" - 7'10"	Sand, clayey 20 percent, fine, brown.
7'10" - 8'0"	Sand, clayey 20 percent, fine, brown, indurated.
8'0" - 10'0"	Sand, clayey 25 percent, fine, gray-brown.
10'0" - 13'0"	No recovery.
13'0" - 16'6"	Sand, fine, white.
16'6" - 18'0"	No recovery.
18'0" - 20'6"	Sand, clayey 5 percent, fine, medium gray.
20'6" - 23'0"	Sand, clayey 5 percent, fine, tan.
23'0" - 25'6"	Sand, clayey, 5-10 percent, fine to medium, tan.
25'6" - 27'0"	No recovery.
27'0" - 29'0"	Sand, clayey 5 percent, fine grading downward to very fine, tan.
29'0" - 32'0"	Sand, clayey 5 percent, medium to coarse, tan.
32'0" - 34'4"	Sand, clayey 5 percent, fine to medium, gray.
34'4" - 40'0"	Sand, clayey 5-15 percent, fine, gray, trace of mica.
40'0" - 42'6"	Phosphatic sand, clayey 10 percent, greenish-gray; quartz sand fine; phosphorite nodules coarse sand to granule size, black and tan, 10 percent.
42'6" - 45'7"	Phosphatic sand, clayey 10 percent, gray, trace of mica; quartz sand medium to coarse; phosphorite coarse sand to granule size, black, 25 percent.
45'7" - 47'0"	Phosphatic sand, clayey, calcareous, greenish-gray, quartz sand, medium, 20 percent. Phosphorite nodules, coarse sand to granule size, black, 40 percent.
47'0" - 47'7"	Limestone, sandy, clayey, tan. Quartz sand, medium, 5 percent. Phosphorite nodules coarse sand to granule size, black, 10 percent.

Site no. 29
(originally line 15, hole 3)

Lithologic log of core from NW 1/4 NW 1/4 sec. 3, T. 27 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 16'8"	Sand, clayey, medium to coarse, mottled brown clay about 20 percent.
16'8" - 19'0"	Sand, clayey to very clayey, pink, medium to coarse at top grading downward to medium. Clay increases downward from about 20 percent to about 30 percent.
19'0" - 22'0"	No recovery.
22'0" - 28'0"	Sand, clayey, medium to very coarse, banded and mottled pink and brown, clay content 15-20 percent except at 23 feet where it is about 30 percent, very coarse sand toward base.
28'0" - 31'5"	Sand, medium to coarse, clayey, white, sand grades from medium at top to coarse at base. Clay content about 15-20 percent.
31'5" - 57'0"	Sand, medium to coarse, slightly clayey, white, trace of mica, sand grades from medium to coarse at top down to medium at base, clay content about 10-15 percent. No recovery between 33'1" and 40'0" and between 53'0" and 56'5".
57'0" - 59'0"	Phosphatic sand, medium to very coarse, some pebble, very clayey, brown. Quartz sand, medium to coarse 40-50 percent. Phosphorite nodules medium sand to pebble size, mainly very coarse sand size, tan, brown, 10-20 percent.
59'0" - 60'5"	Clay, sandy, pebbly, brown, stiff. Quartz sand, medium to very coarse, 20 percent. Phosphorite nodules medium sand to pebble size, brown, tan, 10 percent.

Site no. 30
(originally line 15, hole 4)

Lithologic log of core from NE 1/4 sec. 12, T. 27 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 33'0"	Sand, clayey, very coarse to coarse, some quartz, granule, red brown, pink around 29 feet and brown below 31 feet. Grain size decreases somewhat in lower part. No recovery between 20'0" and 22'0" and between 25'0" and 28'0".

Site no. 30.--Continued.

Depth in feet and inches	Description
33'0" - 38'0"	Sand, clayey, medium to coarse, 2-inch bed of very coarse at 35 feet, grain size decreases downward, tan at top, gray at base, trace of mica.
38'0" - 42'0"	Sand, clayey, medium, tan and gray, gradational contact above, sharp contact below. No recovery 39'0" - 41'0".
42'0" - 45'0"	Sand, clayey, medium to very coarse, brown, a few lenses of pure clay 1/4 inch thick.
45'0" - 46'0"	Sand, slightly clayey, coarse, gray.
46'0" - 65'0"	Sand, medium to fine, clayey to very clayey, tan and gray banded and mottled. Medium at top decreasing downward to fine, clayey at top increasing downward to very clayey, trace of mica.
65'0" - 68'0"	Phosphatic sand, very clayey, brown, some gray clay lenses 1/4 inch thick at top. Quartz sand medium to coarse 4 percent, clay 40 percent, phosphorite nodules medium to very coarse sand size, some granule and pebble sizes, nodules tan at top of interval and brown at base, 20 percent.
68'0" - 72'6"	Phosphatic sand, very clayey, greenish-gray. Quartz sand, medium 50 percent; clay translucent, greenish-gray slightly calcareous 40 percent; phosphorite nodules medium to coarse sand size, tan to brown, 10 percent.
72'6" - 73'7"	Limestone, very sandy, clayey, soft, greenish-gray. Lime and clay, 60 percent. Quartz sand, medium, 30 percent. Phosphorite nodules medium sand to granule size, brown, 10 percent.

Site no. 31
(originally line 15, hole 5)

Lithologic log of core from SW 1/4 SW 1/4 sec. 3, T. 27 S., R. 26 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 8'3"	Sand, coarse to very coarse, clayey, mottled and banded with red, brown, gray.
8'3" - 11'0"	No recovery.

Site no. 31.--Continued.

Depth in feet and inches	Description
11'0" - 13'0"	Sand, coarse to very coarse, clayey, mottled with pink, brown, and gray.
13'0" - 14'0"	No recovery.
14'0" - 15'0"	Sand, coarse to very coarse, clayey, red.
15'0" - 19'5"	No recovery.
19'5" - 21'0"	Sand, fine, slightly clayey to clayey, white.
21'0" - 26'0"	No recovery.
26'0" - 28'5"	Sand, medium to very coarse, clayey to slightly clayey, tan.
28'5" - 31'0"	Sand, fine to medium, sparsely coarse especially at top, clayey, white, trace of mica.
31'0" - 32'5"	No recovery.
32'5" - 34'0"	Sand, medium to very coarse, slightly clayey to clayey, white.
34'0" - 42'4"	Sand, fine, some coarse especially at top, clayey, white.
42'4" - 46'10"	No recovery.
46'10" - 48'5"	Sand, fine, clayey, white.
48'5" - 52'0"	Sand, very fine to fine, clayey to very clayey, brown and tan banded, some lenses 1/4 inch thick of silty clay.
52'0" - 55'4"	Sand, very fine, very clayey, brown and gray mottled and banded, trace mica in places, especially near 53'0"; clay content is about 50 percent.
55'4" - 57'0"	Phosphatic sand, fine to very coarse, some quartz pebble, very clayey, brown. Quartz sand and pebble about 40 percent. Clay about 40 percent. Phosphorite nodules sand size and granule size 5-20 percent.
57'0" - 63'0"	Phosphatic sand, fine to granule, clayey to very clayey, brown at top, tan at base. Quartz sand, fine to medium, about 60 percent. Clay, 30 percent. Phosphorite nodules, medium sand to granule size, brown, tan, 10-20 percent.

Site no. 31. -- Continued.

Depth in feet and inches	Description
63'0" - 69'0"	Phosphatic sand, fine to medium, some coarse to pebble, clayey to very clayey, tan. Quartz sand, fine to medium 60 percent. Clay, 35 percent. Phosphorite nodules medium sand to pebble size, 5 percent.
69'0" - 70'0"	Phosphatic sand, very clayey, pebbly, calcareous, green and brown. Quartz sand, medium, 40 percent. Clay, 40 percent. Phosphorite nodules, coarse sand to pebble size, tan, brown, 20 percent.
70'0" - 72'0"	Phosphatic sand, medium, clayey, calcareous, sparse phosphorite nodules, brown.
72'0" - 76'7"	Limestone, very soft at top, soft at base, clayey, some indistinct fossils, cream color.

Site no. 32 in text, page 37

Site no. 33
(originally line 14, hole 1)

Lithologic log of core from NE 1/4 NE 1/4 sec. 20, T. 28 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'4"	Not cored.
10'4" - 13'0"	Sand, fine to medium, slightly clayey, black from organic matter.
13'0" - 14'0"	Sand, fine to medium, clayey, brown, indurated - organic and iron hardpan.
14'0" - 18'2"	Sand, fine to medium, very clayey, medium gray except brownish at top, plastic, sparse white granules - probably apatite, maybe clay.
18'2" - 21'1"	Sand, very fine to fine, slightly clayey, medium gray, plastic.
21'1" -- 25'0"	Sand, very fine to fine, very slightly clayey, light gray.
25'0" - 29'9"	Sand, fine to medium, very slightly clayey, light gray.
29'9" - 35'1"	No core recovery.

Site no. 38.--Continued

Depth in feet and inches	Description
35'1" - 35'4"	Sand, medium to coarse, slightly clayey, light gray, indurated, cemented with crystals of secondary phosphate.
35'4" - 40'9"	Sand, very fine to fine, very slightly clayey, white.
40'9" - 42'0"	Phosphatic sand, very fine to fine, clayey, white. Phosphorite nodules, 5-10 percent, soft, white and tan.
42'0" - 44'0"	Phosphatic sand, fine to very coarse, slightly clayey, brown. Quartz sand 40 percent, fine to medium. Phosphorite nodules 40 percent, medium to very coarse sand size, brown.
44'0" - 49'6"	Phosphatic sand, fine to granule, very clayey, yellowish-brown, calcareous. Quartz sand 30 percent, fine to medium. Phosphorite nodules 30 percent, medium to very coarse sand size, occasional granule, white, tan, brown.
49'6" - 51'4"	Limestone very sandy, tan, soft. Quartz sand 15 percent, fine to medium. Phosphorite nodules 15 percent, medium to granule, tan, brown. Clay and carbonate 70 percent. Phosphorite nodules and quartz sand are dispersed and also concentrated in pockets.

