

E R R A T A

Florida Geological Survey
Report of Investigations No. 15
Geology and Ground-Water Resources of
Highlands County, Florida

- Page 8 - (9th line from bottom of page) occurring not accurring.
- Page 12 - (16th line from bottom of page) p. 233 not p. 223.
- Page 16 - (17th line) unconformably not uncomformably.
- Page 21 - (10th line from bottom of page) Discorinopsis not Dis-
corpinopsis.
- Page 25 - (5th line) 1,300 not 13,000.
- Page 25 - (16th line) unconformity not uncomformity.
- Page 26 - (23rd line) fig. 4 not fig. 4c.
- Page 27 - (12th line from bottom of page) p. 137-138 not p. 137-
318.
- Page 28 - (17th line) p. 77-79). not p. 138, 139).
- Page 38 - (18th line) 7.4 feet not 10.17 feet.
- Page 53 - There are two wells numbered 358. The first one should
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- Page 62 - Under remarks, the references to figures 7a and 7b
should be to figure 7.
- Page 75 - Under use, well 422, D not F.
- Page 79 - (18th line) formation not formations.
- Page 101 - Surface altitude at well 428 should be 80 ± 10 not $80+10$.
- Page 113 - (6th line from bottom of page) Moodys Branch (?) not
Ocala.
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STATE BOARD OF CONSERVATION

Ernest Mitts, Director

FLORIDA GEOLOGICAL SURVEY

Herman Gunter, Director

REPORT OF INVESTIGATIONS NO. 15

GEOLOGY AND GROUND-WATER RESOURCES
OF
HIGHLANDS COUNTY, FLORIDA

By
ERNEST W. BISHOP
U. S. GEOLOGICAL SURVEY
MIAMI, FLORIDA

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
FLORIDA GEOLOGICAL SURVEY

TALLAHASSEE
FLORIDA

1956

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Florida Geological Survey

August 6, 1956

Mr. Ernest Mitts, *Director*
Florida State Board of Conservation
Tallahassee, Florida

Dear Mr. Mitts:

I am transmitting a report entitled "GEOLOGY AND GROUND-WATER RESOURCES OF HIGHLANDS COUNTY, FLORIDA", prepared by Ernest W. Bishop, Geologist, formerly with the United States Geological Survey, but now employed by the Florida Geological Survey. This study presents the basic data necessary for the intelligent development of the water resources of Highlands County and also contributes considerably to our knowledge of the geology of the State.

This study, undertaken by the United States and Florida Geological Surveys, is being published as Report of Investigations No. 15.

Respectfully,

Herman Gunter, *Director*

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*The nomenclature and classification of this report accord with those of the U. S. Geological Survey except for the Moodys Branch formation, which has not been accepted for official use in Florida by the U. S. Geological Survey, and the Ocala limestone, which is here restricted by the separation of the Moodys Branch.	
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GEOLOGY AND GROUND-WATER RESOURCES OF HIGHLANDS COUNTY, FLORIDA

By

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U. S. Geological Survey
Miami, Florida

ABSTRACT

The area of Highlands County consists of rolling hills and flat marine-terrace plains. The climate is subtropical and the average annual rainfall is 52.22 inches. Citrus culture, winter-vegetable farming, and livestock raising are the principal occupations. Irrigation of citrus groves from lakes, streams, and wells is practiced extensively.

The rocks exposed in Highlands County are of Tertiary and Quaternary age. The county is almost completely mantled by marine deposits of Pleistocene age. The Hawthorn formation of early and middle Miocene age is the oldest outcropping formation and is exposed in clay pits on some of the highest hills. The county is underlain by 9,000 to 13,000 feet of sedimentary rocks ranging in age from Early Cretaceous to Recent.

Ground water is obtained from two major sources: (1) the Floridan aquifer, which consists of the Eocene and younger formations underlying the confining clays of the Hawthorn formation, and (2) the aquifers in the upper part of the Hawthorn and in overlying formations.

The Floridan aquifer, which is under artesian pressure, is recharged by rain that falls on the topographic high that is centered in northern Polk County and extends into western Highlands County. In Highlands County almost all large supplies of water (over 500 gpm) from the Floridan aquifer are obtained from the very permeable Lake City limestone of Eocene age. In the western part of the county water from the Floridan aquifer has a low mineral content, whereas in the southeastern part there are indications of contamination by trapped sea water. The Floridan aquifer furnishes water to many irrigation wells. Also, the towns of Sebring and Avon Park draw upon this aquifer for their municipal supplies.

The aquifers in the upper part of the Hawthorn and in younger formations are recharged principally by local rainfall, and they furnish water to most domestic and stock wells and to the town of DeSoto City. Large supplies of water are available in the coarse clastic deposits in the upper part of the Hawthorn formation in the western part of the

county. Part of the water in the Hawthorn and the Tamiami formations in that part of the county is under artesian pressure in the low areas. Water from the upper part of the Hawthorn and in younger formations has a great range in chemical composition, though it is uniformly more mineralized in the southeastern part of the county.

A discussion of the principal chemical constituents of ground water in relation to use and geologic occurrence of the water is based on analyses of 36 samples of ground water. The water analyzed ranges from excellent to satisfactory for most purposes.

The hydrologic and geologic data for this report were obtained in the field during the years 1950 and 1951. Records for 439 wells were obtained and some of these data were used to prepare a piezometric map. Geologic cross sections were prepared from a study of the surface and subsurface stratigraphy. The field data are included in this report.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

The investigation upon which this report is based was begun in March 1950 as part of a program of ground-water studies in Florida by the United States Geological Survey in cooperation with the Florida Geological Survey. Several similar areal investigations have been completed since this program was begun in 1930 and several are now being made in other parts of the State.

The principal purpose of the investigation has been to provide basic information necessary to the useful development of irrigation, industrial, municipal, stock, and domestic ground-water supplies.

The investigation was made under the general supervision of A. N. Sayre, Chief, Ground Water Branch, U. S. Geological Survey, and Dr. Herman Gunter, Director, Florida Geological Survey; immediate supervision was given by Nevin D. Hoy, District Geologist, U. S. Geological Survey, Miami. Julia Gardner and F. S. MacNeil of the U. S. Survey identified some of the fossil material collected during this investigation. Robert L. Taylor also of the Federal Survey, at Sebring, Fla., gave valuable assistance in many surface-water phases of the investigation.

LOCATION AND EXTENT OF THE AREA

Highlands County includes an area of about 1,090 square miles in the south-central part of the Florida Peninsula. Prior to 1921 the area considered in this report was part of DeSoto County which, in

turn, was created from Manatee County in 1887. Its location with respect to adjoining counties is shown in Figure 1.

PREVIOUS INVESTIGATIONS

A detailed study of the geology and ground-water resources of Highlands County has not been undertaken previously. However, other studies have been made that have a bearing on the county, and the most important of these are listed below. Specific references are made at appropriate places in the text to publications that are listed at the end of this report.

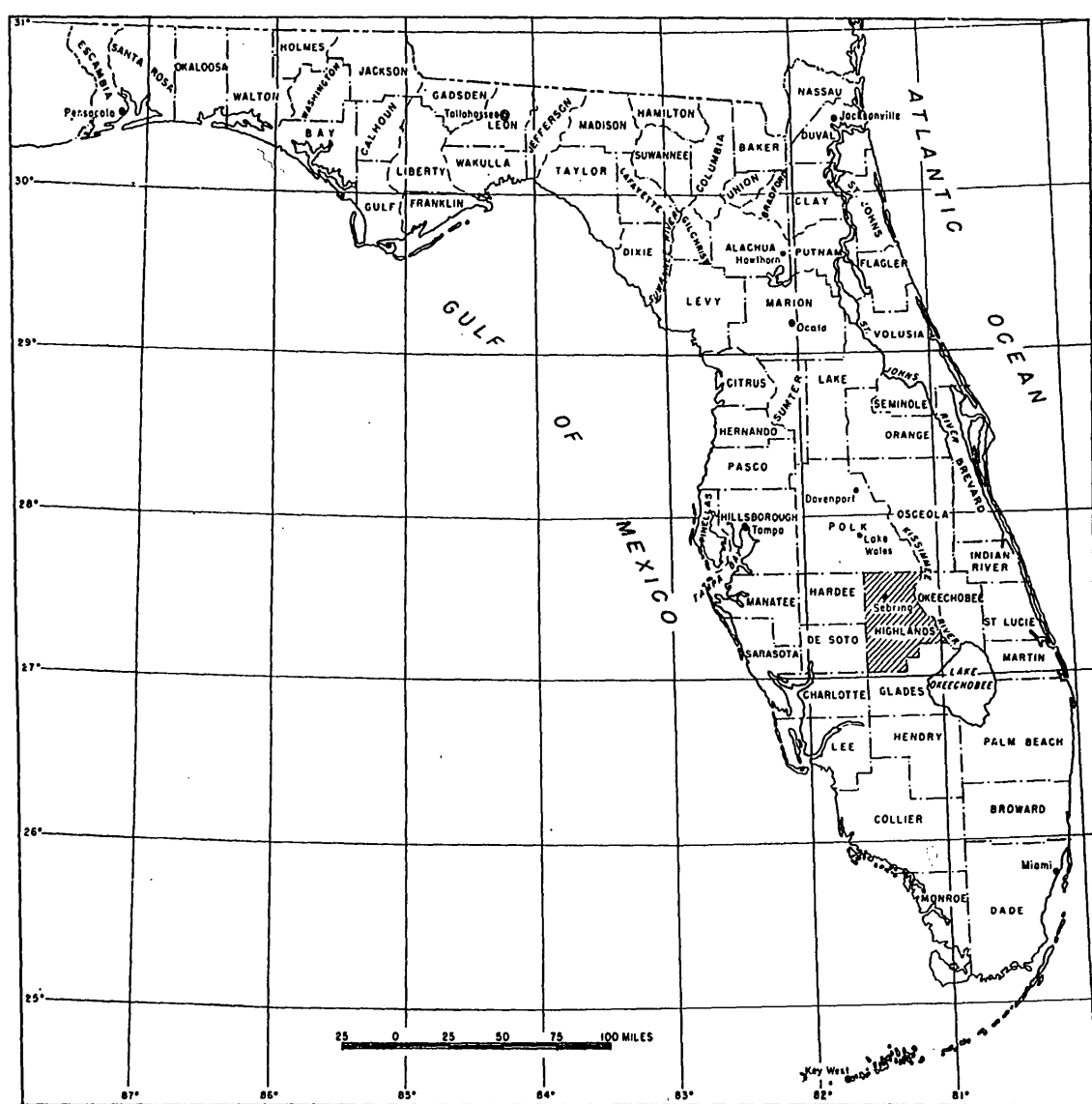


FIGURE 1.—Map of Florida showing area of investigation.

An early report by Matson and Sanford (1913, p. 294-296) contains information on Highlands County (then part of DeSoto County). A report on the chemical character of Florida's water, by Collins and Howard (1928, p. 216-217), contains analyses of water from

Sebring and Avon Park. A report on the geology of Florida by Cooke and Mossom (1929, p. 150, 181, 191) contains references to the geology of the county. An important paper on artesian water in peninsular Florida, by Stringfield, was published in 1936. The phosphate reserves of the county are discussed in a report by Mansfield (1942, p. 35, 69, pl. 5). Davis (1943, p. 40-58, fig. 1) described and mapped 10 physiographic regions of southern Florida, 4 of which extend into Highlands County. He also described (1946, p. 129-132) the peat deposits of the Lake Istokpoga area. Parker and Cooke (1944, pl. 3) mapped the Pleistocene marine terraces of southern Florida. Cooke's "Geology of Florida" (1945, p. 208, 233, 290, and pl. 1) mentions formations in Highlands County. Gunter (1948, fig. 1, p. 40-41) gives information on oil-exploratory wells in the county. A report on Pleistocene shorelines by MacNeil (1949, p. 98, 101, pl. 19), contains references to the county.

ACKNOWLEDGMENTS

Appreciation is extended to the many residents of the county who readily gave information regarding their wells. Special acknowledgment is given to the owners and drillers of the following well-drilling companies in Florida, whose cooperation facilitated the preparation of this report: C. M. Beels & Son, Arcadia; C. P. Cannon & Sons, Palmetto; Layne-Atlantic, Orlando; Curtis Dansby, Auburndale; E. W. "George" Dansby, Wauchula; Libby and Freeman, Orlando; E. W. Kelsey (deceased), Lake Placid; May Brothers Co., Tampa; Meredith Bros., Orlando; M. M. Martin, Okeechobee; and Kenneth Turley, Lake Placid. Gratitude is expressed to John W. Griffin, State Archaeologist, for his interest and aid in preparing the section on Indian occupation. Dr. Herman Gunter, Director of the Florida Geological Survey, and Dr. Robert O. Vernon, Assistant Director, were especially helpful in furnishing many valuable data regarding the geology of the area.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

Highlands County lies in the Atlantic Coastal Plain physiographic ground-water province (Meinzer, 1923a, pls. XXVIII, XXXI) and is subdivided into four physiographic regions (after Davis, 1943, p. 45-51, fig. 1): (1) the Western Flatlands, (2) the Highlands Ridge, (3) the Istokpoga-Indian Prairie Basin, and (4) the Eastern Flatlands (see fig. 2). The Western Flatlands are a part of Cooke's (1939,

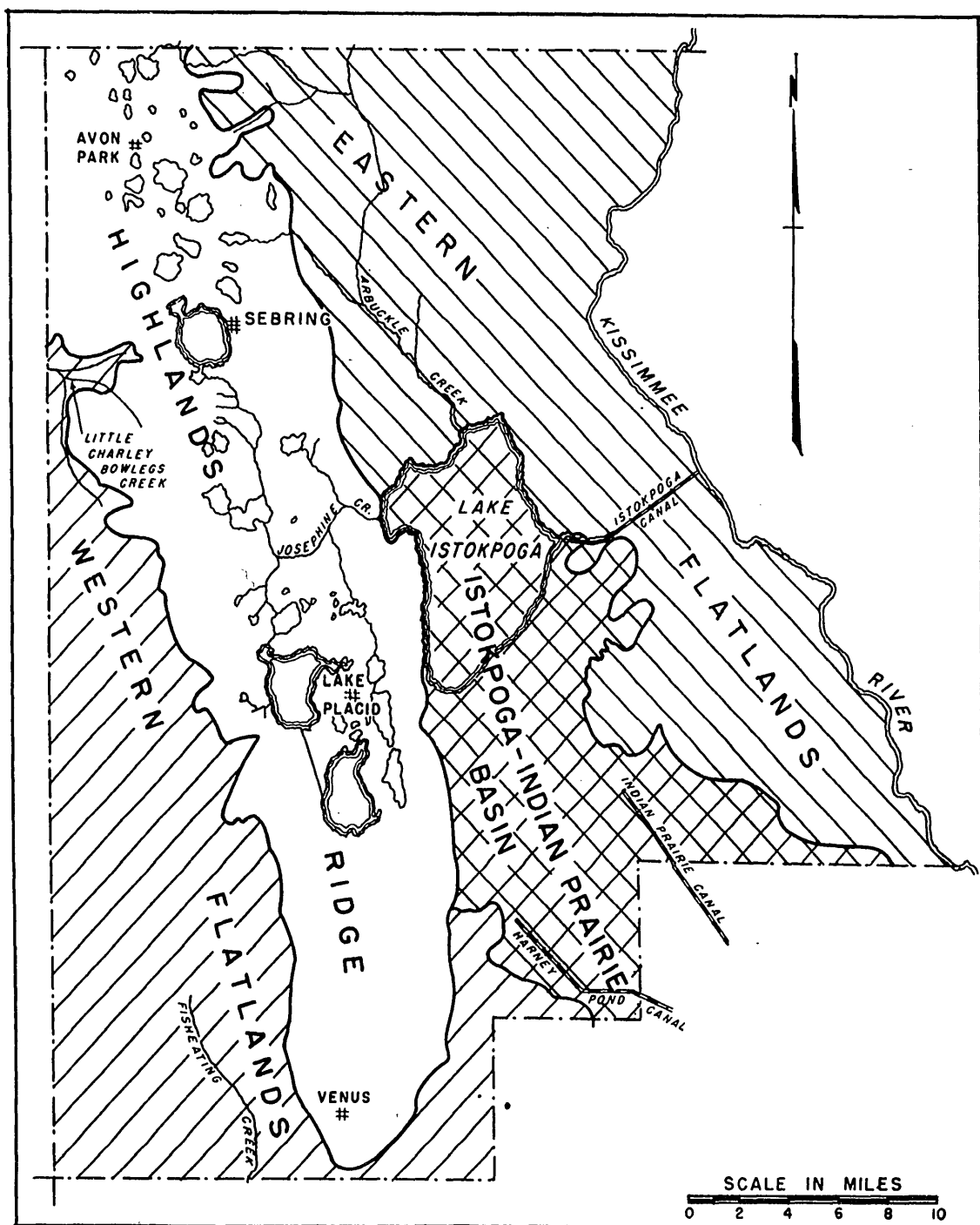


FIGURE 2. — Map of Highlands County showing physiographic regions.

p. 15-16) Coastal Lowlands unit and Vernon's (1951, p. 16) Terraced Coastal Lowland. The Highlands Ridge province is the southern end of the central Highlands of Cooke (1939, p. 21-23) and Vernon's (1951, p. 16) Delta Plains Highlands in peninsular Florida.

The Western Flatlands, the Istokpoga-Indian Prairie Basin, and the Eastern Flatlands are similar in that they are relatively flat and poorly drained, whereas the Highlands Ridge is an area of rolling hills separated from the other regions by steep escarpments. The Highlands

Ridge, being surrounded by low areas, has the appearance of an island or a peninsula.

WESTERN FLATLANDS

The Western Flatlands region includes the area of flat marine-terrace plains in the extreme southern and southwestern parts of the county. It slopes gently from an elevation of about 90 feet in the northern part to about 40 feet in the southern part. The area is a flat, monotonous, almost treeless plain containing many shallow depressions, which are filled with water during the rainy season. It contains two streams: Little Charley Bowlegs Creek in the northern part, and Fisheating Creek in the southern part. These streams, while having fairly well defined channels, have not cut back into the terraced plains far enough to drain the numerous ponds and marshes.

HIGHLANDS RIDGE

The Highlands Ridge region includes the narrow, elongated area of rolling uplands that extends from the northwestern part of the county south-southeastward almost to the Glades-Highlands County line. This region ranges in elevation from about 40 feet to more than 200 feet and contains numerous hills and lakes. The hills are of two types: those formed by differential erosion of the Miocene land surface and now mantled by sands of Pleistocene age; and in the eastern part of the area, coastal bars formed during the Pleistocene.

Most of the lakes in the Highlands Ridge region are fairly deep and either are circular or have outlines that resemble two or more intersecting circles. It is believed that these lakes were created as a result of local subsidence due to collapse of subterranean limestone caverns. A few small ponds exist during periods of heavy rainfall in some of the swales between the coastal bars.

The Highlands Ridge area north of Sebring is drained by tributaries of Arbuckle Creek, and that south of Sebring by Josephine Creek and its tributaries. Many of the lakes in this area are in closed depressions and have no surface outlets.

ISTOKPOGA-INDIAN PRAIRIE BASIN

The Istokpoga-Indian Prairie Basin covers the flat, very poorly drained area of swamps and marshes in the southeastern part of the county between the Highlands Ridge on the west and the Eastern Flatlands. Elevations of the land-surface area range from about 25 to 40 feet. Lake Istokpoga, which is at the head of the basin, occupies

an area of about 44 square miles and has a maximum depth of about 10 feet. The natural drainage of the lake is south through the Indian Prairie Basin, but the construction of dikes and canals has now diverted a large portion of the drainage through the Istokpoga Canal into the Kissimmee River. The Indian Prairie and Harney Pond canals have been dug to drain the area south of the lake. Prior to the construction of canals the surface water was not confined to any definite channel but moved by sheet flow south toward Lake Okeechobee.

EASTERN FLATLANDS

The Eastern Flatlands region comprises the flat areas in the eastern and north-central parts of the county and is bounded on the northwest by the Highlands Ridge and on the southwest by the Istokpoga-Indian Prairie Basin. It extends into adjoining counties on the north, east and south. This area, in general, is better drained than either the Western Flatlands or the Istokpoga-Indian Prairie Basin, although locally it contains ponds and marshes. The streams draining the region are the Kissimmee River and Arbuckle Creek. Land-surface elevations in this area range from about 30 to 100 feet, although a long, narrow north-south ridge between Arbuckle Creek and the Kissimmee River has a maximum elevation of 146 feet.

POPULATION AND DEVELOPMENT

According to the 1950 census, Highlands County has a population of 13,636, which represents an increase of about 46 percent since 1940. Sebring, the county seat and largest town, has a population of 5,006 and Avon Park 4,612. The towns of Lake Placid and DeSoto City have populations of 417 and 220, respectively.

Agriculture is the dominant economic activity in Highlands County, chief agricultural products being citrus fruits, cattle, and winter vegetables. According to V. T. Oser, County Agricultural Agent, there are more than 20,000 acres of bearing citrus trees and between 65,000 and 75,000 head of cattle on about 500,000 acres of pastureland. In addition to the citrus fruits the county produces mangoes, avocados, pineapples, bananas, and other tropical and semitropical fruits. The leading winter truck crops are tomatoes, green beans, green peas, and cabbage. Strawberries, blackberries, grapes, corn, Irish potatoes, sweet potatoes, sugar cane, and forage crops also are grown.

The only other economic activity of great importance is the tourist industry, which is estimated to increase the population of the towns in Highlands County as much as 15 percent during the winter months.

The Highlands Ridge region contains most of the population of the county and is the center of the tourist industry. Citrus and tropical fruits are the chief agricultural products of this region.

The Eastern Flatlands region is sparsely populated but contains a population second to that of the Highlands Ridge. Almost the entire region is devoted to cattle raising.

The Western Flatlands region is very sparsely populated and the agricultural effort is devoted entirely to the raising of cattle.

The Istokpoga-Indian Prairie Basin also is very sparsely populated. The area of deep peat just south of the lake is devoted to truck crops and lily bulbs, with cattle being raised in much of the basin.

TRANSPORTATION

Highlands County is served by two railroad lines: the Seaboard Air Line Railroad, passing through Avon Park, Sebring, Lorida, and Fort Bassinger, and the Atlantic Coast Line, passing through Avon Park, Sebring, DeSoto City, Lake Placid, and Venus.

State and national highways cross the county from north to south and east to west. U. S. Highway 27, passing through Avon Park, Sebring, and Lake Placid is one of the principal north-south routes in the central part of the State, connects Miami with cities to the north, and affords relief from the congested coastal routes. State Highway 70 is the principal east-west route and connects Highlands County with cities on the Atlantic and Gulf coasts. The county also has many roads of minor importance ranging from well-paved roads to sandy trails cut through the palmettos.

CLIMATE

The climate of Highlands County is subtropical, with seasonal rainfall and abundant sunshine. The mean temperature at Avon Park is 73.1°F. The maximum and minimum mean monthly temperatures are 82.0° and 63.2°F., occurring in August and January, respectively.

Rainfall has been recorded by the United States Weather Bureau at stations near Avon Park almost continuously since 1892. The normal annual rainfall at Avon Park is 52.22 inches, of which 75 percent falls in the months of May through October. Deviations from the mean, however, are frequent and extreme, (see fig. 3). The recorded annual rainfall at Avon Park ranged from a minimum of 35.88 inches in 1927 to a maximum of 75.20 inches in 1930. The distribution of the normal rainfall by months at Avon Park is given in table 1.

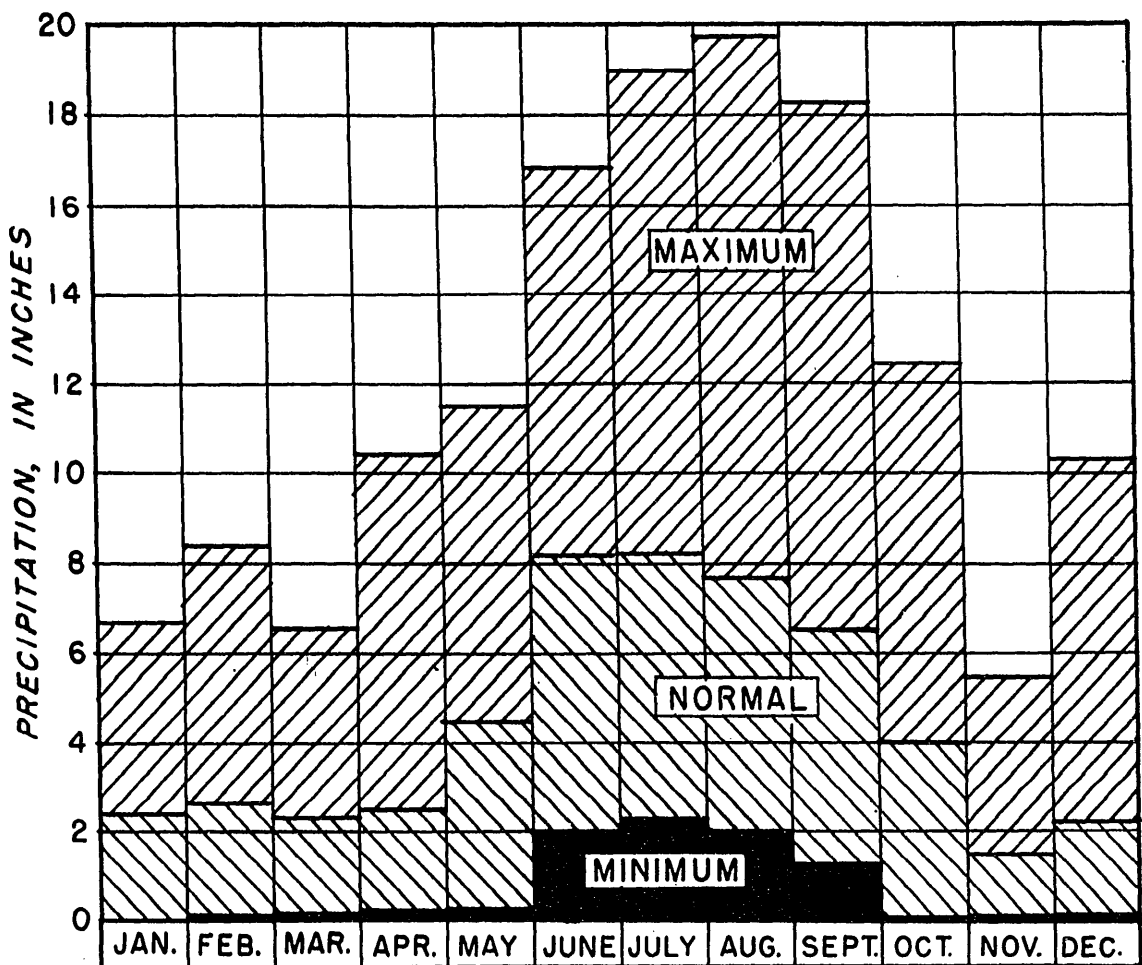


FIGURE 3. — Monthly distribution of rainfall at Avon Park for 53-year period of record through 1950.

Table 1. — AVERAGE MONTHLY RAINFALL AT AVON PARK FOR 53-YEAR PERIOD OF RECORD THROUGH 1950

Month	Rainfall (inches)	Month	Rainfall (inches)
January	2.22	July	8.18
February	2.43	August	7.83
March	2.17	September	6.67
April	2.37	October	4.04
May	4.52	November	1.56
June	8.13	December	2.10

During the summer months, rain usually occurs in Highlands County in squalls that cover a small area with an intense downpour; therefore, rainfall records are valid only in the immediate vicinity of a given gage. An extreme example of this is shown by the amount of rainfall measured at two stations, one at Avon Park and the other at Venus, in the year 1946. The amount of rainfall at the Avon Park station was 50.70 inches, while that at Venus, about 35 miles to the south, was only 29.65 inches.

MINERAL RESOURCES

Although a large part of Highlands County is underlain by deposits of pebble phosphorite in the Hawthorn formation, most of these deposits are probably too deep and poor to be mined economically.

The Hawthorn formation contains sandy clay which is used as road-surfacing material and has been mined from small pits in the vicinity of Avon Park and DeSoto City, south of Highlands Hammock, and at Childs. Large amounts of the material are still available from beneath a thin overburden in the Avon Park area, but it is not now being mined because the land is more valuable for citrus culture.

The minerals ilmenite, zircon, and rutile are commonly present in the terrace sands of the Highlands Ridge region. The writer has noted concentrations of these minerals in the beach sands of many lakes in the ridge section. It is possible that economic deposits of these minerals may be present in Highlands County, especially along Pleistocene strand lines, but their discovery will undoubtedly entail extensive prospecting.

INDIAN OCCUPATION

During the field work for this report, artifacts and faunal remains were collected from the surface of an aboriginal midden deposit in Highlands County and sent to John W. Griffin, State Archaeologist, for determination. Concerning this collection and summarizing the archaeology of the county, Mr. Griffin (in a personal communication to the writer May 28, 1951) states:

"Very little is known of the archaeology of this county, and although there are doubtless many sites, only nine, including the present one, are listed in the files of the Department of Sociology and Anthropology of the University of Florida, and the Archaeological Survey of the Florida Park Service. The only excavations made under modern controlled methods are those of the Florida Park Service at the Goodnow Mound and Skipper site on Lake Josephine.¹

"So far as cultural sequence is concerned the area is largely a blank. Prehistoric and historic burial sites can be separated on the basis of the presence or absence of European trade materials, but the dominance of a single undecorated pottery type over a long period of time hinders further subdivision. More intensive work will doubtless reveal sites containing trade pottery from other portions of Florida which can be placed in a time sequence.

¹ Griffin, John W., and Smith, Hale G., *The Goodnow Mound, Highlands County, Fla.: Contributions to the Archaeology of Florida*, no. 1, Tallahassee, 1948.

"The site discovered by the U. S. Geological Survey, which we may call the Hen Scratch Midden, is in the northwest corner NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 35, T. 36 S., R. 28 E. The site, consisting of gray, carbonaceous sand containing pottery and midden refuse, is from one to three feet thick, lying under much, if not all, of a ten-acre hammock in the midst of a drained marsh or prairie.

"The following mammal bones were present in the deposit: portions of deer jaws (*Odocoileus virginianus*), the upper cheek teeth of a rabbit (*Sylvilagus*), the lower jaw of a round-tailed muskrat (*Neofiber alleni*), and the lower jaw of a raccoon (*Procyon lotor*).² Dr. Sherman notes that the larger deer teeth are about the size of *O. v. virginianus*, while one of the jaws is smaller than usual for this subspecies. Amphibian and reptile remains included a vertebra of a salamander (*Siren*), 2 vertebrae of unidentified snakes, and a number of unidentified turtle bones.³

"Mollusca included only fresh water and land forms, except for two marine species which had been worked into artifacts as described below. *Pomacea paludosa* is readily identified, but lacking adequate comparative collections the most common fresh water species at the site, one univalve and the other bivalve, have not been identified. The land snail *Euglandina rosea*, common in many Florida sites, was represented in the collection.

"The only non-ceramic artifacts consist of fragments of two marine shells. One of these, a *Busycon perversum*, is a portion of a shell pick, with the beak ground down, but the whorl is too broken to permit identification of the type of hafting. The other specimen is a portion of a *Fasciolaria gigantes* with some evidence of smoothing at the margin of the orifice, but it is too fragmentary to permit identification of artifact type.

"Ceramics consist of 96 potsherds, 93 of which are Belle Glade Plain.⁴ One sherd is a probable Belle Glade Plain piece which once had an added rim strip. There are also 2 rather nondescript gritty plain sherds. Twenty of the Belle Glade sherds are rim sherds, and 16 of these have a flat inward cambered lip so characteristic of the type. Of the remaining rim sherds, 3 have rounded lips and one has a flat lip slightly rounded. Five of the Belle Glade Plain sherds possess so-called 'lacing' or 'patch' holes.

² Identifications by Dr. H. B. Sherman, Department of Biology, University of Florida, Gainesville.

³ Examined by Dr. Coleman Goin, Department of Biology, University of Florida.

⁴ Belle Glade Plain is defined by Gordon R. Willey, in 'Excavations in Southeast Florida,' Yale University Publications in Anthropology, no. 42, p. 25-26, New Haven, 1949.

"It is, unfortunately, impossible to date this site within close limits. The pottery type Belle Glade Plain is characteristic of the Okeechobee-Kissimmee area over a considerable period of time, usually estimated to extend from about the first into the seventeenth century. The present evidence does not permit us to narrow this range further.

"The small collection gives us indications of both the hunting and the collecting of a shell-fish as sources for food. Most of the bones and shells found in the deposit are probably food refuse, although some may have become naturally included. The two marine shell artifacts indicate trade with the sea coast."

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

SUMMARY OF STRATIGRAPHY

The rocks exposed in Highlands County are of Miocene, Pleistocene, and Recent ages. The oldest outcropping formation is the Hawthorn of early and middle Miocene age, which is exposed in clay pits on the Highlands Ridge. The Tamiami formation of late Miocene age wedges out against the eastern flank of the Highlands Ridge and is completely covered by Pleistocene deposits. The formations of Pleistocene age mantle the entire county and are overlain locally by Recent deposits of dune sand, peat, and alluvium.

The writer did not find or recognize any deposits of Pliocene age in Highlands County. The Citronelle formation, as identified by Cooke (1945, p. 223) in Highlands County, tentatively is included in the Hawthorn formation. The Caloosahatchee marl was extended from its outcrop area in Glades County by Cooke (1945, pl. 1) on the premise that it merged with the Citronelle formation of Highlands County, supposedly a near-shore or beach deposit of the same sea in which the shell marl of the Caloosahatchee accumulated. Cooke did not list any exposures of the Caloosahatchee in Highlands County nor did the author find any exposures or any suggestion of the formation in well cuttings. It is possible that deposits of the Caloosahatchee marl underlie parts of the Western Flatlands, the Istokpoga-Indian Prairie Basin, and the Eastern Flatlands.

Cooke (1945, p. 208) extended the Bone Valley formation into the northeastern part of the county on the basis of the occurrence of the pebble phosphorite reported by Mansfield (1942, p. 6-7, pl. 5). The writer has examined cuttings from several wells scattered throughout the part of the county mapped as Bone Valley by Cooke, and

has found phosphorite pebbles in some, but he has failed to find any material that could definitely be referred to the Bone Valley. The phosphorite pebbles were in sediments lithologically similar to those that have been referred to the Hawthorn formation in other parts of the peninsula.

Information derived from the logs of water wells and deep oil-test wells shows that the area is underlain by 9,000 to 13,000 feet of relatively flat lying sedimentary rocks overlying rocks of volcanic origin. The pre-Miocene sedimentary deposits in the county record shallow-water, offshore marine environments, with the shoreline far to the north. Clastic materials were deposited for the first time during Miocene time. At the close of the middle Miocene a finger of a large delta extended south across the western part of the county. The advances of the sea during late Miocene and Pleistocene times deposited near-shore material and modified the middle Miocene land surface. The withdrawal of the Pleistocene seas ended large-scale deposition in the county.

The nature of the geologic formations and the character of the contained ground-water supplies in Highlands County are described briefly in the generalized section (table 2) and in more detail in the following pages of this report.

PRE-TERTIARY ROCKS

Evidence as to the age and lithology of the older rocks underlying Highlands County is afforded by a deep oil-test well, the Carlton no. 1, drilled by Humble Oil & Refining Co., about 5 miles northwest of Venus in the center of the SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 38 S., R. 29 E., to a depth of 12,985 feet. According to Applin (1951), this well entered pre-Mesozoic rocks at 12,618 feet and penetrated 367 feet of basalt, rhyolite porphyry, and related volcanic rocks which he tentatively classified as early Paleozoic or possibly pre-Cambrian.

