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Sarasota County Intermediate Aquifer System Core Drilling and Analysis

by

Kenneth M. Campbell, Thomas M. Scott,
Richard Green and William L. Evans, III

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Introduction

The Florida Geological Survey (FGS), in cooperation with the U. S. Geological Survey (USGS) and Sarasota County, drilled and analyzed two core holes in Sarasota County (Figure 1). This investigation focused on the Neogene stratigraphy of the intermediate aquifer system in the two cores which were drilled into the Oligocene "Suwannee Limestone" and the top of the Floridan aquifer system. Funding was provided by the FGS with assistance from the USGS (Purchase Order 047670-92).

The study area is located in southwestern peninsular Florida approximately centered on the axis of the Florida Platform. Water resources in Sarasota County are drawn in large part from the intermediate aquifer system and the Floridan aquifer system. The Floridan aquifer system is comprised of Paleogene and earliest Neogene carbonate sediments. The intermediate aquifer system and confining unit is composed of Neogene Hawthorn Group sediments. The Neogene stratigraphic section in this area is incomplete due to non-deposition and erosion with part of the Miocene and much of the Plio-Pleistocene missing.

The Carlton Reserve core, FGS W-16782, 580' TD, is located in the northwest quarter of the northwest quarter of section 31, Township 38 South, Range 20 East. The South Venice core, FGS W-16814,