Site no. 34
(originally line 14, hole 2)

Lithologic log of core from SE 1/4 NE 1/4 sec. 21, T. 28 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 8'2"	Not cored.
8'2" - 9'10"	Sand, fine to medium grain, slightly clayey, very dark brown at top to brown at bottom.
9'10" - 10'4"	No recovery.
10'4" - 14'4"	Sand, fine grain, clayey to very clayey, light gray-brown, contains abundant lenses and patches of brown clay.
14'4" - 14'11"	No recovery.
14'11" - 18'9"	Sand, fine to medium grain, slightly clayey, brown, bottom contact gradational over 3 inches.

Site no. 34.--Continued

Depth in feet and inches	Description
18'9" - 22'10"	Sand, fine to medium grain, loose, no clay, light brown and tan, bottom contact gradational over 2 inches.
22'10" - 30'6"	Sand, medium to mostly fine grain, slightly clayey, to very clayey in places, brown at top grading to light tan at bottom, sugary texture, somewhat leached.
30'6" - 31'3"	No recovery.
31'3" - 40'6"	Sand, fine to coarse grain with sparse quartz granules, slightly clayey in patches, sparse fine grain black heavy minerals, bottom contact sharp.
40'6" - 43'7"	Sand, fine to mostly very fine grain, clayey, tan, sparse fine grain black heavy minerals, trace of muscovite, bottom contact gradational over 5 inches.
43'7" - 45'0"	Phosphatic sand, fine to coarse grain with sparse quartz granules, very clayey (sparsely calcareous) tan to light gray-tan; unit contains slightly abundant limy shale pebbles; 15-25 percent coarse grain to pebble size gray and mostly black phosphorite nodules.
45'0" - 45'8"	No recovery.
45'8" - 49'4"	Phosphatic sand, medium to coarse grain, very clayey, calcareous, dark gray brown, sparse limy shale pebbles - some partially phosphatized (black) mostly at top of unit; sparse soft limestone (clayey), patches increase toward bottom; 25-35 percent medium grain to granule size, brown and mostly black phosphorite nodules; bottom contact gradational over 8 inches.
49'4" - 51'2"	Limestone soft, sparsely sandy (fine grain) very clayey at top (with lenses and patches); color tan; 5-10 percent fine grain to fine pebble size black and mostly tan phosphorite nodules, percentage of phosphorite diminishes toward bottom of unit.

Site no. 35
(originally line 14, hole 3)

Lithologic log of core from NE 1/4 SE 1/4 sec. 22, T. 28 S., R. 25 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 16'0"	Sand, medium, clayey, brownish-gray.

Site no. 35.--Continued

Depth in feet and inches	Description
16'0" - 64'0"	Sand, fine at base and top, medium between 20 and 50 feet, very slightly clayey, tan. No recovery between: 27'5" - 31'0", 36'0" - 38'0", 45'0" - 47'0", 49'0" - 59'0", 63'0" - 64'0".
64'0" - 65'7"	Sand, fine, very slightly clayey, trace phosphorite nodules of medium sand size, tan, trace mica.
65'7" - 69'0"	Phosphatic sand, fine to medium, clayey, dark grayish-green. Quartz sand fine. Phosphorite nodules, medium sand size, black, 10 percent; sparse mica.
69'0" - 73'5"	Sand, fine to granule, very clayey, dark green, calcareous at base; quartz sand fine 50 percent; phosphorite medium sand to granule size, black, 20 percent.
73'5" - 75'7"	Limestone, very sandy, greenish-gray above to light gray below. Quartz sand fine to medium 15 percent. Phosphorite nodules, medium to very coarse sand size, mostly black, 15 percent. Less sandy at bottom.

Site no. 36
(originally line 14, hole 4)

Lithologic log of core from NW 1/4 sec. 25, T. 28 S., R. 25 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 10'10"	Not cored.
10'10" - 15'0"	Sand, fine to medium grain, clayey, alternating irregular thin bands of reddish brown, gray, white, and mostly yellow-brown; slightly abundant fine to medium grain black heavy minerals.
15'0" - 17'1"	No recovery.
17'1" - 18'7"	Same as 10'10" - 15'0" but heavies less abundant.
18'7" - 19'1"	No recovery.
19'1" - 20'4"	Sand, medium to coarse grain, clayey, yellow-brown to light tan.
20'4" - 21'0"	No recovery.
21'0" - 27'3"	Sand, fine to coarse grain, poorly sorted, slightly clayey, light tan with sparse streaks of yellow-brown.

Site no. 3β.--Continued.
(originally line 14, hole 4)

Depth in feet and inches	Description
27'3" - 28'9"	No recovery.
28'9" - 35'7"	Sand, fine to coarse grain, clayey at top to slightly clayey at bottom, light yellow-brown at top.
35'7" - 37'0"	No recovery.
37'0" - 49'2"	Sand, very fine to very coarse grain (graded bedding), slightly clayey in places, light gray-white with some red and yellow-brown mottling in top 2 feet; trace of muscovite.
49'2" - 51'7"	No recovery.
51'7" - 53'2"	Sand, fine to very coarse grain, very poorly sorted, slightly clayey, white.
53'2" - 55'8"	No recovery.
55'8" - 59'6"	Sand, coarse to very coarse grain with sparse finer sizes, slightly clayey in places, faint bedding in places, white.
59'6" - 63'2"	No recovery.
63'2" - 68'2"	Sand, very fine to fine grain, slightly clayey at top to very clayey at bottom, white to light tan, trace of muscovite; bottom contact sharp.
68'2" - 68'5"	Sand, very fine grain, sparsely clayey, gray, sparse muscovite.
68'5" - 69'11"	No recovery.
69'11" - 73'6"	Clay, slightly sandy in places, gray, abundant irregular lenses of sand, medium grain, sparse muscovite in clay and sand lenses. Bottom contact gradational over 6 inches.
73'6" - 76'5"	Phosphatic sand, medium grain, clayey, dark greenish-gray, abundant scattered lenses of black greenish-gray clay. 1-3 percent fine grain to granule size black phosphorite nodules, bottom contact gradational over 12 inches.
76'5" - 81'3"	Phosphatic sand, fine to coarse grain, clayey (patches and seams), gray; slightly abundant scattered small patches of clayey, slightly sandy, phosphatic limestone; 15-25 percent fine grain to fine pebble size black phosphorite nodules; bottom contact gradational over 8 inches.
81'3" - 83'6"	Limestone, soft, very clayey, sandy (mostly fine grain), tan, 5-10 percent fine grain to granule size tan, brown, and mostly black phosphorite nodules.

Site no. 37
(originally line 14, hole 7)

Lithologic log of core from NW 1/4 SE 1/4 sec. 15, T. 28 S., R. 26 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 12'5"	Clay, sandy (fine to medium grain), light gray-tan.
12'5" - 13'2"	No recovery.
13'2" - 15'6"	Sand, fine to medium grain with sparse coarse grain, very clayey at top to clayey at bottom, light brown; faint graded bedding.
15'6" - 15'9"	No recovery.
15'9" - 15'11"	Sand, fine to medium grain, clayey, tan, indurated.
15'11" - 17'1"	Sand, fine to coarse grain (washed by drill water ?), sparse clayey brown.
17'1" - 17'9"	Sand, very fine to medium grain, clayey, dark brown to tan at bottom, bottom 3 inches sugary texture; somewhat leached.
17'9" - 18'5"	No recovery.
18'5" - 27'9"	Sand, very fine to fine grain with sparse coarse grains and granules, clayey, tan, appears leached, faintly bedded in places, no recovery 20'1" - 20'7" and 24'7" - 25'11".
27'9" - 41'3"	No recovery.
41'3" - 44'2"	Sand, very fine grain to sparse granule size, slightly clayey to clayey (all washed by drill water).
44'2" - 62'10"	No recovery.
62'10" - 67'11"	Sand, fine grain, sparse medium to coarse grain, slightly clayey, trace fine grain heavy minerals.
67'11" - 74'0"	No recovery.
74'0" - 77'6"	Sand, very fine to fine grain, slightly clayey, light gray to tan, sparse muscovite towards bottom; bottom contact gradational over 8 inches.
77'6" - 81'1"	Clay, sandy to very sandy, black with abundant patches and streaks of gray-brown; slightly abundant quartz granules and pebbles in top 6 inches. Bottom contact sharp.

Site no. 37.--Continued.

Depth in feet and inches	Description
81'1" - 81'10"	Sand, fine to medium, slightly clayey, tan.
81'10" - 85'0"	No recovery.
85'0" - 86'8"	Sand, fine grain, slightly clayey, light tan; bottom contact gradational over 3 inches.
86'8" - 89'0"	Sand, fine grain, slightly clayey to very clayey at bottom, greenish-gray, sparse muscovite; bottom contact gradational over 6 inches.
89'0" - 89'11"	Clay, very sandy (fine to medium grain), dark gray-green, bottom contact sharp.
89'11" - 91'1"	Clay, slightly calcareous, very irregularly laminated, sparse small clayey limestone pebbles some partially phosphatized, sparse black pebble size phosphorite nodules.
91'1" - 91'3"	Gravel, clayey limestone pebbles, some partially phosphatized, black phosphorite nodules of pebble size; very clayey, very sandy, top and bottom contacts sharp.
91'3" - 93'5"	Clay, very irregular, laminated, sparsely calcareous in places, gray streaked with black, bottom contact gradational over 3 inches.
93'5" - 97'0"	Clay, sandy, calcareous, gray and tan, contains abundant patches and lenses of clayey phosphatic limestone; abundant clayey limestone pebbles, some with black phosphatic coatings; 4-6 percent medium grain to pebble size brown and mostly black phosphorite nodules.
97'0" - 97'10"	Limestone, very clayey, slightly sandy, very fossiliferous (mollusks), abundant large indurated fragments; 6-8 percent fine grained to pebble size brown and black phosphorite nodules.