The surface of the Pre-Mesozoic rocks range from about 9,000 feet below sea level at Avon Park to about 13,000 feet below sea level at Venus (Applin, 1951, fig. 2), and is overlain unconformably by rocks of Cretaceous age.

Cretaceous rocks were penetrated in the Carlton well between the depths of 5,096 and 12,618 feet. The upper 2,500 feet of these rocks, which consists primarily of limestone and some dolomite, has been referred to the Gulf series. The remainder of the section, which consists of limestone, anhydrite, and some dolomite overlying basal sand, has been referred to the Comanche series. The presence of anhydrite in the

Table 2. — GEOLOGIC FORMATIONS OF THE TERTIARY AND QUARTERNARY SYSTEMS IN HIGHLANDS COUNTY

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Series	Formation	Thickness (feet)	Physical character	Water supply
Recent		0-20	Dune sand, peat, and alluvium.	Not used as a source of water.
Pleistocene	Undifferen- tiated deposits	1-100	Gray-orange to white medium to coarse quartz sand in high areas of the county; fine to medium clayey, calcareous quartz sand in the low areas.	Furnishes domestic and stock supplies locally throughout the county.
Miocene	Tamiami formation	0-100	Dark-blue to white clayey, sandy shell marl; quartz sand and sandy clay.	A source of domestic and stock supplies in the eastern part of the county.
	Hawthorn formation	300-650	Dark-green to white montmorillonitic clay; white to cream dense sandy phosphatic limestone; fine to pebble-size quartz sand and phosphorite; white to red kaolinitic sand.	The deltaic part of the formation is a very important source of large supplies of water locally in the Ridge section. The marine part of the formation furnishes small to medium supplies of water from thin beds of limestone and sand.
Oligocene	Suwannee limestone	0-80	Cream-colored soft chalky, slightly crystalline, porous limestone.	Not an important source of large supplies of water; permeable.
Eocene	Ocala limestone	150-250	Light-gray to cream-colored soft, chalky foraminiferal limestone.	Not an important source of large supplies of water except in the southeastern part of the county; permeable.
	Moodys Branch formation	50-150	Cream to tan-gray granular to chalky foraminiferal limestone.	Not an important source of large supplies of water; permeable.
	Avon Park limestone	200-350	Light-gray to light-brown soft to hard granular to chalky, slightly porous limestone, with secondary calcite and some dolomitic limestone.	Not an important source of large supplies of water; permeable.
	Lake City limestone	400±	Brown hard crystalline dolomite and cream-colored permeable limestone and dolomitic limestone.	A very important source of large supplies of water throughout the county; highly permeable.
	Oldsmar limestone	670±	Fragmental limestone, partly to completely dolomitized.	Little is known about the water supply of this formation.
Paleocene	Cedar Keys limestone	1,670±	White to cream fragmental limestone and some gypsum.	No wells in the county are known to obtain water from this formation.

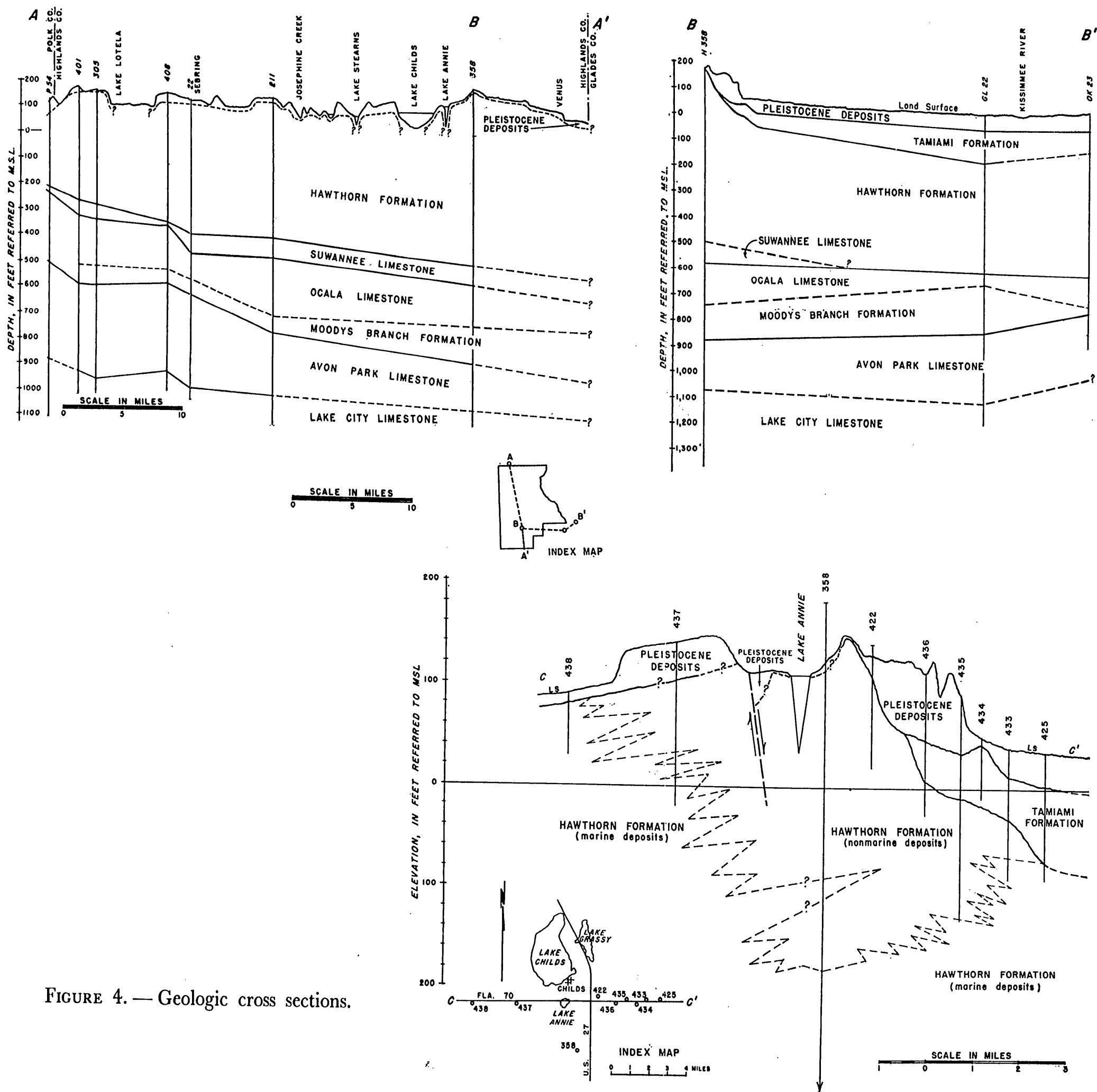


FIGURE 4. — Geologic cross sections.

Comanche series indicates restricted areas of supersaline seas and evaporite conditions, and according to the principles discussed by Ver Wiebe (1950, p. 145-146), it suggests the possibility that great reefs which are potential oil reservoirs may have been formed in this part of the United States during Cretaceous time.

TERTIARY SYSTEM

Paleocene Series

CEDAR KEYS LIMESTONE

Name. — The name Cedar Keys limestone, taken from the town of Cedar Keys, Levy County, was proposed by Cole (1944, p. 27-28) for limestones known only "in wells in peninsular and northern Florida from the first appearance of the *Borelis* fauna to the top of the Upper Cretaceous."

Lithology. — Vernon (1951, p. 85) states: "The Paleocene of peninsular Florida is white, cream and gray, pasty to fragmental limestones, which have rare lenses of oolitic limestone. The porosity of the rock is impregnated by gypsum, giving it a speckled appearance."

Distribution and stratigraphic relations. — Cooke (1945, p. 33) states: "The Cedar Keys limestone probably underlies all of Florida except the northwestern part, where the equivalent formation is the Porters Creek clay." Concerning the stratigraphic relations of the Cedar Keys, Vernon (p. 85) states: "It lies below a definite Salt Mountain fauna of lower Eocene, Wilcox age, and conformably upon transitional Upper Cretaceous beds. It thus occupies the interval represented elsewhere by the beds of Midway age."

Thickness. — The thickness of the Cedar Keys limestone in Highlands County is not known, but Applin and Applin (1944, p. 1704, 1707) report a total thickness of 1,670 feet in Pioneer Oil Co.'s no. 1 Hecksher-Yarnell well in sec. 28, T. 30 S., R. 25 E., Polk County.

Paleogeography. — According to Cooke (1945, p. 33-34): "The Cedar Keys limestone was deposited in the open ocean. The shoreline extended across Alabama and Georgia, circling northwestward up the Mississippi Embayment, in and near which the Porters Creek clay was deposited contemporaneously."

Paleontology. — Applin and Jordan (1945, p. 131) consider the following Foraminifera diagnostic of the formation:

Borelis floridanus Cole

Borelis gunteri Cole

Cribospirina? bushnellensis Applin and Jordan

Planispirina? kissengenensis Applin and Jordan

Valvulammina nassauensis Applin and Jordan

Water Supply. — No water wells are known to obtain their supplies from this formation in Highlands County.

Eocene Series

OLDSMAR LIMESTONE

Name. — The name Oldsmar limestone is applied by Applin and Applin (1944, p. 1702) to limestone of Wilcox age penetrated between depths of 2,165 and 3,090 feet in R. V. Hill's "Oldsmar well" (sec. 18, T. 38 S., R. 17 E.) in Hillsborough County.

Lithology. — Concerning the Oldsmar limestone, Vernon (1951, p. 87) states: "It is composed essentially of fragmental marine limestones, partially to completely dolomitized and containing irregular and rare lenses of chert, impregnations of gypsum and thin shale beds."

Distribution and stratigraphic relations. — According to Cooke (1945, p. 40), the Oldsmar limestone underlies the peninsula, the northeastern part of Florida, and the southeastern part of Georgia, probably rests unconformably on formations of the Midway group, and is overlain unconformably by formations of the Claiborne group.

Thickness. — The thickness of the Oldsmar limestone in Highlands County is not known. Applin and Applin (1944, p. 1702) report a total thickness of 670 feet in the no. 1 Hecksher-Yarnell well in Polk County.

Paleogeography. — The Oldsmar limestone was deposited in an open sea. According to Cooke (1945, p. 41), the boundary between the area of clastic and nonclastic deposition shifted back and forth several times across northwestern Florida and southern Alabama.

Paleontology. — The fauna of the Oldsmar consists for the most part of Foraminifera, of which the following are considered by Applin and Jordan (1945, p. 131) to be diagnostic of the formation:

Clavulina floridana Cole
Coskinolina elongata Cole
Helicostegina gyralis Barker and Grimsdale
Lituonella elegans Cole
Lockhartia cushmani Applin and Jordan
Miscellanea nassauensis Applin and Jordan
M. nassauensis var. *reticulosus* Applin and Jordan
Pseudophragmina (Proporocyclina) cedarkeysensis Cole

Water supply. — Little is known about the water supply of this formation in Highlands County.

LAKE CITY LIMESTONE

Name. — The name Lake City limestone is applied by Applin and Applin (1944, p. 1697) to limestone of Claiborne age penetrated be-

tween depths of 492 and 1,010 feet in a city well at Lake City, Columbia County.

Lithology. — The Lake City limestone, in Highlands County, consists of layers of hard, brown, porous, crystalline dolomite and hard, tan to cream, porous limestone and dolomitic limestone.

Distribution and stratigraphic relations. — The Lake City limestone underlies the entire Florida Peninsula and probably rests unconformably on the Oldsmar limestone. It is possible that some of the beds referred to the Lake City in this report belong to the Oldsmar, but because of the lack of diagnostic fossils they cannot be placed in that formation with certainty. In Highlands County the Lake City limestone is conformably overlain by the Avon Park limestone, which also is of Claiborne age. In Highlands County the Lake City limestone apparently has an east-west strike and dips south an average of about 5 feet per mile, the top of the formation ranging from about 900 feet below sea level in the northern part of the county to about 1,100 feet below sea level in the southern part.

Thickness. — According to Cooke (1945, p. 46), the Lake City limestone ranges in thickness from 400 to 500 feet in the northern part of Florida, and from 200 to 250 feet in the southern part of the peninsula.

Paleogeography. — Cuttings from the Lake City limestone in Highlands County indicate that it was an offshore deposit which received very little clastic sediment. Applin and Applin (1944, p. 1696) have recognized a clastic facies in northwestern Florida that is probably equivalent to the Lake City limestone. According to Cooke (1945, p. 46), the shoreline, during the time that the Lake City was being deposited, extended across the southern part of Alabama and northeast across central Georgia, the northwestern part of Florida being nearest the land.

Paleontology. — Foraminifera make up the large percentage of fauna in the Lake City limestone. Applin and Jordan (1945, p. 131) consider the following to be diagnostic of the formation:

Amphistegina lopeztrigoi D. K. Palmer
Amphistegina nassauensis Applin and Jordan
Archaias columbiensis Applin and Jordan
Asterigerina cedarkeysensis Cole
Dictyoconus americanus (Cushman)
Discocyclus (Asterocyclus) monticellensis Cole and Ponton
Discorbis inornatus Cole
Eodictyoconus cubensis (Cushman and Bermudez)
Epistomaria semimarginata (d'Orbigny)
Eponides gunteri Cole
Fabularia gunteri Applin and Jordan

Fabularia vaughani Cole and Ponton
Gunteria floridana Cushman and Ponton
Lepidocyclina (Polylepidina) antillea Cushman
Lepidocyclina (Pliolepidina) cedarkeysensis Cole
Linderina floridensis Cole
Lockhartia cushmani Applin and Jordan
Operculinoides jennyi Barker

Water supply.—The Lake City limestone, because of its high permeability, is a highly productive aquifer in Highlands County and is utilized to a large extent wherever large quantities (500 to 1,500 gallons per minute) of ground water are needed for municipal and irrigation supplies.

The permeability of the formation compared with the overlying formations in the Floridan aquifer is indicated by pumping tests made by Briley & Wild, consulting engineers of Daytona Beach, during the drilling of well 403 (see table 3). This table shows that 85 feet of additional penetration into the Lake City limestone, after 915 feet of the Floridan aquifer had been penetrated, increased the yield at a drawdown of 25 feet from 463 to 636 gallons per minute.

Water from the Lake City limestone ranges from soft to hard, the hardness increasing toward the southern end of the county. Locally there is an excessive amount of iron, more than 0.3 part per million, some of which may be from the well casings, but in general the water is satisfactory (see table 9).

Table 3. -- YIELD, DRAWDOWN, AND SPECIFIC CAPACITY OF WELL 403
 AT 1,216 AND 1,301 FEET BELOW LAND SURFACE

Depth (ft.)	Yield (gpm)	Drawdown (ft.) ¹	Specific capacity ²	Remarks
1,216	145	7	20.7	915 feet of open hole in the Floridan aquifer; 90 feet of the Lake City limestone penetrated.
1,216	205	10	20.5	
1,216	243	12	20.2	
1,216	463	25	18.5	
1,216	633	36	17.6	
1,301	175	4	43.7	1,000 feet of open hole in the Floridan aquifer; 175 feet of the Lake City limestone penetrated.
1,301	200	5	40.0	
1,301	292	8	36.5	
1,301	408	13	31.4	
1,301	508	17	29.9	
1,301	609	23	26.5	
1,301	636	25	25.4	
1,301	818	35	23.4	

¹ Pumping time not recorded.

² The specific capacity of a well is the yield in gallons per minute per foot of drawdown.

AVON PARK LIMESTONE

Name. -- The name Avon Park limestone is applied by Applin and Applin (1944, p. 1680) to limestone of Claiborne age penetrated be-

tween depths of 600 and 930 feet in a well drilled at the Avon Park Bombing Range (sec. 31, T. 32 S., R. 30 E.) in Polk County.

Lithology. — The Avon Park limestone, in Highlands County, consists of layers of light-gray to light-brown, soft to hard, slightly porous, granular to chalky limestone with considerable secondary calcite and some dolomitic limestone.

Distribution and stratigraphic relations. — The Avon Park limestone underlies most of the Florida Peninsula and rests conformably on the Lake City limestone. In Highlands County the Avon Park limestone is unconformably overlain by the basal member of the Moodys Branch formation of Jackson age.

Thickness and structure. — The Avon Park limestone, in Highlands County, ranges in thickness from about 200 to 350 feet, the top of the formation ranging from about 500 feet below sea level in the northern part of the county to about 900 feet below sea level in the southern part. The Avon Park strikes east-west and dips south an average of about 10 feet per mile.

Paleogeography. — The Avon Park limestone was deposited in the open sea and received very little clastic sediment. According to Cooke (1945, p. 51, 52) the entire Florida plateau was probably submerged, but the position of the shoreline is unknown.

Paleontology. — The most distinctive fossil in the Avon Park in this area is the small echinoid *Peronella dalli* (Twitchell), which is very common in the upper part of the formation. Cuttings from this zone in some of the wells consist almost entirely of calcitic fragments or whole specimens of this species. The foraminiferal fauna of the Avon Park is also very abundant and distinctive. Applin and Jordan (1945, p. 130, 131) list the following Foraminifera as diagnostic:

Coskinolina floridana Cole
Cribrbulimina cushmani Applin and Jordan
Cyclamina watersi Applin and Jordan
Dictyoconus cookei (Moberg)
Discorinopsis gunteri Cole
Flintina avonparkensis Applin and Jordan
Lituonella floridana Cole
Rotalia avonparkensis Applin and Jordan
Spirolina coryensis Cole
Textularia coryensis Cole
Valvulamina minuta Applin and Jordan
Valvulina avonparkensis Applin and Jordan
Valvulina intermedia Applin and Jordan
Valvulina martii Cushman and Bermudez

Water supply. — The Avon Park limestone is not an important source of large water supplies in Highlands County, but it is utilized

locally in the area around the town of Avon Park. In other parts of the county it contributes some water to wells that penetrate the underlying Lake City limestone.

MOODYS BRANCH FORMATION*

Name. — The Moodys Branch formation was named for exposures of Jackson age along Moodys Branch of the Pearl River in the city of Jackson, Miss. The name Moodys Branch was first used in connection with deposits of Jackson age in Mississippi by Otto Meyer (1885, p. 435). E. N. Lowe (1915, p. 80) described Moodys Branch green marls as a formation of the Jackson group and thought the bed overlay the Yazoo clay marl. Cooke (1918, p. 186-198) describes the Moodys calcareous marl member as the basal member of the Jackson formation and that it rests conformably on the Yegua formation of Claiborne age and is overlain by the Yazoo clay member of the Jackson formation. The Mississippi Geological Survey now divides the Jackson formation into the Yazoo clay at the top and the Moodys marl at the base. In southern Alabama the Jackson group is composed of two formations: the Ocala limestone at the top and the Moodys Branch formation at the base.

For many years the beds representing the base of the Jackson group in Florida have been referred to the Ocala limestone. R. O. Vernon (1951, p. 115) correlated these beds with the basal Jackson in southern Alabama, which have been traced from Mississippi, and has proposed the name Moodys Branch formation to include two members, the Inglis member at the base and the Williston member at the top, for beds in the lower part of the Jackson group in Florida.

Puri (1953, p. 130) has raised the rank of the two members to formations and no longer uses the name Moodys Branch in Florida.

Lithology. — The Moodys Branch formation in Highlands County consists of cream to tan-gray, slightly hard to soft, granular to chalky, foraminiferal limestones which locally contain some crystalline calcite. In some areas of the county the hardness of the formation increases toward the base. The limestones in the upper part of the formation are so similar to the overlying Ocala limestone that the contact between the two formations is not clearly defined. In this report no attempt

* After the manuscript for this report was completed Puri (1953, p. 130) and Puri in Vernon and Puri (1956, p. 35-38) proposed the following classification of the upper Eocene in Florida.

Ocala Group	{	Crystal River formation
		Williston formation
		Inglis formation

This classification is presently in use by various workers in the field and is officially accepted by the Florida Geological Survey.

has been made to differentiate between the two members of the formation.

Distribution and stratigraphic relations. — The Moodys Branch formation is known to underlie a large portion of the central and northwestern parts of the Florida Peninsula. It rests unconformably on rocks of Claiborne age and is conformably overlain by the Ocala limestone.

Thickness and structure. — The Moodys Branch formation in Highlands County apparently ranges in thickness from about 50 to 150 feet, the top of the formation ranging from about 500 feet below sea level in the northern part of the county to about 750 feet below sea level in the southern part. The formation strikes east-west and dips south an average of about 4 feet per mile.

Paleogeography. — The Moodys Branch formation was deposited in a shallow sea, the shoreline probably extending across southern Mississippi and Alabama, and northeast across central Georgia. At its type locality, according to Cooke (1918, p. 186-198), the formation grades from a bed of quartz sand, glauconite, and shells at the base to indurated marl or impure limestone at the top, indicating that the shoreline moved slowly north during the time the formation was being deposited.

Paleontology. — The most conspicuous elements of the Moodys Branch formation in this area are the Foraminifera. Concerning the Foraminifera of the Inglis member, Vernon (1951, p. 118) states: "Miliolids are very abundant, but are usually so poorly preserved that specific identification can rarely be made. Only one large Foraminifera, *Camerina vanderstoki* (Rutten and Vermunt) is present and it is limited to the upper few feet. *Amphistegina pinarensis cosdeni* Applin and Jordan, *Nonion advenum* (Cushman), *Rotalia cushmani* Applin and Jordan, *Cameguyia perplexa* Cole and Bermudez, *Fabiania cubensis* (Cushman and Bermudez), *Spiroloculina seminolensis* Applin and Jordan, *Elphidium* sp. 'A'. Peneroplid Sp. 'X' and *Discorpinopsis gunteri* Cole characterize the bed."

Concerning the Foraminifera of the Williston member, Vernon (1951, p. 142) states: "Miliolids are the most abundant fauna in the Williston member outranking the camerinids in numbers of individuals but being less by volume. The miliolids are largely undescribed and are generally so poorly preserved that specific identification is prevented. . . . The most common species and greatest number of specimens in the bed is *Camerina vanderstoki* (Rutten and Vermunt) with minor percentages of *C. guayabalensis* Barker, *C. sp. cf. C. moodybranchensis*

Gravell and Hanna, *Operculinoides floridensis* (Heilprin), *O. vaughani* (Cushman) var. (noded septae). *Lepidocyclus ocalana* Cushman and *Heterostegina ocalana* Cushman are rare throughout the bed and more common at the top than at the base."

Water supply.—The Moodys Branch formation probably is not capable of producing large supplies of water for irrigation and municipal needs in Highlands County, but it does contribute some water to wells that penetrate underlying formations.

OCALA LIMESTONE

Name.—The Ocala limestone was named for exposures in the vicinity of Ocala, Marion County, by Dall and Harris (1892, p. 103, 157, 311), who assigned them to the Eocene or Oligocene. Later studies by Cooke (1926, p. 251-297) proved the limestone to be of Jackson (late Eocene) age, and Cooke and Mossom (1929, p. 47-48) defined the Ocala to include "all rocks of Eocene age exposed in Florida."

Vernon (1951, p. 156-159) restricted the term Ocala to include only the late Jackson and assigned the basal beds to the Moodys Branch formation of early Jackson age.

Puri (1953, p. 130) has redefined Vernon's Ocala (restricted) and named it the Crystal River formation. He has included the Crystal River, Williston, and Inglis formations in the Ocala group.

Lithology.—The Ocala limestone in Highlands County is a light-gray to cream, soft, chalky, coquina limestone composed almost entirely of tests of large Foraminifera.

Distribution and stratigraphic relations.—The Ocala limestone underlies most of Florida and extends westward across Alabama to the Tombigbee River, and northward to Twiggs and Wilkinson Counties in Georgia (Cooke, 1945, p. 55-57). In Highlands County the Ocala rests conformably on the Moodys Branch formation. In the western part of the county it is overlain unconformably by the Suwannee limestone of Oligocene age; in the eastern part of the county, however, it is unconformably overlain by the Hawthorn formation of Miocene age.

Thickness and structure.—The Ocala limestone in Highlands County apparently ranges in thickness from about 150 to 250 feet, the top of the formation occurring about 250 feet below sea level in the northern part of the county and about 650 feet below sea level in the southern part. The formation strikes roughly east-west and dips south an average of about 10 feet per mile.

Paleogeography. — The Ocala limestone was deposited in an open, fairly shallow sea, the shoreline, according to Cooke (1945, p. 57), extending across Alabama from Choctaw County to Houston County and northeast across Georgia past Macon to Augusta. Equivalent near-shore deposits are the Yazoo clay in Mississippi and western Alabama and the Barnwell formation composed chiefly of sand, in Georgia.

Paleontology. — The most conspicuous fossils found in the Ocala limestone in Highlands County are the numerous specimens of *Lepidocyclina ocalana* Cushman and varieties. Applin and Jordan (1945, p. 130) list 15 species of Foraminifera as diagnostic of the Ocala limestone, but as the Ocala of their paper comprises both the Ocala limestone (restricted) and the Williston member of the Moodys Branch formation, the list includes species that are now known to be characteristic of the Moodys Branch as well as the Ocala.

Water supply. — Data furnished by well drillers, as well as those obtained during actual drilling, indicate that the ground-water yield from the Ocala limestone is not as large as the yield from deeper Eocene formations. The smaller yield from the Ocala may be due to the presence of localized less permeable zones within the limestone, for in some parts of southeastern Highlands County the Ocala limestone is capable of producing fairly large volumes of water. Information on the depths of wells penetrating the Floridan aquifer suggests that in the ridge area sufficient water for large-scale irrigation is not available in either the Ocala or the Avon Park limestone, and that wells must penetrate the Lake City for the required quantities.

Oligocene Series

SUWANNEE LIMESTONE

Name. — The name Suwannee limestone was proposed by Cooke and Mansfield (1936, p. 71) for the yellowish limestone typically exposed along the Suwannee River in Hamilton and Suwannee Counties.

Lithology. — The Suwannee limestone in Highlands County consists predominantly of cream-colored, slightly porous, soft, chalky to slightly crystalline limestone.

Distribution and stratigraphic relations. — Well cuttings indicate that the Suwannee limestone is not continuous in the subsurface of peninsular Florida. In Highlands County it is present only in the western part of the county, where it rests unconformably on the Ocala limestone and is unconformably overlain by the Hawthorn formation.

Thickness and structure. — The maximum thickness of the Suwan-

nee limestone in Highlands County is only about 80 feet, the top of the formation ranging from about 200 feet below sea level in the northern part of the county to about 550 feet below sea level in the southern part. The Suwannee strikes east-west and dips south an average of about 6 feet per mile.

Paleogeography. — The Suwannee limestone was deposited in a fairly shallow open ocean, the shoreline, according to Cooke (1945, p. 89), extending across Alabama from Washington County to Henry County across Georgia to Burke County. The Flint River formation, containing much clastic material, is thought to be the near-shore equivalent of the Suwannee limestone in northwestern Florida, southeastern Alabama, and southern Georgia, and the Chickasawhay limestone, also containing clastic material, is probably the equivalent in southwestern Alabama and southeastern Mississippi (Cooke, 1945, p. 88-89).

Paleontology. — The Suwannee limestone contains echinoids, mollusks, and forams. The echinoid *Cassidulus gouldii* (Bouvé) is the most conspicuous and widespread fossil in the outcrop areas. In Highlands County, where the Suwannee limestone is known only from well cuttings, the most conspicuous fossils are Foraminifera of which *Rotalia mexicana* is the most common. Applin and Jordan (1945, p. 129, 130) consider the following Foraminifera to be diagnostic of the formation:

Asterigerina subacuta floridensis Applin and Jordan
Coskinolina floridana Cole
Dictyoconus cookei (Moberg)
Elphidium leonensis Applin and Jordan
Elphidium aff. *E. poeyanum* (d'Orbigny)
Heterostegina texana Gravel and M. A. Hanna
Miogypsina (*Miogypsina*) *gunteri* Cole
Nonion advenum (Cushman)
Nonionella leonensis Applin and Jordan
Operculinoides vicksburgensis Vaughn and Cole
Quinqueloculina leonensis Applin and Jordan
Rotalia byramensis Cushman
Rotalia mexicana Nuttall
Rotalia mexicana mecatepecensis Nuttall
Valvulammina? sp.

Water supply. — The Suwannee limestone is not an important aquifer in Highlands County, although locally it is used for small domestic supplies.

Miocene Series

HAWTHORN FORMATION

Name. — The Hawthorn formation was named for exposures of early and middle Miocene age in the vicinity of Hawthorn in Alachua County, Fla., by Dall and Harris (1892, p. 107). The Hawthorn for-

mation of this report includes all marine, littoral and deltaic beds of early and middle Miocene age in Highlands County.

Cooke (1945, p. 109) recognized the three divisions — early, middle, and upper — of the Miocene in peninsular Florida. Vernon (1951, p. 179) studied sediments from more than 13,000 wells drilled in 35 counties extending from Jefferson County to Hillsborough County. In this area he definitely identified material of Tampa (early Miocene) age only in Hernando, Hillsborough, Pasco, Pinellas, and Polk Counties, and he identified it questionably in southern Citrus, Jefferson, Indian River, southern Lake, and Osceola Counties. In the outcrop area in the vicinity of Tampa Bay, the Tampa limestone⁵ is a cream to white sandy limestone containing specimens of *Archaias* and *Sorites*. Vernon (1951, p. 181) indicates a definite time break between the end of Tampa and the beginning of Hawthorn deposition and thus restricts Tampa deposition to early Miocene, and the Hawthorn formation to middle Miocene. However, the extent of the unconformity is not known, and Cooke (1945, p. 115, 145) indicates uncertainty concerning the time break. Regardless of the presence of an unconformity, there is no evidence that it is a division marker between early and middle Miocene.

In his examination of well cuttings in Highlands County, the author found material that might be equivalent to the sandy limestone of the Tampa in only the northern part of the county. These limestones were included in the Hawthorn. In western Highlands County typical marine sediments of the Hawthorn were found to overlie the Suwannee limestone unconformably, and in the eastern part of the county a similar relationship was noted with the Ocala limestone.

It may be that Highlands County was a high, exposed area from post-Oligocene to middle Miocene time, and that no material of Tampa age was deposited in the area. It is possible also that the lower Miocene Tampa sea covered the county with thin deposits of limestone which were subsequently removed during the pre-middle Miocene erosion interval. If the transgressing sea during Tampa time was shallow and of limited extent, the Tampa limestone might occur only locally, possibly in depression on the pre-Miocene erosion surface. A third possibility seems apparent, whereby Highlands County remained submerged by shallow seas during both early and middle Miocene times and deposition was continuous throughout that time interval. If the greater percentage of the materials brought down and deposited in eastern High-

⁵ Tampa limestone, as officially used by the U. S. Geological Survey, is referred to as the Tampa formation by the Florida Geological Survey.

lands County and southeastern Florida during early Miocene time were clastics, then sand, silt, and clay would predominate rather than carbonates, as in western Florida. Therefore, marine clastics in the lower part of the Hawthorn formation at some places in southern Florida may be equivalent to limestone of Tampa age in other areas. Cooke (1945, p. 145) appears to favor the probability that the Hawthorn sea was an expanded Tampa sea.

In extending the Citronelle formation into northwestern Highlands County, Cooke (1945, p. 233) stated: "The high ridge that extends northward from Sebring is capped with coarse red sand that probably represents the Citronelle formation, though some of it may be Pleistocene." The deposit of coarse red sand referred to by Cooke extends as far south as Childs. The writer has concluded from his examination of well cuttings that this deposit grades downward and laterally through coarse, micaceous, quartz sand, locally containing quartzite pebbles and white kaolinite, into typical marine Hawthorn, and that the deposit must, therefore, be a part of the Hawthorn formation. These red, clayey sands have thus been included in the Hawthorn formation of this report.

That the deposits which overlies the typical marine Hawthorn are themselves Hawthorn in age is confirmed by the fact that the Tamiami formation of late Miocene age wedges out against their flanks. (See cross section C-C', fig. 4c). A further indication that they are of Hawthorn age is that they contain quartz pebbles like those found in typical marine Hawthorn deposits in other parts of the peninsula.

The stratification of these deposits and the presence of quartz pebbles in them suggest that they were deposited by streams rather than by ocean currents. Deltaic stratification can be seen in the sandpits just north of Davenport in Polk County, sec. 27, T. 26 S., R. 27 E., where sand-mining operations have exposed large, well-developed foreset beds.

The evidence found by the writer suggests to him that a large river existed in peninsular Florida during Hawthorn time and that the thick section of coarse clastic material in Highlands and Polk Counties is in reality an extension of the deltaic facies of the Hawthorn formation. A middle Miocene delta plain was proposed by Vernon (1951, p. 184) for the panhandle and peninsular sections of Florida. The deposits in Highlands County may be an extension of this delta plain built by a river flowing southward between structural irregularities developed along the Ocala uplift during the Miocene epoch.

The presence of pebbles in the marine Hawthorn suggests that the immediate source of its clastic material, possibly a beach or an estuary,

was much nearer than has heretofore been supposed. James B. Cathcart of the U. S. Geological Survey (personal communication, 1952), in his work on the phosphorite deposits of southern Florida, has observed quartz pebbles in the Hawthorn formation underlying the Bone Valley formation and believes that the volume of such material is too great to be accounted for by rafting or other minor forms of transportation.

Lithology. — The marine deposits of the Hawthorn formation in the county are composed primarily of beds of dark-green to white, phosphatic clay and lenticular bodies of white to cream, dense, sandy, phosphatic limestone, phosphorite pebbles, and quartz sand.

The deltaic deposits consist of quartz ranging from fine sand to pebble gravel and some phosphorite, mica, and kaolinite.

Distribution and stratigraphic relations. — The marine deposits of the Hawthorn underlie all the county and rest unconformably on the Suwannee or Ocala limestone. In the eastern and possibly the southwestern parts of the county the formation is overlain unconformably(?) by the Tamiami formation. In the ridge section the marine deposits are overlain conformably by the deltaic beds.

The deltaic beds, which are unconformably overlain by Pleistocene deposits, apparently grade horizontally into typically marine deposits, the marine nonclastics being represented at the same stratigraphic level as coarse sands and clays in the deltaic beds. As the marine deposits contain some of the coarse material found in the deltaic beds, there must be some interfingering of the deposits laterally.

Thickness. — In Highlands County the Hawthorn formation ranges in thickness from about 300 feet in the low areas in the northern part of the county to about 650 feet in the Lake Placid area.

Paleogeography. — Cooke (1945, p. 137-318) states: "During Alum Bluff time the sea extended across the southern tip of South Carolina, across southern Georgia almost to the Fall Line, across all of Florida, southern Alabama, and westward to Texas. East of the Apalachicola River it deposited the Hawthorn formation; west of it successively the Chipola and the Shoal River formations in Florida and the Hattiesburg clay in Mississippi and Louisiana."

Vernon (1951, p. 181-184) does not agree that the Hawthorn sea covered all of Florida and states: "During the time that early and middle Miocene seas were encroaching upon the State, the land mass created by the Ocala uplift probably stood as a broad plain or a series of undulating hills forming a large insular area or a narrow

peninsula that extended south from Georgia along the western part of peninsular Florida."

A study of the subsurface geology indicates that a large part of Highlands County was probably above the sea at the beginning of Hawthorn time. As the sea rose and covered the county, shifting currents deposited a great thickness of phosphatic clay containing lenses of limestone, sand, and phosphorite of small areal extent. Before the close of Hawthorn time a finger of a large delta had moved across the county to about the Glades-Highlands County line. The remnant of this delta is the core of the present Highlands Ridge.

Paleontology. — Mollusks, echinoids, shark teeth, coral, and a few foraminifers are found in the Hawthorn formation in Highlands County, but none appear to be diagnostic of the formation.