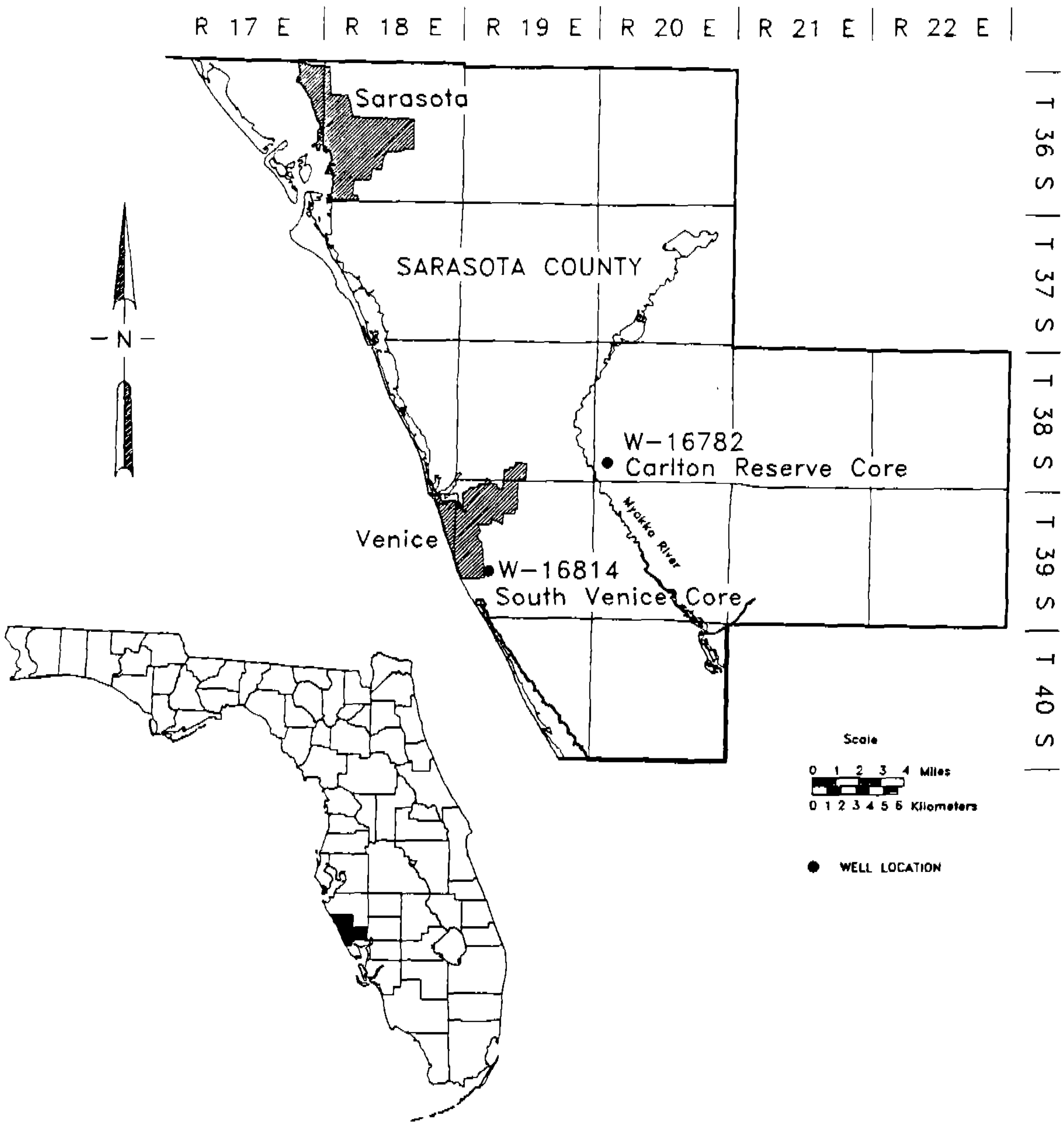


Figure 1: Location map and core locations.

701' TD, is located in the northwest quarter of the northwest quarter section 29, Township 39 South and Range 19 East. Both coreholes were drilled utilizing a Failing 1500 drill rig. Core samples were collected from the land surface to the total depth of each well. Split spoon samples were collected at selected intervals in the unconsolidated sediments for hydraulic conductivity analysis. The Carlton Reserve well was converted to a four inch diameter monitor well by plugging the hole back to 190 feet and installing casing from the land surface to 175 feet. The open hole interval is from 175-190 feet. The South Venice core was abandoned after coring, in accordance with Southwest Florida Water Management District and Sarasota County regulations.

Lithologic descriptions were generated for each core by a FGS geologist utilizing a binocular microscope. The descriptions (Appendix 1) follow the standard FGS format and were entered into the FGS data base via WELL LOG DATA SYSTEM software (Geosys Inc., 1992). Formation picks were made based on the core samples in conjunction with the gamma logs for the cores.

Structure

The broad Florida Platform extends southward from the North American continent, separating the Gulf of Mexico from the Atlantic Ocean. The exposed portion of the platform forms the State of Florida with the present day western coast of peninsular Florida approximating the axis of the Florida Platform. The Sarasota County study area, located on the southwestern portion of the Florida peninsula, lies near the center of the southern half of the platform.

The main structural features that affected Cenozoic deposition in the study area include the Sarasota Arch, South Florida Basin, Ocala Platform and Okeechobee Basin. The Sarasota Arch and the South Florida Basin influenced deposition during the Paleogene while the Ocala Platform and the Okeechobee Basin affected deposition during the Neogene.

Subsurface investigations in southwestern Florida have encountered complex geologic conditions in the Neogene section. Some researchers have delineated faults disrupting the strata and complicating the hydrostratigraphic and lithostratigraphic interpretations (Sproul et al., 1972; Hutchinson, 1991). Other investigators recognized folding in seismic reflection surveys run parallel to the coastline (Missimer and Gardner, 1976). This has led to speculation that deep seated faulting was responsible for the near surface structures. Interesting new data acquired during recent seismic surveys off the southwestern coast of the state have revealed that the reflectors in the mid-Eocene section are essentially flat lying while reflectors in the Mio-Pliocene section appear folded (Missimer, personal communication, 1993). Evans and Hine (1988) discussed the existence of a number of small "basins", erosional features and "deltas".