Site no. 38
(originally line 14, hole 8)

Lithologic log of core from NW 1/4 SE 1/4 sec. 14, T. 28 S., R. 26 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 12'5"	No recovery.
12'5" - 13'0"	Sand, loose, fine to medium, tan.
13'0" - 36'0"	Sand, clayey, fine to medium, some coarse especially near base; red, brown, and tan banding and mottling; clay about 20-30 percent.
36'0" - 38'0"	No recovery.
38'0" - 43'5"	Sand, slightly clayey, fine to medium, white and pink mottling; clay about 10 percent.
43'5" - 46'0"	No recovery.
46'0" - 63'0"	Sand, very slightly clayey, fine, light pink. Clay 5-10 percent.
63'0" - 70'0"	No recovery.
70'0" - 85'0"	Sand, very slightly clayey, very fine to fine, white; clay about 5-10 percent.
85'0" - 97'0"	Sand and silt, very clayey, brown. Quartz from silt to very fine sand size; contact with overlying fine sand is gradational over about a foot; clay over 20 percent.
97'0" - 97'5"	Clay, silty and sandy, brown; contacts above and below gradational; trace of mica.
97'5" - 101'5"	Sand, very fine to fine, very clayey; brown clay over 20 percent. Black chert nodules 3 inches long at 100'0".
101'5" - 104'5"	No recovery.
104'5" - 107'0"	Clay, sandy, pebbly, green; clay 60 percent. Quartz sand fine to medium, 20 percent; phosphorite medium sand to pebble size, tan, gray, brown, 20 percent.
107'0" - 107'5"	Clay, sandy, green; clay 75 percent; quartz sand, very fine to fine, 25 percent.

Site no. 38.--Continued.
(originally line 14, hole 8)

Depth in feet and inches	Description
107'5" - 110'0"	Phosphatic sand, very clayey, bluish-gray. Quartz sand very fine to medium 50 percent. Clay 30 percent, translucent. Phosphorite nodules fine to medium, black, tan, brown, occasional pebble 20 percent.
110'0" - 115'0"	No recovery.
115'0" - 117'5"	Limestone, sandy, clayey, tan, soft. Quartz sand fine to medium 30 percent. Phosphorite nodules medium to coarse sand size, tan, gray, brown, 10 percent. Trace of marcasite or pyrite, small fossils.

Site no. 39
(originally line 13, hole 1)

Lithologic log of core from SW 1/4 SW 1/4 sec. 7, T. 30 S., R. 26 E., Polk County, Florida.

Depth in feet and inches	Description
0'0" - 6'3"	Not cored.
6'3" - 6'10"	Sand, medium to coarse grained, sparsely clayey; brown.
6'10" - 9'7"	No recovery.
9'7" - 12'10"	Sand, fine to medium grain, loose, yellow-tan; bottom contact gradational over 4 inches.
12'10" - 18'2"	Sand, medium to coarse grain, clayey to very clayey; brown at top grading downward into mottled red and yellow-brown; bottom contact gradational over 1 foot.
18'2" - 29'11"	Sand, fine to coarse grain; compact; very clayey; tan streaked with with white and yellow-brown; bottom contact gradational over 10 inches.
29'11" - 36'11"	Sand, fine grain to granule; clayey; slightly compact; mottled light brown and cream; sugary texture in places (appears leached).
36'11" - 45'7"	No recovery.
45'7" - 48'2"	Sand, fine grain to fine pebble size (very poorly sorted); slightly clayey; cream color; contains very small patches of yellow-brown clay; lower contact indefinite.

Site no. 39.--Continued.

Depth in feet and inches	Description
48'2" - 48'9"	Sand, medium to mostly fine grain; sparsely clayey; mottled light yellow-brown and white.
48'9" - 57'0"	No recovery.
57'0" - 62'11"	Sand, fine grain; slightly clayey; uniform yellow-white at top to crudely thin-banded yellow-brown and white at bottom; sparse black heavy minerals; bottom contact gradational over 8 inches.
62'11" - 73'7"	Phosphatic sand, fine grained to granule; sparsely clayey to slightly clayey; irregular bands of clay; yellow-brown; 35 - 60 percent fine-grained sand size to fine pebble; white, cream, gray, and brown phosphorite nodules (some soft), fine grain heavy minerals at top; very slightly calcareous in bottom 3 feet; bottom contact gradational over 8 inches.
73'7" - 74'7"	Clay, very sandy (fine grain to granule); crudely bedded yellow-brown and gray (clay); calcareous; 25-35 percent fine sand size to pebble size gray and tan phosphorite nodules; bottom contact sharp.
74'7" - 75'6"	Limestone, soft, slightly sandy, clayey, light cream ; 5-10 percent medium grain to fine pebble size tan, cream, and gray phosphorite nodules; hard limestone in bottom 2 inches of same composition as above but with mollusk imprints.

Site no. 40
(originally line 13, hole 2)

Lithologic log of core from NW 1/4 NE 1/4 sec. 17, T. 30 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 6'0"	Not cored.
6'0" - 9'8"	Sand, medium grain to granule, very clayey, light gray; bottom contact gradational over 10 inches.
9'8" - 11'5"	Sand, fine grain, clayey, gray-white.
11'5" - 16'1"	No recovery.
16'1" - 25'8"	Sand, very fine to fine grain, slightly clayey, gray-white, trace of muscovite; bottom contact gradational over 10 inches.
25'8" - 29'2"	Sand, very fine to fine grain, slightly clayey, light gray; contains abundant thin lenses and patches of light gray clay.

Site no. 40.--Continued.

Depth in feet and inches	Description
29'2" - 31'0"	No recovery.
31'0" - 32'7"	Sand, mostly very fine grain with sparse quartz granules, very clayey, light greenish-gray; bottom contact gradational over 3 inches.
32'7" - 33'10"	Clay, slightly sandy, mottled blue-green and light gray, 25 - 35 percent medium sand to fine pebble size tan phosphorite nodules; bottom contact gradational over 2 inches.
33'10" - 37'4"	Clay, sparsely sandy, brown with irregular lenses and patches of blue-gray clay; 5 percent fine to medium sand size tan phosphorite nodules; bottom contact gradational over 2 inches.
37'4" - 38'10"	Clay, slightly sandy, slightly calcareous; mottled and streaked yellow-brown and greenish-gray; 30 - 40 percent medium sand to coarse pebble size tan phosphorite nodules, a few large phosphorite nodules have limestone centers; bottom contact obscured.
38'10" - 43'4"	Clay, sparsely sandy, calcareous, brown with abundant patches of blue-gray clay; 5 - 10 percent fine sand to medium pebble size tan phosphorite nodules; top 2 feet contains scattered sparse slightly phosphatized limestone fragments (mollusk imprints noted); bottom 1 foot contains patches of soft limestone (slightly sandy with 5 - 10 percent tan phosphorite nodules).
43'4" - 44'9"	No recovery.
44'9" - 46'0"	Clay, slightly sandy, very calcareous, light gray-brown; 5 percent fine sand to granule size tan and cream phosphorite nodules; contains patches of soft limestone; bottom contact gradational over 6 inches.
46'0" - 50'9"	Limestone, soft, sandy, clayey in places, light gray-tan; 5 - 15 percent fine sand to fine pebble size cream and mostly tan phosphorite nodules; sparsely scattered mollusk imprints.

Site no. 41
(originally line 13, hole 3)

Lithologic log of core from NE 1/4 NE 1/4 sec. 9, T. 30 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 6'6"	No recovery.
6'6" - 7'6"	Sand, fine to medium grain, very clayey, light gray, very compact.
7'6" - 8'8"	No recovery.
8'8" - 9'6"	Sand, fine to medium grained, very clayey at top to slightly clayey at bottom, gray.
9'6" - 9'11"	No recovery.
9'11" - 22'3"	Sand, fine to coarse grain, with sparse quartz granules, sparsely clayey to slightly clayey in places, brown.
22'3" - 24'9"	No recovery.
24'9" - 27'4"	Sand, medium to mostly coarse grained, no clay (appears washed by drill water), mottled brown with some white.
27'4" - 31'0"	No recovery.
31'0" - 37'1"	Sand, medium to mostly coarse grain, sparse to slightly clayey, tan.
37'1" - 49'5"	No recovery.
49'5" - 71'7"	Sand, fine to mostly very fine grain, slightly clayey at top grading to very clayey at bottom; trace to sparse muscovite in places; trace of fine grain black heavy minerals.
71'7" +/- 72'3"	No recovery.
72'3" - 75'9"	Sand, very fine to fine grained, slightly clayey with thin irregular lenses of silt and clay, dark greenish-gray to black, trace of muscovite, trace of fine grain black phosphorite (?) nodules; bottom contact gradational over 5 inches.
75'9" - 77'0"	Phosphatic sand, fine to medium grain, with sparse quartz granules, clayey, gray-black streaked with dark greenish-brown; 30 - 45 percent tan, gray, and mostly black fine sand size to fine pebble size phosphorite nodules; bottom contact gradational over 4 inches.

Site no. 41.--Continued

Depth in feet and inches	Description
77'0" - 81'2"	Clay, very sandy in places, calcareous, gray-black with streaks and patches of tan, small patches of soft tan limestone, sparse hard limestone pebbles (up to 15 mm), abundant scattered irregular lenses and beds containing 50 - 60 percent fine sand size to granule size, mostly black, phosphorite nodules.
81'2" - 81'7"	No recovery.
81'7" - 85'9"	Limestone, soft, sparsely sandy, abundant gray clay seams and patches in top 2 feet of unit, gray at top grading to light tan at bottom; 5 - 10 percent fine sand size to fine pebble size tan and mostly black phosphorite nodules; phosphorite percentage decreases toward bottom.

Site no. 42
(originally line 13, hole 4)

Lithologic log of core from NE 1/4 SE 1/4 sec. 15, T. 30 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 10'0"	Not cored.
10'0" - 10'8"	Sand, medium to coarse grain, loose, white streaked with yellow-brown.
10'8" - 14'2"	No recovery.
14'2" - 19'11"	Sand, fine to coarse grain, very clayey, compact, light brown.
19'11" - 23'10"	No recovery.
23'10" - 30'7"	Sand, fine to medium grain, coarse in places, clayey, compact, light brown, sugary texture; some aluminum phosphate (?) cementing material; top 2 inches indurated.
30'7" - 33'2"	No recovery.
33'2" - 35'4"	Sand, medium grain with sparse coarse grain, clayey, compact, tan, sugary texture.
35'4" - 37'0"	No recovery.
37'0" - 39'0"	Same as 33'2" to 35'4".
39'0" - 39'7"	No recovery.