Geologic exposures. — The Hawthorn is the oldest formation exposed in the county and can be seen in the many claypits on the ridge from Avon Park south to Lake Annie (see measured sections 407-410, p. 138, 139).

Water supply. — The deltaic beds of the Hawthorn formation are an important source of water supply and are tapped by an increasing number of screened wells developed at depths generally less than 200 feet. A 12-inch well near Avon Park, 180 feet deep and containing 120 feet of slotted casing, yields 1,800 gallons per minute from this aquifer.

Most of the marine beds are of low permeability, but the limestone units of the marine beds of the formation furnish small to moderate supplies of water locally.

TAMIAMI FORMATION

Name. — The name Tamiami limestone was first used by Mansfield (1939, p. 8) for the beds exposed in the shallow ditches along the Tamiami Trail in the Big Cypress Swamp. Cooke and Mossom (1929, p. 156) regarded the beds as a different facies of the Caloosahatchee marl of Pliocene age and did not offer a different formational name. Because of the sandy nature of the rock, Parker and Cooke (1944, p. 62) called it the Tamiami formation. Parker (1951, p. 822-823) assigned the deposits to the upper Miocene and included in the Tamiami formation the Buckingham limestone of Mansfield (1939) and the upper part of the Hawthorn formation of Parker and Cooke (1944). As thus defined, the Tamiami formation includes all deposits of late Miocene age in southern Florida.

Lithology. — The Tamiami formation in Highlands County is com-

posed of beds of dark-blue to white, clayey, sandy, shell marl, quartz sand, phosphorite, and sandy clay.

Distribution and stratigraphic relations. — The Tamiami formation probably underlies all of Florida south and east of the Highlands Ridge. In Highlands County it has been found in the low area east of the ridge, but it possibly underlies also the low areas in the southwestern part of the county. The Tamiami rests unconformably(?) on the Hawthorn formation and is overlain unconformably by Pleistocene deposits.

Thickness. — The Tamiami formation ranges in thickness from a featheredge on the east side of the Highlands Ridge to a probable maximum of about 100 feet near the Kissimmee River in the extreme southeastern part of the county.

Paleogeography. — During late Miocene time the Highlands Ridge was a peninsula that formed the southernmost dry land in Florida.

Paleontology. — The Tamiami formation is abundantly fossiliferous in Highlands County and contains the remains of mollusks, echinoids, barnacles, and foraminifers.

Water supply. — The Tamiami formation is used as a source of domestic and stock-water supplies in the eastern part of the county, though locally it contains moderately mineralized water.

QUATERNARY SYSTEM

Pleistocene Series

INTRODUCTION

The Pleistocene epoch in the United States has been divided into glacial stages (periods of maximum accumulation of ice) and interglacial stages (periods of minimum accumulation of ice). These glacial and interglacial stages are listed from the oldest to the youngest as follows:

Pleistocene series

Nebraskan glacial

Aftonian interglacial

Kansan glacial

Yarmouth interglacial

Illinoian glacial

Sangamon interglacial

Wisconsin glacial

Recent series

The glacial advances lowered the sea level by storing large volumes of the earth's water as ice. During the interglacial stages the water was returned to the sea, thereby causing a rise in its level. The greatest rise of the sea during the Pleistocene is estimated by Cooke (1939, p. 34) to have been to about 270 feet above present sea level, and the greatest lowering is thought to have been to about 300 feet below present sea level.

The fluctuations of sea level in Florida produced great changes in the pre-Pleistocene land surface. In Highlands County the most important changes were brought about by coastal erosion and deposition, resulting in marine terraces and coastal bars. A part of, or possibly all, the solution that created the circular lakes and depressions probably occurred during low stages of the Pleistocene seas.

Parker and Cooke (1944, pl. 3) show five Pleistocene marine terraces in Highlands County, the Pamlico, Talbot, Penholoway, Wicomico, and Sunderland, with shorelines at 25, 52, 70, 100, and 170 feet, respectively, above present sea level. MacNeil (1949, pl. 19) mapped three Pleistocene shorelines in Highlands County, the Pamlico at 30 feet, the Wicomico at 100 feet, and the Okefenokee at 150 feet. The maps of the above-mentioned investigators were made from aerial photographs without vertical control in Highlands County.

During the course of the present investigation detailed topographic maps on a 5-foot contour interval, prepared for the Corps of Engineers, U. S. Army, were obtained for a part of the ridge section. These maps show that some of the Pleistocene terraces have been tilted and possibly faulted.

The pattern of tilting is confusing but, in general, the affected area lies east of a line that touches points about a mile west of Lake Childs and Lake Jackson and west of a parallel line that crosses the western side of Lake Istokpoga. The tilted area extends from about 6 miles south of Lake Annie into southern Polk County. The only part of this area that presents a clear picture of the tilting is the southeastern part of the ridge section in T. 38 S., R. 30 E. Here the 150-foot contour crosses a well-developed marine scarp, about 35 feet high, in a distance of less than 3 miles. The tilting is to the north in this area.

Throughout the tilted area of Highlands County there are what seem to be zones of faulting, which further complicate the picture. The chain of lakes lying between Lake Jackson and Lake Annie are in a graben-shaped depression (see cross section C-C', fig. 4), which is lowest in the Josephine Creek area, where circular lakes of the type

mentioned by MacNeil (1949, p. 101) are present below the 100-foot contour. Topographic features that have the appearance of fault scarps have been noted near Avon Park and Lake Placid. The feature near Avon Park (secs. 7 and 8, T. 33 S., R. 29 E.) is a very straight south-facing scarp on the edge of a filled-in lake or sheltered bay. This feature is hard to explain on the basis of wave erosion or longshore currents because of its sheltered position. The feature near Lake Placid (secs. 8 and 9, T. 37 S., R. 30 E.) is a north-facing scarp that seems to have no relation to the nearby marine scarps.

Aerial photographs of the area between Arbuckle Creek and the Highlands Ridge show the drainage pattern to be somewhat rectangular and suggest that the streams may be fault controlled.

Because of the difficulty of correlating the terraces, all deposits of Pleistocene age in Highlands County are herein grouped together.

PLEISTOCENE DEPOSITS

Lithology. — The Pleistocene deposits in the Highlands Ridge area consist of gray-orange to white, medium to coarse, quartz sand, with locally interbedded brown clayey zones near the basal contact with the Hawthorn formation. Fine to medium, clayey, calcareous, quartz sand is predominant in the lower areas of the county.

Distribution and stratigraphic relations. — The Pleistocene deposits crop out over most of the county, lying unconformably on the Hawthorn formation in the western part of the county, and on the Tamiami formation east of the ridge. In the ridge section, good exposures can be seen in many of the road and railroad cuts (see measured sections).

Thickness. — Pleistocene deposits in Highlands County range in thickness from about a foot in the low area west of the ridge to about 100 feet in the coastal bars on the east side of the ridge.

Paleogeography. — Several advances and retreats of the shoreline over Highlands County occurred during the Pleistocene epoch. During the Aftonian interglacial stage the area was either completely covered by the sea or completely covered except for a few islands in the ridge section. During the Kansan glacial stage the county was dry land. This cycle was repeated during the following glacial and interglacial stages, a smaller portion of the county being submerged by each succeeding advance of the sea.

During the interglacial stages of the early Pleistocene the Highlands Ridge apparently separated an area of relatively deep open water to the east from an area of shallow water immediately to the west. Because of this, the eastern part of the ridge was subjected to the action of long-

shore currents and large waves, resulting in the formation of numerous coastal bars. The western side of the ridge escaped violent wave action and a fairly smooth marine plain developed, with very little material being deposited in the area to the west of the plain.

The lakes of Highlands County are post-middle Miocene in age, probably early Pleistocene, and were formed at a time when the sea level stood below its present level. A lowering of the water table probably accompanied the drop in sea level and resulted in an increase in the rate of circulation of water in the limestone below the clay of the Hawthorn formation. Solution caverns which developed in the limestone later collapsed to form many of the lakes of the area.

Paleontology. — The marine fossils of the Pleistocene deposits of the county consist almost entirely of Foraminifera which are found in the lower part of the deposits in the low areas east of the ridge; of these, the following have been identified:

Elphidium gunteri Cole

Nonion pompilioides (Fichtel and Moll)

Rotalia beccarii (Linné) var. *tepida* Cushman

Rotalia beccarii (Linné) var. *ornata*? Cushman

The remains of terrestrial vertebrates have been reported in several of the swamps and lakes in the county.

Water supply. — The Pleistocene deposits furnish small to moderate supplies of water to stock and domestic wells in places throughout the county.

Recent Series

INTRODUCTION

The Recent deposits in Highlands County consist of dune sand, peat, and alluvium. It is likely that some of these deposits were beginning to form during the Pleistocene epoch, but as there are insufficient data available to subdivide them as to age, and as they are still being formed, they are all tentatively placed in the Recent series.

DUNE SAND

Dune sand occurs near many of the larger lakes in the county and also forms thin coverings over the Pleistocene coastal bars in the southern part of the ridge. The sand is composed predominantly of white, medium to coarse, quartz sand, but includes a small amount of organic material. As the dune sand lies above the water table no water is obtained from it.

PEAT DEPOSITS

Many marshes and swamps in the county contain peat deposits of varying thickness and purity. The largest deposit is in the area south of

Lake Istokpoga and, according to Davis (1946, p. 129), underlies an area of approximately 35,000 acres, most of the deposit being between 3 and 8 feet thick. No wells obtain water from these peat deposits in the county.

ALLUVIUM

Well-developed flood plains are present in the valleys of the Kissimmee River and Arbuckle Creek, and along the lower portion of Fish-eating Creek. The flood-plain deposits are made up almost entirely of fine to medium sand and organic material mixed in varying degree and ranging from small deposits of sandy peat to bars of pure sand. The deposits reach a probable maximum thickness of about 20 feet in the Kissimmee River valley. No wells are known to obtain water from alluvial deposits in Highlands County.

GROUND WATER

Ground water is the water occurring in the pores or openings of the earth's crust within the zone of saturation. The zone of saturation is defined as that in which the rocks are saturated with water under hydrostatic pressure. It is the zone of saturation that supplies water to wells and springs.

In this report ground water will be discussed under two different headings based on occurrence: (1) nonartesian water, the water that is unconfined in the earth's crust; and (2) artesian water, the water that is confined under pressure between relatively impermeable beds.

NONARTESIAN WATER

Source

In Highlands County the nonartesian ground water is derived almost entirely from rain falling within the county. Part of the water that falls as rain evaporates, part of it is absorbed by plants and transpired into the atmosphere, and part of it is carried away by surface runoff. The remaining part which escapes evaporation, transpiration, and surface runoff moves downward through the underlying strata until it reaches the zone of saturation and becomes part of the body of ground water. Unconfined ground water moves at varying rates through the aquifer, under the influence of gravity.

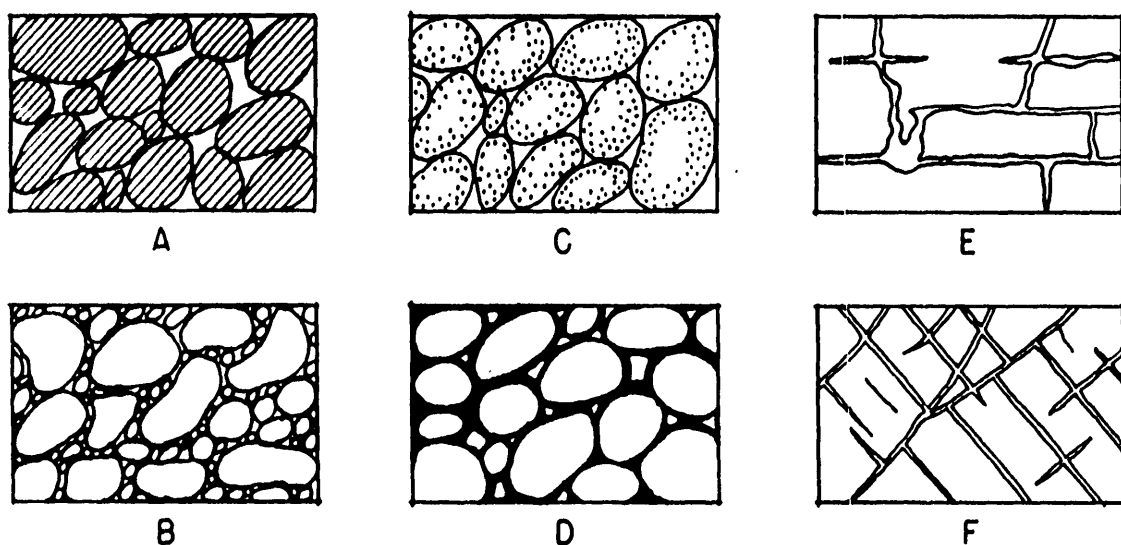
Occurrence

The following discussion of the principles governing the occurrence of ground water has been adapted from Meinzer (1923a).

Ground water occurs in Highlands County in the numerous open

spaces in rock material below the water table. These open spaces range in size from minute pores of microscopic dimensions to openings several inches in width. It is from these openings that wells obtain their water.

The amount of water that can be stored in a water-bearing rock is determined by the porosity of the rock. Porosity is expressed as the percentage of the total volume of rock that is occupied by openings. When all the openings in a rock are filled with water, the rock is saturated. The porosity of the water-bearing material underlying Highlands County is controlled by (1) the degree of assortment of the constituent particles; (2) the shape and arrangement of the particles; (3) the degree of cementation and compaction; and (4) the degree to which percolating water has removed soluble mineral matter. Fracturing is not an important contributor to the porosity of the rocks in the county. Well-sorted sedimentary rocks generally have a high porosity, whereas poorly sorted deposits have a much lower porosity because the fine material fills the open spaces in the coarse material. Several common types of open spaces, or interstices, and the relation of texture to porosity are shown in figure 5. The specific yield is a measure of the capacity of a saturated rock to yield water from storage. It may be defined as the ratio of (1) the volume of water which, after being saturated, it will yield by gravity to (2) its own volume.



A, Well-sorted sedimentary deposit having a high porosity; B, poorly sorted sedimentary deposit having low porosity; C, well-sorted sedimentary deposit consisting of pebbles that are themselves porous so that the deposit as a whole has a very high porosity; D, well-sorted sedimentary deposit whose porosity has been diminished by the deposition of mineral matter in the interstices; E, rock rendered porous by solution; F, rock rendered porous by fracturing. (From O. E. Meinzer.)

FIGURE 5. — Diagram showing several types of rock interstices and the relation of rock texture to porosity.

The amount of water that rock material can hold is determined by

its porosity, but the rate at which it will yield water to wells is determined by its permeability. The permeability of a rock is its capacity for transmitting water under a hydraulic gradient, and it is measured by the rate at which it will transmit water through a given cross section under a given loss of head per unit of distance. Beds of dense clay may have higher porosity than beds of coarse sand, but because of the small size of their pores they may transmit no appreciable amount of water and may be considered to be relatively impermeable.

The porosity and permeability of limestone vary greatly. The thick section of limestone composing the Floridan aquifer is porous and permeable, although it varies both laterally and vertically. The porosity of the limestone beneath the land surface in Highlands County is the result of percolating waters dissolving the limestone as they descended to the water table when the region stood much higher above sea level than it does now. This condition occurred several times during the Pleistocene, when there were eustatic changes in sea level, and probably in early periods of the late Cenozoic, when the region was uplifted in relation to sea level. The leaching during those periods in the Pleistocene and early Tertiary produced a porous and cavernous limestone which is now saturated with water. The logs and information gained from well drillers do not indicate extensive cavernous zones beneath this area, however. The measurements listed in the logs for wells 183, 358, 400, 401, 403, 408, Glades 22, and Okeechobee 23 indicate a differing degree of permeability of the limestone laterally and vertically.

The Water Table and Movement of Nonartesian Ground Water

The water table is defined as the upper surface of the zone of saturation except where that surface is formed by an impermeable body. When water enters the earth at the surface of the ground, part of it moves down through the zone of aeration to the zone of saturation, or the body of unconfined ground water, but part of it is retained in the zone of aeration by capillary action. The amount of water that is retained by capillarity is determined by the size of the openings in the zone of aeration. At the bottom of the zone of aeration is a belt, called the capillary fringe, in which moisture is held up by capillarity above the water table. In fine-grained material this belt may be several feet thick. Water in the zone of aeration, whether in transit or in the capillary fringe, is not available to wells but may be utilized by plants. Wells must penetrate the zone of saturation before water enters them. The relation of the zone of saturation to the zone of aeration is shown in figure 6.

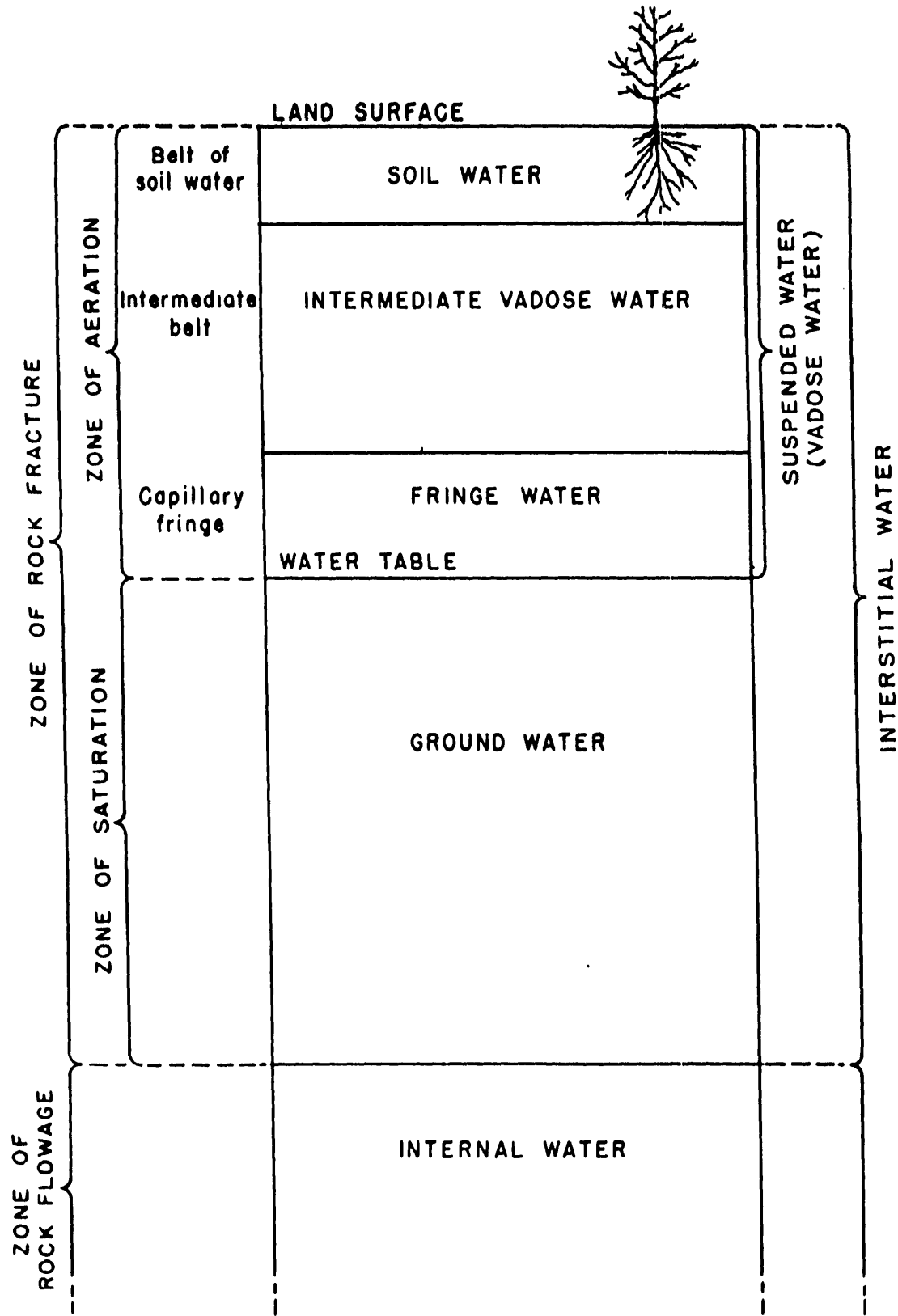


FIGURE 6.-- Diagram showing division of subsurface water
(From Meinzer, 1923b, fig. 2)

SHAPE AND SLOPE OF WATER TABLE

The water table is a sloping surface having many local irregularities due to differences in permeability of the water-bearing material and to

discharge or recharge of the ground-water reservoir. The frictional resistance to the movement of the water in coarse-grained material is less than in fine-grained material and therefore the slope of the water table decreases as the grain size increases.

Ground water moves in the direction of maximum slope, which is at right angles to contours drawn on the water table.

RELATION TO TOPOGRAPHY

In the low, flat areas of the county the water table is less than 10 feet below the land surface and has about the same relief as the land surface. Contours drawn on the water table in Highlands County would be roughly parallel to the topographic contours.

In the Highlands Ridge section the water table follows the configuration of the land surface in a general way but has far less relief. Its maximum depth below the land surface is about 60 feet.

FLUCTUATIONS OF THE WATER TABLE

The water table is a fluctuating surface that rises when the rate of recharge exceeds the rate of discharge and declines when the recharge is less than the discharge.

The factors that tend to lower the water table in Highlands County are: (1) evaporation and transpiration; (2) seepage into streams and lakes; (3) draft from wells; and (4) subsurface movement of water out of the county.

The factors that tend to raise the water table in the county are: (1) precipitation within the county that passes through the surficial material and descends to the water table; (2) seepage from the Kissimmee River and some of the creeks and lakes, at times when the water level in these bodies of water is higher than the adjoining water table; (3) seepage of water from irrigated lands; and (4) subsurface movement of water into the county.

In September 1948, seven test-observation wells (nos. 9 through 15) were drilled in Highlands County. Equipped with automatic water-stage recorders, they furnish continuous records of the fluctuations of the water table. Descriptions of the wells and the water-level measurements for 1948-49 are given in the 1949 annual water-level report of the U. S. Geological Survey (Clark and Schroeder, 1952, p. 64-67). Subsequent water-level measurements will be published in ensuing annual reports. Descriptions of the wells are included also in table 11.

Of the 7 wells, 2 (nos. 10 and 14) are on the Highlands Ridge, 1 (no. 15) is in the Western Flatlands, and the remainder are in the Eastern Flatlands. The hydrographs of these wells, representing the

averages of the daily high and low readings, and the cumulative departure from normal rainfall at Avon Park are shown in figure 7.

Some correlation is apparent between the cumulative departures from normal rainfall and the hydrographs of wells 10 and 14. The hydrographs of the other wells have very little correlation with the rainfall plot, partly because of local variations in the distribution of rainfall, but probably more because of the small storage capacity of the water-bearing materials. In many parts of the low areas of the county, especially the Istokpoga-Indian Prairie Basin, the water table stands near the land surface even during the dry season. At the beginning of the rainy season the small amount of storage space above the water table is rapidly filled, so that the water table rises to the land surface before the rainy season is over. Additional rainfall does not then cause a rise in the water table, but instead contributes to surface runoff. This condition is reflected in the observation wells by a rise of water levels to a maximum height before the bulk of the rain falls.

Water-level fluctuations recorded in these wells during the years 1949 through 1951 ranged from 4.63 feet in well 15 to 10.17 feet in well 14 (see fig. 7).

Recharge

RECHARGE FROM LOCAL RAINFALL

Nearly all the recharge to the unconfined aquifers in the county is derived from local rainfall, which averages about 52 inches annually. Because the surficial material is very permeable, no appreciable surface runoff occurs except in places where the water table is near, or coincides with, the land surface. Tests made by the Soil Conservation Service in Highlands County indicate that rainfall would have to be more than 80 inches an hour to cause surface runoff from some of the sandy soils on the Highlands Ridge.

RECHARGE FROM LAKES AND STREAMS

The recharge from lakes and streams probably accounts for only a small amount of the total recharge, but it occurs locally at times when the surface of the lakes and streams are higher than the water table, because of irregular distribution of rainfall and topographic peculiarities. The most notable example of this type of recharge is in the Indian Prairie Basin, where the land surface slopes away from the southern end of Lake Istokpoga. Some recharge occurs when the level of the lake stands higher than the water table immediately to the south. At times the lake level is higher even than the land surface to the south, but surface-water flow is prevented by a system of dikes.

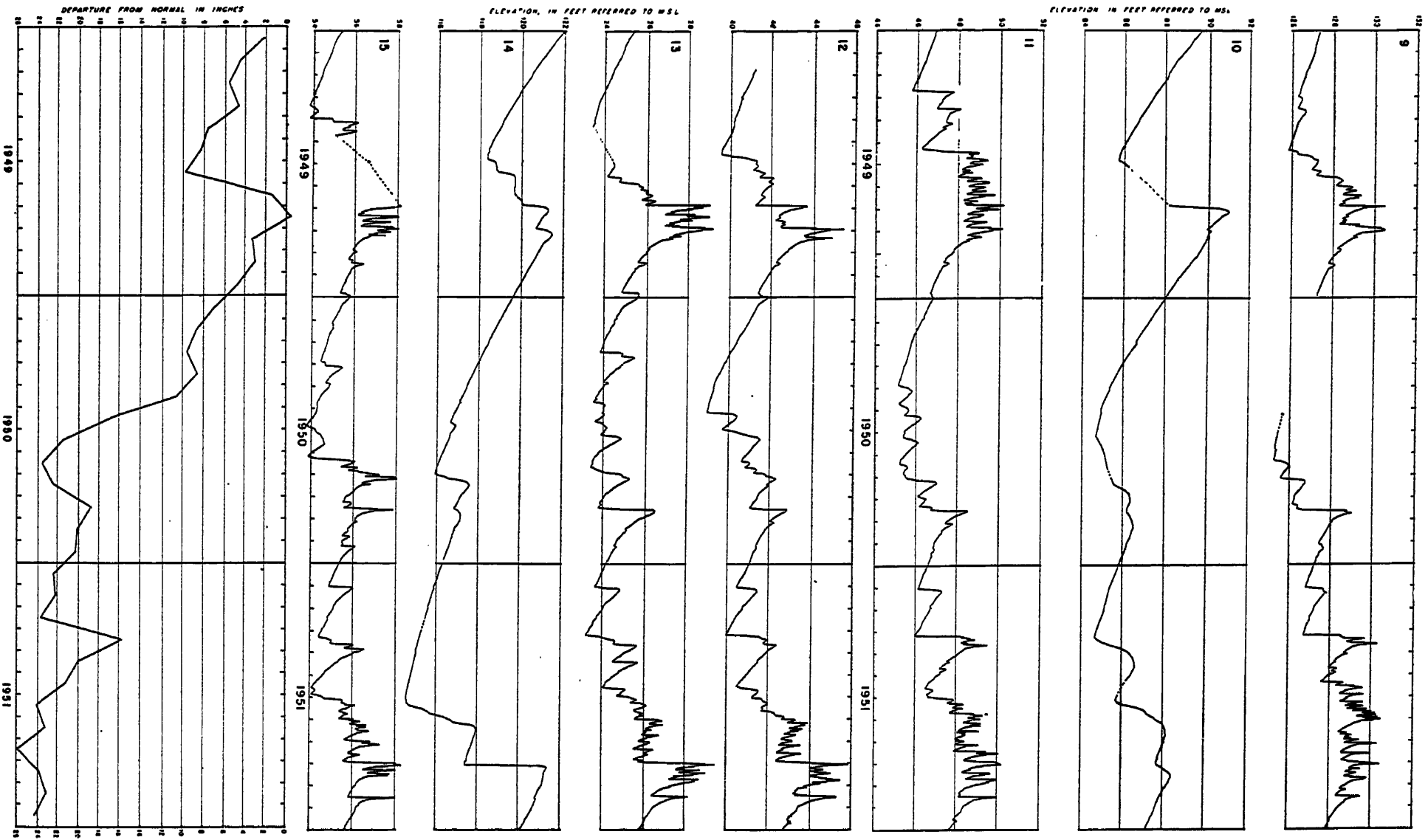


FIGURE 7. — Hydrographs of seven observation wells and the cumulative departure from normal rainfall at Avon Park.

RECHARGE FROM IRRIGATION

Some of the water applied for irrigation descends to the water table.

SUBSURFACE INFLOW

A small amount of unconfined ground water moves into the ground-water reservoir of northeastern Highlands County from aquifers in southern Polk County, where the slope of the water table is to the southeast. Inflow probably occurs also in the southwestern part of Highlands County, in the Fisheating Creek area. Some inflow occurs also from shallow artesian aquifers.

Discharge

DISCHARGE BY EVAPOTRANSPIRATION

In Highlands County a large amount of unconfined ground water is lost by evapotranspiration, especially in those areas where the water table is at or near the surface. Charts from all the observation wells, except wells 10 and 14, show distinct, steplike declines of the water table, most pronounced during the afternoons of days that are relatively hot and dry. These declines amount to as much as 0.05 of a foot per day in some localities.

In the high areas, where the water table is below the reach of most plant roots, the plants obtain their water from the zone of soil moisture, thereby reducing the recharge to the shallow ground-water reservoir.

DISCHARGE INTO LAKES AND STREAMS

Streams and lakes whose surfaces stand lower than the water table in adjacent areas receive water from the zone of saturation. Examples of this type of ground-water discharge may be noted in Highlands County by observing the water levels in small lakes that are subjected to intense pumping for a short period of time. If water is pumped out of a lake faster than it is replenished from ground water the lake level will drop, but when pumping has ceased the lake level will rise nearly to its original level. The amount and rate of drawdown caused by pumping from the lake and the rate of recovery after pumping stops depend in part upon the rate and duration of pumping and in part upon the permeability of the water-bearing materials. Heavier pumping throughout longer periods causes large drawdowns and more rapid recovery after pumping ceases. Also, with lower permeability the drawdown will be larger and initial rate of recovery more rapid. In Highlands County, ground water is almost constantly feeding into streams

and lakes, because the surfaces of most of these open bodies of water are normally lower than the water table as a result of evaporation and flow out of the area.

SUBSURFACE OUTFLOW

In addition to discharge into lakes and streams, which removes ground water from the area, there is some seepage into ground-water reservoirs outside the county. Ground water is moving out of the county into adjacent counties along the southern and northwestern boundaries, as evidenced by the slope of the water table.

DISCHARGE FROM WELLS

Natural discharge, discussed above, seems to account for most of the discharge of unconfined ground water from the county; the rest is through wells.

Most domestic and stock wells in Highlands County draw water from the unconsolidated aquifer containing nonartesian ground water. The most common type of well in the unconsolidated materials is the driven well, which consists of a $1\frac{1}{4}$ to $1\frac{1}{2}$ inch metal pipe equipped with a screened drive point. These wells are driven into the aquifer and are usually pumped with a pitcher pump. Another type used in unconsolidated deposits is the screened well, which is similar in principle but is usually larger in diameter, and its screen is placed at the bottom of a drilled hole instead of being driven. Gravel is commonly placed around the screen to increase the effective diameter of the well and thus reduce the drawdown, and to reduce the velocity of the incoming water sufficiently to prevent fine material from moving into the well.

ARTESIAN WATER

Artesian water is ground water that rises above the level at which it is encountered in wells (Meinzer and Wenzel, 1942, p. 451). Artesian conditions exist where water in permeable water-bearing beds is confined between relatively impermeable beds. (See fig. 8.)

Source

The piezometric map of the State (fig. 9) indicates that the artesian water in Highlands County is derived from rainfall on the topographically high area extending southward from northern Polk County. ✓

Occurrence

Artesian water in Highlands County occurs at depths ranging from less than 10 feet to more than 1,500 feet. There are two distinct artesian systems in the area: (1) the Floridan aquifer, which consists of the

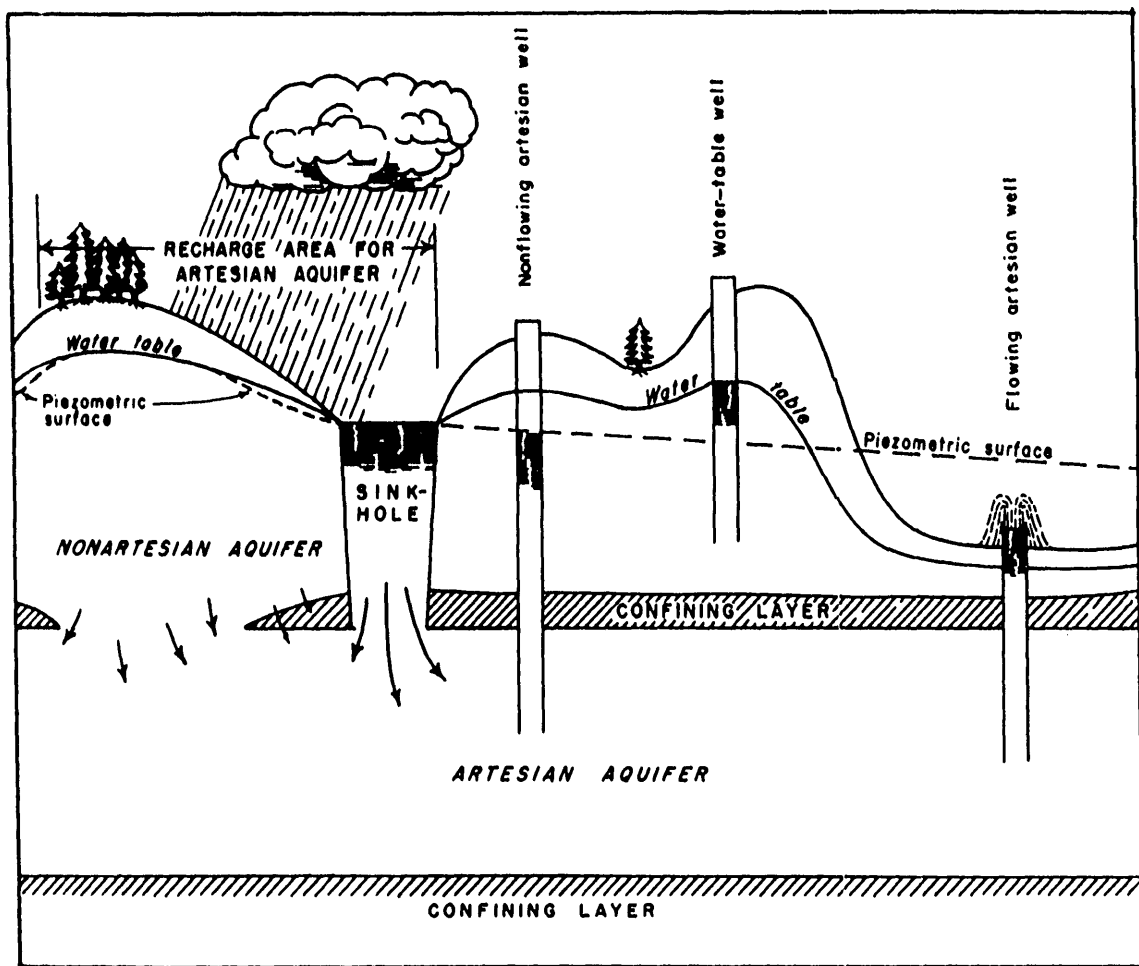


FIGURE 8. — Diagram showing generalized artesian conditions.

group of water-bearing limestones that are overlain by the confining clays of the Hawthorn formation, and (2) the shallow artesian system which consists of the unconsolidated aquifers in the upper part of the Hawthorn and in the Tamiami formation.

The name Floridan aquifer was proposed by Parker (1951) for the principal artesian aquifer of the State, which is composed largely of limestones of Tertiary age underlying the thick clay section of the Hawthorn formation. The Floridan aquifer underlies all the State, except possibly the extreme western part, and extends into southern Georgia, southwestern South Carolina, and southeastern Alabama.

The shallow artesian aquifers are present only locally under the low areas adjacent to the Highlands Ridge.