Lithostratigraphy

This investigation focused on the stratigraphy of the Neogene section as recognized in two Florida Geological Survey drilled coreholes, Carlton Reserve (W-16782) and South Venice (W-16814).

The FGS coreholes were drilled to a depth sufficient to reach the top of the Oligocene "Suwannee Limestone" and the top of the Floridan aquifer system (Figures 2-4).

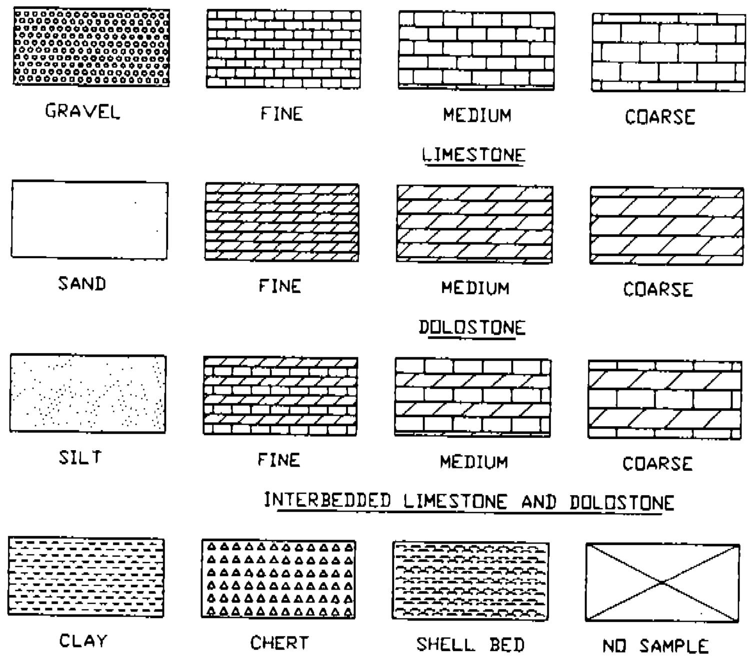
The "Suwannee Limestone" is referred to in quotes as a result of uncertainties concerning the actual formational identification of the Oligocene limestones in southern Florida. In the past, the first carbonate unit below the base of the Tampa Limestone (now Tampa Member of the Arcadia Formation, Hawthorn Group) was assigned to the Suwannee Limestone based simply on superposition. There is concern that these sediments may actually be younger than the type Suwannee Limestone and, since there is significant lithologic variation from the type, may be a separate formation. In keeping with the conventions described on the COSUNA chart for the Gulf Coastal Region (Braunstein et al., 1988) the name is used in quotes to designate that it is a formal lithostratigraphic unit name that may be incorrectly used.

The "Suwannee Limestone" occurs at 572 feet and 681 feet below land surface (bls) in the Carlton Reserve and South Venice cores, respectively. The carbonate sediments encountered are white to yellowish-gray, moderately- to well-indurated, fossiliferous packstones to grainstones. Foraminifera are the most common faunal constituent followed by molds of mollusks. Traces of clay, probably washed in to the formation, were noted. Approximately eight feet of "Suwannee Limestone" was cored at the Carlton Reserve site, while at South Venice 20 feet was cored.

The "Suwannee Limestone" is unconformably overlain by the

EXPLANATION

HATCHING PATTERNS



COMMENTS

M	MICRITE	T	SILT
S	SAND	C	CLAY
P	PHOSPHATE GRAVEL	Sh	SHELL
p	PHOSPHATE SAND	D	DOLOSTONE
O	ORGANICS	L	LIMESTONE
R	SPAR	H	HEAVY MINERALS
I	IRON STAIN	NO SPL	NO SAMPLE
Q	QUARTZ	G	GYPSUM
A	ANHYDRITE	Py	PYRITE
Ch	CHERT		

Figure 2: Explanation of hatching patterns and codes used in stratigraphic columns (Figures 3 and 4).