Site no. 42.--Continued

Depth in feet and inches	Description
39'7" - 42'3"	Sand, medium to coarse grain, slightly clayey, light tan; bottom contact gradational over 3 inches.
42'3" - 44'0"	Sand, very fine to fine grain, clayey, cream color.
44'0" - 44'10"	No recovery.
44'10" - 46'6"	Same as 42'3" to 44'0".
46'6" - 52'1"	No recovery.
52'1" - 65'6"	Sand, very fine to fine grain, clayey at top to very clayey at bottom, cream; sparse fine to medium sand size muscovite in places.
65'6" - 66'3"	No recovery.
66'3" - 70'0"	Sand, very fine grain, very clayey, light tan, sparse fine to medium size muscovite; bottom contact sharp (appears leached).
70'0" - 75'0"	Sand, fine to medium grain, clayey, irregularly laminated brown and gray-black; lenses and small patches of brown clay mostly in bottom 1 foot; bottom contact gradational over 6 inches.
75'0" - 76'0"	Phosphatic sand, same as above but with approximately 5 percent fine sand size to fine pebble size black phosphorite nodules and small patches of brown soft clayey limestone; one fragment of marcasite containing black phosphorite nodules at 75'0".
76'0" - 81'6"	Phosphatic sand, medium grain, slightly clayey to clayey in places, slightly calcareous, dark grayish-black; contains fragments of moderately indurated tan phosphatic limestone; 30 - 45 percent fine sand to fine pebble size tan and mostly black phosphorite nodules.
81'6" - 91'1"	No recovery.
91'1" - 94'3"	Limestone, soft, sandy (fine to coarse grain), grayish-brown; contains very angular fragments of hard brown limestone.

Site no. 43
(originally line 13, hole 5)

Lithologic log of core from NW 1/4 SE 1/4 sec. 13, T. 30 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 12'4"	Not cored.
12'4" - 12'10"	Sand, fine to medium grain, sparsely clayey, light yellow-brown.
12'10" - 13'6"	No recovery.
13'6" - 14'0"	Sand, fine to medium grain, slightly clayey at top, to clayey at bottom, yellow-brown, bottom contact gradational over 4 inches.
14'0" - 20'4"	Sand, fine to medium grain, clayey to very clayey, very compact, mottled and streaked yellow-brown, gray-white, and red.
20'4" - 20'11"	No recovery.
20'11" - 29'2"	Same as 14'0" - 20'4" but colors less intense toward bottom.
29'2" - 29'9"	No recovery.
29'9" - 34'4"	Sand, medium to mostly fine grained, clayey, light yellow-brown at top to white at bottom, with reddish-brown streaks scattered throughout unit.
34'4" - 40'8"	No recovery.
40'8" - 42'6"	Sand, fine to medium grain, clayey, white with thin streaks of light yellow-brown.
42'6" - 43'8"	No recovery.
43'8" - 49'3"	Sand, fine to medium grain, clayey, white, sparse muscovite.
49'3" - 51'2"	No recovery.
51'2" - 54'2"	Same as 43'8" - 49'3" but mostly fine grained.
54'2" - 55'0"	No recovery.
55'0" - 59'11"	Sand, very fine to fine grain, clayey, white , fine to coarse sand size muscovite, sparse at top, more abundant at bottom.
59'11" - 61'9"	No recovery.
61'9" - 64'10"	Sand, very fine to fine grain, clayey, white , sparse muscovite throughout unit.

Site no. 43.--Continued

Depth in feet and inches	Description
64'10" - 65'6"	No recovery.
65'6" - 70'6"	Sand, very fine grain, clayey, white, sparse muscovite.
70'6" - 70'10"	No recovery.
70'10" - 72'4"	Sand, fine grain, clayey to very clayey, yellow-brown with abundant streaks and seams of red and gray-white; sparse muscovite; bottom contact gradational over 6 inches.
72'4" - 73'9"	Clay, very sandy (fine grain), sparse muscovite, gray with abundant closely spaced thin streaks of red and yellow-brown; bottom contact sharp.
73'9" - 80'10"	Clay, slightly sandy at top to very sandy at bottom (fine grain), black, sparse mica, bottom contact gradational over 10 inches.
80'10" - 84'8"	Phosphatic sand, fine to medium grain, clayey, sparsely calcareous at top to calcareous at bottom, dark greenish-black, sparse mica, 4 - 6 percent coarse grain to mostly pebble size black phosphorite nodules; bottom two feet of unit contains patches of soft limestone (sandy with 5 - 10 percent fine sand size to pebble size black phosphorite nodules); bottom contact gradational over 3 inches.
84'8" - 85'10"	Limestone, soft, slightly sandy, clayey, gray; 10 - 20 percent fine sand size to pebble size tan, cream, and mostly black phosphorite nodules; unit contains hard fragments and pebbles of limestone; top 2 inches of unit is well indurated, partially silicified, containing mollusk molds with drusey quartz coatings.

Site no. 44
(originally line 13, hole 6)

Lithologic log of core from SE 1/4 NW 1/4 sec. 18, T. 30 S., R. 27 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 10'8"	Not cored.
10'8" - 11'1"	Sand, fine to medium grain, slightly clayey, brownish-black, iron-stained hardpan layer, bottom contact gradational over 3 inches.
11'1" - 15'9"	Sand, fine to medium grain, clayey, dark brown, contains patches of brown clay in top half of unit, bottom 2 feet appears washed by drill water.

Site no. 44.--Continued.

Depth in feet and inches	Description
15'9" - 17'9"	Clay, sandy to very sandy (fine to mostly coarse grain), brown; 1-inch black clayey sand hardpan layer at bottom of unit.
17'9" - 19'0"	No recovery.
19'0" - 20'2"	Sand, medium grain with sparse coarse grain, clayey in patches, brown with black streaks.
20'2" - 22'5"	Sand, medium grain with sparse coarse grains and granules, sparsely clayey, light brown (appears washed by drill water).
22'5" - 23'10"	Sand, medium to coarse grain, very clayey, light brown, sugary texture, appears leached.
23'10" - 24'6"	No recovery.
24'6" - 25'6"	Sand, coarse grain to granule size, clayey, sugary texture, light brown, graded bedding; bottom contact sharp.
25'6" - 30'0"	Sand, bedded (mostly fine grain beds with thin beds of medium grain to granule size), clayey to very clayey, light tan, slight muscovite in places, appears leached.
30'0" - 31'0"	No recovery.
31'0" - 33'0"	Sand (washed by drill water), medium grain, slightly clayey, tan.
33'0" - 33'9"	No recovery.
33'9" - 35'8"	Sand, medium to coarse grain, slightly clayey, faint graded bedding, light gray-tan, sugary texture, appears somewhat leached.
35'8" - 38'10"	No recovery.
38'10" - 44'5"	Sand, very fine to fine grain, clayey, cream color, slight muscovite in places.
44'5" - 47'5"	No recovery.
47'5" - 56'2"	Sand, very fine grain, clayey to very clayey in places, sparse to slight muscovite, gray-white, sparse fine sand size heavies; bottom contact sharp.
56'2" - 56'11"	Sand, very fine grain, clayey, yellow-brown, sparse muscovite; bottom 1 inch is tan in color but same composition; bottom contact sharp.

Site no. 44. --Continued

Depth in feet and inches	Description
56'11" - 67'4"	Clay, slightly sandy in places, dark green to black, sparse muscovite, contains patches and lenses of fine sand. Bottom 1 foot contains 1 - 5 percent coarse sand size to pebble size black phosphorite nodules; bottom contact gradational over 4 inches.
67'4" - 71'7"	Clay, slightly sandy, slightly calcareous, greenish-gray, contains abundant patches of soft clayey, phosphatic tan limestone; sparse pebbles; one hard limestone pebble with partial coating of black phosphate at 69'6"; unit contains 4 - 8 percent fine sand size to mostly pebble size black phosphorite nodules.
71'7" - 72'4"	No recovery.
72'4" - 81'5"	Clay, sandy, calcareous, mottled gray and tan; contains scattered patches and lenses of sand and very abundant patches of soft tan phosphatic limestone; 5 - 10 percent fine sand size to pebble size black phosphorite nodules.

Site no. 45
(originally line 13, hole 7)

Lithologic log of core from SW 1/4 SW 1/4 sec. 29, T. 30 S., R. 27 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 10'7"	Not cored.
10'7" - 19'11"	Sand, fine to mostly coarse grain, clayey to very clayey, tan, faint graded bedding.
19'11 - 22'4"	No recovery.
22'4" - 24'8"	Sand, medium grain to granule size, brown (no clay - but has been washed by drill water).
24'8" - 28'2"	No recovery.
28'2" - 30'5"	Sand, fine grain to sparse granule size, sparsely clayey but has been washed by drill water, light brown; bottom 2 inches not washed, clayey; shows graded bedding from coarse at top to fine at bottom.
30'5" - 41'7"	No recovery.
41'7" - 50'5"	Sand, very fine to fine grain, clayey, light tan, sparse to slight amounts of muscovite, trace of fine sand size black heavy minerals; has been washed by drill water.

Site no. 45--Continued

Depth in feet and inches	Description
50'5" - 51'8"	No recovery.
51'8" - 54'6"	Sand, very fine to fine grain, clayey, gray-tan, sparse muscovite; unit contains abundant lenses and patches of brown micaceous clay; bottom contact sharp.
54'6" - 55'4"	Clay, sandy (fine grain), dark greenish-gray; contains patches and seams of fine black micaceous sand.
55'4" - 56'2"	No recovery.
56'2" - 76'10"	Clay, slightly sandy to very sandy in places, sparse muscovite, dark greenish-gray, bottom contact gradational over 3 inches.
76'10" - 78'10"	Sand, medium grain to granule size, clayey, slightly calcareous, dark gray, contains abundant patches and streaks of light tan phosphatic soft limestone; 20 - 40 percent fine sand size to pebble size black phosphorite nodules.
78'10" - 80'8"	No recovery (bottom was hard rock).