The Piezometric Surface and Movement of Artesian Water

The piezometric surface, or pressure-head-indicating surface, is an imaginary surface to which the water from a given artesian aquifer

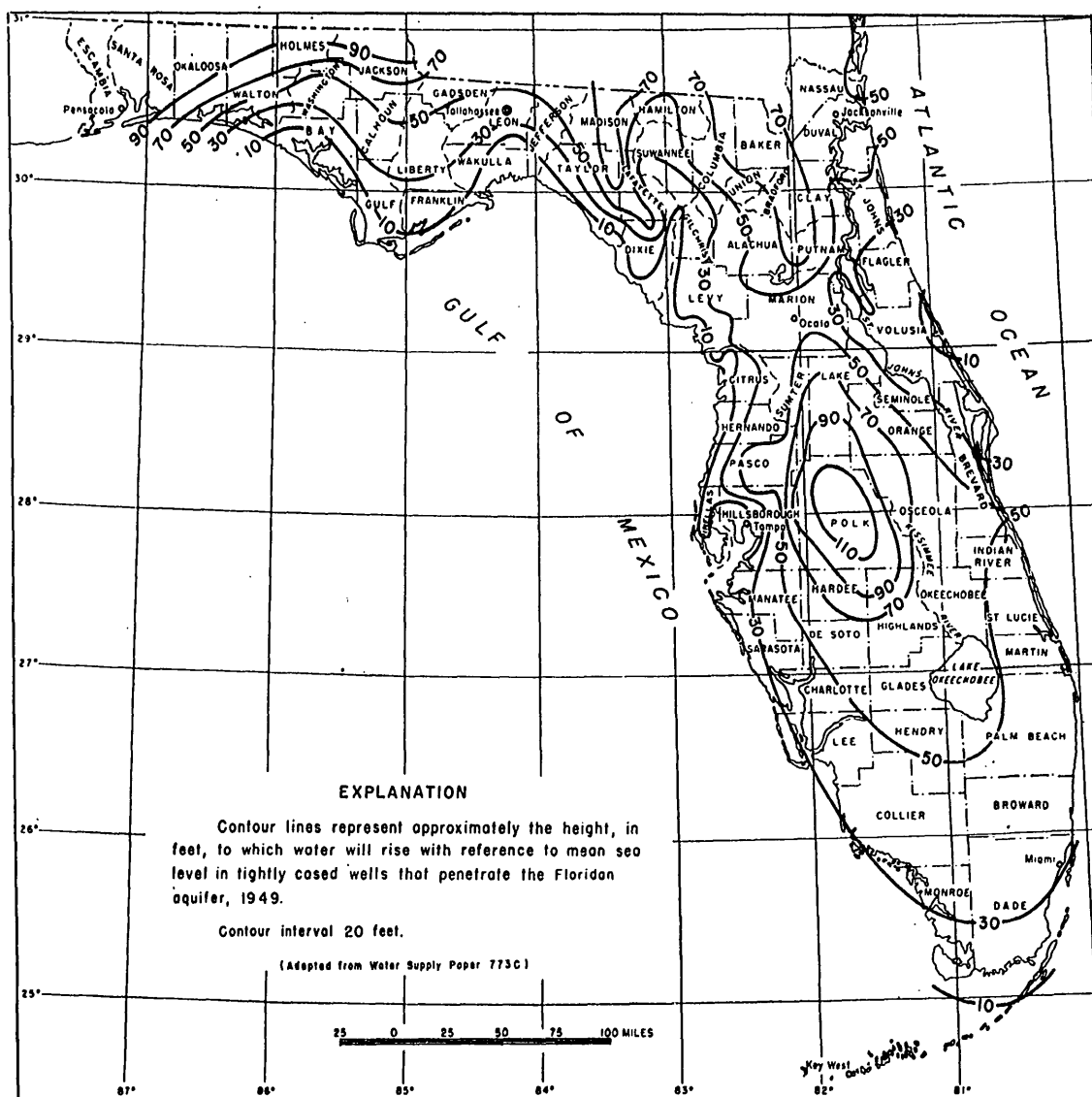


FIGURE 9. — Map showing piezometric surface of the Floridan aquifer in Florida.

will rise in tightly cased wells that penetrate the aquifer. It is generally represented by a piezometric contour map. Such a map has been prepared for Highlands County showing approximately the height to which water will rise in wells terminating in beds below the clays of the Hawthorn formation (fig. 10).

Movement of water in an artesian aquifer is from areas of high artesian pressure head toward areas of lower head at right angles to the contour lines representing the piezometric surface.

SHAPE AND SLOPE

The piezometric surface slopes from areas of recharge to areas of discharge and shows irregularities due to unequal discharge and recharge and unequal frictional resistance to the flow of water offered by materials comprising the aquifer.

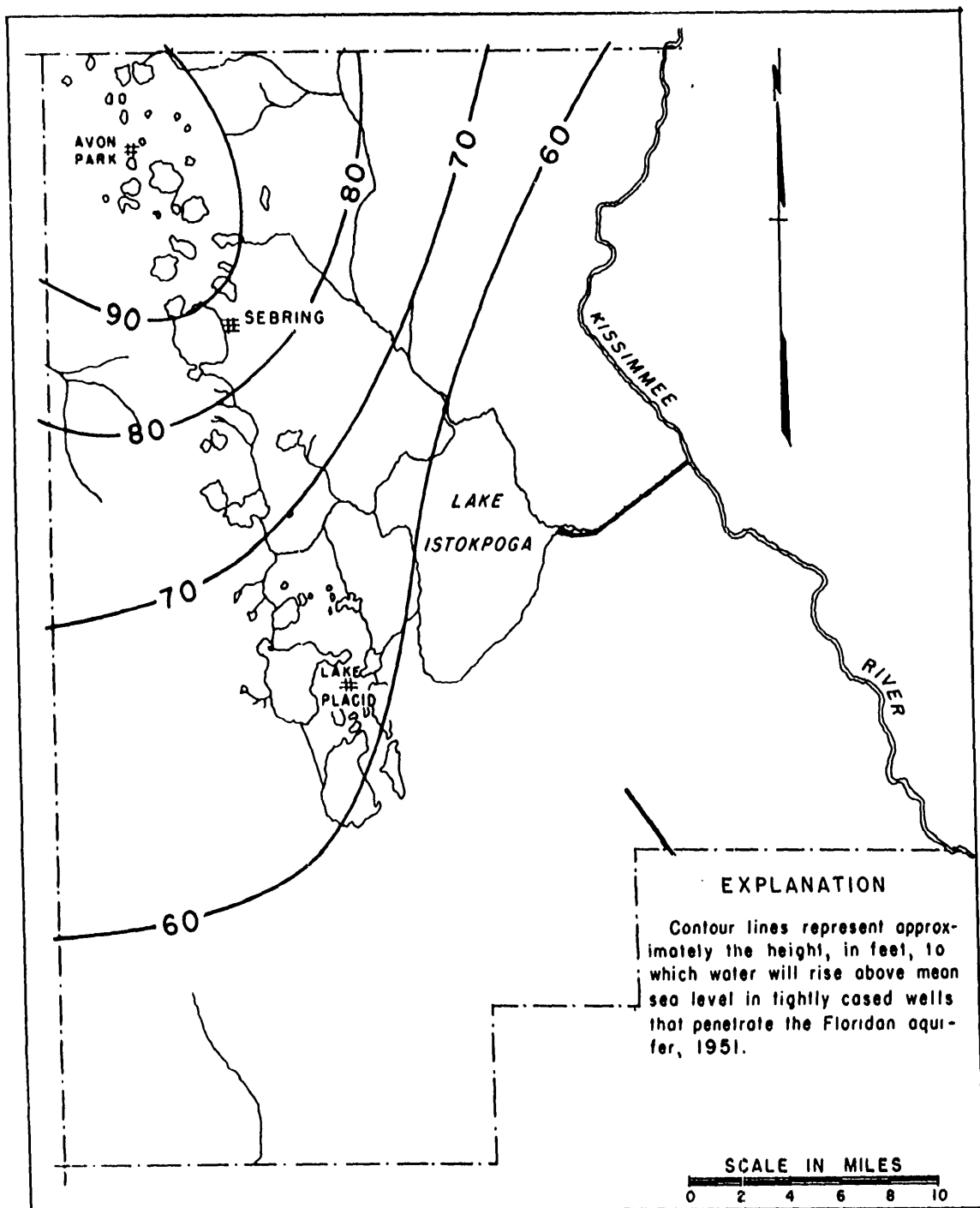


FIGURE 10. -- Map showing the piezometric surface of the Floridan aquifer in Highlands County.

RELATION TO TOPOGRAPHY

Topography is the controlling factor in determining whether or not a tightly cased artesian well will flow at land surface. An artesian well will flow if the piezometric surface is higher than the land surface; it will not flow if the piezometric surface is below the land surface.

FLUCTUATIONS OF THE PIEZOMETRIC SURFACE

Measurements of artesian water levels show that the piezometric

surface is not a stationary surface, but that it fluctuates almost constantly. In Highlands County fluctuation in artesian wells is caused by rainfall, by changes in atmospheric pressure, and discharge from wells.

Rainfall. — The effects of rainfall are most noticeable in some aquifers of the shallow artesian system. Many owners of shallow artesian wells report a rise in head accompanied by an increase in flow after heavy rains. The effects of rainfall on the artesian pressure in the Floridan aquifer were not evaluated in Highlands County because of the scarcity of measureable wells. Most wells in the Floridan aquifer are irrigation wells that are not used during periods of rainfall. It is quite possible, therefore, that some of the increase in head during these periods is due to cessation of pumping rather than to rainfall.

Changes in atmospheric pressure. — No studies were made in Highlands County of the relation between changes in atmospheric pressure and fluctuations of the piezometric surface, but as such a relationship is quite common in artesian systems (Stringfield, 1936, p. 139) it is assumed to exist in the area of this report. Concerning this phenomenon, Meinzer (1932, p. 141-142) states: "If a well ends in an artesian formation and this formation or the overlying confining beds have sufficient strength to resist deformation by slight changes in pressure at the surface, the well will act as a barometer. The fluctuations of its water level will have virtually the same range of fluctuations as would be shown by a water barometer, or 13.5 times the range in a mercury barometer. However, for obvious reasons, the movements of the water level in the well will always be in the opposite direction from those in an ordinary mercury barometer. . . ."

"If a well ends in an artesian formation that has volume elasticity, such as incoherent sand, and is confined beneath beds of soft shale that is impermeable but yields to even slight pressure, its water level will have smaller fluctuations resulting from atmospheric changes than that of a water barometer. . . ."

Pumpage and flow. — Locally, large fluctuations of the piezometric surface are caused by variations in draft from artesian wells. This is most noticeable in the northeastern part of the county where most of the deep irrigation wells are located. Many of the well owners report sporadic fluctuations during the irrigation season and a loss of head when neighboring wells are being used.

Recharge

Recharge of an artesian aquifer takes place in the high areas of the system where the confining bed is absent or is penetrated by openings such as sinkholes. In such areas the water moves down from the unconfined water body, the zone of aeration, or surface water bodies until it enters the artesian aquifer. It then moves beneath the confining bed toward the points of discharge, under the influence of gravity. In areas where the confining bed is present and the water table stands higher than the piezometric surface, the difference between the head of the water in the artesian aquifer and that of the nonartesian aquifer may cause water to move through the confining bed, thereby recharging the artesian aquifer. The rate of this recharge depends upon the relative permeability and thickness of the confining bed and the difference in head between the artesian and free water.

In Highlands County the fact that the piezometric highs of both the deep and the shallow artesian systems coincide with the topographic high suggests that some recharge takes place along the Highlands Ridge. Well logs indicate that the confining bed of the Floridan aquifer, in the area north of Sebring, is thin and fairly permeable, being composed predominantly of sandy material and minor amounts of clay. South of Sebring it is much thicker but probably has sand-filled openings beneath some of the lakes. Data obtained during the drilling of wells 358 and 400, south of Lake Childs, indicate that some recharge is occurring even near the southern end of the ridge. The upper 300 feet of material penetrated by well 358 is chiefly quartz sands of medium permeability. Underlying the sands to a depth of 680 feet is a section of interbedded or interfingered clays, sands, and limestones. Some of the water-bearing beds of the underlying Floridan aquifer are separated by beds of relatively low permeability in the Ocala, Moodys Branch, and Avon Park formations which impede the downward movement of water, causing the head to be much higher in the upper parts of the aquifer.

Tables 4 and 5 are measurements of water levels made during the drilling of wells 358 and 400, respectively. The water-level measurements show a net decline in head of 50 to 60 feet between the shallow water-bearing beds in the Hawthorn formation or Suwannee limestone and the deeper beds in the Avon Park or Lake City limestones. Head differentials of this magnitude indicate that appreciable recharge moves to deep, more permeable parts of the aquifer from the shallower material.

Table 4. — WATER-LEVEL MEASUREMENTS MADE DURING DRILLING OF WELL 358. WELL CASED TO 517 FEET.

Date 1950	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
July 13	690	Suwannee	66.2
July 20	710	do.	62.0
July 26	735	do.	70.5
Aug. 2	1,000	Moody's Branch(?)	99.5
Aug. 16	1,138	Avon Park	98.0
Aug. 25	1,259	Lake City(?)	126.0
Aug. 30	1,323	do.	125.5
Sept. 8	1,371	do.	124.2
Sept. 21	1,474	do.	126.5
Sept. 29	1,526	do.	127.9
Oct. 2	1,550	do.	126.8

Table 5. — WATER-LEVEL MEASUREMENTS MADE DURING DRILLING OF WELL 400

Date 1951	Depth of hole (feet)	Well cased to	Formation penetrated	Water level, feet below land surface
May 21	548	540	Hawthorn	66.5
May 24	670	660	Suwannee	103.0
May 31	740	700	do.	113.0
June 4	805	700	Ocala	114.0
June 6	940	700	Moody's Branch(?)	124.0
June 8	960	700	do.	122.0
June 12	1,080	700	Avon Park	119.5
June 14	1,095	700	do.	117.0
June 19	1,095	700	do.	116.5
June 22	1,095	700	do.	115.5
July 6	1,095	700	do.	117.0
July 13	1,095	700	do.	116.0
July 27	1,095	700	do.	116.0
Aug. 3	1,095	700	do.	117.0
Aug. 17	1,095	700	do.	116.0
Aug. 24	1,130	700	do.	118.0
Aug. 31	1,205	700	do.	118.0
Sept. 7	1,260	700	Lake City(?)	117.0
Sept. 13	1,300	700	do.	117.0
Sept. 21	1,350	700	do.	116.5
Sept. 27	1,380	700	do.	117.0
Oct. 4	1,400	700	do.	117.0
Oct. 15	1,439	700	do.	115.0

Figure 10 indicates the piezometric surface in the vicinity of wells 358 and 400 is at an elevation of about 60 feet. Land surface elevations in the area range from 150 feet to 200 feet and average about 175 feet. The topography is chiefly rolling sandy hills and shallow valleys which form very effective catchment areas where little or no runoff occurs. Although data are not available, the elevation of the water table beneath this portion of the ridge probably ranges from 100 to 125 feet, or higher. This assumption seems to be borne out by the occurrence of springs

along the western scarp of the ridge and a piezometric elevation of 70 to 80 feet in shallow artesian wells, just off the scarp, east of Lake Annie. The source of water for the springs and shallow artesian wells is the shallow water-bearing sands beneath the ridge. Although, the major portion of the unconfined water movement is horizontal, a part moves downward by gravity through the impeding beds to the Floridan aquifer where water levels are lower.

Discharge

Artesian water is discharged in the area both naturally and from wells.

NATURAL DISCHARGE

Shallow artesian system. — This system loses its artesian pressure within a few miles of the recharge area because of leaky confining beds. The water seeps into and joins the unconfined water body.

Floridan aquifer. — Very few data are available on the natural discharge of water from the Floridan aquifer in Highlands County. It is assumed that there is some leakage upward in the low areas where the piezometric surface is higher than the water table. The amount is probably small because of the great thickness and impermeability of the confining bed. Drillers have reported that the clays of the Hawthorn formation are thin or absent beneath many of the circular depressions, probably filled-in sinks, that occur throughout southern Florida. If this is true, then some natural discharge probably occurs through these openings on low ground, just as recharge through them occurs on high ground.

Water level rises were observed during the drilling of wells 183 and 408 in the Sebring-Avon Park area, and well 22, south of the ridge in Glades County. The changes in water levels with depth in these wells are shown in tables 6, 7, and 8, respectively.

Table 6. — WATER-LEVEL MEASUREMENTS MADE DURING DRILLING OF WELL 183. WELL CASED TO 304 FEET.

Date 1950	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
May 31	300	Hawthorn	20.80
June 8	850	Avon Park	17.00
June 12	915	do.	16.00
June 15	945	do.	15.20
June 21	1,066	do.	16.20
June 23	1,102	Lake City	16.20
June 29	1,192	do.	16.00

Table 7. — WATER-LEVEL MEASUREMENTS MADE DURING DRILLING OF WELL 408. WELL CASED TO 463.5 FEET.

Date 1951	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
May 5	525	Ocala	67.30
June 1	980	Avon Park	56.50
June 4	1,035	do.	54.20
June 6	1,160	Lake City	61.00
June 7	1,183	do.	60.20
June 8	1,185	do.	60.00
June 12	1,205	do.	57.60
June 14	1,268	do.	61.40
June 19	1,305	do.	56.30
June 22	1,390	do.	55.00
June 25	1,400	do.	55.00
July 7	1,400	do.	54.50

Table 8. — WATER-LEVEL MEASUREMENTS MADE DURING DRILLING OF WELL GL 22.

Date 1951	Depth of hole (feet)	Formation penetrated	Water level, feet above land surface
Feb. 27	515	Hawthorn	6.0
Feb. 28	573	do.	6.0
Mar. 1	610	do.	30.0
Mar. 1	632	Ocala	32.0
Mar. 1	760	Moody's Branch(?)	31.0
Mar. 6	1,190	Lake City(?)	30.0
Mar. 6	1,215	do.	31.0

The observed rises in water levels, with a deepening of the wells, indicate the probability of ground-water discharge by upward flow from the deeper zones of high permeability in the aquifer to shallower zones, and seepage through the fairly permeable confining bed, as a result of head differentials. The process of discharge from deeper material under high head is in effect the reverse of that of recharge from shallow materials which occurs in the southern part of the ridge.

The piezometric surface of the Floridan aquifer in the Sebring-Avon Park area ranges in elevation from 90 to 95 feet. The land surface elevation near well 183 is about 105 feet, however, the well is located on the eastern edge of the ridge and surface elevations to the east average about 85 feet. Water-table measurements are not available but topography indicates that the drainage of the ridge area is eastward and the elevation of the water table in the vicinity of well 183 is generally lower than the regional piezometric surface of the artesian aquifers; thus, leakage is upward from the Floridan aquifer.

A similar situation exists in the vicinity of well 408, although the land surface elevation is considerably higher (150 feet) than at well 183. The drainage of shallow ground water from beneath the ridge is

generally north or northeast into the Carter Creek system and the water table in the area north of Sebring is lowered sufficiently to permit upward seepage of artesian water through the impeding beds.

The magnitude of head differential of the water surface in the Floridan aquifer and the water-table aquifers in areas south of the ridge presupposes the occurrence of appreciable upward leakage through the confining bed. The average water-table elevation near well 22 in Glades County is below 25 feet, whereas the piezometric surface of the Floridan aquifer is in the order of 55 feet. Thus, appreciable losses by upward leakage from the artesian aquifer must occur throughout the areas of low elevation.

DISCHARGE FROM WELLS

Shallow artesian wells. — Wells terminating in the shallow artesian aquifer flow as much as 50 gallons per minute. They are cased to the bottom, allowing entrance of the water only at the open end of the casing. Many of the holes extended below the casing when they were drilled but they have since filled in with unconsolidated sediments. The caving has diminished the flow in some wells, but not in all.

Wells in the Floridan aquifer. — Wells terminating in the Floridan aquifer are generally 10 to 14 inches in diameter and yield 500 to 1,500 gallons per minute by pumping. They are cased through the overlying unconsolidated material and are left open in the limestones of the Floridan aquifer to allow water to enter from all the water-bearing beds. It is estimated that the withdrawal from wells developed in this aquifer, for public supplies and irrigational use, amounted to 1½ billion gallons of water in 1951.

UTILIZATION

Domestic Supplies

Most of the domestic supplies in the rural areas and small towns that have no public supplies are obtained from wells. A large number of these are shallow sand-point wells equipped with hand pumps. These shallow wells are quite satisfactory in some areas of the county but are unsatisfactory in others, owing to the rather high content of iron and organic impurities in water obtained at shallow depths. (See Quality of Water section, p. 98.) The present trend in drilling domestic wells in the ridge section is to tap aquifers of the Hawthorn formation, which generally furnish more satisfactory water than the formations of Pleistocene age. A few domestic supplies are obtained from lakes.

Irrigation Supplies

Farmers in central Florida have practiced irrigation more extensively

during the last few years because they have found that it enables them to realize a better return from their investment. Where sufficient water is not available from lakes and streams, irrigation wells are drilled. These range from shallow wells, 2 inches in diameter, used to irrigate truck crops, to deep wells, 14 inches in diameter, capable of producing 1,500 gallons per minute and used to irrigate large citrus groves. There is also a growing interest in the use of well water for irrigating pastureland.

The average yearly use of water from wells for irrigation in Highlands County is estimated to be about 650 million gallons. The average yearly use of surface water (derived from lakes which themselves are fed by ground water) for irrigation is estimated to be about 3 billion gallons.

Stock-Water Supplies

Practically all stock in Highlands County is raised in the low flat areas. Even though there are many marshes and small ponds in these areas, a large number of wells are used to obtain water. Ranchers increasingly tend to furnish well water for their animals rather than let them drink from the marshes and ponds, many of which are infested with parasites. Most wells used are sand-point wells equipped with wind-mills, and draw their supplies from the shallow ground-water body. In the areas near the Highlands Ridge, flowing wells that tap the shallow artesian aquifers yield some of the stock supplies.

Public Supplies

Four towns in Highlands County have public water systems: Avon Park, Sebring, DeSoto City, and Lake Placid. All except Lake Placid, which uses the water of Lake Sirena, obtain their supplies from wells. (For more complete information concerning public-supply wells in Highlands County see tables 9 and 11.)

AVON PARK

The water supply for Avon Park is obtained from three wells (391, 392, and 403) that draw from the Floridan aquifer. Well 391 is 1,040 feet deep and is cased to 350 feet with 10-inch pipe. Well 392 is 1,153 feet deep and is cased to 260 feet with 15-inch casing. Well 403 is 1,301 feet deep and is cased to 301 feet with 10-inch pipe. The three wells together can produce about 1,800 gallons per minute with the present pumps. The estimated total pumpage for the year 1950 was about 375,000,000 gallons.

SEBRING

The town of Sebring obtains its water supply from three wells

(22, 23, and 24) in the Floridan aquifer, which according to D. H. Durrance, Water Superintendent, can produce a combined total of 4,000 gallons per minute with the present pumps. Well 22 is 1,278 feet deep and is cased to an unknown depth with 8-inch pipe. Wells 23 and 24 are both 1,400 feet deep and are cased to unknown depths with 8- and 10-inch pipes, respectively. The total pumpage for the year 1950 was 385,670,000 gallons.

DESOTO CITY

The water supply for the town of DeSoto City is obtained from a screened well (394) drawing from the Hawthorn formation. The well is 88 feet deep, is cased to 68 feet with 4-inch pipe, and is finished with a 20-foot screen. The estimated yearly pumpage for 1950 was about 15,000,000 gallons.

LAKE PLACID

The water supply for the town of Lake Placid is obtained from Lake Sirena, a small lake just south of the town. The total annual pumpage in 1950 was 24,820,000 gallons.

QUALITY OF WATER

The chemical character of ground water in Highlands County is shown by analyses, made by the U. S. Geological Survey, of water collected from 36 wells distributed as uniformly as practicable within the area and among the water-bearing formations (table 9). The analyses show only the dissolved mineral content and do not indicate the sanitary condition of the water.

Chemical Constituents in Relation to Use

IRON (Fe)

Iron is dissolved from many rock materials and the quantity in ground water may differ greatly from place to place even within the same aquifer. If the iron content is much more than 0.1 part per million, the excess may separate out as a reddish sediment, which stains bathroom fixtures, cooking utensils, and fabrics. An excess of iron may also cause an offensive taste and odor, and cause clogging as well, by promoting bacterial growth in the water mains (Ryan, 1937, p. 199).

Excess iron may be removed from most water by simple aeration and settling or filtration. In some water, especially that which is soft or has a low pH, aeration must be supplemented by chemical treatment with lime or soda ash.

Of the 36 samples of water collected from wells in Highlands County,

Table 9.—CHEMICAL ANALYSES OF GROUND WATER IN HIGHLANDS COUNTY
(CHEMICAL CONSTITUENTS IN PARTS PER MILLION)

Well No.	Depth (feet)	Principal geologic source	Temperature (°F)	pH	Color	Total hardness as CaCO ₃	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)
1	640	Ocala	77	7.8	0	340	0.00	61	46	43	111	180	110	0.5	0.1
16	1,410	Lake City	79	7.7	0	118	.00	32	9.6	6.1	90	44	9	.0	.5
20	624	Moodys Branch	76	7.7	0	55	.00	17	3.8	4.5	68	0	7	.0	.1
24	1,400	Lake City	81	7.9	0	66	.00	18	4.9	3.8	74	4.0	6	.0	.2
26	35	Hawthorn	77	6.2	0	8	.01	.7	6.8	.....	6	2.0	11	.0	.2
28	750	Avon Park	77	7.9	0	66	.00	24	1.5	14	110	0	5	.0	.2
37	554	Ocala	76	8.0	0	72	.00	20	5.1	4.8	89	0	5	.0	.1
38	1,440	Lake City	77	7.7	0	72	.00	18	6.6	4.8	86	0	10	.1	.1
40	315	Hawthorn	74	8.0	0	64	.00	18	4.4	6.5	85	0	5	.1	.1
64	1,150	Lake City	81	8.0	0	70	.00	17	6.6	3.3	85	0	5	.0	.0
87	979	Avon Park	76	8.0	0	56	.00	18	3.0	5.0	71	0	7	.0	.1
112	508	Ocala (?)	.....	7.9	0	82	.01	21	7.2	7.6	108	0	7	.0	.1
126	1,150	Lake City	77	7.5	2	50	.38	18	1.1	7.4	65	.5	9	.0	.1
128	90	Hawthorn	73	6.4	2	2	.00	.....	.....	7.3	9	1	6	.0	.6
131	125	Hawthorn	73	7.2	18	181	1.9	67	3.2	8.7	232	1	9	.1	.2
141	230	Hawthorn	76	7.5	6	175	.04	55	9.0	13	234	1	6	.0	.5
149	24	Hawthorn	74	5.2	1	7	.01	2.3	.4	13	6	9	10	.0	8.0
161	670	Ocala	75	7.6	2	73	.00	16	8.1	5.7	88	4	6	.3	.1
179	30	Pleistocene	73	5.1	4	5	.03	1.5	.4	9.4	6	.8	14	.1	.1
182	240	Hawthorn	74	7.6	7	133	.00	34	12	13	134	28	15	.3	.1
211	1,450	Lake City	81	7.6	7	141	.38	37	12	10	167	10	12	.1	.2
214	86	Hawthorn	77	6.1	3	2	.06	.8	.1	8.2	9	1.5	6	.0	3.6
235	25	Hawthorn	74	4.7	30	14	.50	2.4	2.0	4.9	2	39	57	.0	.5
269	137	Hawthorn	73	6.3	18	30	1.1	8.8	2.0	9.9	42	7	8	.5	.4
273	65	Tamiami	74	6.2	7	22	1.1	7.9	.6	4.0	28	1	6	.4	.5
330	49	Hawthorn	76	5.9	7	9	.00	1.9	1.0	4.4	12	.8	5	.1	.5
334	38	Tamiami	73	7.3	104	446	1.2	91	53	219	530	20	330	.2	.9
337	45	Pleistocene	74	7.3	60	255	.72	89	7.8	12	310	0	20	.2	.9
344	252	Hawthorn	74	7.7	25	217	.06	78	5.7	29	266	0	44	.3	.5
351	35	Pleistocene	74	5.4	5	13	.00	3.6	1.0	13	6	1.0	16	.0	18
358	30	Hawthorn	73	6.3	30	43	3.2	9.9	4.5	6.3	64	3	6	.4	.7
358	1,550	Lake City	82	7.4	7	185	.00	40	21	5.3	123	73	14	.3	.3
376	20	Hawthorn	75	5.7	7	14	.62	3.5	1.3	7.7	20	1	9	.2	.2
391	1,040	Avon Park	77	7.7	7	106	.62	26	11	1.4	123	.8	6	.2	.2
393	80	Hawthorn	74	5.8	12	27	1.1	7.5	2.0	20	29	4.5	.6	.5	.....
394	88	Hawthorn	78	5.2	7	2	.00	.4	.2	4.3	3	.2	4	.0	3.4

24 contained less than 0.1 ppm of iron, 6 contained between 0.1 and 1.0 ppm, 5 contained between 1.0 and 3.0 ppm, and 1 contained 3.2 ppm.

CALCIUM (Ca)

In southern Florida calcium is dissolved from rock materials containing calcium carbonate (limestone, dolomite, marl, and shells) by water containing carbon dioxide. Calcium is the main cause of hardness of the water in Highlands County. The calcium content of the 36 samples collected ranged from 0.4 to 91 ppm.

MAGNESIUM (Mg)

In southern Florida magnesium is dissolved from sedimentary rock material that contains magnesium carbonate. Magnesium is present also in sea water, and the relative abundance of the element in some wells in southeastern Highlands County may be due in part to contamination by trapped sea water. Next to calcium, magnesium is the principal cause of the hardness of water in this area. The magnesium content of the 36 samples collected ranged from 0.1 to 53 ppm.

SODIUM (Na) AND POTASSIUM (K)

Sodium and potassium are dissolved from most rock materials and are normally present in small amounts in the water of this area. Small to moderate amounts of these constituents have little or no effect on the suitability of water used for most purposes. However, if the sodium content is much higher than 100 ppm it may cause foaming in steam boilers. Of the 36 samples, all but 1 contained less than 50 ppm of sodium and potassium. The water from well 334 contained 219 ppm, probably as a result of contamination by trapped sea water.

BICARBONATE (HCO_3)

Bicarbonate is derived from the solution of carbonate rocks by water containing carbon dioxide. Bicarbonate, as such, has little effect on the use of water. The bicarbonate content of the samples ranged from 2 to 530 ppm.

SULFATE (SO_4)

Sulfate in this area is dissolved from sedimentary rocks containing sodium and calcium sulfate, which may be salts from trapped sea water. Sulfate itself has little effect on the general use of water, but if it is present in sufficient quantity in hard water it may contribute to boiler scale. Sodium and magnesium sulfate, if present in sufficient quantity, give a bitter taste to water and produce a laxative effect. Of the 36

samples collected, 10 contained no measurable quantity of sulfate, 20 contained 10 ppm or less, 5 contained between 10 and 100 ppm, and 1 contained 180 ppm.

CHLORIDE (Cl)

In this area chloride is dissolved in small quantities from most sedimentary rocks and in larger quantities from sea salts or trapped sea water. Chloride has little effect on the suitability of water for most uses, unless there is enough to affect the taste. However, large quantities of chloride may affect the suitability of water for industrial use, as it increases the corrosiveness when combined with large quantities of calcium and magnesium. Of the samples analyzed, 25 contained 10 ppm or less of chloride, 7 contained more than 10 but no more than 20 ppm, 2 contained more than 21 but no more than 60 ppm. One contained 110 ppm and 1 contained 330 ppm.

FLUORIDE (F)

Fluoride is dissolved in small quantities from some of the sedimentary rocks. It is known to affect the suitability of water only in its relation to dental growth in children; water containing more than 1.5 ppm of fluoride is likely to produce mottled enamel (Dean, 1936, p. 1269-1272). However, small quantities of fluoride, not sufficient to cause mottled enamel, are likely to be beneficial by inhibiting tooth decay (Dean, Arnold, and Elvove, 1942, p. 1155-1179). Of the 36 samples analyzed 17 contained no fluoride, and 19 contained 0.1 to 0.8 ppm.

NITRATE (NO_3)

Nitrate is generally formed from the oxidation of ammonium compounds, which, in turn, are derived from decaying organic matter (Ryan, 1937, p. 42). Small quantities of nitrate have no effect on water for ordinary uses, but large quantities may indicate pollution. Of the 36 samples analyzed, 32 contained less than 1.0 ppm of nitrate and 4 contained more than 1.0 but no more than 18.0 ppm.

TOTAL HARDNESS AS CaCO_3

The hardness of water, which is the property that generally receives the most attention, is commonly recognized by the increased amount of soap needed to produce a lather, and by the sticky, insoluble precipitate that it forms with soap. Calcium and magnesium cause most of the hardness. These constituents are also the active agents in the formation of most of the scale in vessels in which water is heated or evaporated.

Water having a hardness of no more than 50 ppm is generally rated as soft, and its treatment under ordinary circumstances is not necessary. Hardness of 50 to 150 ppm does not seriously interfere with the use of water for most purposes, but it does increase the consumption of soap. It is usually profitable for laundries, or other industries that use large quantities of soap, to soften such water. Water in the upper part of this range of hardness will cause considerable scale in steam boilers. Hardness of more than 150 ppm is very noticeable, and if the hardness is much over 200 ppm it is common practice to soften the water for household use or to obtain softer water from some other source.

The samples of water collected range in hardness from 2 to 446 ppm. Of these samples of water 15 had a hardness of 50 ppm or less, 14 had a hardness of more than 50 but no more than 150 ppm, 3 a hardness of more than 150 but no more than 200 ppm, 3 a hardness between 300 and 400 ppm, and 1 a hardness of 446 ppm.

COLOR

The materials that color ground water in this area are derived from organic matter and are in themselves harmless. Color is measured in terms of an arbitrary color standard. Color of less than 10, according to this standard, is not objectionable to those who have not been accustomed to colorless water. Color generally may be removed from water by coagulation and filtration.

Of the 36 samples analyzed for this report, 12 were colorless, 16 had color of less than 10, and 8 had color ranging from 12 to 104.

pH

The term pH is used to express acidity or alkalinity. Water that is neither acid nor alkaline is said to be neutral and has a pH value of 7. Water having an alkaline reaction has a pH higher than 7, whereas water having an acid reaction has a pH less than 7. The presence of alkaline salts causes a high pH in water, and the presence of dissolved carbon dioxide gas in the form of carbonic acid is the most common cause of a low pH. For all practical purposes the pH of a water depends on the ratio of the alkaline salts to the dissolved carbon dioxide. The suitability of a water is affected by its pH in that the lower the pH the greater the corrosiveness to metals, although not all water having the same pH is equally corrosive.

Of the 36 samples analyzed for this report 22 gave an alkaline reaction and 14 gave an acid reaction, the pH for all the samples ranging from 4.7 to 8.0.

TEMPERATURE

The temperature of the water from wells in the county ranges from about 70° to as high as 80°F. The lower temperatures are found in the relatively shallow wells, and the higher ones in deeper wells. The temperatures in the shallow wells vary slightly with the seasons, but those in the deeper wells remain fairly constant throughout the year.

HYDROGEN SULFIDE (H₂S)

Hydrogen sulfide gas, probably formed by the reduction of sulfate in the rocks, occurs in many wells in Highlands County. The hydrogen sulfide contents are not listed in table 4, however, as any gas that was in the samples when they were collected had been dissipated by the time they reached the laboratory. Hydrogen sulfide has the odor of rotten eggs and is found in small quantities in much of the water of this area. It usually disappears quickly when water is aerated or allowed to stand in an open vessel.