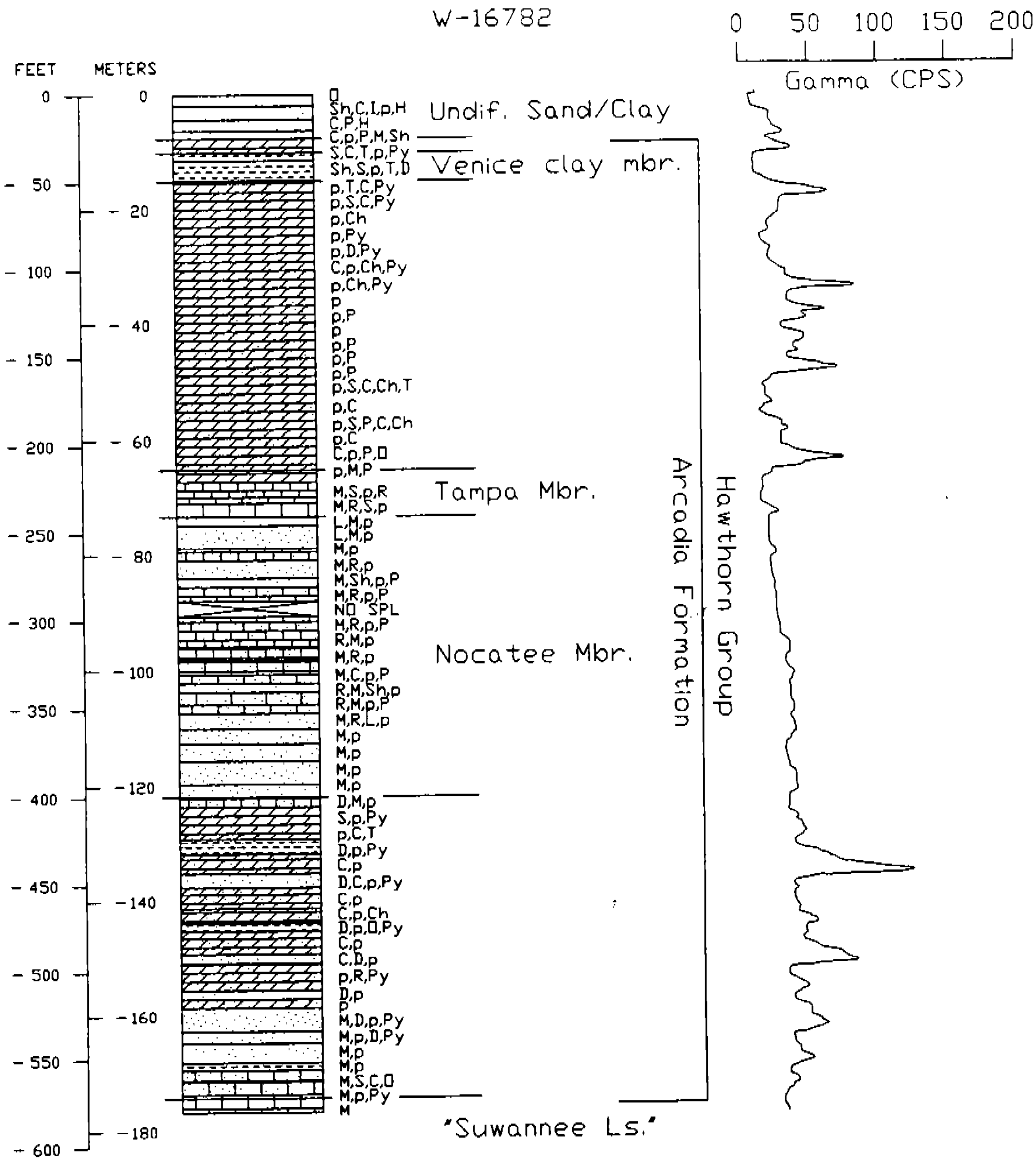


Figure 3: Stratigraphic column and gamma-ray log for Carlton Reserve Core.