Site no. 46
(originally line 13, hole 8)

Lithologic log of core from NE1/4 SE1/4 sec. 28, T. 30 S., R. 27 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 10'7"	Not cored.
10'7" - 11'11"	Sand, fine to medium grain, clayey to very clayey, light brown with thin horizontal seams of dark brown.
11'11" - 13'6"	No recovery.
13'6" - 17'6"	Sand, fine grain to granule size, slightly clayey to very clayey, brown graded bedding throughout; fine grain beds at top, coarse at bottom.
17'6" - 19'10"	No recovery.
19'10" - 21'3"	Sand, fine grain with slight amounts of very coarse grain, intermediate sizes subordinate, clayey, light tan, sugary texture (appears very much leached).
21'3" - 25'9"	No reocovery.
25'9" - 28'3"	Sand, fine grain to granule size, slightly clayey to clayey, tan, graded bedding.

Site no. 46. --Continued

Depth in feet and inches	Description
28'3" - 30'4"	No recovery.
30'4" - 33'3"	Sand, fine grain with sparse coarse and granule size (not clayey but washed by drill water), mottled tan and white.
33'3" - 34'3"	No recovery.
34'3" - 35'8"	Sand, fine to medium grain, light tan and white.
35'8" - 40'0"	No recovery.
40'0" - 43'7"	Sand, fine to medium grain, sparsely clayey, light tan with sparse white patches.
43'7" - 58'9"	No recovery.
58'9" - 59'6"	Sand, fine to very coarse grain, slightly clayey, greenish-brown, sparse muscovite, trace of black phosphorite nodules, bottom contact sharp.
59'6" - 60'0"	Sand, fine grain, slightly clayey, gray, sparse muscovite.
60'0" - 61'9"	No recovery.
61'9" - 65'4"	Sand, fine to medium grain, sparsely clayey (washed by drill water), light gray, sparse muscovite.
65'4" - 69'1"	No recovery.
69'1" - 75'7"	Sand, very fine to fine grain, slightly clayey at top to clayey at bottom, greenish-gray, sparse muscovite, trace of black phosphorite nodules in bottom 18 inches, varied appearance from 71'4" - 72'4" (alternating light and dark layers 1/4- inch thick).
75'7" - 76'0"	No recovery.
76'0" - 79'10"	Clay, very sandy (fine grain), dark greenish-gray, sparse muscovite, sparse fine sand size to pebble size black phosphorite nodules; bottom contact gradational over 2 inches.
79'10" - 80'8"	Clay, sandy , dark greenish-gray, contains abundant clear quartz pebbles (some flat), small patches of tan clayey limestone, 20 - 40 percent fine sand size to mostly pebble size black phosphorite nodules; bottom contact gradational over 3 inches.
80'8" - 83'2"	Clay, very sandy (fine grain), greenish-gray, sparse quartz pebbles, 4-8 percent fine sand size to pebble size black phosphorite nodules; bottom contact sharp.

Site no. 46.--Continued

Depth in feet and inches	Description
83'2" - 83'11"	Limestone, soft , clayey, sparsely sandy (fine grain), light gray-tan; contains irregular thin lenses with 8 - 10 percent fine to coarse sand size black phosphorite nodules.

Site no. 47
(originally line 10, hole 3)

Lithologic log of core from SW 1/4 NW 1/4 sec. 33, T. 32 S., R. 25 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 6'2"	Not cored.
6'2" - 7'4"	Sand, fine to medium grained, clayey, light tan with thin seams and stringers of yellowish-brown and white.
7'4" - 9'0"	No recovery.
9'0" - 19'3"	Same as 6'2" - 7'4" with bottom 3 feet slightly coarser grained and less clayey.
19'3" - 20'8"	No recovery.
20'8" - 27'6"	Sand, medium to coarse grained, sparsely clayey to clayey, cream to light tan, lower contact gradational over 18 inches.
27'6" - 28'5"	Phosphatic sand, medium to granule size, clayey, light gray; 20 percent medium sand size to mostly pebble size (up to 20mm) tan and cream phosphorite nodules; lower contact gradational over 2 inches.
28'5" - 32'10"	Phosphatic sand, medium to coarse grain, slightly clayey to very clayey, gray with thin yellow-brown seams, alternating lenses, and graded, thin beds of greenish-gray clay and highly phosphatic slightly clayey sand; 25- 35 percent fine to coarse sand size, tan, brown, cream and black phosphorite nodules; bottom contact gradational over 6 inches.
32'10" - 37'0"	Phosphatic sand, fine to coarse grained, brown, highly phosphatic lenses alternating with calcareous brown and greenish-gray clay lenses; 30-45 percent fine sand size to pebble size brown, tan, and cream phosphorite nodules; bottom contact sharp.
37'0" - 38'3"	Limestone soft, slightly sandy with sparse scattered clay patches; mottled light yellow-tan and white; abundant pelecypod imprints; 5 percent fine to coarse sand size brown phosphorite nodules.

Site no. 48
(originally line 10, hole 2 B)

Lithologic log of core from SE 1/4 sec. 22, T. 32 S., R. 25 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 7'1"	Poor recovery, 3 inches at top is clay, 3 inches at base is sand.
7'1" - 8'3"	Clay, sandy (fine grained), dark brown; basal contact gradational.
8'3" - 9'7"	Sand, medium to coarse grained, clayey to slightly clayey, gray-tan; trace of phosphorite particles in basal 6 inches; lower contact gradational.
9'7" - 11'6"	Phosphatic sand, slightly clayey, medium grained, crude bedding, light yellow-tan, with very thin green clay lenses (horizontal); 25 - 35 percent phosphorite nodules, fine to coarse sand size, tan, cream, and brown, some pebble size. Basal contact gradational over 3 inches.
11'6" - 12'8"	Phosphatic sand, clayey; lenses of light bluish-green clay. More than 25 percent phosphorite nodules, tan, cream, and black pebbles.
12'8" - 13'7"	No recovery.
13'7" - 17'2"	As above.
17'2" - 17'8"	No recovery except for 1 inch or less of limestone at base.

Site no. 49
(originally line 12, hole 1)

Lithologic log of core from SW 1/4 NE 1/4 sec. 36, T. 31 S., R. 25 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 6'0"	Not cored.
6'0" - 7'4"	Sand, very fine grained, very clayey, light brown, abundant indurated lumps of vesicular sandstone in top 5 inches of unit.
7'4" - 8'3"	No recovery.
8'3" - 11'0"	Sand, fine to medium, slightly clayey to clayey, light tan, appears somewhat leached.

Site no. 49.--Continued

Depth in feet and inches	Description
11'0" - 12'1"	Phosphatic sand, fine grain with sparse coarse, very clayey, cream; 10 - 15 percent white coarse grain phosphorite nodules with sparse fine grained black phosphorite nodules; bottom contact sharp.
12'1" - 12'10"	Clay bed, cream color with thin streaks of yellow-brown; bottom contact sharp.
12'10" - 19'0"	Phosphatic sand, medium to coarse grain, very clayey, cream and yellow-brown, crudely banded, 15 - 25 percent fine sand size to mostly granule size cream and mostly tan phosphorite nodules.
19'0" - 20'2"	No recovery.
20'2" - 24'0"	Clay, very slightly sandy, mottled and banded white and yellow-brown, with scattered moderately indurated fragments of white claystone; 20 - 40 percent fine sand size to pebble size cream and tan phosphorite nodules.
24'0" - 25'3"	No recovery.
25'3" - 29'4"	Same as 20'2" - 24'0" with marked decrease in phosphorite nodules in bottom 18 inches.
29'4" - 30'7"	No recovery.
30'7" - 32'5"	Clay, slightly sandy, mottled white and yellow-brown contains slightly abundant indurated fragments of sand, clay and phosphorite, slightly calcareous at bottom; 5 - 15 percent fine sand size to pebble size cream and tan phosphorite nodules.
32'5" - 33'1"	Limestone, soft with abundant hard fragments (mottled white and yellow-brown), clayey, sparsely sandy, fossiliferous (pelecypods); 3 - 5 percent fine sand size to fine pebble size tan phosphorite nodules.

Site no. 50
(originally line 12, hole 2)

Lithologic log of core from SW 1/4 SW 1/4 sec. 32, T. 31 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 6'0"	Not cored.
6'0" - 8'0"	Sand, medium grained with sparse coarse, light brown.
8'0" - 8'6"	No recovery.

Site no. 50.--Continued

Depth in feet and inches	Description
8'6" - 17'3"	Sand, medium to coarse, clayey at top to very clayey at bottom, sugary texture throughout, light tan, abundant aluminum phosphate; top 6 inches contains abundant indurated vesicular lumps cemented with aluminum phosphate; bottom 2 inches contains small lumps of white clay-stone; bottom contact gradational over 4 inches.
17'3" - 19'10"	Phosphatic sand, medium grain, very clayey, mottled and crudely banded light gray and light greenish-brown; 5 - 10 percent fine sand size to granule size white, tan, and black phosphorite nodules; bottom contact gradational over 8 inches.
19'10" - 21'10"	Phosphatic sand, fine to medium grained, clayey to very clayey, slightly calcareous, light gray-tan; contains abundant beds, lenses, and patches of light greenish-gray clay; 10 - 15 percent fine sand size to fine pebble size cream, brown, and tan phosphorite nodules.
21'10" - 23'10"	Phosphatic sand, medium grain, clayey, slightly calcareous, laminated, gray-brown; 40 - 60 percent medium to coarse sand size brown phosphorite nodules at top of unit decreasing gradually towards bottom to 5 - 10 percent; bottom 6 inches abundant laminated light greenish-brown clay with thin seams of fine sand containing very fine to fine brown phosphorite nodules.
23'10" - 25'0"	No recovery.
25'0" - 26'6"	Clay, calcareous, crudely laminated, light greenish-brown horizontally streaked yellow-brown; contains abundant lenses and fine seams of fine sand which consists of 40 - 60 percent fine grain mostly brown phosphorite nodules; bottom contact gradational over 8 inches.
26'6" - 31'0"	Limestone, soft, very clayey, slightly sandy (fine grained), mottled light gray and yellow-brown; sparse fine to medium sand size phosphorite nodules at top gradually increasing downward to 30 - 40 percent fine sand size to granule size brown phosphorite nodules.