Chemical character in relation to stratigraphy

The ground water in Highlands County is derived from two major sources: (1) the Floridan aquifer, and (2) the aquifers in the upper part of the Hawthorn and in younger formations. Locally, in the southeastern part of the county, water from both sources has a relatively high mineral content, probably as a result of contamination by sea water trapped during high stages of the Pleistocene sea. A summary of the quality of water from the two major sources is given in table 10.

THE FLORIDAN AQUIFER

In the ridge section of the county, water from the Floridan aquifer has a low mineral content and does not differ greatly in quality from one to the other of the formations composing the aquifer. In the southeastern part of the county water from the aquifer has a much higher mineral content.

AQUIFERS IN THE UPPER PART OF THE HAWTHORN AND IN YOUNGER FORMATIONS

Water from the Hawthorn and younger formations in all the county, except the southeastern part, ranges widely in chemical composition. That in the southeastern part of the county, east of the shallow artesian system, has a uniformly high mineral content.

SUMMARY AND CONCLUSIONS

Ground water occurs in at least three distinct aquifers of unequal importance — the water-table, or unconfined aquifer, local shallow artesian aquifers, and the Floridan artesian aquifer.

Table 10 -- CHEMICAL ANALYSES, IN PARTS PER MILLION, OF WATER
FROM THE TWO MAJOR GROUND-WATER SOURCES IN HIGHLANDS COUNTY

	FLORIDAN AQUIFER		AQUIFERS IN THE HAWTHORN AND YOUNGER FORMATIONS	
	Ridge section of Highlands County (Samples from 14 wells)	Southeastern part of county (Samples from well no. 1)	All of county except southeastern part (Samples from 18 wells)	Southeastern part of county east of area of shallow artesian flow (Samples from 3 wells)
Iron (Fe)	0 to 0.62	0	0 to 3.2	0.06 to 1.2
Calcium (Ca)	16 to 40	61	.4 to 67	78 to 91
Magnesium (Mg)	1.1 to 21	46	.1 to 12	5.7 to 53
Sodium and potassium	1.4 to 14	43	4.0 to 20	15 to 219
Bicarbonate (HCO_3)	65 to 167	111	2.0 to 234	266 to 530
Sulfate (SO_4)	0 to 73	180	0 to 39	0 to 20
Chloride (Cl)	5 to 14	110	.6 to 57	20 to 332
Fluoride (F)	0 to .3	.5	0 to .8	.2 to .3
Nitrate (NO_3)	0 to .5	.1	.1 to 18	.5 to .9
Hardness as CaCO_3	50 to 185	340	2 to 181	217 to 446
Specific conductance at 25°C (micromhos)	130 to 400	928	26.7 to 380	540 to 1780
Color	0 to 7	0	0 to 30	25 to 104
pH	7.4 to 8.0	7.8	4.7 to 7.6	7.3 to 7.7
Temperature, °F	74 to 82	77.5	73 to 78+	73 to 74.5+

The water-table aquifer in the Highlands Ridge area is composed of Pleistocene sand deposits and the deltaic portion of the Hawthorn, made up of white to red, kaolinitic, quartz sand containing pebbles of quartz and, in places, of phosphorite. In the rest of the area the aquifer is composed of post-Miocene sands, the Tamiami formation, and, locally, the upper part of the Hawthorn formation. The beds of coarse sand and gravel in the Hawthorn in the ridge and the area west of it are an important source of water and are being utilized by an increasing number of screened and gravel-packed wells developed at depths of 120 to 200 feet. In the remainder of the county the water-table aquifer is a source of water for stock and domestic supplies.

Recharge to the unconfined ground-water body is derived principally from local rainfall, which averages about 52 inches a year. Because of the permeability of the surficial material throughout the county, the rainfall percolates rapidly down into the water-table aquifer, surface runoff occurring only where the aquifer is so full that it rejects the recharge. A few lakes and streams also are a source of recharge, at least at times, to the unconfined ground-water body. Some recharge is derived also from seepage from the shallow artesian aquifers, and from downward seepage of irrigation water.

Discharge of unconfined ground water occurs through evapotranspiration, streams, lakes, canals, and wells. Evapotranspiration accounts for a large percentage of the total ground-water discharge in areas where the water table is near the land surface. Studies have not been made of the evapotranspiration losses in the area, but they are estimated to exceed half the average annual rainfall. Ground water also is constantly being discharged into the streams and canals of the area, which during periods of low flow are maintained almost entirely from ground-water storage. Wells account for only a small amount of the total discharge. However, the amount of ground water discharged into lakes when they are being pumped for citrus irrigation is large, probably amounting to about 3 billion gallons in 1951.

Shallow artesian aquifers of minor importance, composed of coarse sand, gravel, or shell beds, occur locally in the Tamiami formation and the upper part of the Hawthorn in the area east of the ridge. They are found mainly on the flanks of the Highlands Ridge; the recharge area on the ridge and the upper reaches of its flanks have sufficient relief to provide an artesian head in the aquifers. The shallowest aquifers can be tapped by wells 10 to 15 feet deep, but because of very leaky confining beds their areal extent is small. In the Kissimmee

Valley area within the county an artesian aquifer occurs locally at depths of 125 to 150 feet below the land surface.

Recharge to the shallow artesian aquifers is by rainfall on and along the flanks of the ridge. Although a small amount of water from the aquifers is utilized for stock and domestic needs, most of it is discharged through leaky confining beds upward into the water-table aquifer.

The Floridan, or principal artesian, aquifer underlies the entire county and is the most important aquifer in the area. In the northwestern and southwestern parts of the county the top of the aquifer is respectively about 150 and 500 feet below mean sea level. The marine clay marls of the Hawthorn, which underlie the water-bearing gravel and sands of the deltaic part of that formation, compose the confining beds of the Floridan aquifer. Limestones in the lower part of the Hawthorn and the limestones of the Suwannee, Ocala, Moodys Branch, Avon Park, and Lake City formations constitute the part of the aquifer utilized in Highlands County. This upper 1,000 feet of the aquifer represents about one-third of the total thickness of the Tertiary limestone section, of which an undetermined thickness constitutes the Floridan aquifer. The Lake City limestone is the most important water-producing formation in the aquifer and is the principal source of many large water supplies for municipal use and irrigation. A 16-inch well drilled to a depth of 1,300 feet was reported to yield 2,000 gpm with a drawdown of 26 feet. The limestones of the lower part of the Hawthorn and of the Suwannee, Ocala, Moodys Branch, and Avon Park are not as permeable as the Lake City. These limestones are not in themselves important sources of water supplies, but as components of the Floridan aquifer they contribute water to wells that penetrate the lower formations; also, of course, water must pass through these limestones to reach the Lake City limestone. In the northwestern part of the county, the lower part of the Hawthorn is sufficiently permeable to be a potential source of medium to large supplies of water.

The piezometric surface of the Floridan aquifer ranges from about 95 feet above mean sea level at Avon Park to 55 feet at Brighton. It slopes in a general southeasterly direction, the piezometric high corresponding roughly to the topographic high.

Although the entire ridge section of Highlands County is in the recharge area for the Floridan aquifer, most of the recharge to the aquifer occurs north of Sebring. Cuttings from wells in the area north of Sebring indicate that the beds overlying the limestones of the Floridan aquifer are thin and fairly permeable. The recharge area extends north-

ward into Polk County, where the principal recharge to the aquifer occurs.

Discharge from the Floridan aquifer in Highlands County is by wells and the upward percolation in low areas through sand-filled sinks or collapse basins. About 1½ billion gallons of water for public and irrigation supplies is estimated to have been pumped in 1951 from the Floridan aquifer.

Table 11. — RECORD OF SELECTED WELLS IN HIGHLANDS COUNTY

(1 D, domestic; I, irrigation; O, observation; P, public supply; S, stock; T, test)

(2 Water level, in feet, above (+) or below (—) land surface)

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
1	About 17 miles west of Okeechobee on the south side of State Highway 70, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 26, T. 37 S., R. 32 E.	Lykes Bros.	640	8-6	.....	Ocala	D	Water level +22 ft., ² Oct. 10, 1952. Well 1 in W.S. P. 773-C. See table 9.
5	10 feet west of the aerator of the Hendricks Army Air Field water-treatment plant, about 6.3 miles southeast of Sebring, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 7, T. 35 S., R. 30 E.	U. S. Air Force.	176	8	.....	Hawthorn	D	Gravel-packed well. See log. F.G.S. well W595.
9	12 miles east of State Highway 64 on the south side of the road to Fort Kissimmee, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 7, T. 33 S., R. 31 E.	U. S. Geological Survey	26	6	22	Pleistocene	O	See fig. 7a; log.
10	0.9 mile west of State Highway 17 on the south side of State Highway 623, about 4 miles southeast of Sebring, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 35 S., R. 29 E.	do.	45	6	41	Hawthorn (?)	O	See fig. 7a.
11	3.1 miles northwest of the Istokpoga Canal on the south side of State Highway 66, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T. 35 S., R. 31 E.	do.	16	6	13	Pleistocene	O	See fig. 7a.
12	3.7 mile west of the Kissimmee River on the north side of State Highway 100, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 36 S., R. 33 E.	U. S. Geological Survey	21	6	18	Pleistocene	O	See fig. 7b; log.
13	0.5 mile west of the Kissimmee River on the north side of State Highway 70, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 37 S., R. 33 E.	do.	20	6	16	Pleistocene	O	See fig. 7b.
14	3.1 mile south of State Highway 70, on the east side of State Highway 25, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 38 S., R. 30 E.	do.	35	6	29	Hawthorn (?)	O	See fig. 7b.
15	0.1 mile north of the Highlands-Glades County line on the east side of State Highway 25, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 39 S., R. 30 E.	do.	23	6	19	Hawthorn (?)	O	See fig. 7b.
16	0.4 mile east of State Highway 25, and then 0.4 mile north on east side of clay road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 3, T. 35 S., R. 29 E.	S. Kahn.	1,410	12	.....	Lake City	I	See table 9.
18	4.3 mile east of Atlantic Coast Line Railroad station at Avon Park on east side of State Highway 64, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 17, T. 33 S., R. 29 E.	J. C. Ragsdale.	125+	2 $\frac{1}{2}$	125	Hawthorn	D, S	

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
20	2.8 miles east of Atlantic Coast Line Railroad Station at Avon Park on State Highway 64, then 0.6 mile east of clay road and 0.4 mile south on east side of private road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, T. 33 S., R. 29 E.	Rex Beach Estate..	624	8	.....	Moodys Branch..	D,S,I	See table 9.
21	2.5 miles east of Atlantic Coast Line Railroad Station at Avon Park on State Highway 64, then 0.1 mile south on west side of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 19, T. 35 S., R. 29 E.	W. F. Ward.....	56	2	.....	Hawthorn.....	D	Sand-point well.
22	West side of Park Street at intersection of Pine Street, Sebring, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, T. 34 S., R. 29 E.	Town of Sebring...	1,278	8	.....	Lake City.....	P	F.G.S. well W894. See log.
23	Northeast corner of Cypress Street and Franklin Street, Sebring, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 34 S., R. 29 E.	do.....	1,400	12-8	.....	do.....	P	
24	South of intersection of Eucalyptus Street and Avocado Street, Sebring, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 34 S., R. 29 E.	do.....	1,400	12-10	.....	do.....	P	See table 9.
26	0.3 mile south of Polk County line on State Highway 25, then 0.2 mile southwest of private road, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 33 S., R. 28 E.	M. Stagers.....	35	2	.....	Hawthorn.....	D	See table 9.
28	1.1 miles south of Polk County line on State Highway 25, then 0.4 mile southwest of clay road, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 33 S., R. 28 E.	S. Wittenstein.....	750	2	.....	Avon Park.....	D	See table 9.
31	2.6 miles north from State Highway 64 at Avon Park on State Highway 25, then 1.0 mile northeast on clay road to east side of road on edge of lake, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 33 S., R. 28 E.	Episcopal Church..	25+	60	5	Pleistocene (?)...	D	Concrete curbing.
32	2.0 miles north from State Highway 64 at Avon Park on State Highway 25, then 0.6 mile southwest on west side of clay road around Lake Byrd, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9, T. 33 S., R. 28 E.	C. H. Shepard.....	35	2	.....	Hawthorn (?)....	D	
36	1.5 miles north from State Highway 64 at Avon Park on State Highway 25, then 1.0 mile west and 0.8 mile south on clay road, and then 0.2 mile west of road, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 17, T. 33 S., R. 28 E.	Avon Park Citrus Co.	1,167	12	.....	Lake City.....	I	Water level, -77.67, Oct. 15, 1952. Yield 1,400 gpm.
37	1.0 mile north from State Highway 64 at Avon Park on State Highway 25, then 0.6 mile west on north side of clay road, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 33 S., R. 28 E.	do.....	554	4 $\frac{1}{2}$	.....	Ocala.....	D	See table 9.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
38	3.0 miles north from Seaboard Air Line Railroad crossing south of Lake Letta on State Highway 17, then 0.5 mile east on clay road, then 0.1 mile north of road, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 33 S., R. 29 E.	Avon Park Citrus Co.	554	12	.....	Lake City	I	See table 9.
40	1.9 miles north from State Highway 64 at Avon Park on State Highways 25 and 17, then 0.4 mile southwest on South side of clay road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9, T. 33 S., R. 28 E.	J. P. Garber	315	2 $\frac{1}{2}$	.....	Hawthorn	D	do.
43	1.7 miles north from State Highway 64 at Avon Park on State Highways 25 and 17, then 0.5 mile east on private road on north side, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 33 S., R. 28 E.	L. S. Pickett	29	1 $\frac{1}{4}$	.....	Pleistocene (?) ...	D	Sand-point well.
48	1.5 miles north from State Highway 64 at Avon Park on State Highways 17 and 25, then 0.3 mile east and 0.1 mile south on east side of clay road, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 33 S., R. 28 E.	C. L. Armstrong ...	60	2	.....	Hawthorn (?)	D	do.
49	1.5 miles north from State Highway 64 at Avon Park on State Highways 17 and 25, then 1.0 mile east and 0.2 mile north on east side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 11, T. 33 S., R. 28 E.	A. R. Klemm	43	1 $\frac{1}{2}$	.....	do.	D	do.
61	1.5 miles north from State Highway 64 at Avon Park on State Highways 17 and 25, then 1.8 miles east on north side of road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, T. 33 S., R. 28 E.	Minute Maid Corp.	107	3	100	Hawthorn	D	Screened well.
64	1.5 miles north from State Highway 64 at Avon Park on State Highways 17 and 25, then 1.9 miles north and 1.4 miles east on south side of clay road, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1, T. 33 S., R. 28 E.	do.	1,150	12	.....	Lake City	I	See table 9.
68	1.1 miles west from State Highways 17 and 25 at Avon Park, on State Highway 64, then 0.1 mile south on private road, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 20, T. 33 S., R. 28 E.	C. H. Ellis	48	1 $\frac{1}{4}$	.....	Hawthorn	D	Sand-point well.
70	2.6 miles west from State Highways 17 and 25 at Avon Park on State Highway 64 on northwest corner of clay road, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 33 S., R. 28 E.	G. S. Sloman	38	1 $\frac{1}{4}$	.....	Hawthorn (?)	D	do.
72	1.5 miles north from State Highway 64 at Avon Park on State Highways 17 and 25, then 2.0 miles east and 0.4 mile south on west side of clay road, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 33 S., R. 28 E.	H. A. Jackson	80	2	.....	Hawthorn	D	do.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
77	1.3 miles east from State Highways 17 and 25 at Avon Park on State Highway 64, then 0.3 mile north and 0.4 mile east on north side of clay road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 23, T. 33 S., R. 28 E.	T. H. Maxwell.....	85	3	.....	Hawthorn.....	D	Sand-point well.
82	2.0 miles east from State Highways 17 and 25 at Avon Park on State Highway 64, then 1.0 mile north and then 0.3 mile east on north side of clay road, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 33 S., R. 28 E.	D. M. Ellis.....	64	2	.....	Hawthorn (?)....	D	do.
83	0.5 mile south of intersection of State Highways 17 and 64 at Avon Park on east side of clay road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 22, T. 33 S., R. 28 E.	S. McKenzie.....	78	3	.....	Hawthorn.....	D	do.
86	0.8 mile south of intersection of State Highways 17 and 64 on clay road, then 0.25 mile east on south side of clay road, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 33 S., R. 28 E.	W. O. Skipper.....	38	2	.....	Hawthorn (?)....	D	do.
87	3.4 miles east of State Highway 17 on State Highway 64, then 0.5 mile south on east side of road, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 30, T. 33 S., R. 29 E.	Snow Crop Corp. . .	979	8-5	350	Avon Park.....	D, I	See table 9.
88	2.9 miles north of Seaboard Railroad crossing on State Highway 17, then 1.6 miles east and 0.5 mile north on west side of road, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 33 S., R. 29 E.	H. C. Maddox.....	26	2	.....	Hawthorn (?)....	S	Sand-point well.
90	2.2 miles south of State Highway 64 on east side of State Highway 17, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 33 S., R. 28 E.	W. Kluberge.....	35	1 $\frac{1}{2}$	.....	Pleistocene (?)...	D	Sand-point well.
92	3.3 miles north of Seaboard Railroad crossing on State Highway 17, then 0.8 mile west and south on west side of clay road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 36, T. 33 S., R. 28 E.	C. E. Hyde.....	94	2	.....	Hawthorn (?)....	D	do.
96	1.5 miles south of State Highway 64, then 0.8 mile southeast to Lake Lotela, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 35, T. 33 S., R. 28 E.	L. D. Bigoney.....	28	2	.....	Pleistocene (?)...	D	do.
101	1.9 miles south of State Highway 64, then 0.6 mile west to Lake Lelia, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 34, T. 33 S., R. 28 E.	G. E. Shaffer.....	87	1 $\frac{1}{4}$	.....	Hawthorn (?)....	D	do.
104	2.5 miles south of State Highway 64, then 0.2 mile southeast to Lake Denton, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T. 34 S., R. 28 E.	S. P. Durrance.....	30	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	do.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
107	4.7 miles south of State Highway 64 to Lake Sebring, then 0.9 mile west on north side of road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 34 S., R. 28 E.	Maxcy Securities, Inc.	1,130	8	.....	Lake City.....	D, S	
112	2.5 miles north of Seaboard Railroad on State Highway 17, then 1.5 miles south, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, T. 33 S., R. 29 E.	F. Addinsell.....	508	6-4	.....	Ocala (?).....	D	See table 9.
114	2.0 miles north of Seaboard Railroad on west side of State Highway 17, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T. 33 S., R. 29 E.	H. Jines.....	11	1 $\frac{1}{4}$	.....	Pleistocene.....	D	Sand-point well.
119	0.8 mile north of Seaboard Railroad on State Highway 17, then 0.7 mile east on north side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 5, T. 34 S., R. 29 E.	G. M. Towne.....	115	2	.....	Hawthorn.....	D	do.
126	0.6 mile south of Seaboard Railroad on State Highway 17, then 1.3 miles east and 0.1 mile south on east side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 9, T. 34 S., R. 29 E.	N. Wolf.....	1,150	12	.....	Lake City.....	I	See table 9.
128	0.5 mile south of Seaboard Railroad on State Highway 17, then 1.3 miles east, 0.8 mile south and 0.3 mile east on south side of road, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 16, T. 34 S., R. 29 E.	W. C. Waldron.....	90	2	.....	Hawthorn.....	D	do.
131	0.6 mile south of Seaboard Railroad on State Highway 17, then 8.9 miles east on north side of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T. 33 S., R. 20 E.	O. Murphey.....	125	2	80	do.....	S	Water level +5 ft., May 9, 1950. See table 9.
132	0.6 mile south of Seaboard Railroad on State Highway 17, then 11.6 miles east on north side of road, SW $\frac{1}{4}$ sec. 26, T. 34 S., R. 30 E.	C. Redwine.....	180	2	.....	Hawthorn.....	D, S	
133	2.6 miles south from traffic circle in Sebring on State Highway 25, on west side of highway, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 5, T. 35 S., R. 29 E.	H. W. Harris.....	70	2	.....	Hawthorn (?).....	D	
139	1.7 miles south from Seaboard Railroad crossing south of Lake Letta on State Highways 17 and 25 at tourist court on east side of Highway, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 18, T. 34 S., R. 29 E.	R. Kosman.....	55	1 $\frac{1}{4}$	.....	do.....	D	
141	5.9 miles west of State Highway 25 on State road 634, then 0.5 mile north to Highlands Hammock State Park Office, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 34 S., R. 28 E.	Highlands Hammock	230	4	102	Hawthorn.....	D	See table 9.

Table 11.—Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
147	0.6 mile west of State Highway 25 on State Road 634, then 2.8 miles south on graded road to edge of Lake Buck, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 35 S., R. 29 E.	W. H. Calhoun.....	45	1 $\frac{1}{4}$	.....	Hawthorn (?)....	D	
148	3.2 miles west from State Highway 25 on State Road 634, then 0.2 mile north on west side of road, SE $\frac{1}{4}$ sec. 35, T. 34 S., R. 28 E.	L. D. Mather.....	40	3	.....	do.....	D, I	Screened well.
149	5.0 miles east of State Highway 25 on State Road 634, then 1.9 miles south, and then 1.8 miles west on west side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 8, T. 35 S., R. 28 E.	J. Vaughn.....	24+	30	24	Hawthorn.....	D	Concrete curbing. See table 9.
150	1.4 miles north from State Highway 700 on State Highway 25, then 0.2 mile east at end of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 35 S., R. 29 E.	A. H. Bee.....	32	2	.....	Hawthorn (?)....	D	Sand-point well.
157	0.4 mile east from State Highway 25 on State Highway 700, then northeast and north 3.0 miles on old highway, and then west 0.5 mile on north side of clay road, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 35 S., R. 29 E.	W. H. Brooker.....	22	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	do.
161	0.4 mile east from State Highway 25 on State Highway 700, then northeast and north 4.0 miles on old highway, and then 0.4 mile east to dairy, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 34 S., R. 29 E.	J. R. Ramer.....	670	4	.....	Ocala.....	S	See table 9.
170	1.3 miles north from State Highway 700 on State Highway 25, then east 0.2 mile on clay road, then north 1.6 miles, then west 1.0 mile, and then north 0.4 mile on east side of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 33, T. 34 S., R. 29 E.	A. I. Young.....	35	2	.....	Pleistocene (?)...	D	Sand-point well.
173	3.3 miles east from State Highway 25 on State Highway 700, north side, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 18, T. 35 S., R. 30 E.	R. X. Droit.....	21	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	Sand-point well.
179	8.5 miles east from State Highway 25 on south side of State Highway 700, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 35 S., R. 30 E.	A. C. Ponder.....	30	1 $\frac{1}{4}$	.....	do.....	D	See table 9.
182	8.8 miles east from State Highway 25 on south side of State Highway 700, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 35 S., R. 30 E.	L. Waldron.....	240	2	.....	Hawthorn.....	D	Flowing sand-point well. See table 9.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
183	3.0 miles north from Seaboard Railroad crossing south of Lake Letta on State Highway 25, then 1.9 miles east on north side of clay road, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 30, T. 33 S., R. 29 E.	Avon Park Citrus Corp.	1,212	5	304	Lake City.....	D	Water level — 15.5 ft., June 29, 1952. Log included. F.G.S. well W2397.
192	10.9 miles east from State Highway 25 at DeSoto City, on State Highway 700, 100 feet east of Post Office at Lorida, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 8, T. 35 S., R. 31 E.	R. L. Stokes.....	20	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	Sand-point well.
195	About 11 miles east from State Highway 25 at DeSoto City, on the north side of State Highway 700, on the owner's property, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 8, T. 35 S., R. 31 E.	E. Boney.....	235	2	.....	Hawthorn.....	D	
201	3.4 miles east from State Highway 25 at DeSoto City on the north side of State Highway 700 at the junction with the road to Hendricks field, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 18, T. 35 S., R. 30 E.	C. A. Causey.....	223	3	211	Hawthorn.....	D	
203	1.2 miles south from State Highway 700 at DeSoto City on State Highway 25, then 1.2 miles west on the south side of clay road, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 35 S., R. 29 E.	L. C. Smith.....	110	2	.....	do.....	D	Sand-point well.
204	1.2 miles south from State Highway 700 at DeSoto City on State Highway 25, then 1.5 miles west on the south side of clay road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 35 S., R. 29 E.	do.....	20	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	do.
211	1.0 mile east from State Highway 25 at DeSoto City on State Highway 700, then 1.8 miles south on paved road, then 0.4 mile west on clay road, and then 0.1 mile north on the west side of private road, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 35 S., R. 29 E.	Maxcy Securities, Inc.	1,455	12-10	.....	Lake City.....	D, I	See table 9; log. F. G. S. well W1464.
212	1.0 mile east from State Highway 25 at DeSoto City on State Highway 700, then 1.8 miles south on paved road, then 0.8 mile west on clay road, and then 0.5 mile north on the east side of unimproved road, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 35 S., R. 29 E.	J. H. Twitty.....	58	2	.....	Hawthorn.....	D	Sand-point well.
214	1.0 mile east from State Highway 25 at DeSoto City on State Highway 700, then 3.2 miles south on paved road, and then 0.5 mile east to end of clay road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 35, T. 35 S., R. 29 E.	F. B. Tauchen.....	86	2	.....	Hawthorn.....	D	Sand-point well. See table 9.

Table 11.—Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
217	2.5 miles south from State Highway 700 at DeSoto City on State Highway 25, then 0.1 mile west on the north side of private road, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 34, T. 35 S., R. 29 E.	J. E. Wilson.....	30	2	.....	Hawthorn (?)....	D	Sand-point well.
222	6.2 miles south from State Highway 700 at DeSoto City on west side of State Highway 25, at fruit stand, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 36 S., R. 29 E.	J. L. McLure.....	51	2	.....	do.....	D, I	Screened well.
230	0.3 mile north from Atlantic Coast Line Railroad crossing, which is about 1 mile north of Lake Placid, on State Highway 25, then 0.6 mile west on south side of road to Hen Scratch, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 36 S., R. 29 E.	P. B. Hartman.....	37	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	Sand-point well.
235	0.3 mile north from Atlantic Coast Line Railroad crossing which is about 1 mile north of Lake Placid on State Highway 25, then 4.10 miles west on road to Hen Scratch, and then 0.2 mile north at end of private road, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 28, T. 36 S., R. 29 E.	M. P. Miller.....	25	1 $\frac{1}{4}$	.....	Hawthorn.....	D	do. See table 9.
236	0.3 mile north from Atlantic Coast Line Railroad crossing, which is about 1 mile north of Lake Placid, on State Highway 25, then 8.3 miles west on the north side of road to Hen Scratch, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25, T. 36 S., R. 28 E.	J. K. Roosevelt....	50	2	.....	Hawthorn.....	D	Sand-point well.
241	About 0.1 mile west of Atlantic Coast Line Railroad crossing, which is about 1 mile north of Lake Placid on State Highway 25 near the east shore of Lake Stearns, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 36 S., R. 30 E.	I. Boriss.....	46	2	.....	do.....	D	do.
251	0.5 mile east from State Highway 25 at Lake Placid on State Highway 621, then 0.2 mile south on east side of private road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, T. 36 S., R. 30 E.	A. Blair.....	115	2	95	do.....	D	20 ft. of screen; see log. F.G.S. well W2850.
255	1.4 miles east from State Highway 25 at Lake Placid on State Highway 621, then 0.5 mile north on west side of road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 36 S., R. 30 E.	C. Tompkins.....	48	1 $\frac{1}{4}$	.....	Pleistocene (?)..	D	Sand-point well.
260	1.7 miles east from State Highway 25 at Lake Placid on State Highway 621, then 1.9 miles south, and then 0.1 mile west at the end of private road, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 8, T. 37 S., R. 30 E.	G. Parks.....	26	2	.....	Pleistocene.....	D	Sand-point well.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
269	1.8 miles east from State Highway 25 at Lake Placid on State Highway 621, then 1.4 miles northwest, then 0.2 mile south, and 0.1 mile east on south side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 36 S., R. 30 E.	J. R. Hendry.....	137	3	90	Hawthorn.....	D	Water level +15 ft., July 18, 1950. See table 9.
273	2.9 miles east from State Highway 25 at Lake Placid on State Highway 621, then 3.9 miles south on clay road, and then about 300 feet east of road, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 37 S., R. 30 E.	J. J. Hendry.....	65	2	35	Tamiami.....	I	Water level +16 ft., July 19, 1950. See table 9.
284	6 miles east from State Highway 25 at Lake Placid on south side of State Highway 621, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 37 S., R. 31 E.	O. Reynolds.....	580	6	.....	Suwannee (?)....	D	Water level +16.5 ft., April 11, 1951. Reported flow 300 gpm.
286	6 miles east from State Highway 25 at Lake Placid on State Highway 621, then 6.6 miles northwest on road, and then 300 feet west of road, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 36 S., R. 31 E.	Lykes Bros.....	150	1 $\frac{1}{4}$	.....	Hawthorn.....	D	
287	6 miles east from State Highway 25 at Lake Placid on State Highway 621, then 7.4 miles northwest on road, then 0.2 mile west on north side of private road, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 3, T. 36 S., R. 31 E.	Lykes Bros.....	35	1 $\frac{1}{4}$	.....	Pleistocene.....	D	Sand-point well.
292	11.3 miles east from State Highway 25 at DeSoto City on State Highway 700, then 0.7 mile southeast on sand road, and then 3.2 miles south on west side of sand road, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 33, T. 35 S., R. 31 E.	A. Boney.....	214	2	.....	Hawthorn.....	D	
293	11.3 miles east from State Highway 25 at DeSoto City on State Highway 700, then 0.7 mile southeast on sand road, then 2.3 miles south on road, and then 0.4 miles east on north side of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 28, T. 35 S., R. 31 E.	do.....	20	3	.....	Pleistocene.....	S	Sand-point well.
295	0.6 mile south from State Highway 621 at Lake Placid on State Highway 25, then 0.5 mile east on clay road, and then 0.2 mile north on west side of road, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 37 S., R. 30 E.	G. L. Pendarvis....	30	2	.....	Pleistocene (?)...	D	
299	0.8 mile south from State Highway 621 at Lake Placid on State Highway 25 at the southwest corner of junction with paved road, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 37 S., R. 30 E.	G. Smoak.....	90	4	.....	Hawthorn (?)....	D	