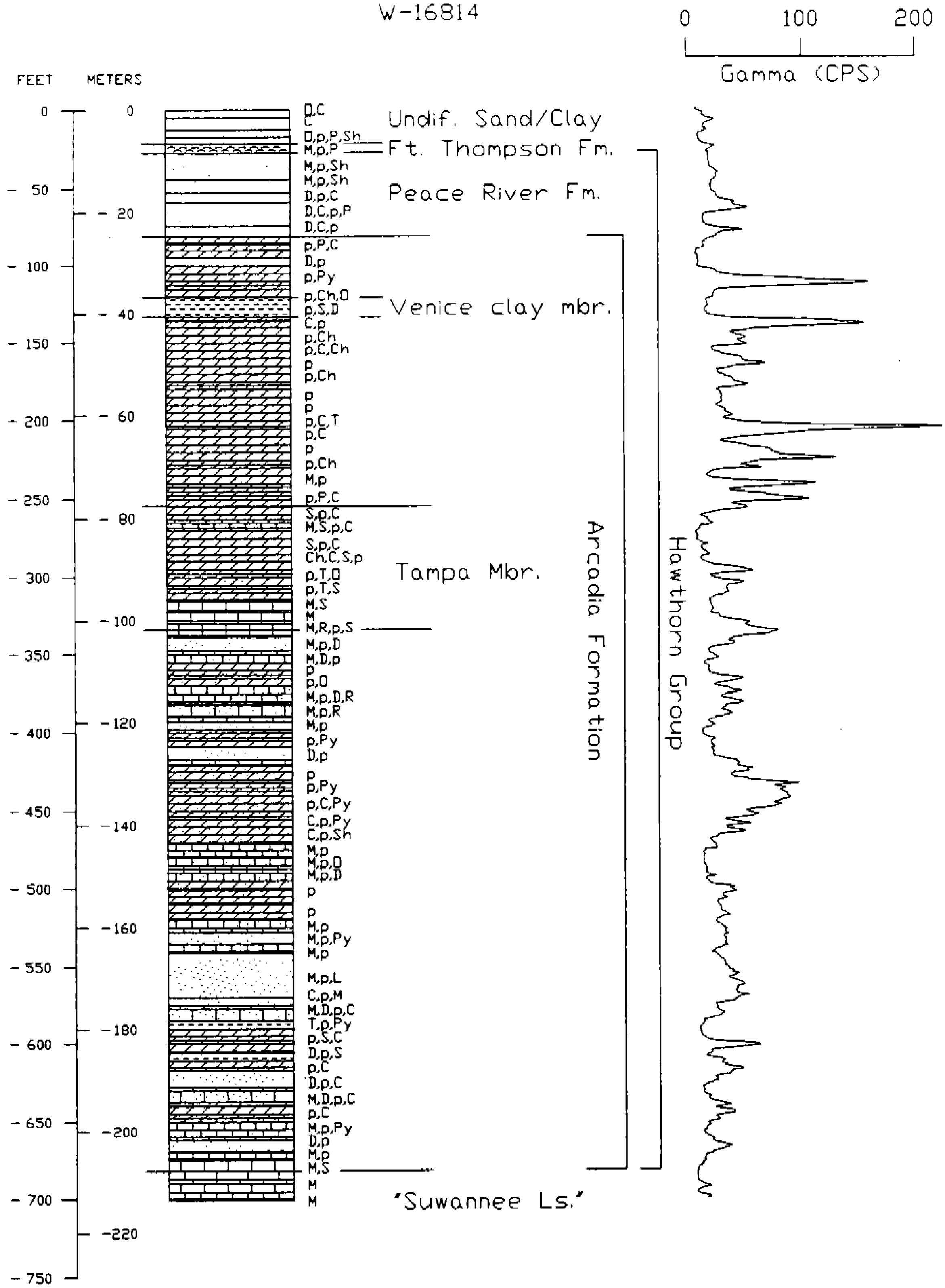


Figure 4: Stratigraphic column and gamma-ray log for South Venice Core.