Site no. 51
(originally line 12, hole 3)

Lithologic log of core from SW 1/4 SW 1/4 sec. 33, T. 31 S., R. 26 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 5'5"	Not cored.
5'5" - 6'10"	Sand, medium to coarse grain, sparsely clayey, brown; scattered lumps of slightly vesicular hardpan.
6'10" - 8'2"	No recovery.
8'2" - 12'7"	Sand, fine grain to granule, quartz pebbles, sugary texture, tan, sparsely clayey; contains scattered slightly indurated small lumps cemented with aluminum phosphate (?).
12'7" - 15'11"	No recovery.
15'11" - 27'5"	Sand, fine to medium grained, sparsely clayey in places, white; bottom contact gradational over 3 inches.
27'5" - 32'10"	Sand, fine to medium grained, sparsely clayey at top to slightly clayey at bottom, yellow-brown.
32'10" - 33'5"	No recovery.
33'5" - 36'9"	Clay, slightly sandy; yellow-brown mottled and streaked with white, black, and cream; contains abundant very irregular lenses of white friable kaolinite (?); sparsely scattered coarse sand size to fine pebble size soft white phosphorite nodules; unit appears to have undergone long weathering.
36'9" - 38'2"	No recovery.
38'2" - 40'7"	Clay, sandy, crudely laminated, light brown; contains very abundant irregular lenses and seams of fine sand size to granule size cream and reddish-orange phosphorite nodules, 15 - 25 percent total phosphorite nodules in unit; bottom contact gradational over 8 inches.
40'7" - 43'1"	Limestone, soft, clayey, sparsely sandy, light tan; 3 - 5 percent very fine sand size tan phosphorite nodules.

Site no. 52
(originally line 12, hole 4)

Lithologic log of core from SW 1/4 SW 1/4 sec. 34, T. 31 S., R. 26 E., Polk Coutny, Florida

Depth in feet and inches	Description
0'0" - 7'0"	Not cored.
7'0" - 9'8"	Sand, medium grained, sparsely clayey, brown; sparse fine black heavy minerals.
9'8" - 12'9"	No recovery.
12'9" - 14'6"	Same as 7'0" - 9'8" ; bottom contact gradational over 6 inches.
14'6" - 28'8"	Sand, fine to coarse grained, clayey to very clayey, mottled red, brown, and gray.
28'8" - 32'2"	No recovery.
32'2" - 42'0"	Sand, medium grained, slightly clayey in places, brown at top to tan at bottom; bottom contact gradational over 18 inches.
42'0" - 49'0"	Sand, fine to medium grained, sparsely clayey to slightly clayey, yellow-brown; bottom 1 foot contains sparse, very slightly indurated sand lumps cemented with aluminum phosphate; bottom contact gradational over 1 foot.
49'0" - 57'0"	Sand, fine to medium grained, sparsely clayey, mottled yellow-brown and tan; contains sparse, scattered, small patches of black organic (?) material.
57'0" - 58'3"	No recovery.
58'3" - 60'7"	Same as 49'0" - 57'0".
60'7" - 62'3"	No recovery.
62'3" - 63'3"	Same as 49'0" - 57'0"
63'3" - 66'9"	No recovery.
66'9" - 67'8"	Sand, fine to medium grained, trace of clay (appears washed by drill water), mottled tan and yellow-brown; trace of fine sand size black phosphorite (?) nodules.
67'8" - 79'0"	No recovery.
79'0" - 79'4"	Sand, fine to medium grained, no clay, light brown; trace of fine sand size black phosphorite nodules.
79'4" - 85'2"	No recovery.

Site no. 52--Continued

Depth in feet and inches	Description
85'2" - 86'5"	Same as 79'0" - 79'4" with sparse clay.
86'5" - 89'10"	No recovery.
89'10" - 91'4"	Phosphatic sand, medium grained to granule, very clayey, yellow-brown; contains claystone fragments (phosphorite grains within fragments); 10 - 20 percent coarse sand size to fine pebble size gray and cream phosphorite nodules.
91'4" - 97'0"	Phosphatic sand, medium to coarse grained, clayey to very clayey, mottled and irregularly streaked yellow-brown and gray, calcareous, crudely bedded; 20 - 30 percent medium sand size to granule size, black and mostly cream phosphorite nodules; bottom of unit contains claystone bed 2 inches thick sparsely sandy with 4 - 6 percent fine to medium sand size cream and tan phosphorite nodules.
97'0" - 99'1"	Clay, calcareous, very sparsely sandy (coarse grained), light gray-brown with abundant streaks of yellow-brown 5 percent fine sand size to granule size cream and mostly tan phosphorite nodules.

Site no. 53
(originally line 12, hole 6)

Lithologic log of core from NW 1/4 NE 1/4 sec. 31, T. 31 S., R. 27 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 8'6"	Not cored.
8'6" - 9'3"	Sand, fine to medium grain, loose, brown.
9'3" - 10'3"	No recovery.
10'3" - 18'2"	Sand, fine grain, sparsely clayey at top to slightly clayey at bottom, brown at top to tan at bottom; abundant organic material at 10'11"-12'0" ; hardpan lumps from 12'6" - 14'3" ; bottom contact gradational over 1 foot.
18'2" - 41'5"	Sand, fine to medium, slightly clayey to clayey, light gray-tan; sparse fine grained, black heavy minerals.
41'5" - 42'7"	No recovery.
42'7" - 44'9"	Sand, fine grain, slightly clayey, mottled light gray and tan.
44'9" - 49'0"	No recovery.

Site no. 53.--Continued

Depth in feet and inches	Description
49'0" - 50'1"	Sand, fine grain, slightly clayey, cream color.
50'1" - 53'4"	No recovery.
53'4" - 53'6"	Sand, fine grain, clayey, mottled light yellow-brown and cream.
53'6" - 55'0"	No recovery.
55'0" - 55'4"	Sand, as 53'4" - 53'6".
55'4" - 56'11"	No recovery.
56'11" - 59'7"	Sand, fine to medium grain, slightly clayey to clayey, cream color.
59'7" - 62'7"	No recovery.
62'7" - 63'7"	Sand, fine grain, very sparse coarse grain, compact, clayey, cream color.
63'7" - 67'10"	No recovery.
67'10" - 73'1"	Sand, fine grain, clayey to very clayey, cream color; from 71'2" to 71'8" very clayey, sparse quartz granules mottled brown and light gray.
73'1" - 75'4"	No recovery.
75'4" - 75'7"	Sand, fine grain, sparse quartz granules, compact, clayey, light gray.
75'7" - 80'0"	No recovery.
80'0" - 81'0"	Same as 75'4" - 75'7".
81'0" - 82'5"	No recovery.
82'5" - 89'4"	Sand, very fine to fine grain, slightly clayey to clayey, light tan, sparse fine to medium sand size muscovite; bottom contact gradational over 6 inches.
89'4" - 92'2"	Sand, fine grain, sparse coarse grain, clayey, gray-brown; medium sand size muscovite; bottom contact sharp.
92'2" - 101'4"	Clay, slightly sandy in places (very fine grained), very dark greenish-gray at top to gray-black at bottom; sparse fine to medium sand size muscovite; clay contains abundant beds, lenses and patches of sand (fine grained, gray, sparse muscovite); sparse fine to coarse sand size black phosphorite in bottom 18 inches mostly in the sand lenses. Bottom contact gradational over 6 inches.

Site no. 53.--Continued

Depth in feet and inches	Description
101'4" - 103'5"	Gravel, slightly sandy, very clayey, very calcareous, gray tan; pebbles with rounded black phosphatic exterior coating, interior composed of hardpan limestone containing tan phosphorite grains; angular fragments of hard fossiliferous (mollusks) phosphatic limestone : unit contains 10 - 15 percent coarse sand size to medium pebble size tan and black phosphorite nodules. Probably conglomerate at top of Hawthorn.

Site no. 54
(originally line 12, hole 8)

Lithologic log of core from NE 1/4 SW 1/4 sec. 33, T. 31 S., R. 27 E., Polk County, Florida

Depth in feet and inches	Description
0'0" - 5'9"	Not cored.
5'9" - 7'6"	Sand, fine to medium grained, very clayey, light tan, with thin streaks of yellow-brown.
7'6" - 8'6"	No recovery.
8'6" - 9'10"	Sand, fine to medium grained, very clayey, light tan, trace of muscovite.
9'10" - 11'0"	No recovery.
11'0" - 12'3"	Same as 8'6" - 9'10".
12'3" - 13'8"	No recovery.
13'8" - 15'6"	Sand, fine to medium grained, very clayey, light tan, sugary texture, aluminum phosphate (?) in places.
15'6" - 17'2"	Sand, fine to very coarse grained, very clayey, light tan, alternating lenses of coarse and fine sand.
17'2" - 18'0"	No recovery.
18'0" - 22'9"	Sand, fine to medium grained, clayey, light tan, appears somewhat leached in places; trace of muscovite.
22'9" - 23'4"	No recovery.
23'4" - 30'2"	Sand, fine to medium grained, clayey, light tan; abundant patches of finer grained material, slightly darker in color and with sugary texture (appears somewhat leached); trace to sparse muscovite.