Table 11.—Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
305	0.5 mile north from junction of State Highways 17 and 64 near Lake Verona in Avon Park, then 0.3 mile east on the north side of road, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 33 S., R. 28 E.	R. H. Lawhon.....	1,230	12-10	345	Lake City.....	I	Water level —67.5 ft., Aug. 15, 1950. Reported yield 1,500 gpm. See log. F.G.S. well W2398.
312	1.6 miles south from State Highway 621 at Lake Placid on State Highway 25, then 1 mile west on unimproved road, then 0.3 mile north on east side of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 37 S., R. 30 E.	L. L. Henderson....	10	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	Sand-point well.
320	3.5 miles west from State Highway 25 on State Highway 70, then 2.1 miles north on west side of clay and sand road, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25, T. 37 S., R. 29 E.	G. McSwain.....	18	1 $\frac{1}{4}$	.....	Pleistocene.....	None	do.
325	3.5 miles west from State Highway 25 on State Highway 70, then 1.5 miles north on clay and sand road, and then 0.2 mile east on private road to well, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 25, T. 39 S., R. 29 E.	J. C. Ralls.....	65	1 $\frac{1}{4}$	.....	Hawthorn (?)....	D	do.
327	3.4 miles north from State Highway 70 on State Highway 25, then 0.2 mile west on south side of road, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 17, T. 37 S., R. 30 E.	E. W. Kelsey.....	80	3	.....	Hawthorn.....	D	Screened well.
329	1.6 miles north from State Highway 70 on west side of State Highway 25, SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 28, T. 37 S., R. 30 E.	E. L. Taylor.....	21	2	.....	Pleistocene (?)...	D	Sand-point well.
330	2.3 miles west from State Highway 25 on the north side of State Highway 70, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 37 S., R. 30 E.	A. J. Reynolds.....	49	4	45	Hawthorn (?)....	D	Flowing well. See table 9.
332	7.5 miles west from State Highway 25 on State Highway 70, then about 0.1 mile south of road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 38 S., R. 31 E.	T. J. Durrance.....	100	3	.....	Tamiami.....	D	
334	9.1 miles west from State Highway 25 on State Highway 70, then 0.1 mile north on east side of private road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 37 S., R. 31 E.	G. H. Tucker.....	88	1 $\frac{1}{4}$	.....	do.....	D	See table 9.
337	19.0 miles east from State Highway 25 on State Highway 70, then 4.3 miles north and then 1.7 miles east on sand road, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 36 S., R. 33 E.	W. F. Underhill....	45	2	.....	Pleistocene.....	D	do.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
342	19.0 miles east from State Highway 25 on State Highway 70, then 9.0 miles north, then 2.5 miles northwest and then 0.2 mile north on sand road, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 36 S., R. 32 E.	L. L. Williams.....	171	1 $\frac{1}{4}$	.....	Hawthorn.....	D	
343	19.0 miles east from State Highway 25 on State Highway 70, then 9.0 miles north, then 2.9 miles northwest, and then 0.1 mile north to fish camp, center of west half, sec. 2, T. 36 S., R. 32 E.	J. Deadwyler.....	82	2	44	Tamiami.....	D	
344	19.0 miles east from State Highway 25 on State Highway 70, then 9.0 miles north and 4.1 miles northwest, and then 0.1 mile north to fish camp, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 35 S., R. 32 E.	R. Durrance.....	252	2	155	Hawthorn.....	D	See table 9.
345	19.0 miles east from State Highway 25 on State Highway 70, then 9.0 miles north and then 7.3 miles northwest on north side of road, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 30, T. 35 S., R. 32 E.	S. McClelland.....	43	1 $\frac{1}{4}$	.....	Pleistocene.....	D	
351	2.9 miles south from State Highway 70 on State Highway 17, then 0.1 miles west on clay road, SW $\frac{1}{4}$ sec. 17, T. 38 S., R. 30 E.	J. C. Carlton.....	34	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	See table 9.
357	10.2 miles south from State Highway 70 on State Highway 17, then 2.4 miles west and northwest, and then 0.2 mile northeast, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 39 S., R. 29 E.	S. Miller.....	30	1 $\frac{1}{4}$	11	Hawthorn.....	D	do. Well caves.
358	2.6 miles south from State Highway 70 on State Highway 17, then 0.2 mile east of highway in grove, center sec. 17, T. 38 S., R. 30 E.	Sebring Packing Co.	1,550	12-10	517	Lake City.....	I	See table 9; see log. F.G.S. well W2399.
362	1.3 miles north from State Highway 731 on State Highway 17, then 2.6 miles northwest, then 2.1 miles west, then 0.2 mile south, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 39 S., R. 29 E.	N. E. Browning....	18	1 $\frac{1}{4}$	.....	Hawthorn (?)....	D	Sand-point well.
370	3.8 miles west from State Highway 25 on State Highway 731, then 0.6 mile north and then 0.2 mile east on north side of road, NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T. 39 S., R. 29 E.	N. B. Jackson.....	35	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	do.
376	3.5 miles west from State Highway 25 on State Highway 731, then 0.6 mile south on west side of road, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 39 S., R. 29 E.	B. Hope.....	20	2	10	Hawthorn.....	D	Water level +1.5 ft., Oct. 4, 1950. See table 9.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
379	2.0 miles west from State Highway 25 on State Highway 731, north side, at garage, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 24, T. 39 S., R. 29 E.	W. J. Espenlaub	125+	2	125	Hawthorn	D	Well flows during rainy season
384	1.3 miles west from State Highway 25 on State Highway 731, then 0.5 mile south, and then 0.7 mile west on south side of road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 39 S., R. 29 E.	N. B. Jackson.....	23	1 $\frac{1}{4}$	.....	Hawthorn (?)....	D	Well flows after local rains.
387	0.3 mile north from Highlands-Glades County line on State Highway 25, then 0.1 mile east on private road, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 39 S., R. 30 E.	J. H. Peoples.....	25	1 $\frac{1}{4}$	.....	Pleistocene (?)...	D	Sand-point well.
389	4.0 miles north from Highlands-Glades County line on west side of State Highway 25, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 17, T. 39 S., R. 30 E.	R. J. Hargrove.....	30	1 $\frac{1}{4}$	.....	do.....	D	do.
390	Southwest corner of intersection of State Highways 25 and 70, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 38 S., R. 30 E.	H. R. Blair.....	96	4	.....	Hawthorn (?)....	D	Screened well.
391	300 feet south of State Highways 64 and 17 in Avon Park between Seaboard Air Line and Atlantic Coast Line railroad tracks, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 22, T. 33 S., R. 28 E.	Town of Avon Park	1,040	10	350	Avon Park.....	P	See table 9. Well listed in W.S.P. 596-G.
392	0.6 mile south from State Highway 64 at Avon Park on State Highways 17 and 27, then 0.8 mile south and then 0.1 mile east to power plant, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 26, T. 33 S., R. 28 E.	Florida Power Corp.	1,153	15	260	Lake City, Avon Park	P	
393	14.5 miles west from State Highway 25 on north side of State Highway 70, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T. 37 S., R. 28 E.	C. C. Carlton.....	80	1 $\frac{1}{4}$	.....	Hawthorn.....	S	See table 9.
394	0.8 mile north from State Highway 700 on State Highway 17, then 300 feet south on west side of clay road, SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 35 S., R. 29 E.	DeSoto City.....	88	4	68	do.....	P	20 feet of screen. See table 9.
396	3.8 miles west from State Highway 25 on State Highway 731, then 1.1 miles north on State Highway 17, and then 3.0 miles west and 0.4 mile south on clay road, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 39 S., R. 29 E.	C. Arnold.....	23+	1 $\frac{1}{4}$	23	Hawthorn (?)....	D	Flows 7 gpm.
399	10.9 miles east from State Highway 25 at DeSoto City on State Highway 700, then 2.5 miles south on sand road, 50 feet west of post office at Lorida, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 35 S., R. 31 E.	R. C. Carlton.....	1,106	6	294	Lake City.....	I	Water level +10.5 ft., Mar. 11, 1951. See log. F.G.S. well W2401.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
400	3.9 miles south from State Highway 70 on State Highway 25, then 0.4 mile west on clay road, and then about 0.2 mile north of road, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 20, T. 38 S., R. 30 E.	C. Brown.....	1,439	12-10	700	do.....	I	Water level - 115 ft., Oct. 15, 1951. See log. F.G.S. well W2848.
401	0.8 mile west from State Highway 17 on State Highway 64, then 1.8 miles north on clay road, and then 0.3 mile west on south side of sand road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 33 S., R. 28 E.	Minute Maid Corp.	1,301	16-12	455	Lake City.....	I	Water level - 87 ft., Feb. 27, 1951. Yield 2,565 gpm. See log. F.G.S. well W2378.
403	0.5 mile north from State Highway 64 on west side of Seaboard Air Line and Atlantic Coast Line railroad tracks in Avon Park, then 0.2 mile west on south side of clay road, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 22, T. 33 S., R. 28 E.	Town of Avon Park	1,301	10	301	do.....	P	Water level - 74 ft., Apr. 11, 1951. Yield 636 gpm. See log. F.G.S. well W2843.
405	0.8 mile south from traffic circle in Sebring on State Highway 25, then 1.3 miles east of State Highway 17, and then 0.8 mile south on east side of road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 34 S., R. 29 E.	T. O. Kuhl.....	120	2	.....	Hawthorn.....	T	See log. F.G.S. well W2849.
406	1.5 miles north from State Highway 64 in Avon Park on State Highway 25, then 3.0 miles east on clay road, then 0.5 mile north on clay road, then 0.9 mile north-east on clay road, and then about 0.2 mile north of road, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 7, T. 33 S., R. 29 E.	N. Gumenick.....	590	4-3	.....	Ocala.....	I	Water level - 55 ft., June 11, 1951.
407	0.8 mile west on road from Atlantic Coast Line railroad station in Lake Placid, and 70 feet north of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 36 S., R. 29 E.	T. U. Jackson.....	200	2	.....	Hawthorn.....	T	See log. F.G.S. well W2845.
408	1.3 miles south from Seaboard Air Line Railroad crossing near Lakemont on State Highway 17, and then 0.4 mile west on north side of clay road, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 18, T. 34 S., R. 29 E.	B. F. Conner.....	1,400	14	464	Lake City.....	I	Water level - 55 ft., June 25, 1951. Yield 1,200 gpm. See log. F.G.S. well W2859.
409	4.1 miles south from State Highway 634 at the entrance of Highlands Hammock State Park on sand road, then 1.0 mile west on sand road, and then 0.4 mile south on winding sand trail, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 28, T. 35 S., R. 28 E.	I. C. Hart.....	20	.....	.....	Hawthorn.....	S	Water level +3 ft., July 13, 1951. Well is large rectangular ditch.
411	3.9 miles south from State Highway 70 on State Highway 25, then 0.5 mile west on clay road, and then 0.1 mile south of road, S $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 20, T. 38 S., R. 30 E.	A. M. Huff.....	200	10	110	do.....	I	Gravel-packed well with 90 ft. of slotted pipe. Est. yield 1,200 gpm.

Table 11. — Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
414	1.1 miles north from Seaboard Air Line Railroad crossing near Lakemont on the west side of State Highway 17 in a drive-in-theatre, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T. 34 S., R. 29 E.	Floyd Theaters, Inc.	120	4	110	do.....	P	Gravel-packed well with 10 ft. of screen. See log. F.G.S. well W2846.
415	2.3 miles north from Seaboard Air Line Railroad crossing near Lakemont on State Highway 17, and then west 0.7 mile on south side of clay road, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 33 S., R. 29 E.	B. H. Griffin.....	1,140	12-10	397	Lake City.....	I	Water level -35.5 ft., Nov. 21, 1951. Est. yield 1,400 gpm.
416	0.9 mile north from State Highway 621 on west side of State Highway 25, NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, T. 36 S., R. 30 E.	M. A. Smoak....	250	10	150	Hawthorn.....	I	Gravel-packed well with 100 ft. of slotted pipe. Yield 1,320 gpm.
417	2.1 miles south from State Highway 70 on State Highway 25, then 0.3 mile west on clay road, and then 1.3 miles north on east side of clay road, NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 4, T. 33 S., R. 30 E.	G. McSwain.....	130	8	80	do.....	I	Gravel-packed well with 50 ft. of slotted pipe.
421	1.3 miles north from the Seaboard Air Line Railroad crossing near Lakemont on State Highway 17, then 0.7 mile east on clay road, and then 0.2 mile north of road, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T. 33 S., R. 29 E.	J. M. Stiles.....	180	12-10	60	do.. ..	I	Water level -22 ft., Dec. 11, 1951. Gravel-packed well with 120 ft. of slotted pipe. Est. yield 1,800 gpm.
422	0.3 mile north from State Highway 70 on State Highway 25, then 0.3 mile east on north side of private road, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 37 S., R. 30 E.	J. K. Roosevelt ..	100	2	.....	do.....	F	See log. F.G.S. well W2847.
423	4.0 miles north from Highlands-Glades County line on State Highway 25, northwest corner sec. 16, T. 39 S., R. 30 E.	H. B. Snivley	82	4	74	do.....	D	8 ft. of screen. Yield 60 gpm. See log. F.G.S. well W2840.
424	2.2 miles east from State Highway 25 on north side of State Highway 70, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 37 S., R. 30 E.	U. S. Geological Survey	21	6	18	Pleistocene (?)...	O	
425	4.8 miles east from State Highway 25 on State Highway 70, then 0.1 mile north of road, SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T. 37 S., R. 31 E.	U. S. Geological Survey	125	4	65	.....	T	See log.
426	1 mile east from Lake Istokpoga on south side of Istokpoga Canal, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 36 S., R. 31 E.	do.....	65	4	54	.....	T	do.
427	300 feet west of bridge over the Kissimmee River on north side of State Highway 700, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 8, T. 36 S., R. 33 E.	do.....	101	4	94	.....	T	do.

Table 11. -- Continued

Well No.	Location	Owner	Depth (ft.)	Diameter (in.)	Casing depth (ft.)	Probable geologic source	Use ¹	Remarks
428	In Highlands Hammock State Park, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 35 S., R. 28 E.	Florida Park Service	48	2	.....	.....	T	do.
433	3.2 miles east from State Highway 25 on the north side of State Highway 70, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 37 S., R. 30 E.	U. S. Geological Survey	130	.....	.....	.....	T	do.
434	2.7 miles east from State Highway 25 on the south side of State Highway 70, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, T. 38 S., R. 30 E.	do.....	60	.....	.....	.....	T	do.
435	2.2 miles east from State Highway 25 on the north side of State Highway 70, SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 37 S., R. 30 E.	do.....	220	.....	.....	.....	T	do.
436	1.4 miles east from State Highway 25 on south side of State Highway 70, NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 38 S., R. 36 E.	U. S. Geological Survey	140	.....	.....	.....	T	See log.
437	4.2 miles west from State Highway 25 on south side of State Highway 70, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T. 38 S., R. 29 E.	do.....	160	.....	.....	.....	T	do.
438	6.5 miles west from State Highway 25 on south side of State Highway 70, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 5, T. 38 S., R. 29 E.	do.....	60	.....	.....	.....	T	do.
439	10.1 miles south from State Highway 70 on State Highway 25, then 3.7 miles west on south side of State Highway 17, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 39 S., R. 29 E.	do.....	210	.....	.....	.....	T	do.

MEASURED GEOLOGIC SECTIONS

The Hawthorn formation and formations of Pleistocene age are exposed in many of the clay pits, road cuts, and drainage ditches in Highlands County. Some of the best exposures are listed below; all the material described is nonfossiliferous.

Stations 401 and 426. — Road-metal pit in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 11, T. 33 S., R. 28 E., 3 miles north of Avon Park. The geologic section exposed in this pit shows the unconformable contact between the Hawthorn formation and formations of Pleistocene age and also gives some indication of the unevenness of the pre-Pleistocene land surface. (See figure 11.)

Station 407. — Abandoned road-metal pit in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 35 S., R. 29 E., 1 mile west of DeSoto City. Surface altitude 110 feet.

SECTION	THICKNESS (FEET)
Pleistocene deposits:	
2b. Sand, fine to medium, carbonaceous, tan-gray.....	0.5
2a. Sand, medium to coarse, slightly clayey, light-gray-orange to orange	22.0
Hawthorn formation:	
1b. Clay, sandy (medium to very coarse), red-orange; nodules of yellow to white sandy clay. Hardens on exposure, stands in vertical cuts	6.0
1a. Sand, medium to very coarse, clayey, tan-gray to orange.....	1.5

Station 410. — Stream bank and auger hole in the northwest corner, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 39 S., R. 29 E., 4 miles northwest of Venus. Surface altitude 90 $\pm$ 5 feet.

SECTION	THICKNESS (FEET)
Pleistocene deposits:	
2b. Sand, fine to medium, quartz, carbonaceous, light-gray to brown. Grades into bed below	3.0
2a. Sand, quartz, fine to medium, with some coarse sand at bottom of bed, tan.....	2.0
Hawthorn (?) formation:	
1c. Clay, sandy, medium to coarse, plastic, tan, stained with limonite	2.0
1b. Same as bed 1c but clay is tan to turquoise	1.0
1a. Sand, quartz, medium to coarse, with some tan clay	0.5

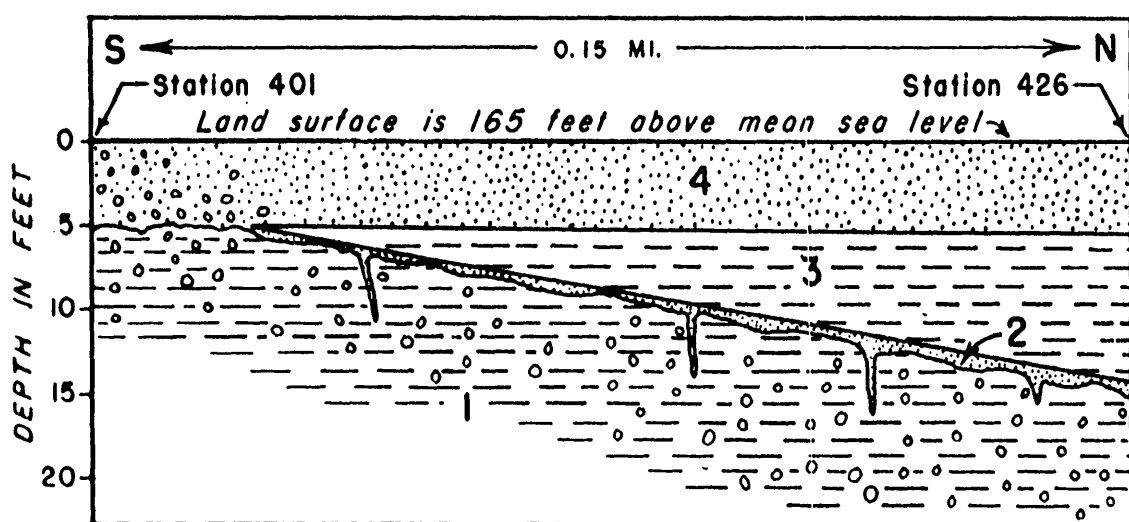
Station 415. — Road cut in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 35 S., R. 29 E., 6 miles southeast of Sebring. Surface altitude 115 $\pm$ 5 feet.

SECTION	THICKNESS (FEET)
Pleistocene deposits:	
1b. Sand, quartz, fine to coarse (average medium), rounded, frosted, light-yellow-orange	0.5
1a. Sand, quartz, medium to coarse, (average coarse), rounded, partially frosted, gray-orange, with a large amount of heavy minerals	30.0

Bed 1a is typical of the material comprising the many coastal bars in the eastern and southern parts of the Highlands Ridge.

Station 408.—Road-metal pit in the center of the NE¼ sec. 32, T. 37 S., R. 30 E., 6 miles south of the town of Lake Placid. Surface altitude 165'5 feet.

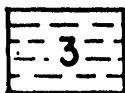
SECTION	THICKNESS (FEET)
Pleistocene deposits:	
2. Sand, quartz, medium to coarse, cream-orange	4.0
Hawthorn formation:	
1. Clay, sandy (medium to very coarse), brick-red to brown; nodules of white sandy kaolinite and ironstones. Stands in vertical cuts	5.0



EXPLANATION



Sand, quartz, light gray-orange, medium to coarse. This bed contains numerous rounded ironstones at station 401 with the stones increasing in number toward base of bed. (Pleistocene).



Sand, quartz, light gray to orange, medium to coarse with layers of red-brown to yellow-brown clayey sand becoming massive toward bottom of bed. Upper part of bed shows some stratification on weathered surfaces. (Pleistocene).



Sand, quartz, white, coarse. This bed forms a thin layer between beds 1 and 3. Spring line. (Pleistocene).



Clay, sandy, massive, orange to red-orange, with nodules of ironstone and nodules and pipes of yellow-brown sandy clay. Sand fine to coarse, average coarse. Bed is capped locally with hard limonitic sandstone. Stands in vertical cuts. (Hawthorn formation).

FIGURE 11.—Idealized geologic section between stations 401 and 426.

Station 409. — Drainage ditch in the center of section 11, T. 36 S., R. 28 E., about 8 miles southwest of DeSoto City. Surface altitude 70±10 feet.

SECTION	THICKNESS (FEET)
Pleistocene deposits:	
2. Sand, quartz, carbonaceous, medium to fine, gray	1.5
Hawthorn(?) formation:	
1. Marl, sandy, light-gray to tan-gray, hardens to limestone on exposure	1.5

WELL LOGS

Well 22

(F. G. S. no. 894)

At Sebring near power plant. Surface altitude 120 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
No sample	0- 130
Hawthorn formations:	
Quartz sand	130- 180
Sand, fine to granule-size, quartz, brown and black phosphorite	180- 190
Sand, sandy limestone, shell fragments, and brown phosphorite	190- 305
Limestone, phosphatic, coarsely sandy	305- 315
As above, and sand	315- 345
Limestone, impure, 50 percent black phosphorite	345- 355
As above, and sand	355- 375
Limestone, impure, black phosphorite	375- 395
Dolomite, "sugary", light-tan; "sugary" phosphatic limestone	395- 415
Limestone, sandy, phosphatic	415- 435
Sand and phosphorite	435- 445
Sand, phosphorite, and limestone	445- 515
Suwannee limestone:	
Limestone, chalky, white to very light tan, <i>Rotalia mexicana</i>	515- 585
Ocala limestone:	
Limestone, cream-colored, very granular, <i>Lepidocyclina</i> <i>ocalana</i> , <i>Eponides jacksonensis</i> , <i>Gypsina globula</i> , <i>Operculinoides</i> sp.	585-?
Avon Park limestone:	
Limestone, chalky-white to light-tan, mostly aggregate of calcite rhombs. <i>Discorinopsis gunteri</i> , <i>Coskino-</i> <i>lina floridana</i> , at 1,000 feet <i>Spirolina coryensis</i>	?-1,040
Lake City limestone at 1,110 feet:	
As above, and 10 percent brown "sugary" dolomite with <i>Fabularia vaughani</i> at 1,110 feet	1,040-1,200
Dolomite, dark-tan, dense	1,200-1,240
Dolomite, dark-tan, and nearly white limestone with <i>Dictyoconus cookei</i>	1,240-1,260
No sample	1,260-1,278

Well 5

(F. G. S. no. 595)

Near DeSoto City, 400 feet west of the southeast corner of sec. 7, T. 35 S., R. 30 E.

Surface altitude, 60.5 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, white to brown, very fine to coarse (average fine), rounded to angular, frosted	0-	20
Sand, quartz, brown, very fine to coarse, average medium, rounded to angular, frosted; some organic material	20-	35
As above, plus about 40 percent silty or clayey organic material	35-	37
Sand, quartz, black, carbonaceous, containing thin pieces of laminated peat	37-	42
Sand, quartz, gray-brown, silty	42-	45
As above, plus some gray clay	45-	50
Sand, quartz, gray-white, with only a small amount of silt, sand grains (average fine)	50-	55
As above, very fine to coarse (average medium)	55-	60
As above, plus a few medium, sand-size phosphorite grains	60-	70
Sand, quartz, tan-gray (average medium)	70-	75
Sand, quartz, gray-white, very fine to medium (average fine)	75-	90
As above, but very fine to coarse (average medium)	90-	94
As above, plus some peat and carbonaceous sandstone	94-	100
As above, but sand is cream white, very fine to coarse (average medium)	100-	105
Tamiami formation:		
Shell marl, green-gray, very finely sandy and silty. Shells compose 20-30 percent of sample, mainly pelecypod fragments	105-	113
As above, plus some muscovite and numerous small grains of brown to black phosphorite. Sparse foram fauna, principally <i>Rotalia beccarii</i> var.; also a few unidentified ostracods and fish bones. Mollusk fragments compose about 5-10 percent of sample	113-	118
As above, but with more muscovite and phosphorite, and fewer shell fragments. <i>Eponides</i> cf. <i>mansfieldi</i> , <i>Elphidium incertum</i> ? and other forams	118-	143
Shell marl, slightly silty and clayey, sandy, fine to coarse (average medium)	143-	148
Hawthorn(?) formation:		
Sand, quartz, white, very fine to coarse, (average medium), with phosphorite grains, some as large as 9 mm in diameter. Few shell fragments, very sparse foram fauna	148-	150
As above, but phosphorite grains smaller in size	150-	176

Well 9

In the NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 7, T. 33 S., R. 31 E., Highlands County.

Surface altitude 131 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, white, fine to medium.....	0-	4
Sand, quartz, brown to gray-white, fine to medium (average fine)	4-	18
Sand, quartz, grayish-white, fine to medium (average medium)	18-	24
Sand, quartz, dirty gray-white, fine to medium	24-	26

Well 10

In the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 35 S., R. 29 E., Highlands County.

Surface altitude 117.8 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits and Hawthorn(?) formation undifferentiated:		
Sand, quartz, brown, fine to medium (average medium)	0-	35
Sand, quartz, tan, fine to medium (average medium)	35-	40.5
Sand, quartz, gray-white, tan, fine to medium (average medium)	40.5-	45

Well 11

In the NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T. 35 S., R. 31 E., Highlands County.

Surface altitude 51.2 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, gray-brown, fine to medium (average medium)	0-	12
Sand, quartz, grayish-white, fine to medium (average medium)	12-	16
Clay, gray, sticky, and very fine quartz sand	16	

Well 12

In the NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 36 S., R. 33 E., Highlands County.

Surface altitude 45.6 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, grayish-white, fine to medium (average fine)	0-	16
Sand, quartz, grayish-brown, fine to medium	16-	18
Sand, quartz, light-tan, fine to medium	18-	21

Well 13

In the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 37 S., R. 33 E., Highlands County.

Surface altitude 29.2 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, white, fine to medium (average fine)	0-	15
Sand, quartz, brown, fine to medium	15-	20

Well 14

In the NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 38 S., R. 30 E., Highlands County.

Surface altitude 136 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits and Hawthorn(?) formation undifferentiated:		
Sand, quartz, grayish-white, fine to medium	0-	2
Sand, quartz, brown, fine to medium (average medium).....	2-	19
Sand, quartz, tan, fine to medium (average medium).....	19-	30
Sand, quartz, light-tan, grayish-white, fine to medium (average medium)	30-	35

Well 15

In the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 39 S., R. 30 E., Highlands County.

Surface altitude 58.5 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits and Hawthorn(?) formation undifferentiated:		
Sand, quartz, carbonaceous, black	0-	0.3
Sand, quartz, brown, grayish-white, fine to medium (average medium)	0.3-	14
Sand, quartz, brown, fine to coarse (average medium- coarse)	14-	17
Sand, quartz, tan, fine to coarse (average medium to coarse)	17-	20
Sand, quartz, grayish-white, fine to medium (average medium)	20-	23

Well 183

(F.G.S. no. 2397)

Three miles southeast of Avon Park in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 30,

T. 33 S., R. 29 E. Surface altitude 105 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
No samples	0-	177
Hawthorn formation:		
Sand, quartz, micaceous, white, fine to granule-size, rounded to angular, and some white clay	177-	188
Sand, quartz, micaceous, light-yellow to tan-gray, fine to small pebbles, with pebbles of phosphorite and white clay nodules	188-	199
As above, plus some blue-green clay and gastropods.....	199-	222
Sand, quartz, light-cream, fine to pebble-size, with phosphorite pebbles up to 6 mm in diameter.....	222-	242

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
As above, plus some very sandy white limestone. Phosphorite makes up about 30 percent of this sample.	
Mollusk fragments	242- 254
Clay, tan-gray, sandy, phosphatic, with some limestone as above	254- 310
Sand, quartz, gray, medium to coarse, with some dense crystalline phosphatic limestone. Shark's teeth and echinoid fragments	310- 321
Limestone, cream, dense, finely crystalline, with phosphorite and some very coarse quartz sand.....	321- 360
Limestone, clayey, dark-gray, dense, hard, with some limestone, as above, and phosphorite pebbles	360- 375
Limestone, quartz sand, phosphorite pebbles, and clay; limestone, white to dark-gray, dense, hard to soft, finely crystalline, sandy, phosphatic; quartz sand, clear to gray, fine to very coarse; phosphorite pebbles up to 5 mm in diameter; clay, dark-green. Echinoid spines, shark's teeth, mollusk fragments, ostracods and Foraminifera	375- 435
Suwannee limestone:	
Limestone, slightly sandy, cream, soft, porous, crystalline; calcite rhombs and some phosphorite. Echinoid spines, Foraminifera, <i>Rotalia mexicana</i> and others	435- 450
Limestone, slightly sandy, cream, soft, chalky, a few phosphorite pebbles and pieces of dark dense limestone. Numerous Foraminifera, <i>Rotalia mexicana</i> , <i>Elphidium leonensis</i> and others	450- 495
Ocala limestone:	
Limestone, large foraminiferal coquina, cream, soft, porous; with some material as above. <i>Lepidocyclina ocalana</i> , <i>Operculinoides ocalanus</i> , and others	495- 615
No samples	615- 635
Moody's Branch (?) formation:	
Limestone, cream, hard, calcitic. Few large foraminifera	635- 665
Limestone, large foraminiferal coquina, cream, hard, porous, some soft chalky limestone	665- 720
Limestone, large foraminiferal coquina, light-gray. Camerinidae numerous	720- 735
No samples	735- 765
Avon Park limestone:	
Limestone, light-tan-gray, hard, crystalline, with some white chalky limestone. Gastropods, Foraminifera and echinoids; <i>Coskinolina floridana</i> , <i>Peronella dalli</i>	765- 825
Limestone, cream, hard, porous. <i>Dictyoconus cookei</i>	825- 840
As above, plus some white dense crystalline limestone. Fossiliferous	840- 975
Limestone, cream to tan, hard, porous. Fossiliferous	975-1,000
As above, plus <i>Spirolina coryensis</i> and numerous miliolids	1,000-1,050
Dolomite, tan to light-brown, dense, waxy, crystalline, with some limestone, as above	1,050-1,057
As above, plus some dense dark limestone	1,057-1,066
As above, plus some soft white limestone	1,066-1,085
Lake City limestone:	
As above, plus <i>Dictyoconus americanus</i>	1,085-1,100
Dolomite, light-brown, finely crystalline, waxy; with some hard white porous limestone. Fossiliferous	1,100-1,155
Sand, dolomite, with some chalky, white porous limestone	1,155-1,212

Water-level measurements made during drilling of well. Well cased to 304 feet.

Date 1950	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
May 31	330	Hawthorn	20.80
June 8	850	Avon Park	17.00
June 12	915	do.	16.00
June 15	945	do.	15.20
June 21	1,066	do.	16.20
June 23	1,102	Lake City	16.20
June 29	1,192	do.	16.00

Well 211
(F. G. S. no. 1464)

Two miles south of DeSoto City in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 27, T. 35 S., R. 29 E. Surface
altitude 135 feet. (Adapted from a log by Robert O. Vernon,
Florida Geological Survey)

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Hawthorn formation:	
Sand, quartz, medium to fine, poorly sorted, red	20- 70
As above, but white	70- 100
Sand as above, and sandy cream to light-gray limestone containing phosphorite	100- 140
Sand, quartz, coarse to fine	140- 165
As above, fine to medium	165- 185
Sand, quartz, fine to medium and sandy gray-green fuller's earth clay	185- 200
As above, plus a sandy carbonaceous clay	200- 210
Sand, quartz, fine to medium; black carbonaceous clay; cream sandy phosphatic limestone	210- 215
Sand, quartz, coarse to fine, and phosphorite	215- 240
Limestone, tan, finely crystalline, sandy, phosphatic, many mollusk fragments	240- 252
No sample	252- 270
Sand, quartz, coarse to fine, and brown sandy waxy clay....	270- 295
Sand, quartz, fine to medium, and phosphorite	295- 325
Sand, quartz, coarse to medium, phosphorite, and finely crystalline limestone	325- 335
As above, plus tan impure dense limestone	335- 340
As above, but increased phosphorite and tan limestone	340- 345
Sand, quartz; dense argillaceous gray limestone; and fissile gray clay	345- 350
No sample	350- 368
Limestone, dense, finely crystalline, cream, containing phosphorite and mollusk shell fragments	368- 375
As above, more phosphorite	375- 400
Limestone as above and dense brownish-gray hard phos- phatic limestone	400- 405
Limestone as above and cream finely crystalline dense sandy phosphatic limestone	405- 440
Limestone, dense, cream, finely crystalline; sand and limestone as above	440- 451
Limestone, dark-gray, dense, hard, phosphatic	451- 460
Limestone as above, mottled brown and made porous by many mollusk and coral remains; much phosphorite and sand	460- 465
Clay, micaceous, dark-greenish-gray, and dark-gray dense phosphatic limestone	480- 500
Sand, quartz, fine to medium, with phosphorite and rock above	500- 505

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
As above, plus light-green fissile fuller's earth clay	505- 510
Sand as at 500-505	510- 515
No sample	515- 541
Suwannee limestone:	
Limestone, granular, cream, porous, soft, <i>Rotalia mexicana</i> , <i>Cytheridea blaspiedi</i> (?) Starfish ossicles	541- 565
No sample	565- 575
Limestone, porous, white to cream, soft. Fossils above; crab claws	575- 590
As above, plus quartz sand	590- 600
Limestone, porous, cream, soft, chalky	600- 610
Ocala limestone:	
Limestone as above. <i>Lepidocyclina ocalana</i> , <i>Lepidocyclina fragilis</i>	610- 635
No sample	635- 640
Limestone as above, foraminiferal coquina. <i>Operculina</i> , <i>Camerina</i> , <i>Lepidocyclina</i>	640- 695
Coquina limestone, cream, soft, porous; composed of <i>Lepidocyclina</i> , Bryozoa, echinoids and camerinids	695- 745
Coquina limestone, cream, soft, porous, large foraminifers	745- 840
Moody's Branch(?) formation:	
Coquina limestone as above, the camerinids making up a greater percentage of the total Foraminifera	840- 889
Limestone, cream, soft, massive, porous, containing many flat echinoids, crab claws, and large Foraminifera	889- 895
Same as above, but containing many calcite clusters and vugs, and more granular, with fewer large fos- sils. <i>Amphistegina pinarensis</i> var.	895- 900
Avon Park limestone:	
Limestone, cream, granular, soft, massive, porous, fos- sils as above, and a large rotalid foram	900- 910
Limestone, cream, granular, soft, massive, porous, with fossils from above. <i>Coskinolina</i> sp. large rotalid	910- 920
Limestone as above, many <i>Coskinolina</i> and associated forams and also fossils caved from above	920- 935
Limestone, light-gray to brownish-gray, granular, soft, massive, slightly porous. <i>Spirolina coryensis</i> , <i>Lituonella</i> , <i>Coskinolina</i> and cavings from above.....	935- 980
Limestone, cream to light-gray, granular, moderately hard, rather dense, massive, foraminiferal; com- posed of a mass of forams set in a light-gray chalky matrix. <i>Coskinolina</i> relatively abundant	980-1,005
Limestone, light-gray, granular, soft, massive, foramini- feral; fossils as above, but rare. Calcite rhombs	1,005-1,025
Limestone as above but harder, having more cement and more fossils; species as above	1,025-1,065
Limestone as above and tan finely crystalline, soft mas- sive porous dolomite; limestone and associated fos- sils caved from above	1,065-1,085
Limestone, cream to tan, granular, soft, massive, dense to porous, with cavings from above	1,085-1,105
Limestone, cream to light-gray, granular, dense to por- ous, hard but containing soft streaks, massive; made up of forams in a light-gray chalky matrix, which has been recrystallized in places	1,105-1,125
Limestone as above and light-gray porous soft chalky limestone; many <i>Coskinolina</i> , <i>Lituonella</i> , <i>Spirolina</i> , <i>Textulariella</i> , and other Gulf Hammock fauna	1,125-1,145

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Limestone as above and tan dense brittle fine-grained to granular, hard, fossiliferous limestone; the fossils appear to be somewhat rounded by abrasion. <i>Fabularia</i> sp.	1,145-1,185
Top of Lake City limestone at 1,150:	
Limestone, tan to light-brown, dense, with porous layers, fine granular to crystalline; some pieces are waxy and very dense and others are somewhat laminated with carbonaceous plant remains, small amounts of pyrite; fragments of limestone from above	1,185-1,195
Limestone as above and fragments of cream dense soft chalky limestone with harder limestone granules embedded in the matrix. <i>Dictyoconus americanus</i>	1,195-1,225
Limestone, tan to light-brown, dense, hard and brittle to soft and waxy, fine-grained to chalky. <i>Dictyoconus</i> sp.	1,225-1,265
Limestone as above and tan to light-gray dense fine-grained to chalky massive limestone with much secondary calcite. Some particles seem to be argillaceous, to have laminated carbonaceous plant remains, and to be waxy. Many Foraminifera. <i>Dictyoconus americanus</i>	1,265-1,285
Limestone, tan to cream, finely ground and possibly granular, dense, very fine grained, hard, foraminiferal. <i>Dictyoconus americanus</i> , <i>Spirolina</i> sp.	1,285-1,315
Limestone, cream, granular, soft, massive, slightly porous, foraminiferal, with calcitic secondary growths. A large percentage of the sample is composed of whole and broken specimens of <i>Dictyoconus</i> and <i>Coskinolina</i>	1,315-1,325
Limestone as above in larger fragments and fragments of dark-brown finely crystalline soft dense dolomite. <i>Dictyoconus americanus</i>	1,325-1,365
Limestone and dolomite, as at 1,325-1,365 feet, in fine grains of about equal proportions	1,365-1,375
Top (?) of the Oldsmar limestone at 1,375:	
Sample predominantly brown finely crystalline dense hard dolomite and limestone, as above. A fragment that is questionably referred to <i>Helicostegina gyralis</i> (?), at 1,375-1,385 feet, and an unidentifiable <i>Lepidocyclina</i> , at 1,385-1,395 feet	1,375-1,415
Predominantly dark-brown to black finely crystalline soft slightly porous massive dolomite and limestone as above	1,415-1,435
Dolomitic limestone, tan to light-brown, finely crystalline, soft, porous, and limestone as above. No new fossils	1,435-1,455

Well 251

(F. G. S. no. 2850)

(One mile east of Lake Placid in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 31, T. 36 S., R. 30 E., Highlands County. Surface altitude 90 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits and Hawthorn formation, undifferentiated:	
Sand, quartz, medium to coarse, frosted light-gray	0- 1
Sand, quartz, medium to coarse, frosted, gray-orange	1- 7
Sand, quartz, medium to very coarse, frosted, dark-brown	7- 8

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
As above but lighter in color	8-	11
Sand, quartz, carbonaceous, medium to coarse, frosted, gray-orange	11-	15
Sand, quartz, fine to coarse, frosted, red-brown	15-	18
Sand, quartz, fine to elongated pebbles 8 mm in length, poorly sorted, frosted, light-brown	18-	50
Clay, lilac-colored, and fine to coarse frosted sand	50-	58
As at 18-50 feet	58-	60
Sand, quartz, medium to coarse, frosted, light-brown	60-	65
Sand, quartz, fine to pebble-size, frosted, and some light-brown clay	65-	82
Clay, sandy, fissile, yellow-green, very micaceous, num- erous small grains of ilmenite, and round clear quartz sand grains	82-	87
Sand, quartz, medium to very coarse, frosted to clear, with some dark-lilac clay coating the grains	87-	88
Clay, sandy, orange to gray-orange, some white clay, and clear medium to coarse quartz sand	88-	94
Sand, quartz, medium to coarse, frosted to clear, yellow- cream, some mica and white calcareous clay particles	94-	115

Well 305

(F. G. S. no. 2398)

One mile northeast of Avon Park, in the southwest corner, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 14, T. 33 S.,
R. 28 E., Highlands County.