Arcadia Formation of the Hawthorn Group. The unconformable contact resulted from a world-wide mid- to Late Oligocene sea level drop due to the development of southern hemisphere glaciation. This unconformity is often difficult to recognize due to similarities in lithologies between the top of the "Suwannee Limestone" and the basal Tampa Member or undifferentiated Arcadia Formation. The occasional difficulty in recognizing the disconformity spawned the humorous term Suwa-Tampa-Haw to describe the unit. This difficulty is predominantly related to lithologic descriptions and formational picks made from well cuttings. Close examination of high-quality core samples allows the unconformity to be recognized (Appendix 1).

The erosional disconformity forming the upper surface of the Hawthorn Group shows significant variability. Following the axis of the Florida Platform northward onto the Ocala Platform, progressively more of the stratigraphic section is removed. In the Tampa area, for example, most of the Arcadia Formation is missing leaving the Tampa Member at or near the surface. The converse is true to the south. The Hawthorn Group sediments thicken to the south as the axis of the Platform dips in that direction. Down dip on the eastern flank of the Platform, the Hawthorn Group thickens significantly, forming a more complete section.

The Hawthorn Group, in these cores, consists of the Arcadia Formation with its component Tampa and Nocatee Members and the Peace River Formation (Scott,1988). The upper Hawthorn Group Peace River Formation is absent in the Carlton Reserve core due to erosion. The absence of the Peace River Formation in this core is not b118b.pdf

unusual for this area. The Peace River Formation is present in the South Venice core.

The Arcadia Formation, Hawthorn Group contains a wide variety of lithologies in the study cores. In general, carbonates dominate the section with siliciclastic beds being less abundant (Figures 2-4). Siliciclastic units were more abundant in the Carlton Reserve core, where the Nocatee Member was recognized, than in the South Venice core. Phosphate is virtually ubiquitous in these sediments. Although economic concentrations are not present, the concentration of phosphate particles varies considerably, from less than one to more than 25 percent of the sample.

Dolostone tends to dominate the carbonate lithologies of the Arcadia Formation in this region. Limestone becomes more common within this section to the south and southeast. More limestone was present in the Carlton Reserve core than in the South Venice core.

The Nocatee and Tampa Members of the Arcadia Formation were identified in the Carlton Reserve core while only the Tampa was present in the South Venice core. The Tampa Member consists of slightly to non-phosphatic, sandy carbonates. The Nocatee Member is composed predominantly of quartz sands with varying percentages of carbonate, silt, clay and phosphate. The presence of the Tampa Member in the South Venice core represents a slight southward shift in the limits of the unit (Scott, 1988). Presence of the Nocatee Member in the Carlton Reserve core necessitates expanding the Nocatee's areal extent.

One of the units of primary interest in this study is the

Venice clay member (Joyner and Sutcliffe, 1976), an informal unit originally identified as a lower member of the Tamiami Formation. Upon investigating the Carlton Reserve core, it was surprising to find characteristic Arcadia Formation sediments superimposed on the clays referred to the Venice clay member. The implication is that either the Arcadia sediments were reworked locally during the Pliocene and redeposited on the Venice clay member, or the Venice clay member is part of the Arcadia Formation. Subsequent discussions with Lucy McCartan (USGS, personal communication, 1992) indicated that microfossils were recovered from the Venice clay member in the USGS Walton core. The fossils suggested an Early to Middle Miocene age which is compatible with the age range of the Arcadia Formation.

Following this lead, the Venice clay member has been recognized in the Arcadia Formation in other cores on file at the FGS. Scott (1992) suggested the informal placement of the Venice clay member in the Arcadia Formation based on the subjacent and suprajacent lithologies and preliminary fossil evidence.