Site no. 54.--Continued

Depth in feet and inches	Description
30'2" - 39'1"	No recovery.
39'1" - 50'9"	Sand, fine, gray, clayey, light tan at top to grayish tan at bottom, sparse muscovite. Bottom contact gradational over 8 inches.
50'9" - 59'9"	Phosphatic sand, mostly fine grain with sparse medium grain to small pebble (some pebbles are quartz), clayey, gray-tan; contains abundant irregular beds, lenses, and patches of gray-green clay; sparse muscovite; 15 - 25 percent mostly granule size tan and mostly black phosphorite nodules (variably distributed); bottom contact gradational over 3 inches.
59'9" - 64'11"	Clay, sandy (very fine grained), calcareous, dark greenish-gray, with scattered irregular lenses and seams of fine sand containing sparse muscovite and fine sand size black phosphorite nodules; bottom contact gradational over 1 foot.
64'11" - 70'1"	Clay, very sandy (very fine grained), very calcareous, dark greenish-gray, contains abundant pelecypod shells and shell fragments (paper thin whole shells average approximately 10 mm in length); trace of muscovite; 1 - 2 percent fine sand to granule size black phosphorite nodules; bottom contact sharp.
70'1 - 71'2"	Limestone hard, sparsely sandy, light gray-tan, very fossiliferous, mollusks and forams (?), slightly porous. Bottom of unit is soft and very clayey with sparse small hard limestone fragments; trace of black phosphorite nodules in unit.
71'2" - 72'4"	No recovery.
72'4" - 74'6"	Limestone, soft, very clayey in places, cream with patches of light gray; contains abundant lumps of compact but friable limestone of granular texture; trace of black phosphorite nodules in unit.

Site no. 55
(originally line 11, hole 1)

Lithologic log of core from N W 1/4 NW 1/4 sec. 1, T. 34 S., R. 25 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 5'5"	Not cored.
5'5" - 6'8"	Sand, medium grain, clayey, tan.
6'8" - 9'1"	No recovery.
9'1" - 10'4"	Sand, medium grained, clayey, very compact, light greenish-gray with thin, closely spaced, wavy, horizontal, dark brown streaks.
10'4" - 11'5"	No recovery.
11'5" - 12'4"	Same as 9'1" - 10'4" , bottom contact sharp.
12'4" - 13'4"	Clay, blue-green; bottom contact sharp.
13'4" - 17'0"	Limestone, clayey, fossiliferous, tan; top 12 inches of unit very soft limestone, rest of unit contains abundant large and small fragments of hard fossiliferous limestone. Many fragments are porous, fossils mostly pelecypods; 5 percent fine pebble size and mostly granule size black phosphorite nodules.

Site no. 56
(originally line 11, hole 2)

Lithologic log of core from SW 1/4 SE 1/4 sec. 31, T. 33 S., R. 26 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 5'5"	Not cored.
5'5" - 8'0"	Sand, fine grained, sparsely clayey, black at top to dark brown at bottom; lower contact gradational over 12 inches.
8'0" - 13'3"	Sand, fine grain with sparse medium and coarse grain, slightly clayey to clayey in places, dark brown at top to light brown at bottom.
13'3" - 14'7"	No recovery.
14'7" - 15'9"	Same as 8'0" - 13'3" with abundant indurated lumps. Bottom contact gradational over 3 inches.

Site no. 56.--Continued

Depth in feet and inches	Description
15'9" - 21'2"	Sand, fine to coarse grain, slightly clayey only in top 2 feet (but portion of unit below this appears washed by drill water), light tan, indurated vesicular fragments in bottom 3 feet.
21'2" - 32'0"	Sand, fine to medium grain, clayey, light gray-tan, contains indurated slightly vesicular fragments cemented with aluminum phosphate (?). Within unit are zones from 5 - 20 inches thick, some are very clayey, some contain only a trace of clay (some washing by drill water is possible), indurated vesicular fragments distributed irregularly but diminishing from top to bottom of unit; bottom contact gradational over 2 feet.
32'0" - 39'3"	Sand, medium grain, slightly clayey, light tan; bottom contact gradational over 5 inches.
39'3" - 41'10"	Phosphatic sand, medium to coarse grain and granule size (some granules are quartz), clayey, gray-green; 10 - 15 percent fine pebble and fine sand sizes but mostly granule size black phosphorite nodules; bottom contact sharp.
41'10" - 42'8"	Shale, slightly calcareous, tan, with 1 inch clayey phosphatic sand lens (same as 39'3" - 41'10") within; sharp contact between shale and phosphatic lens.
42'8" - 44'0"	No recovery.
44'0" - 46'8"	Clay, slightly calcareous, tan, partially indurated small lumps; contains one greenish-gray clay patch with sandy center; contains black phosphorite grains at top of unit.
46'8" - 51'7"	Poor recovery. Limestone, hard, shaly, very sparsely sandy, fossiliferous, light tan, slightly porous; the pores are mostly molds of foraminifera; sparse mollusk imprints; 3 percent mostly granule size black phosphorite nodules and very sparse, small shark teeth.
51'7" - --	Poor recovery. Limestone, hard, slightly sandy, light tan, 2-3 percent fine black phosphorite nodules.

Site no. 57
(originally line 11, hole 3)

Lithologic log of core from SE 1/4 NW 1/4 sec. 4 T. 34 S., R. 26 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 6'10"	Sand, fine grained, dark brownish-black, iron stained, probably abundant organic material; contact gradational over 8 inches.
6'10" - 8'10"	Sand, fine grained, sparsely clayey, brown; lower contact gradational over 4 inches; hardpan layer 7'6" to 8'0".
8'10" - 21'4"	Sand, fine to medium grain with sparse coarse grains, clayey to very clayey, light greenish-gray; lower contact gradational over 6 inches.
21'4" - 24'5"	Phosphatic sand, fine to coarse grained, very clayey, light grayish tan; 4 - 6 percent fine sand size to fine pebble size soft, weathered, cream and white phosphorite nodules.
24'5" - 25'0"	No recovery.
25'0" - 26'11"	Sand, fine to medium grained, slightly clayey, tan, trace of cream phosphorite nodules.
26'11" - 28'0"	No recovery.
28'0" - 28'5"	Same as 25'0" - 26'11".
28'5" - 31'3"	No recovery.
31'3" - 39'8"	Phosphatic sand, fine to medium grained, slightly clayey to clayey, light tan at top to light greenish-gray at bottom, 2 - 5 percent mostly fine to coarse sand size cream and black phosphorite nodules; gradation from cream-colored phosphorite nodules at top to black at bottom of unit; percent of phosphorite nodules gradually increase from top to bottom. Bottom contact gradational over 1 1/2 feet.
39'8" - 47'3"	Phosphatic sand, slightly clayey to sparsely clayey, medium grained, gray; 15 - 20 percent mostly fine to coarse sand size black phosphorite nodules; bottom contact sharp.
47'3" - 51'5"	Clay, calcareous, slightly sandy at top to very sandy (fine grained) at bottom of unit; 20 - 30 percent mostly fine pebble with finer sizes of tan and mostly black phosphorite nodules.
51'5" - 53'10"	Limestone, soft, very clayey, slightly sandy (fine grained), light gray-brown; 10 percent granule and fine sand size (intermediate grain size conspicuously lacking) black phosphorite nodules.

Site no. 58
(originally line 11, hole 4)

Lithologic log of core from SW 1/4 SW 1/4 sec. 34, T. 33 S., R. 26 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 5'7"	Not cored.
5'7" - 8'9"	Sand, fine grained, sparsely clayey, brownish-black at top to dark brown at bottom; bottom contact gradational over 2 inches.
8'9" - 15'1"	Sand, fine to medium with sparse coarse grains, clayey to very clayey, light gray-tan, slightly leached appearance.
15'1" - 16'2"	No recovery.
16'2" - 19'7"	Same as 8'9" - 15'1".
19'7" - 20'8"	No recovery.
20'8" - 42'4"	Phosphatic sand, fine to coarse grained (grades downward from finer to coarser sizes), clayey at top becoming slightly clayey at bottom, light tan; trace to 2 percent granule and finer size cream-colored phosphorite nodules.
42'4" - 43'4"	No recovery.
43'4" - 45'8"	Sand, coarse grained, very sparsely clayey, light tan; trace of black, gray, and cream colored, fine to coarse sand size phosphorite nodules.
45'8" - 50'4"	No recovery.
50'4" - 51'9"	Sand, medium to coarse grained, very sparsely clayey (appears washed by drill water); 25 - 35 percent granule and finer size black phosphorite nodules; bottom contact probably gradational over several inches (uncertain because of washed condition).
51'9" - 56'5"	Limestone, very soft, very clayey, slightly sandy, greenish gray-tan with top 1 foot more clayey and weathered; 10 - 20 percent fine pebble and finer size tan, brown, and cream phosphorite nodules (1 faint pelecypod shell fragment imprint noted at 55 feet).

Site no. 59
(originally line 11, hole 5)

Lithologic log of core from NE 1/4 SE 1/4 sec. 35, T. 33 S., R. 26 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 5'0"	Not cored.
5'0" - 5'2"	Sand, fine grained with sparse coarse, sparsely clayey, light orange-brown; bottom contact gradational over 3 inches.
5'2" - 7'10"	Clay, very sandy (fine grained), light tan; contains slightly abundant, sparsely vesicular, clayey sand lenses; bottom 7 inches of unit is crudely laminated and contains thin irregular reddish and yellowish-brown streaks with sparse small indurated vesicular lumps of clayey sand.
7'10" - 9'4"	Clay, sparsely sandy, light gray; bottom contact sharp.
9'4" - 15'5"	Sand, fine grained, sparsely clayey, light tan; bottom contact gradational over 4 inches.
15'5" - 17'4"	Sand, clayey at top to sparsely clayey at bottom, fine to medium grained, light gray-tan; contains abundant indurated fragments of vesicular sandstone cemented with aluminum phosphate (?).
17'4" - 18'9"	No recovery.
18'9" - 29'8"	Sand, medium grained, sparsely clayey in places, gray-white.
29'8" - 31'0"	No recovery.
31'0" - 36'0"	Sand, medium grained, very sparsely clayey, gray-white; trace at top to about 1 percent at bottom of unit, mostly fine sand size black, tan, and cream phosphorite nodules; contact completely gradational.
36'0" - 41'2"	Phosphatic sand, medium grained, sparsely clayey to slightly clayey at bottom, light gray; 1 percent at top to 8 percent at bottom, granule and finer sizes cream, tan, and mostly black phosphorite nodules.
41'2" - 44'0"	No recovery.
44'0" - 45'7"	Phosphatic sand, medium to coarse grained, sparsely clayey, gray 8 - 10 percent fine sand size to granule size black phosphorite nodules.
45'7" - 47'2"	No recovery.