Surface altitude 160 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
No samples	0-	220
Hawthorn formation:		
Phosphorite, clayey, calcareous; black phosphorite in light-green nonplastic clay, phosphorite pebbles up to 12 mm in diameter; numerous small calcite rhombs ..	220-	260
Clay (fuller's earth) and phosphorite, slightly sandy, calcareous, light-green to olive-drab	260-	295
Limestone, phosphatic, finely crystalline, white. Mol- lusk fragments	295-	345
Limestone, phosphorite, and sand; limestone finely cry- stalline to porcelaneous, dense, phosphorite brown to black. Mollusks, echinoid spines and Foramini- fera— <i>Elphidium</i> sp. and others	345-	440
Suwannee limestone:		
Limestone, hard, white, chalky, porous, with some dense hard gray limestone and sand, possibly from above. Mollusks, echinoid fragments, and numerous For- aminifera— <i>Rotalia mexicana</i> , miliolids	440-	500
Ocala limestone:		
Limestone, hard to soft, cream, chalky, porous, highly fossiliferous; <i>Lepidocyclus ocalana</i> and other For- aminifera common to the Ocala limestone	500-	640
Limestone, large foraminiferal coquina harder than above, cream to tan-gray. <i>Lepidocyclus ocalana</i> , <i>Heterostegina ocalana</i> , and Camerinidae	640-	680
Moodys Branch(?) formation:		
Limestone, large foraminiferal coquina, hard, cream to tan-gray. <i>Camerina moodybranchensis</i>	680-	730
As above, plus some hard, dense gray limestone	730-	760
Avon Park limestone:		

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Limestone, hard, cream, highly calcitic. Foraminifera and echinoids, <i>Coskinolina floridana</i> , <i>Dictyoconus cookei</i> , <i>Peronella dalli</i>	760- 820
Limestone, hard, light-brown, calcitic, porous. Fauna as above	820- 860
As above, plus some soft chalky limestone	860- 880
As at 820-860 feet, plus <i>Spirolina coryensis</i>	880- 960
Limestone, hard, cream, calcitic, porous. Fauna as above....	960-1,050
As above, plus some very finely crystalline dense hard light-brown dolomite	1,050-1,100
Limestone, hard, cream, calcitic, porous. Poorly preserved Foraminifera	1,100-1,120
Lake City limestone:	
Dolomite, hard, dark red-brown, crystalline, with limestone as above. <i>Dictyoconus americanus</i>	1,120-1,140
Limestone, fairly hard, white, porous, chalky, with some tan granular limestone. Gastropod and echinoid fragments	1,140-1,160
Dolomite, hard, brown, finely crystalline, dense, waxy, with limestone as above. Echinoid spines, Foraminifera	1,160-1,180
Dolomite, hard, brown, granular, porous, waxy, with some hard white chalky limestone and numerous brown rhombic crystals	1,180-1,220
No samples	1,220-1,230
Water-level measurements made during drilling. Well cased to 345 feet.	

Date	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
1950			
Aug. 2	1,120	Lake City	68.0
Aug. 9	1,215	do.	67.0
Aug. 16	1,230	do.	67.5
Sept. 7	1,230	do.	65.0

Well 358

(F. G. S. no. 2399)

Seven miles north of Venus, in the center of sec. 17, T. 38 S., R. 30 E., Highlands County. Surface altitude 182 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits:	
Sand, quartz, dark-gray-orange, medium to coarse, frosted Hawthorn(?) formation:	0- 10
Sand, quartz, cream to cream-orange, medium to coarse, frosted	10- 70
Sand, quartz, white to cream, medium to coarse, frosted	70- 100
Sand, quartz, white to light-gray, coarse, frosted	100- 140
Sand, quartz, cream to light-tan-gray, medium to very coarse, partly frosted, with some hard, white clay	140- 200
Sand, quartz, micaceous, cream to light-yellow, fine to very coarse, partly frosted, with some white to cream clay	200- 270
Clay, sandy, very micaceous, light-green, fissile, plastic	270- 290
No sample	290- 300
Sand, quartz, micaceous, gray, fine to medium, angular, clear, with some gray to gray-orange clay	300- 340
As above, plus some light-red-brown clay	340- 360
Sand, quartz, micaceous, gray-green, fine to coarse, angular to subrounded, clear to frosted, with some slightly calcareous olive-drab clay	360- 380

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Clay, fuller's earth, slightly sandy, calcareous, micaceous, dark-green, with some white clay, dark crystalline calcite, dark chert, and small particles of organic material	380- 440
Limestone, slightly sandy, cream, dense, finely crystalline, with some dark-gray dense limestone, chert, sand, clay as above, and phosphorite pebbles. Mollusk fragments and shark's teeth	440- 450
Clay, sandy, calcareous, phosphatic, white to dark-green in lower part; some finely crystalline sandy dense white limestone. Mollusk fragments	450- 470
No sample	470- 480
Sand, quartz, clayey, tan-gray, fine to coarse, some phosphorite	480- 490
Clay, fuller's earth, sandy, phosphatic, light-tan-gray to gray	490- 500
Clay, fuller's earth, phosphatic, gray-green to dark-green; some finely crystalline dense white clay	500- 520
Limestone, cream, finely crystalline, dense, with phosphorite and sand. Mollusk fragments	520- 530
As above, plus some light-brown dense limestone.....	530- 540
Clay, white to gray, phosphatic	540- 550
Limestone, as at 520-530 feet plus clay as above	550- 570
Limestone, cream, finely crystalline, dense, with some dark dense limestone; some very sandy cream limestone; phosphorite, and clay as at 540-550 feet	570- 580
Clay, light-gray to gray, sandy, calcareous, phosphatic	580- 590
Clay, fuller's earth, gray-green to green, slightly sandy, phosphatic; some white clay. Lower 10 feet contains some tan dense limestone	590- 680
Suwannee limestone:	
Limestone, cream, chalky to granular, soft, porous. Foraminifera numerous, <i>Rotalia mexicana</i> and others	680- 710
Limestone, cream, crystalline, porous, fossiliferous	710- 730
Limestone, cream, soft, chalky, porous, fossiliferous	730- 750
Limestone, cream, hard, crystalline, porous	750- 760
Ocala limestone:	
Limestone, cream, chalky, soft. Numerous large Foraminifera— <i>Lepidocyclina ocalana</i> and others	760- 770
Limestone, foraminiferal coquina, light-gray to tan-gray, soft, porous. Fauna as above	770- 830
As above, but Camerinidae more numerous	830- 920
Moodys Branch (?) formation:	
As above but harder. Foraminifera mostly Camerinidae	920- 940
As above, plus some soft chalky limestone	940- 990
Limestone, tan-gray, soft, chalky, Foraminifera and mollusk fragments	990-1,000
Limestone, foraminiferal coquina, tan-gray; some chalky limestone as above and some fairly hard granular limestone	1,000-1,010
As above, but with more hard limestone	1,010-1,020
As above, plus some gray-green to gray-brown chert	1,020-1,030
Limestone, foraminiferal coquina, tan-gray, fairly hard; some soft, chalky limestone	1,030-1,050
Limestone, foraminiferal coquina, tan-gray, chalky, soft, with some hard dense, crystalline limestone. Numerous echinoid spines	1,050-1,060

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Avon Park limestone:	
Limestone, tan to light-lilac, hard, finely crystalline. Very few large Foraminifera, many <i>Coskinolina floridana</i>	1,060-1,070
As above, plus some dark dense limestone and calcite rhombs	1,070-1,130
Limestone, light-gray, soft, chalky, slightly porous, and limestone as at 1,070-1,130 feet	1,130-1,140
Limestone, cream, granular, hard, slightly porous	1,140-1,150
As above, plus many large Foraminifera and some cry- stalline calcite	1,150-1,160
As above, plus some soft chalky limestone, and some hard, dense white limestone	1,160-1,170
Limestone, cream to light-gray, hard, with much secon- dary calcite and hard, dense light-blue limestone	1,170-1,180
No sample	1,180-1,190
As at 1,170-1,180 feet	1,190-1,200
As above, plus numerous <i>Coskinolina floridana</i>	1,200-1,220
Limestone, cream to light-gray, hard, granular, with secondary calcite in a light-gray chalky matrix	1,220-1,250
Lake City(?) limestone:	
Limestone, dolomitic, light-brown, hard, granular to crystalline, with some dense hard light-gray lime- stone and some dense brown waxy dolomite. For- aminifera numerous	1,250-1,290
Limestone, tan, granular to crystalline, with some brown dolomite in a light-gray chalky matrix	1,290-1,310
Limestone, tan, finely granular, with some white hard dense limestone and some blue dense limestone	1,310-1,320
As above, plus some very hard porous white limestone and secondary calcite	1,320-1,330
Limestone, tan, granular, hard, with some white hard porous limestone and brown waxy dolomite	1,330-1,340
Dolomite, light-brown, finely crystalline, dense, waxy, with some dense white limestone	1,340-1,350
As above, plus some soft light-gray limestone	1,350-1,370
Limestone, tan, granular to crystalline hard, in a light- tan-gray soft slightly clayey chalky matrix	1,370-1,410
Foraminiferal coquina, brown, hard, very porous. Dril- ler reported small cavities in this interval	1,410-1,520
No sample	1,520-1,530
Limestone, light-pink, granular, hard to soft, porous. Some particles appear to be laminated	1,530-1,540
As above, but with more soft limestone	1,540-1,550

Water-level measurements made during drilling. Well cased to 517 feet.

Date 1950	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
July 13	690	Suwannee	66.2
July 20	710	do.	62.0
July 26	735	do.	70.5
Aug. 2	1,000	Moodys Branch(?)	99.5
Aug. 16	1,138	Avon Park	98.0
Aug. 25	1,259	Lake City(?)	126.0
Aug. 30	1,323	do.	125.5
Sept. 8	1,371	do.	124.2
Sept. 21	1,474	do.	126.5
Sept. 29	1,526	do.	127.9
Oct. 2	1,550	do.	126.8

Well 399

(F. G. S. no. 2401)

East side of Lake Istokpoga, in the NW¼NE¼ sec. 29, T. 35 S., R. 31 E., Highlands
County. Surface altitude 44 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
No samples	0- 960
Avon Park limestone:	
Limestone, tan-gray to light-gray, hard, dense, chalky	960- 970
Limestone, tan-gray, soft, crystalline to chalky. <i>Dictyoconus cookei</i> , <i>Lituonella floridana</i> , <i>Coskinolina floridana</i> , <i>Spirolina coryensis</i> , <i>Lepidocyclina</i> sp., and miliolids	970-1,000
Limestone, tan-gray, hard to soft, dense; fauna as above	1,000-1,050
Dolomite, light-brown, hard, crystalline. Foraminifera	1,050-1,070
Lake City limestone:	
Limestone, dolomitic, brown to dark-gray, soft, porous. Foraminifera, numerous <i>Dictyoconus americanus</i> and others	1,070-1,090
No samples	1,090-1,106

Well 400

(F. G. S. no. 2848)

Six miles north of Venus in the NE¼SE¼ sec. 20, T. 38 S., R. 30 E., Highlands
County. Surface altitude 175 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
No samples	0- 320
Hawthorn formation:	
Sand, quartz, micaceous, fine to very coarse, angular, gray, with gray-orange to light gray fissile clay.....	320- 350
As above, plus some white sandy clay.....	350- 360
Sand, quartz, silty, slightly clayey, micaceous, gray-orange, fine to coarse, with small particles of white clay	360- 400
Clay, fuller's earth, slightly sandy, micaceous, greenish-brown, non-phosphatic	400- 410
Clay, limestone and phosphorite; clay, fuller's earth, phosphatic, white to dark-green; limestone, sandy, crystalline, phosphatic, white; phosphorite, black to dark-brown with some small quartz pebbles. Mollusk fragments	410- 420
As above, minus the dark-green clay.....	420- 430
As above, plus phosphorite pebbles up to 10 mm across. Barnacles	430- 450
As above, plus light-greenish-brown clay.....	450- 470
No samples	470-1,078
Avon Park limestone:	
Limestone, finely crystalline, hard, tan, with some hard chalky limestone. Large Foraminifera, molds of mollusks, numerous <i>Peronella dalli</i>	1,078-1,090
Limestone, chalky, hard, tan. Small gastropods, pelecypod fragments, <i>Peronella dalli</i> , <i>Coskinolina floridana</i> , <i>Dictyoconus cookei</i>	1,090-1,110
Limestone, chalky to crystalline, soft, tan. Forams.....	1,110-1,120
As above, plus hard chalky limestone and mollusk fragments	1,120-1,140
As above, plus numerous <i>Coskinolina floridana</i>	1,140-1,145
Limestone, chalky, soft, cream. Mollusk fragments, forams as above, plus <i>Spirolina coryensis</i>	1,145-1,155
As above, but hard.....	1,155-1,205

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Limestone, chalky, hard, light-tan; coral forams, ostracods, starfish ossicles, <i>Lituonella floridana</i>	1,205-1,225
Limestone, dense, hard, light-tan. Forams	1,225-1,235
Lake City (?) limestone:	
As above, plus some tan finely crystalline dolomite.....	1,235-1,255
Limestone, hard, granular, light-tan. Forams, <i>Peronella</i>	1,255-1,310
Limestone, hard, chalky, light-tan. Forams.....	1,310-1,320
As above, but granular with some hard to soft white chalky limestone. Forams	1,320-1,340
Limestone, hard, granular, tan. Forams mostly miliolids....	1,340-1,350
As above, plus some hard chalky porous limestone.....	1,350-1,360
Limestone, very hard, slightly porous, cream. Mollusk molds and forams	1,360-1,370
Limestone, hard, granular, tan, with some hard chalky white limestone. Forams	1,370-1,380
Limestone, dolomitic, hard, granular to crystalline, dark-tan, in a tan slightly clayey chalky matrix. Forams	1,380-1,390
No samples	1,390-1,439

Water-level measurements made during drilling.

DATE 1951	DEPTH OF HOLE (FEET)	WELL CASED TO	FORMATION PENETRATED	WATER LEVEL, FEET BELOW LAND SURFACE
May 21	548	540	Hawthorn	66.5
May 24	670	660	Suwannee	103.0
May 31	740	700	do.	113.0
June 4	805	700	Ocala	114.0
June 6	940	700	Moodys Branch (?)	124.0
June 8	960	700	do.	122.0
June 12	1,080	700	Avon Park	119.5
June 14	1,095	700	do.	117.0
June 19	1,095	700	do.	116.5
June 22	1,095	700	do.	115.5
July 6	1,095	700	do.	117.0
July 13	1,095	700	do.	116.0
July 27	1,095	700	do.	116.0
Aug. 3	1,095	700	do.	117.0
Aug. 17	1,095	700	do.	116.0
Aug. 24	1,130	700	do.	118.0
Aug. 31	1,205	700	do.	118.0
Sept. 7	1,260	700	Lake City(?)	117.0
Sept. 13	1,300	700	do.	117.0
Sept. 21	1,350	700	do.	116.5
Sept. 27	1,380	700	do.	117.0
Oct. 4	1,400	700	do.	117.0
Oct. 15	1,439	700	do.	115.0

Well 401

(F.G.S. no. 2378)

Three miles northeast of Avon Park in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 33 S., R. 28 E.,
Highlands County. Surface altitude 176 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
No samples	0- 420
Hawthorn formation:	
Sand, quartz, coarse to very coarse, with some dark-gray to white dense limestone and phosphorite	

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
pebbles. Mollusk fragments, fish teeth, and echinoid spines	420- 425
Clay, gray-green, with material as above	425- 435
Sand as at 420-425 feet plus clay as above	435- 440
As above, plus shell fragments and some soft chalky cream limestone	440- 445
Suwannee limestone:	
Limestone, tan-gray, soft, chalky, porous. Mollusk fragments, star-fish ossicles and miliolids	445- 470
Limestone, cream, soft, chalky to granular. Mollusk fragments and forams	470- 500
Ocala limestone:	
As above, plus <i>Lepidocyclus ocalana</i>	500- 540
Limestone, foraminiferal coquina, cream, chalky, soft, porous. <i>Lepidocyclus</i> and <i>Camerina</i>	540- 690
Moodys Branch(?) formation:	
As above, plus numerous specimens of <i>Camerina moodybranchensis?</i>	690- 720
Limestone, foraminiferal coquina, cream, porous, granular, harder than above. Numerous <i>Camerinidae</i>	720- 770
Avon Park limestone:	
Limestone, light-tan, hard, granular, dense to porous, calcitic. Numerous <i>Peronella dalli</i>	770- 820
Limestone, tan to light-brown, dense, hard, calcitic. <i>Coskinolina floridana</i> , <i>Dictyoconus cookei</i> , <i>Peronella dalli</i>	820- 830
Limestone, tan, hard, granular. Echinoid spines.....	830- 860
Limestone, tan-gray, hard and soft layers, granular to chalky. Forams	860- 980
Limestone as above, plus small echinoids	980-1,000
Limestone, cream, hard, granular, with some tan dense crystalline limestone. Forams	1,000-1,010
Limestone, cream, hard, chalky. Forams	1,010-1,020
Dolomite, brown, hard, crystalline, with some material as above	1,020-1,030
Limestone, cream, hard, chalky, with some dense tan-gray limestone. Miliolids numerous	1,030-1,060
Limestone, cream, hard, chalky, calcitic, with some brown dolomite as at 1020-1030 feet. <i>Textularia coryensis</i> , miliolids	1,060-1,070
Limestone, cream, hard, granular	1,070-1,080
Dolomite, light-brown, hard, granular, with some white dense limestone and tan to dark-brown chert	1,080-1,090
Limestone, tan, hard, granular, with some white chalky limestone and brown granular dolomite	1,090-1,100
Lake City limestone:	
Limestone, tan, hard, chalky, with some dense gray to black limestone. <i>Dictyoconus americanus</i>	1,100-1,110
As above, plus some brown hard crystalline dolomite.....	1,110-1,140
Limestone, tan, hard, chalky, granular	1,140-1,150
Limestone as above, plus about 30 percent hard brown crystalline dolomite	1,150-1,160
Limestone, tan, hard, porous, granular. <i>Dictyoconus americanus</i>	1,160-1,170
Limestone, tan, hard, granular, with some hard brown crystalline dolomite with dark-gray chert	1,170-1,180
Limestone, tan, hard, granular, with some white dense chalky limestone. Forams	1,180-1,210

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Dolomite, dark-brown, hard, crystalline, porous, with some white chalky limestone	1,210-1,220
Dolomite, red-brown, hard crystalline, waxy, with some white chalky limestone	1,220-1,230
As at 1210-1220 feet	1,230-1,240
As at 1220-1230 feet	1,240-1,290
As above, but lighter in color	1,290-1,301
Water-level measurements made during drilling. Well cased to 455 feet.	

Date	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
1951			
Feb. 9	1,170	Lake City	90.0
Feb. 14	1,250	do.	88.7
Feb. 19	1,275	do.	87.4
Feb. 23	1,300	do.	88.6
Feb. 27	1,301	do.	87.2

Well 403

(F.G.S. no. 2843)

At Avon Park, in the NE¼NW¼ sec. 22, T. 33 S., R. 28 E., Highlands County.
Surface altitude 166 feet. Total depth of well 1,301 feet; cuttings not examined
below 560 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits:	
Sand, quartz, cream-orange to tan-gray, medium to coarse, frosted, with numerous heavy minerals	0- 50
As above, plus some very coarse quartz sand.....	50- 110
Hawthorn formation:	
As above, plus some very pure brown plastic clay	110- 120
Sand, quartz, very clayey, pink to cream, fine to coarse, frosted to clear	120- 140
As above, plus very coarse sand	140- 160
As above, plus some mica	160- 170
No sample	170- 180
As at 160-170 feet, plus a few phosphorite pebbles.....	180- 190
As above, but cream in color and containing many white to brown phosphorite pebbles, some as large as 5 mm across. Mollusk fragments	190- 230
Sand, quartz, cream, coarse to pebble size, with many brown to black phosphorite pebbles as large as 5 mm across	230- 240
Clay, sandy, pebbly, phosphatic, dark-gray-green	240- 260
No sample	260- 280
Marl, slightly sandy, pebbly, phosphatic, light-gray, with some light-gray dense phosphatic limestone. Phosphatized molds of mollusks	280- 290
No sample	290- 300
Limestone and marl, sandy, silty, phosphatic, dense, light-gray to light-brown, with quartz and phos- phorite pebbles. Mollusk fragments	300- 350
Limestone, white to gray, phosphatic, sandy, chalky, medium hard, with phosphorite pebbles, mollusk fragments and gray silty marl and clay	350- 430
Limestone, dark-gray, dense, with dark-colored chert and material as above	430- 450
No sample	450- 460

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Suwannee limestone:	
Limestone, light-gray to cream, soft, chalky, slightly phosphatic. Numerous reef organisms <i>Rotalia mexicana</i> (?)	460- 540
Ocala limestone:	
Limestone, foraminiferal coquina, cream, soft, chalky. <i>Lepidocyclina ocalana</i> , <i>Camerina</i> sp., and others	540- 560

Water-level measurements made during drilling. Well cased to 301 feet.

Date 1951	Depth of hole (feet)	Formation penetrated	Water level, in feet below land surface
Feb. 26	1,020	Avon Park	71.2
Feb. 27	1,045	do.	71.2
Mar. 5	1,070	do.	72.2
Mar. 6	1,100	do.	72.9
Mar. 7	1,120	Lake City(?)	73.1
Mar. 8	1,140	Lake City	73.3
Mar. 9	1,155	do.	73.1
Mar. 12	1,185	do.	72.4
Mar. 14	1,200	do.	72.8
Mar. 15	1,216	do.	73.3
Apr. 4	1,290	do.	73.6
Apr. 11	1,301	Lake City(?)	73.6

Well 405

(F.G.S. no. 2849)

Two miles southeast of Sebring, in the NW¼SW¼ sec. 34, T. 34 S., R. 29 E., Highlands County. Surface altitude 115 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, quartz, gray-orange, medium to coarse (averages medium), frosted	0- 26
Sand, quartz, light-gray, medium to coarse (averages coarse), frosted to clear	26- 33
Hawthorn formation:	
Sand, quartz, clayey, red-orange, medium to coarse (averages coarse), frosted to clear	33- 45
Sand, quartz, tan-gray to light-gray, medium to coarse (averages coarse), clear	45- 120

Well 407

(F.G.S. no. 2845)

At Lake Placid, in the SW¼SW¼ sec. 36, T. 36 S., R. 29 E., Highlands County. Surface altitude 120 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, quartz, gray-orange, medium to coarse (averages medium), frosted	0- 10
As above, but light-orange in color	10- 40
Sand, quartz, white to cream, medium to coarse (averages medium), frosted to clear	40- 50
Hawthorn formation:	
Sand, quartz, cream, slightly micaceous, medium to coarse (averages coarse), frosted to clear; contains small particles of white clay	50- 100

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Sand, quartz, light gray-orange, micaceous, coarse, frosted to clear, with small particles of white clay.....	100- 120
As above, but average sand size is medium.....	120- 130
As at 100-120 feet	130- 150
Sand, quartz, light gray-orange to bright orange, slightly clayey, medium to very coarse (averages coarse), frosted to clear	150- 160
As above, plus mica	160- 180
As above, but tan-gray in color.....	180- 200

Well 408

(F.G.S. no. 2859)

Two miles northwest of Sebring, in the SE¼NW¼ sec. 18, T. 34 S., R. 29 E.,
Highlands County. Surface altitude 150 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits:	
Sand, quartz, gray-brown, medium to coarse (averages coarse), carbonaceous	0- 5
Sand, quartz, cream-orange, slightly clayey, medium to coarse (averages coarse), rounded to sub-rounded, frosted	5- 35
Hawthorn formation:	
Sand, quartz, light-orange, slightly clayey, medium to coarse (averages coarse), rounded to sub-rounded, frosted, with a few small particles of hard, white clay	35- 50
As above, but sand is light gray in color and clear.....	50- 60
As above, but medium sand	60- 75
Sand, quartz, white, coarse, subrounded to subangular, clear to frosted	75- 100
As above, but cream in color and many heavy minerals.....	100- 105
Sand, quartz, light-orange, medium to coarse (averages medium), subrounded to subangular, clear to frosted; heavy minerals numerous	105- 130
Sand, quartz, white, coarse to very coarse (averages coarse), rounded to subangular, clear to frosted.....	130- 145
Sand, quartz, micaceous, slightly clayey, silty, cream, fine to coarse (averages fine), rounded to subangular, clear to frosted	145- 150
As above, plus green clay and quartz granules 4 mm across	150- 160
Sand, quartz, micaceous, white, clean, fine to very coarse (averages coarse), rounded to subrounded, clear to frosted, with phosphorite pebbles to 6 mm in length; phosphorite, white to dark brown; some crystalline calcite. Numerous mollusk fragments, barnacles and shark's teeth	160- 180
As above, plus quartz pebbles 4 to 7 mm long.....	180- 220
As above, plus silt	220- 230
As at 160-180 feet	230- 275
Clay, gray-green to light-gray, pure, sticky, with small to large phosphorite pebbles	275- 280
As above, tan-gray, sandy	280- 285
As above, plus tan-gray hard dense phosphatic limestone....	285- 290
Clay, gray to olive-drab, slightly sandy, with limestone as above, dark-colored phosphorite pebbles and shark's teeth	290- 365
Limestone, white, sandy, phosphatic, dense, with some	

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
white crystalline limestone, blue chert and phosphorite pebbles	365- 375
Clay, white to gray-green, slightly sandy, with material as above	375- 400
Sand, quartz, slightly clayey, gray-green, medium to coarse (averages coarse), clear with small grains of phosphorite and smoky quartz	400- 405
Clay, dark-gray-green to olive-drab, slightly sandy, with phosphorite pebbles and some chert	405- 425
Sand, quartz, tan-gray, fine to very coarse (averages medium), clear, with fragments of cream dense sandy limestone, phosphorite pebbles, chert and dark-green clay	425- 435
Limestone, tan-gray, granular, hard to soft, slightly phosphatic, slightly sandy, with fragments of chert, dark green clay, and phosphorite pebbles. Mollusk fragments, shark's teeth	435- 445
Limestone, tan-gray, granular, hard, slightly phosphatic, slightly sandy; mollusk fragments.....	445- 480
Limestone, tan-gray, chalky, hard to soft, porous, slightly sandy. Small gastropods and pelecypods.....	480- 490
Sand, quartz, light gray, medium to very coarse (averages medium), clear, rounded to subangular, with some dense porcelaneous limestone, tan-gray phosphatic limestone, chert and phosphorite pebbles. Mollusk fragments and fish teeth	490- 495
Suwannee limestone:	
As above, plus soft white chalky limestone	495- 510
Ocala limestone:	
Limestone, tan-gray, granular to chalky, hard to soft, dense. Large and small Foraminifera. <i>Lepidocyclina ocalana</i> and others	510- 605
Limestone, foraminiferal coquina, cream, soft, chalky, porous. <i>Lepidocyclina ocalana</i> and others, mollusk fragments	605- 650
As above, but not as chalky	650- 680
Moodys Branch (?) formation:	
As at 605-650 feet, but containing numerous Camerinidae..	690- 735
As above, but fewer forams	690- 735
Avon Park limestone:	
Limestone, tan-gray, moderately hard, granular, calcitic. Few large Foraminifera, numerous worn <i>Peronella</i> type echinoids, mollusk fragments.....	735- 785
Lithology as above. <i>Coskinolina floridana</i> . <i>Peronella</i> numerous but not as worn as above	785- 795
As above, but <i>Coskinolina floridana</i> very numerous.....	795- 805
As above, plus dark brown crystalline dolomite.....	805- 810
Limestone, cream, hard, calcitic, granular, slightly chalky. Fauna as above	810- 845
As above, plus some soft, chalky limestone	845- 850
As above, plus some finely crystalline dolomite. No echinoids noted	850- 870
Limestone, tan, hard, calcitic, granular, with some light-brown hard porous finely crystalline dolomite. <i>Coskinolina floridana</i>	870- 880
As above, plus soft chalky tan limestone	880- 905
Limestone, tan, hard, slightly calcitic, granular. <i>Coskinolina floridana</i> numerous; mollusk fragments.....	905- 975
As above, plus cream hard dense limestone.....	975- 980

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
As at 905-975 feet, plus some gray hard dense limestone; <i>Peronella</i> type echinoids	980- 985
Limestone, cream to tan, slightly chalky, hard, granular. Few Foraminifera, mollusk fragments	985-1,020
Dolomite, light brown, crystalline, hard, with limestone as above	1,020-1,025
As above, plus some soft gray siltstone	1,025-1,035
Limestone, tan, hard, granular, with some light-brown finely crystalline dolomite. Foraminifera, mostly <i>Miliolidae</i>	1,035-1,040
Limestone, cream, hard, granular, slightly chalky, with dense white limestone. Foraminifera, mollusk frag- ments	1,040-1,050
Limestone, tan-gray, soft, chalky	1,050-1,055
As at 1,040-1,050 feet	1,055-1,065
Limestone, tan, hard, granular, with some light-brown finely crystalline dolomite	1,065-1,070
As at 1,040-1,050 feet	1,070-1,075
Lake City limestone:	
Limestone, tan to cream, hard, finely crystalline to granular, slightly chalky, with some crystalline brown dolomite and dark-colored chert. Foramini- fera, <i>Dictyoconus americanus</i>	1,075-1,100
Limestone, dolomitic, tan, hard, granular, with light to dark chert. Foraminifera, <i>Dictyoconus americanus</i> , mollusk fragments	1,100-1,115
Limestone, cream, granular, medium-hard, slightly chalky, with light to dark chert	1,115-1,130
Limestone, tan, hard, granular to dense and chert. Echinoid and mollusk fragments	1,130-1,150
As at 1,130-1,140 feet	1,150-1,155
Limestone, tan, granular, hard to soft, with brown cry- stalline dolomite. Mollusk fragments	1,155-1,165
Dolomite, dark-brown, crystalline, hard, with lime- stone as above and chert	1,165-1,170
Limestone, cream to gray, hard, granular, with some dolomite as above and chert. Foraminifera	1,170-1,200
Limestone, cream, chalky, soft, with dark crystalline dolomite	1,200-1,205
Dolomite, light-brown, crystalline, hard, with limestone as above. Foraminifera	1,205-1,210
Limestone, cream, hard, granular to dense, with dolo- mite as above. Mollusk fragments	1,210-1,230
Dolomite, dark-brown, hard, granular, with some chert.....	1,230-1,235
As above, plus some white mollusk fragments	1,235-1,240
Dolomite as above, plus cream granular limestone. Forams and mollusk fragments	1,240-1,260
Limestone, tan, hard, granular, with light-brown dolo- mite. Mollusk fragments and Foraminifera	1,260-1,295
Dolomite, brown, granular, very porous, hard, with light-colored chert and limestone as above	1,295-1,300
Limestone, tan, hard, granular, with a small amount of dolomite and chert as above	1,300-1,305
Dolomite, dark-tan, granular, hard.....	1,305-1,320
Limestone as at 1,300-1,305 feet	1,320-1,330
Dolomite, brown, hard, granular, very porous and white limestone containing mollusk fragments and forams....	1,330-1,355
As above, but tan to brown and containing chert	1,355-1,375
Dolomite, brown, granular, hard	1,375-1,385
Dolomite, tan, hard, granular, with some white dense	

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
limestone and chert. Mollusk fragments, Foraminifera	1,385-1,395
Dolomite, brown to tan, hard, granular, porous, with cream limestone and chert. Foraminifera	1,395-1,400

Water-level measurements made during drilling. Well cased to 463.5 feet.