Site no. 59.--Continued

Depth in feet and inches	Description
47'2" - 48'10"	Phosphatic sand, coarse grained to granule size, slightly clayey, dark gray; 10 - 15 percent fine pebble to mostly fine sand size black phosphorite nodules; bottom contact exceptionally sharp.
48'10" - 52'0"	Limestone, hard, very fossiliferous, light tan, pecten imprints and minute gastropods (?), trace of fine grained black phosphorite nodules.

Site no. 60
(originally line 11, hole 6)

Lithologic log of core from NE 1/4 SE 1/4 sec. 31, T. 33 S., R. 27 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 7'6"	Not cored.
7'6" - 7'8"	Sand, fine grained, white.
7'8" - 8'6"	No recovery.
8'6" - 8'7"	Same as 7'6" - 7'8" with light yellowish-brown mottling.
8'7" - 9'5"	No recovery.
9'5" - 9'6"	Same as 8'6" - 8'7".
9'6" - 11'2"	No recovery.
11'2" - 12'9"	Sand, fine grained, sparsely clayey, black at top to brown at bottom of unit, abundant organic material and iron-staining; bottom contact gradational over 10 inches.
12'9" - 19'8"	Sand, fine to medium with sparse, scattered coarse grains, clayey to very clayey, light gray-tan.
19'8" - 21'8"	No recovery.
21'8" - 24'9"	Sand, fine to medium grained, very sparsely clayey (washed by drill water), cream colored; small (5 - 10 mm) well indurated clay (?) lumps in bottom 1 foot of unit; bottom contact gradational over 2 inches.
24'9" - 29'9"	Clay, trace of fine sand, crudely laminated, light gray; contains abundant scattered clayey fine-grained sand lenses and beds, widely variant in thickness.

Site no. 60.--Continued

Depth in feet and inches	Description
29'9" - 30'1"	No recovery.
30'1" - 32'4"	Sand, medium grained, clayey, light greenish-gray.
32'4" - 32'9"	No recovery.
32'9" - 33'3"	Same as 30'1" - 32'4" except 1-inch light green clay bed within.
33'3" - 48'3"	Sand, fine to coarse grained, sparsely clayey (looks washed by drill water), gray-white, in places streaked yellow-brown in top 2 feet of unit; bottom 1 foot of unit becomes clayey with a trace of tan and black phosphorite nodules.
48'3" - 51'2"	No recovery.
51'2" - 54'0"	Phosphatic sand, medium to coarse grained, clayey, gray, sparse coarse sand size black phosphorite nodules.
54'0" - 58'8"	Phosphatic sand, medium grained, clayey, light greenish-gray; contains abundant lenses and patches of green clay and lenses and small patches of white sand; trace to 3 percent fine to coarse grained black and tan phosphorite nodules mostly within the sandy lenses; bottom contact gradational over 12 inches.
58'8" - 61'0"	Clay, sparsely sandy, dark greenish-gray; abundant irregular medium-grained sand lenses which contain 5 - 10 percent fine-to coarse-grained black phosphorite nodules; both clay and sand lenses contain sparse fine-grained white mica.
61'0" - 62'0"	No recovery.
62'0" - 65'0"	Same as 58'8" - 61'0".
65'0" - 66'6"	No recovery.
66'6" - 70'2"	Phosphatic sand, coarse grained, very sparsely clayey, dark gray-black, 10 - 15 percent coarse sand-size to granule size black phosphorite nodules; a 7-inch dark greenish-black clay bed containing sparse white mica between 69'5" - 70'0".
70'2" - 70'10"	No recovery.
70'10" - 71'10"	Phosphatic sand, medium to coarse grained, clayey to very clayey, dark gray; 10 - 15 percent pebble size and finer sizes black phosphorite nodules; bottom contact sharp in color change but gradational in composition over 4 inches.
71'10" - 73'3"	Limestone, hard, very fossiliferous, slightly sandy, very clayey, grayish-tan in places; abundant pelecypods; 5 percent mostly granule size black phosphorite nodules.

Site no. 61
(originally line 11, hole 7)

Lithologic log of core from NW 1/4 SE 1/4 sec. 32, T. 33 S., R. 27 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 2'6"	Not cored.
2'6" - 7'10"	Clay, very sandy, calcareous, light greenish-gray and yellow-brown; contains abundant irregular lenses and patches of very calcareous clay and fine clayey sand; hard fragments of tan limestone; trace of black phosphorite at 5'10".
7'10" - 13'7"	No recovery.
13'7" - 21'9"	Sand, fine to medium grain, clayey to very clayey, dark greenish-gray and gray-tan, faintly banded; trace of cream phosphorite at top, slightly increasing toward bottom; bottom contact gradational over 10 inches.
21'9" - 34'10"	Phosphatic sand, fine to coarse grained, slightly clayey, with sparse thin seams of green clay; 4 - 8 percent fine grain to granule size tan, cream, and mostly black phosphorite nodules. Bottom 1 foot of section contains alternating lenses of green clay and fine-grained sand with sparse fine-grained black phosphorite nodules and trace of white mica; lower contact gradational over 3 inches.
34'10" - 49'11"	Phosphatic sand, medium to coarse grained, slightly clayey, light brownish-gray, faintly bedded--alternating layers of greater and lesser amounts of clay; 5 - 10 percent pebble to mostly fine sand size black phosphorite nodules; bottom contact gradational over 2 inches.
49'11" - 56'1"	Phosphatic sand, medium to coarse grained with sparse quartz granules, slightly clayey to very clayey in places, calcareous, dark greenish-gray; bottom 2 feet contains 2 clay beds (4 inches thick); 15-25 percent fine sand size to coarse pebble size (over 1 inch diameter) black phosphorite; sparse quartz pebbles (10 - 15 mm) at 51'8".

Site no. 62
(originally line 11, hole 8)

Lithologic log of core from SE 1/4 sec. 33, T. 33 S., R. 27 E., Hardee County, Florida

Depth in feet and inches	Description
0'0" - 7'0"	Not cored.
7'0" - 9'0"	Sand, fine-grained, light tan; bottom contact gradational over 1 inch.
9'0" - 11'10"	Sand, fine-grained, mottled and crudely banded light gray and light yellow-brown.
11'10" - 12'2"	No recovery.
12'2" - 14'10"	Sand, very fine-grained, sparse to slightly clayey, light tan; bottom contact gradational over 2 inches.
14'10" - 16'8"	Sand, fine to coarse grained with sparse quartz granules, clayey with small streaks of white kaolin; bottom contact gradational over 2 inches; trace of cream-colored phosphorite nodules.
16'8" - 17'11"	Sand, fine to coarse grained, slightly clayey, irregularly streaked light reddish-brown, yellow-brown and gray-white (more permeable than overlying, and underlying beds which may account for strong color staining).
17'11" - 20'9"	Clay, light gray with abundant sand and clayey sand lenses; trace of fine to medium sand size black phosphorite nodules in sand lenses; bottom contact gradational over 5 inches.
20'9" - 25'8"	Sand, fine to medium grained, light gray, clayey to very clayey at bottom of unit; contains abundant indurated lumps of sandstone.
25'8" - 27'0"	Sandstone, well indurated, fine to coarse grained with sparse quartz granules, light gray; rock contains scattered small worm tubes or burrows 1 - 2 mm in diameter, 4 - 8 mm in length.
27'0" - 28'8"	Sand, fine to medium grained, sparsely clayey, mottled yellow-brown and gray-white.
28'8" - 29'4"	No recovery.
29'4" - 31'0"	Same as 27'0" - 28'8".
31'0" - 34'0"	Sand, fine to medium grained, light gray (no clay but appears washed by drill water).
34'0" - 35'5"	No recovery.
35'5" - 37'7"	Same as 31'0" - 34'0" but sparsely clayey.

Site no. 62.--Continued

Depth in feet and inches	Description
37'7" - 38'3"	No recovery.
38'3" - 40'5"	Sand, fine to medium, slightly clayey, cream colored.
40'5" - 45'5"	No recovery.
45'5" - 49'2"	Sand, fine grained, slightly clayey, cream colored.
49'2" - 51'0"	No recovery.
51'0" - 55'6"	Same as 45'5" - 49'2".
55'6" - 59'1"	No recovery.
59'1" - 64'2"	Sand, medium to coarse grain, slightly clayey, light gray-tan, trace phosphorite nodules in bottom.
64'2" - 65'6"	No recovery.
65'6" - 70'2"	Phosphatic sand, medium grain, slightly clayey, light gray-tan; 1 - 3 percent medium to coarse sand size black, tan, and cream phosphorite nodules; bottom contact sharp.
70'2" - 75'0"	Phosphatic sand, clayey to very clayey, very dark gray, contains abundant scattered beds, lenses, and patches of clay, very dark greenish-gray; sparse fine grain muscovite in both clay and sand; sandy material contains 4 - 6 percent fine grain to granule size black phosphorite nodules; bottom contact sharp.
75'0" - 77'0"	Clay, slightly sandy, slightly calcareous, tan with horizontal gray streaks; faint irregular bedding planes; top 3 inches moderately indurated; 2- 4 percent fine to coarse grained black phosphorite nodules; bottom contact gradational over 4 inches.
77'0" - 78'1"	Limestone, top 6 inches soft, friable below; sparsely sandy, clayey, light gray tan; 2 - 4 percent medium sand size to granule size black phosphorite nodules.

Sites 63 to 71

The geologic sections at sites 63 to 70 are not described in detail in this report. Sites 63 to 65 are described by Carr and Alverson (report in preparation) and detailed geologic sections near sites 66, 67, 68 and 71 are described by Altschuler and others (report in preparation). Sites 69 and 70 are limestone quarries in which Ocala limestone is overlain by a thin veneer of clay.