Date 1951	Depth of hole, (feet)	Formation penetrated	Water level, in feet below land surface
May 5	525	Ocala	67.30
June 1	980	Avon Park	56.50
June 4	1,035	do.	54.20
June 6	1,160	Lake City	61.00
June 7	1,183	do.	60.20
June 8	1,185	do.	60.00
June 12	1,205	do.	57.60
June 14	1,268	do.	61.40
June 19	1,305	do.	56.30
June 22	1,390	do.	55.00
June 25	1,400	do.	55.00
July 7	1,400	do.	54.50

Pumping tests run at 1,185 and 1,400 feet

DEPTH OF WELL (FEET)	PUMPING RATE (GPM)	DRAWDOWN (FEET)
1,185	200	28+
1,400	1,212	39

Well 414

(F.G.S. no. 2846)

Four miles north of Sebring, in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 6, T. 34 S., R. 29 E.,
Highlands County. Surface altitude 107 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits, undifferentiated:	
No sample	0- 10
Sand, quartz, gray-orange, medium to coarse (averages coarse), frosted	10- 20
As above, but gray in color	20- 30
Sand, quartz, dark gray, medium to coarse (averages coarse), frosted to clear, with some organic material	30- 40
Sand, quartz, tan-gray, medium to coarse (averages coarse), frosted to clear	40- 60
As above, but light-gray in color.....	60- 110
Sand, quartz, light-gray, coarse to very coarse (averages very coarse), clear to some frosted, with some smoky quartz	110- 120

Well 422

Five miles south of Lake Placid in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33, T. 37 S., R. 30 E.,
Highlands County. Surface altitude 120 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits:	
Sand, quartz, brown to white, medium to coarse (averages coarse), rounded to subrounded, frosted....	0- 10

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Sand, quartz, cream, medium, rounded to subrounded, clear to frosted with a large amount of sand as above	10-	20
Sand, quartz, slightly micaceous, cream, coarse to very coarse, (averages coarse), rounded to subangular, frosted	20-	30
Hawthorn formation:		
Sand, quartz, slightly micaceous, cream, coarse, rounded to subangular, frosted, with a few small hard particles of white kaolin	30-	40
Sand, quartz, light-cream, coarse, subrounded to subangular, frosted	40-	50
Sand, quartz, light-cream, medium to very coarse, (averages coarse), rounded to subangular, frosted, with a few particles of hard white kaolin.....	50-	60
Sand, quartz, slightly micaceous, light-gray, medium to very coarse, (averages coarse), rounded to subangular, frosted, with many small particles of hard white kaolin	60-	70
As above, but more mica	70-	100

Well 423

Two miles northeast of Venus, in the northwest corner sec. 16, T. 39 S., R. 30 E., Highlands County. Surface altitude 125±10 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits and Hawthorn(?) formation, undifferentiated:		
Sand, quartz, slightly micaceous, light-cream, medium to coarse, (averages medium), rounded to subrounded, frosted, with some medium to coarse heavy minerals.....	0-	20
Sand, quartz, carbonaceous, dark-brown, medium to very coarse, (averages coarse), rounded to subrounded, frosted	20-	30
Sand as above, but medium to coarse, (averages medium), plus some medium rounded to subrounded frosted white sand	30-	40
Sand, quartz, carbonaceous, slightly micaceous, dark-brown, medium to very coarse, (averages coarse), rounded to subrounded, frosted	40-	60
Sand, quartz, slightly micaceous, dark-gray-orange, coarse to very coarse, (averages coarse), rounded to subrounded, frosted	60-	70
As above, but lighter in color	70-	82

Well 425

Five miles east of Lake Annie in the SW¼SW¼ sec. 31, T. 37 S., R. 31 E., Highlands County. Surface altitude 36 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, carbonaceous, black	0-	0.5
Sand, quartz, medium to coarse, tan, and some clay.....	0.5-	32
Tamiami formation(?):		
Limestone, sandy, gray, containing small amount of sandy clay and few phosphate pebbles	32-	46
Clay, shelly, and gravel with thin layers of calcareous sandstone	46-	67

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Sand, quartz, very fine, gray	67- 70
Sandstone, calcareous, soft, and thin beds of clay with pieces of chalk	70- 81
Sand, quartz, partly indurated, coarse, gray, and thin layers of clay	81- 89
Sandstone, calcareous, gray, soft, containing alternate layers of quartz sand, and thin beds of clay. Thin layers of sandy shelly marl from 99 to 108 feet.....	89- 108
Hawthorn formation(?):	
Marl, sandy, green, and thin layers of soft calcareous sandstone from 108 to 118 feet	108- 125

Well 426

About one mile east of Lake Istokpoga in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 36, S., R. 31 E., Highlands County. Surface altitude 39 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, carbonaceous, brown	0- 3
Sand, clayey, gray, and alternating beds of medium quartz sand	3- 9
Sand, clayey, brown	9- 19
Sand, quartz, medium, gray	19- 32
Clay, sandy, gray-green, plastic	32- 46
Sand, quartz, fine to medium, gray	46- 53
Tamiami formation:	
Marl, sandy, shelly, blue-green to gray-white	53- 65

Well 427

Near Fort Bassinger in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 8, T. 36 S., R. 33 E., Highlands County. Surface altitude about 30 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, quartz, gray	0- 2
Sand, quartz, indurated, reddish-brown	2- 20
Sand, quartz, gray, with a small amount of clay	20- 30
Clay, sandy (medium to coarse), dark-gray	30- 36
Sand, clayey, medium to coarse, dark-gray	36- 48
Tamiami formation:	
Shell marl, sandy, grayish-green, with a small amount of calcareous sandstone	48- 65
Marl, sandy, green. Few shells	65- 70
Marl, shelly, sandy, gray	70- 85
Hawthorn formation:	
Marl, clayey, bright green, containing very little sand or shells	85- 101

Well 428

Six miles west of Sebring, in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 35 S., R. 28 E., Highlands County. Surface altitude 80+10 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits(?) and Hawthorn formation, undifferentiated:	
Clay, dark-brown, sandy, carbonaceous	0.0- 6.5
Sand and clay interbedded; sand, quartz, clayey, micaceous, very fine to some coarse, light tan- gray; clay, sandy, light-green	6.5- 36

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Sand and black phosphorite. Sand, quartz, medium to some 6 mm long (averages coarse), clear to frosted. Phosphorite (30 percent of sample), medium to some 5 mm long, polished, with some light-green clay. A few shell fragments and fish teeth	36-	44
Shell marl, sandy, clayey, phosphatic. Gastropods, pelecypods and echinoid spines	44-	48

Well 433

Four and four-tenths miles east of Lake Annie in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 37 S., R. 30 E., Highlands County. Surface altitude 40 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, black, fine to medium	0-	0.5
Sand, quartz, cream, medium to coarse (averages coarse)..	0.5-	2.5
Sand, quartz, brown, very carbonaceous, medium to coarse	2.5-	5.0
Sand, quartz, tan, medium to coarse (averages coarse).....	5.0-	10
Sand, quartz, tan to cream, medium to some granules (averages coarse), with small particles of brown clay	10-	21
Clay, brown to blue, slightly calcareous, fine to coarse; contains finely crystalline pyrite	21-	21.5
Sand, quartz, cream, fine to coarse, with thin layers of brown, blue to cream sandy clay, and pyrite as above	21.5-	27
Tamiami formation:		
Clay, gray-blue, slightly sandy, slightly micaceous, plastic	27-	34.5
Shells in light-blue slightly sandy clay. Shells mostly small fragments, sparse foram fauna— <i>Rotalia beccarii</i>	34.5-	37
Clay, light-blue, silty, slightly micaceous, hard	37-	38
Clay, tan to blue-gray, slightly sandy, plastic, shelly, with some yellow clay in lower part. <i>Buliminella elegantissima</i> abundant	38-	45
Sandstone, tan, calcareous, hard, with some small quartz pebbles and black to rose colored mollusk fragments	45-	50
Sand, quartz, white to cream, micaceous, coarse to pebbles (6 mm across). Shallow artesian aquifer.....	50-	52
Limestone, tan, chalky, hard to soft, with a few shell fragments	52-	52.3
As at 50-52 feet	52.3-	56
Sandstone, tan, micaceous, with some cream clay.....	56-	58
Sandstone, cream, clayey, micaceous, (sand, fine to medium), with thin layers of coarse to pebble size quartz sand	58-	69.5
Sand, cream, coarse to pebble size, micaceous, with some brown to black phosphorite particles, mollusk fragments, shark's teeth, and cream limestone....	69.5-	71.5
Hawthorn formation:		
Sand, quartz, cream, coarse to pebble size, with thin layers of yellow clay. No phosphorite or mollusk fragments	71.5-	80
Clay, cream to orange, micaceous, finely sandy becoming coarsely sandy toward bottom, with inter-		

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
bedded cream medium to pebble size quartz sand and some brown to black phosphorite pebbles.....	80- 100
As above, but with more phosphorite plus some light-blue soft sandy clay. A few mollusk fragments, <i>Nonion glabrella</i> , <i>Buliminella elegantissima</i>	108- 117
Clay, light-blue, with medium to pebble size quartz sand, hard cream calcareous clay and some finely phosphatic gray limestone	117- 121
Clay, dark olive-drab, sandy, micaceous, tough, with shell fragments and some coarse to pebble size quartz sand and phosphorite. <i>Buliminella elegantissima</i> , <i>Nonion glabrella</i> , both species very abundant	121- 130

Well 434

Three and nine-tenths miles east of Lake Annic in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, T. 38 S., R. 30 E., Highlands County. Surface altitude 50 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene and Recent deposits:	
Peat, pure, black	0- 2
Sand, quartz, white, medium to coarse	2- 5
Tamiami formation:	
Clay, gray-green to tan, sandy, with a few shell fragments	5- 9
Clay, brown to orange, sandy (fine to very coarse grains)	9- 10
Clay, light-green in upper part, brown to lavender in lower part, sandy	10- 19
Clay, lavender to cream, very micaceous, sandy.....	19- 23
Clay, yellow-orange, cream to green, sandy, very micaceous	23- 33.5
Clay, cream, sandy; one phosphorite pebble noted. Mollusk fragments, sponge spicules, <i>Rotalia beccarii</i> , <i>Nonion glabrella</i> ?	33.5- 39
Sand, quartz, cream, coarse to pebbles, with some cream clay, mollusk fragments. Shallow artesian aquifer	39- 39.5
Sandstone, cream, hard, with hard chalky limestone and brown phosphorite and chert	39.5- 39.7
Limestone, cream, hard, chalky	39.7- 40
Sand, quartz, white to yellow, micaceous, coarse to pebbles, with phosphorite pebbles, yellow sandy clay and hard chalky cream limestone. A few mollusk fragments, Foraminifera abundant and poorly preserved, <i>Cibicides americanus</i> ? <i>Buliminella elegantissima</i>	40- 58
As above, plus fine to medium consolidated micaceous quartz sand	58- 60

Well 435

Three and four-tenths miles east of Lake Annie in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 37 S., R. 30 E., Highlands County. Surface altitude 90 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, quartz, gray-orange, medium to coarse (averages coarse)	0- 19.5
Sand, quartz, red, clayey, limonitic	19.5- 20

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Sand, quartz, cream to gray-orange, medium to very coarse (averages coarse)	20-	30
As above, but cream in color	30-	45
Peat, pure, black, ignites readily	45-	50
Sand, white to light-gray, fine to medium	50-	55
Tamiami formation:		
Clay, pale-green, sandy	55-	58
As above, plus coarse to granule size quartz sand	58-	65
Sand, quartz, brown to orange-gray, clayey, micaceous, fine to very coarse, with some particles of hard white kaolin	65-	68
Clay, light-green, sandy	68-	69
Clay, tan to gray, sandy, tough, limonitic	69-	73
As above, plus white calcareous clay	73-	75
As at 69-73 feet, plus thin layers of tan to green clay.....	75-	77
Clay, sandy, lavender to orange, with granule quartz grains, shell fragments and a few small particles of phosphorite. Foraminifera abundant. <i>Bulimina elegantissima</i> , <i>Rotalia beccarii</i> , <i>Nonion glabrella</i>	77-	85
Sand, quartz, clayey, tan, medium to granules (averages medium), with a few shell fragments and forams as above	85-	92
Sand, quartz, white to tan, micaceous, very coarse to granules (averages very coarse), with thin layers of cream, orange to brown sandy clay.....	92-	99
Hawthorn formation:		
Sand, quartz, cream, micaceous, coarse to very coarse (averages coarse), with thin layers of clay as above, plus some hard white kaolin	99-	111
Clay, white to orange, very micaceous, sandy (medium to granules), with layers of hard white kaolin at 116 feet and below	111-	124
Clay, cream, pure, with some kaolin as above.....	124-	129
As above, plus fine white to cream clayey micaceous consolidated sand and some medium to granule size quartz sand	129-	139
Sand, quartz, clayey, micaceous, white to gray, medium to granules (averages very coarse), with hard to soft white to tan clay, and a few brown to black phosphorite grains	139-	152
As above, plus sandy white kaolin	152-	160
Sand, quartz, clayey, micaceous, cream, coarse to very coarse, with brown to black phosphorite and thin beds of hard white sandy kaolin.....	160-	218
Clay, dark-olive-drab, tough, pure to sandy, non-fossiliferous and noncalcareous	218-	220

Well 436

Two and six-tenths miles east of Lake Annie in the NW¼NE¼ sec. 3, T. 38 S., R. 30 E., Highlands County. Surface altitude 113 feet.

MATERIAL.	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits, undifferentiated:		
Sand, quartz, white to gray, medium to coarse (averages coarse)	0-	22
Clay, tan, sandy	22-	22.2
Sand, dark-tan, medium to granules (averages coarse).....	22.2-	28
As above, but dark brown (carbonaceous).....	28-	33
Clay, brown, cream to green, silty, sandy (fine to very coarse)	33-	37

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Clay, cream, silty, sandy (fine to coarse), with some white clay	37-	45
As above, but less sandy	45-	50
Clay, white, sandy (fine)	50-	65
Tamiami formation:		
Clay, white, very sandy (fine to very coarse, averages coarse), micaceous, with some light-green to lavender clay	65-	70
As above, but less sandy (fine sand)	70-	82
Clay, light-green, micaceous, sandy, (averages fine), with some particles of slightly calcareous hard white clay	82-	84
Clay, yellow to orange, micaceous, sandy, (averages fine), with some hard white calcareous clay. A few Foraminifera?	84-	87
Sand, quartz, cream, coarse to granules (averages very coarse), with some orange to white hard sandy clay	87-	90
As above, but contains quartz grains up to 6 mm across	90-	105
Hawthorn formation:		
Sand, quartz, cream to white, medium to very coarse (averages coarse), clayey, micaceous, with particles of hard white kaolin	105-	126
Clay, cream, tan to orange, sandy (fine to very coarse, averages medium)	126-	137
Sand, quartz, cream, micaceous, coarse to very coarse (averages coarse), clayey	137-	140

Well 437

Two and four-tenths miles west of Lake Annie in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, T. 38 S., R. 29 E., Highlands County. Surface altitude 140 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Undifferentiated Pleistocene deposits:		
Sand, quartz, black, carbonaceous, medium to coarse.....	0-	3
Sand, quartz, cream to light-gray, medium to coarse (averages coarse)	3-	24
As above, but carbonaceous	24-	37
Hawthorn(?) formation:		
Sand, quartz, dark-brown, medium to coarse (averages coarse), carbonaceous	37-	56
As above, plus thin streaks of hard brittle jet black organic material (coal?)	56-	60
As at 37-56 feet	60-	87
Sand, quartz, tan-gray to light-brown, coarse to very coarse (averages coarse), with a few particles of cream sandy clay	87-	98
Clay, cream, very sandy (medium to very coarse).....	98-	107
Clay, tan to light-green, pure to sandy, (averages coarse) with pyrite, clear calcite and black to brown phosphorite. Shell fragments, shark's teeth.....	107-	110
As above, plus a thin streak of hard brittle sandy blue to black limestone. Phosphorized mollusk fragments....	110-	112
Sand, quartz, cream-gray, coarse to very coarse, with some hard cream clay and black phosphorite grains....	112-	120
Clay, light-green, micaceous, with some hard tan sandy clay and fine to granule size quartz sand and phosphorite	120-	128

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Sand, quartz, tan-gray, medium to very coarse (averages coarse)	128- 132
Clay, dark-olive-drab, very sandy, micaceous, with much fine to granule size quartz grains and a few scattered phosphorite grains. Mollusk or echinoid fragments	132- 160

Well 438

Four and seven-tenths miles west of Lake Annie in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 5, T. 38 S., R. 29 E., Highlands County. Surface altitude 91.5 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Pleistocene deposits, undifferentiated:	
Sand, quartz, black, carbonaceous, fine to medium.....	0- 0.5
Sand, quartz, cream, fine to medium.....	0.5- 1.0
Sand, dark-brown to black, carbonaceous, fine to coarse (averages medium)	1.0- 2
Sand, light-brown, fine to coarse, with small limonitic concretions	2- 4
Clay, cream, very sandy (fine to very coarse)	4- 7
As above, plus some light-blue clay	7- 10
Hawthorn formation:	
Clay, blue-green to orange (sandy, fine to coarse), with a few phosphatized mollusk fragments and shark's teeth	10- 18
Clay, cream, sandy (fine to coarse) with cream to black phosphorite and chert? Phosphatized mollusk fragments	18- 25
Limestone, clay and shell; limestone, cream, sandy, hard, fossiliferous; clay, cream, sandy (fine to very coarse); black phosphorite particles. Crab claws, coiled gastropods and well preserved echinoid fragments	25- 34
Clay, light-blue-green to gray, very sandy (coarse to very coarse), with limestone, phosphorite and fossils as above, plus shark's teeth	34- 43
Clay, dark-olive-drab, very micaceous, sandy. Fossils as above, plus barnacles	43- 55
As above, but contains echinoid fragments and coiled gastropods	55- 60

Well 439

Two miles west of Venus in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 39 S., R. 29 E., Highlands County. Surface altitude 105 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Undifferentiated Pleistocene deposits:	
Sand, quartz, white, very fine to coarse (averages fine)	0- 7.5
Sand, quartz, brown, very fine to coarse (averages medium), carbonaceous	7.5- 11
Hawthorn formation:	
Sand, quartz, dark-brown, fine to very coarse (averages medium) some grains smoky	11- 14
Clay, dark-brown to cream, brittle, sandy, (averages medium); almost a sandstone; smoky grains as above	14- 18
As above, but lighter in color and granule size sand grains	18- 20

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Clay, light-brown, sandy, medium to very coarse (averages coarse)	20-	22
Sand, quartz, cream, medium to very coarse (averages very coarse)	22-	28
As above, plus brown sandy micaceous clay	28-	30
Thin layers (about one-eighth inch) of hard dense pure dark-brown to black shale and fine to very coarse red-brown clayey very micaceous quartz sand.....	30-	41
Sand, quartz, cream, coarse to very coarse (averages coarse), with thin layers of shale as above, but lighter in color and sandier	41-	44
Clay, tan, pure to sandy, micaceous, with medium to very coarse quartz sand	44-	47
Sand, quartz, cream, fine to coarse (averages medium), micaceous	47-	51
Clay, dark-olive-drab, sandy, micaceous, with medium to very coarse (averages coarse) quartz sand; some grains are smoky and contain micaceous inclusions	51-	60
As above, but olive-drab clay is pure to sandy, with cream to tan sandy clay	60-	80
Sand, quartz, light-green, fine to coarse (averages coarse), micaceous, with thin beds of sandy olive-drab clay	80-	90
Sand, quartz, greenish-gray, coarse to very coarse, with a thin olive-drab to cream clay zone at 98.5 feet; many smoky and micaceous quartz grains.....	90-	108
Sand as above, but not as coarse; thin zones of olive-drab clay	108-	112
Clay, olive-drab to cream, sandy, medium to coarse, micaceous	112-	116
As at 108-112 feet	116-	120
Sand, quartz, gray, fine to coarse (averages coarse).....	120-	128
Clay, olive-drab, sandy	128-	129
As at 120-128 feet	129-	130
Clay as at 128-129 feet	130-	131
Sand, quartz, gray, medium to coarse (averages coarse).....	131-	139
Clay, olive-drab, sandy	139-	140
Sand as at 131-139 feet	140-	145
Clay, olive-drab, sandy	145-	145.5
Sand, quartz, gray, coarse to very coarse, with thin beds of sandy olive-drab clay at 155, 158, and 168 feet	145.5-	176
Sand, quartz, gray, coarse to some granules, with thin streaks of sandy, olive-drab clay at 176; many smoky and micaceous quartz grains	176-	202
Phosphorite, quartz sand and blue-gray clay. Phosphorite (about 20 percent of sample), black to brown, rounded, polished, calcareous, to 5 mm across. Sand, quartz, coarse to granules (averages coarse); many smoky and micaceous quartz grains; some cream hard limestone and olive-drab clay. Phosphatized gastropod fragments and fish teeth	202-	204
Limestone, cream to light-blue, hard, dense, fine grained; with gray-blue clay, sand, as above and some phosphorite, as above	204-	208.5
Clay, cream to gray, sandy, with cream to tan hard dense sandy limestone. Phosphorite and sand, as above. Fish teeth	208.5-	210

Well P 54

(F.G.S. no. 2842)

Four miles north of Avon Park in the southeast corner of the NE¼NW¼ sec. 35,
T. 32 S., R. 28 E., Polk County. Surface altitude 113 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
Pleistocene deposits:		
Sand, quartz, medium to coarse, rounded to sub- rounded, frosted, gray-orange to light-cream; some grains are coated with clay	0-	50
Hawthorn formation:		
As above, but white in color and more clay.....	50-	100
Sand, quartz, medium to granule size, rounded to sub- angular, frosted, white	100-	130
As above, plus particles of white kaolin.....	130-	150
Sand, quartz, clayey, micaceous, very fine to fine, with a few granule size sand grains, white.....	150-	210
Sand, quartz, clayey, micaceous, fine to coarse, poorly sorted, white, with some phosphorite. Shark's teeth.....	210-	230
Phosphorite and quartz sand, clayey, micaceous, fine to granule size, poorly sorted, light-brown	230-	240
Clay, calcareous, sandy, tan-gray, with some dense hard white limestone, dense, hard black limestone, sandy limestone, quartz and phosphorite gravel. Phosphatized mollusk fragments	240-	250
Clay, fuller's earth, calcareous, slightly sandy, gray- brown to olive-drab; numerous very small rhombic crystals and some phosphorite	250-	260
Clay, calcareous, sandy, tan-gray, with some dense hard finely crystalline limestone and some phos- phorite. Mollusk fragments	260-	290
Limestone, hard, finely crystalline, tan-gray to tan, with phosphorite pebbles. Gastropods, shark's teeth.....	290-	300
Clay, calcareous, sandy, tan-gray, with some finely crystalline white limestone, brown chert and phos- phorite. Shark's teeth	300-	310
Clay, calcareous, sandy, light-gray, with some hard sandy phosphatic tan limestone	310-	330
Suwannee limestone:		
Limestone, medium hard, chalky, porous, cream, with some sand and phosphorite. Echinoid fragments, gastropods, pelecypods. <i>Quinqueloculina</i> sp.	330-	350
Ocala limestone and Moodys Branch(?) formation:		
Limestone, soft, chalky, porous, cream. Echinoid frag- ments, numerous forams, <i>Rotalia mexicana</i> , and <i>Lepidocyclina ocalana</i>	350-	410
As above. Camerinids	410-	440
As above, but not as fossiliferous	440-	450
Limestone, soft, chalky, porous, cream. <i>Lepidocyclina</i> <i>ocalana</i> , coral	450-	460
No sample	460-	470
As at 410-440 feet	470-	520
No sample	520-	550
As at 410-440 feet. <i>Heterostegina ocalana</i> numerous.....	550-	580
No sample	580-	590
As at 410-440 feet	590-	620
Avon Park limestone:		
As above, plus some secondary calcite. <i>Peronella dalli</i>	620-	630
Limestone, hard, calcitic, porous, cream, with many calcite clusters and vugs. Badly worn gastropods and few large forams. <i>Camerina moodybranchen-</i>		

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
<i>sis, Peronella dalli</i>	630- 640
As above, plus sponge spicules and echinoid fragments.....	640- 650
No sample	650- 660
As at 640-650 feet	660- 670
No sample	670- 690
As at 640-650 feet, plus some badly worn specimens of <i>Coskinolina floridana</i>	690- 700
No sample	700- 710
Limestone, hard, calcitic, porous, cream. Numerous echinoid fragments, and specimens of <i>Coskinolina floridana</i>	710- 720
No sample	720- 750
Limestone, hard, chalky, cream to light-brown. Num- erous echinoid spines and small echinoid <i>Peronel- la dalli</i> ; very few large forams	750- 780
Limestone, hard, crystalline, tan. <i>Coskinolina floridana</i> and <i>Dictyoconus cookei</i>	780- 860
As above, plus some dense hard dark-colored limestone.....	860- 890
As above, plus some hard finely crystalline brown limestone. Miliolids	890- 940
Limestone, hard to medium-hard, chalky, porous, cream, with some finely crystalline cream lime- stone and secondary calcite. Very fossiliferous.....	940-1,000
Lake City(?) limestone:	
Limestone, hard, porous, cream to brown. Forams.....	1,000-1,020
Limestone, clayey, soft, porous, cream to brown, with numerous calcite rhombs.....	1,020-1,030
Limestone, clayey, hard, porous, calcitic, cream. Forams numerous. <i>Valvulammia minuta</i>	1,030-1,050
As above, plus some finely crystalline dense hard light- brown limestone and numerous calcite rhombs. Forams, miliolids numerous	1,050-1,100
Limestone, dolomitic, hard, finely crystalline, waxy, brown, with some finely crystalline to chalky cream limestone	1,100-1,120
No sample	1,120-1,130
Limestone, soft, chalky, cream, with some crystal- line calcite. Few fossils.	1,130-1,140
As at 1,100-1,120 feet plus echinoid fragments.....	1,140-1,150
Limestone, soft, finely crystalline, cream to light brown. Forams	1,150-1,160
As above, but darker in color	1,160-1,170
Limestone, brown, dolomitic, hard, porous, finely crystalline, waxy. Some large cream-colored forams.....	1,170-1,180
As above, plus some chalky cream fossiliferous lime- stone	1,180-1,200
Limestone, brown, dolomitic, hard, porous, finely crystalline, waxy, with some chalky hard porous fossiliferous cream limestone. Forams, sponge spicules, gastropods, and echinoid fragments.....	1,200-1,238

Water-level measurements made during drilling.

Date	Depth of hole (feet)	Formation penetrated	Water level, feet below land surface
1950			
Sept. 7	1,075	Lake City	22.0
Sept. 15	1,105	do.	23.0
Sept. 21	1,130	do.	23.9
Sept. 28	1,180	do.	22.7
Oct. 6	1,210	do.	21.9

Well OK 23

(F.G.S. no. 2844)

Near Okeechobee City, in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 17, T. 37 S., R. 35 E., Okeechobee County. Surface altitude 34 $\pm$ 2 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE	
No samples	0-	65
Tamiami formation:		
Sand, quartz, light-gray, fine to coarse, clear, with many mollusk shells	65-	73
Sand, quartz, micaceous, clayey, fine to medium, with small particles of dark phosphorite and small amount of hard gray sandy phosphatic limestone and a few shell fragments	73-	100
Silt, clayey, sandy, micaceous, light-gray-green, with small particles of dark phosphorite and fragments of Pectinidae	100-	135
Clay, sandy and phosphatic, silty, micaceous, dark-gray-green, with a few mollusk fragments.....	135-	150
Hawthorn(?) formation:		
Clay as above, but dark-blue-green, with mollusk fragments and light to dark phosphorite pebbles to 10 mm across	150-	165
Clay, micaceous, pure, fissile, dark-greenish-brown.....	165-	175
Sand, quartz, clayey, olive-drab, medium to coarse, with small dark phosphorite particles and numerous mollusk fragments	175-	205
Clay, very sandy, micaceous, dark-greenish-brown; sand fine to very coarse (averages medium), with phosphorite as above; very few mollusk fragments.....	205-	275
As above, plus some plastic blue-green shale	275-	285
As above, plus a small amount of hard-gray-brown sandy phosphatic limestone	285-	300
Clay, sandy, micaceous, olive-drab, and sand fine to coarse	300-	380
Clay, slightly sandy, micaceous, plastic, dark-gray-green, with numerous small phosphorite particles.....	380-	400
Clay, pure, gray-green to blue-green	400-	450
Clay, slightly sandy, phosphatic, gray-green with a small amount of tan hard sandy phosphatic limestone and some mollusk fragments	450-	460
Clay as above, plus some finely crystalline tan limestone; finely sandy and phosphatic gray to dark-gray limestone, dark chert and phosphorite pebbles to 5 mm across. Worn mollusk fragments.....	460-	470
Clay, pure, plastic, gray-green, phosphatic, with some material as above	470-	515
As above, plus large phosphorite pebbles and numerous mollusk fragments	515-	525
Clay, tan-gray, with pebbles of phosphorite to 4 mm across. Mollusk fragments, coral, Bryozoa and forams	525-	540
As above, plus some light-gray-green clay	540-	550
Clay, tan-gray with phosphorite pebbles and chert. Mollusk fragments, coral and echinoid spines.....	550-	602
Limestone, tan-gray, hard, with phosphorite and quartz sand; cuttings very fine	602-	625
Ocala limestone:		
Limestone, tan, hard; cuttings very fine	625-	635
As above, plus a few forams, <i>Lepidocyclus ocalana</i> , <i>Camerina</i> sp., coral	635-	670

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Foraminiferal coquina, cream. Forams mostly <i>Lepidocyclina</i> and <i>Camerina</i>	670- 690
As above, plus some cream chalky limestone. Some forams are dark in color	690- 750
Moodys Branch(?) formation:	
Limestone, cream, harder than above, with some dark-gray crystalline limestone. <i>Camerina</i> is the most abundant foram; few <i>Lepidocyclina</i>	750- 765
As above, plus some crystalline calcite and chalky limestone. <i>Camerina moodybranchensis</i> , coiled calcareous tubes	765- 775
Avon Park limestone:	
Limestone, <i>Peronella</i> coquina, tan, hard, with some finely crystalline porous hard cream limestone. Sample composed almost entirely of crystalline fragments and well preserved specimens of <i>Peronella dalli</i> , with a few <i>Dictyoconus cookei</i> and <i>Coskinolina floridana</i>	775- 805
Limestone, cream, hard, chalky, porous, with many tan crystalline fragments of <i>Peronella</i>	805- 830
Limestone, cream, hard to soft, chalky, porous, with echinoid fragments as above, and Foraminifera	830- 850
As above, plus some cream hard dense limestone	850- 925

Flow measurements made during drilling

DEPTH OF HOLE (FEET)	FORMATION PENETRATED	FLOW (GPM)
520	Hawthorn	Trace
602	do.	100+
660	Ocala	350
675	do.	450
925.5	Avon Park	525

Well GL 22

(F.G.S. no. 2396)

About 15 miles southwest of Okeechobee City, in sec. 20, T. 38 S., R. 34 E.,
Glades County. Surface altitude about 25 feet.

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
No samples	0- 65
Tamiami formation:	
Marl, gray, sandy, phosphatic. Fragments of echinoids and <i>Pectens</i>	65- 110
No samples	110- 188
Hawthorn formation:	
Clay, dark-blue green, sandy, coarse, phosphatic. Pelecypods numerous, mostly <i>Pecten</i> and <i>Chlamys</i> , numerous specimens of <i>Chlamys Plagiocentrum</i> sp.	188- 314
Clay, olive-drab, sandy, phosphatic. Many pelecypod fragments, mostly <i>Venus</i> and <i>Dosinia</i> ?	314- 337
No samples	337- 346
Clay, olive-drab, very sandy, fine	346- 357
Clay, light-gray-green, plastic. Mollusk fragments.....	357- 358
Clay, olive-drab to dark-gray-blue, plastic, with some very fine sand and mica	358- 378

MATERIAL	DEPTH, IN FEET BELOW LAND SURFACE
Clay, dark-olive-drab, sandy, medium to coarse.....	378- 388
Clay, blue-gray, plastic, with sand and mica. Mollusk fragments	388- 400
Clay, dark-gray-green, sandy, plastic, with rounded dark phosphorite pebbles to 5 mm across. Fragments of oyster shells	400- 409
Clay, same as at 400-409 feet, but lighter color	409- 418
Clay, dark-green, very plastic, with phosphorite pebbles as above. Mollusk fragments	418- 428
Clay, gray to light-green, plastic, with phosphorite pebbles to 10 mm across and some clay as above. Mollusk fragments	428- 465
No sample	465- 476
Clay, gray, phosphatic. Mollusk fragments	476- 480
Limestone, white, hard, dense, phosphatic. Mollusk fragments	480- 505
Phosphorite pebbles, black to brown to 8 mm across, with some limestone as above	505- 516
Clay, tan to dark-green, plastic, phosphatic, with some gray dense phosphatic limestone. Mollusk fragments	516- 527
Clay, gray-brown, plastic, with numerous small particles of dark phosphorite and material as above.....	527- 537
Clay, white to tan-gray, plastic, with many small particles of phosphorite. Fragments of pelecypods and echinoid spines	537- 575
Washed samples containing dark green shale, quartz sand, phosphorite pebbles, gray sandy phosphatic limestone, and mollusk fragments	575- 590
Limestone, cream, hard, porous, granular, phosphatic, with some tan hard porous crystalline limestone. Fragments of mollusks and a small echinoid.....	590- 610
Limestone, cream, hard, porous, finely granular, with phosphorite and quartz sand	610- 620
Ocala limestone:	
Limestone, foraminiferal coquina, cream, soft, porous, chalky. Several varietal forms of <i>Lepidocyclina</i> (<i>Lepidocyclina</i>) <i>ocalana</i>	620- 667
Moody's Branch(?) formation:	
Limestone, cream, harder than above, granular. No large forams	667- 687
Limestone, foraminiferal coquina, cream, soft, porous, granular. Camerinids most abundant foram	687- 814
Limestone as at 687-814 feet, but fewer forams.....	814- 854
Avon Park limestone:	
Limestone, tan, hard, porous, calcitic. Numerous <i>Peronella</i> type echinoids and coiled calcareous worn tubes	854- 888
Limestone, as at 854-888 feet plus <i>Dictyoconus cookei</i> , <i>Coskinolina floridana</i>	888- 909
Limestone, tan, hard, porous, calcitic, granular. Numerous <i>Peronella</i> type echinoids, <i>Coskinolina floridana</i> and coiled calcareous worn tubes.....	909- 958
Limestone, tan, hard, calcitic, granular, porous, with some white soft chalky limestone. <i>Spirolina coryensis</i>	985-1,022
Limestone, as at 985-1,022 feet plus a <i>Peronella</i> type echinoid and numerous <i>Coskinolina floridana</i>	1,022-1,036
Limestone as at 1,022-1,036 feet minus the echinoid.....	1,036-1,084
Limestone as at 1,036-1,084 feet but softer, plus some large forams	1,084-1,134

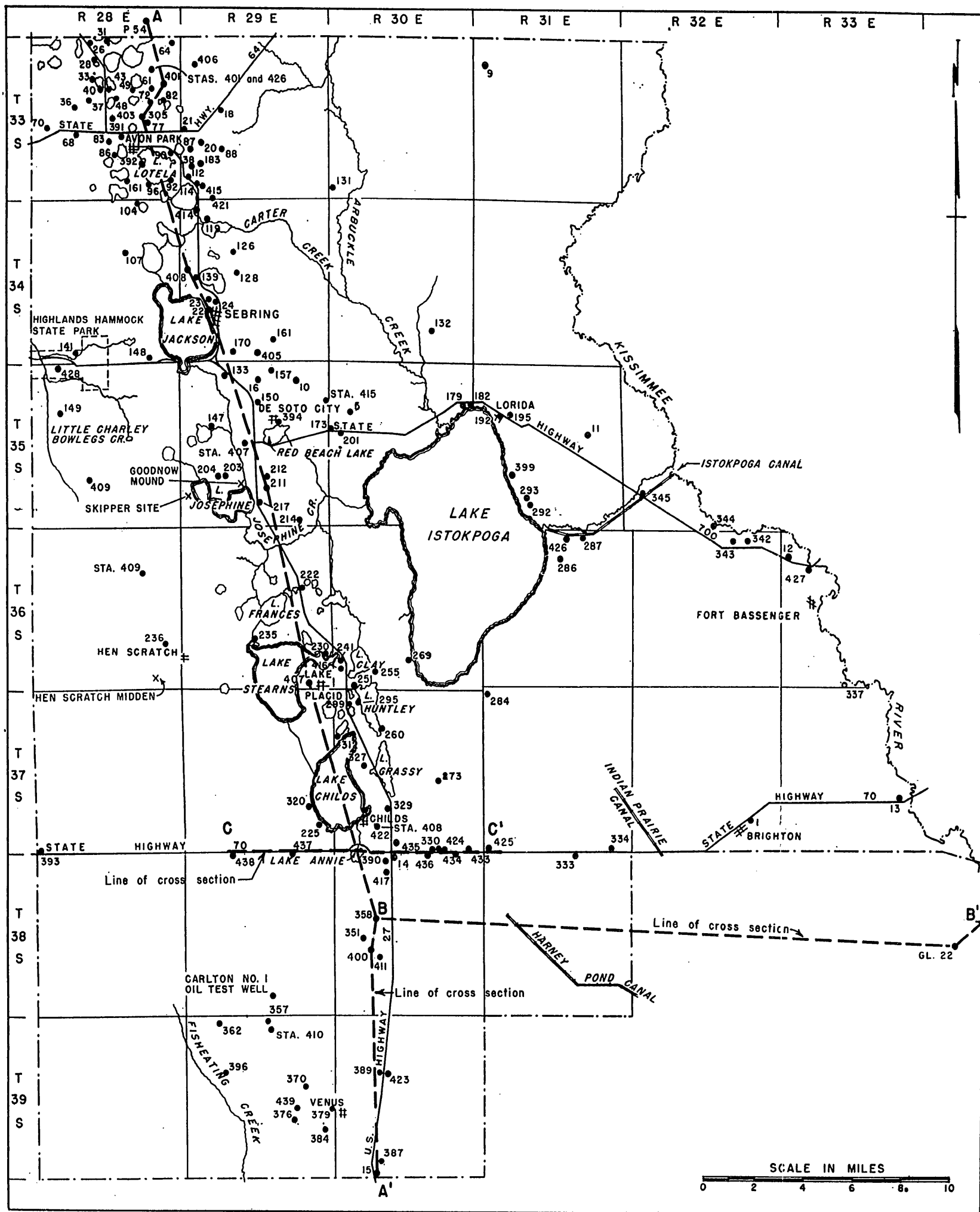


FIGURE 12. — Map of Highlands County showing location of geologic cross sections and selected wells.

MATERIAL

DEPTH, IN FEET
BELOW LAND SURFACE

Lake City(?) limestone:

Limestone, tan to light-brown, hard, calcitic, granular,
porous, with some dark gray dense limestone.

Forams and mollusk fragments 1,134-1,190

Limestone as at 1,134-1,190 feet, plus some light-
brown porous finely crystalline dolomitic limestone.... 1,190-1,215

Water-level and flow measurements made during drilling.

DATE 1951	DEPTH OF HOLE (FEET)	FORMATION PENETRATED	WATER LEVEL, IN FEET ABOVE LAND SURFACE.
Feb. 27	515	Hawthorn	6.0
Feb. 28	573	do.	6.0
Mar. 1	610	do.	30.0
Mar. 1	632	Ocala	32.0
Mar. 1	760	Moodys Branch(?)	31.0
Mar. 6	1,190	Lake City(?)	30.0
Mar. 6	1,215	do.	31.0

DATE 1951	DEPTH OF HOLE (FEET)	FORMATION PENETRATED	FLOW (GPM)
Feb. 24	501	Hawthorn	Trace
Mar. 1	610	do.	200±
Mar. 1	616	do.	290
Mar. 1	667	Ocala	310
Mar. 1	677	do.	340
Mar. 2	854	Moodys Branch(?)	395
Mar. 5	1,119	Avon Park	420
Mar. 5	1,134	do.	445
Mar. 5	1,164	Lake City(?)	480
Mar. 5	1,190	do.	565

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