The Venice clay member is recognized in both cores. It occurs between 33 and 49 feet below land surface (bls) in the Carlton Reserve core and 120 to 133 feet bls in the South Venice core. The Venice clay member is generally a variably dolomitic, gray-green clay with minor amounts of quartz sand and silt. Phosphate is rarely present in identifiable quantities. It appears to become more silty (quartz and/or dolomite) toward the upper and lower contacts. Fossils were not noted in the Venice clay member. Sediments immediately above and below the Venice clay member may be very clayey "dolosilts". These beds are not included in the Venice clay member as defined in this report.

The amount of variability of the Venice clay member was not documented by this investigation. However, the cores investigated revealed some variability in the dolomite, silt and sand content. A new core currently being drilled in the city of Sarasota reveals a thin (five feet) carbonate bed between two clay units that may make up the Venice clay member. It is possible that, upon further study, the clay- and dolomite-rich zones that overlie or underlie the Venice clay member may be included in the informal unit.

The gamma-ray signature of the Venice clay member (Figures 3 and 4) is a zone of low gamma-ray intensity falling between two zones of more intense gamma-ray activity. The overall pattern of gamma-ray activity surrounding the Venice clay member is quite characteristic of the Arcadia Formation in southwestern peninsular Florida (Scott, 1988). The signature of the clay does not include the sharp peaks occurring above and below it. However, in the Carlton Reserve core, the lower shoulder of the upper gamma-ray peak appears to overlap the upper boundary of the unit.

The Arcadia Formation is overlain unconformably by the Peace River Formation of the Hawthorn Group in the South Venice core. The Peace River Formation is identified from 27.5 to 81 feet bls in the core. It consists of two distinct zones, a lower zone from 52.4 to 81 feet and an upper zone from 27.5 to 52.4 feet. Both zones are composed of siliciclastic sediments with minor percentages of carbonate. The lower zone is generally darker colored and often contains more clay. Also, the lower zone contains sandy clays which were not common in the upper zone. The upper zone is generally lighter colored, contains less clay and more carbonate matrix. The upper zone probably represents a reworked Peace River lithology which is consistent with the geologic history of this area.

A thin, poorly preserved Pleistocene section overlays the eroded surface of the Hawthorn Group in both cores. The siliciclastic-rich sections from 25 feet bls to the surface in the Carlton Reserve core and 27.5 feet bls to the surface in the South Venice core are interpreted as being Pleistocene. A recognizable Fort Thompson Formation interval was noted in the South Venice core from 21.5 to 27.5 feet bls. The Fort Thompson Formation was not specifically identified in the Carlton Reserve core but the occasionally fossiliferous sands above the Hawthorn Group are probably of Fort Thompson age based on the inferred regional geologic history.

Paleontology

A paleontologic reconnaissance based on calcareous nannofossils was conducted by FGS paleontologists. Unfortunately, only a very few specimens were located. As has been found to be characteristic of Hawthorn Group sediments, diagenesis has obliterated most fossils.

The nannofossils recognized in the Carlton Reserve core included only two specimens of interest- Discoaster cf. variablis and

D. brouweri. These species have similar age ranges spanning from Middle Miocene to Late Pliocene (Serravalian to Piacenzian). No diagnostic nannofossils were recovered from the South Venice core.

Mollusks are commonly found in both cores, usually as molds and casts. L. Wyngard (USGS, Reston) is currently studying the mollusk faunas present in the cores. Early results suggest some very interesting findings. However, the results are too preliminary to be discussed in this text.

Hydraulic Conductivity

Falling head permeameters were utilized to measure the hydraulic conductivity of 26 split spoon and core samples. Fifteen samples were analyzed from the Carlton Reserve core and 11 from the South Venice core. The following procedure is summarized from FGS permeability lab procedures (Jon Arthur, 1993, personal communication).

Sample selection criteria for hydraulic conductivity were based on the requirement that channel or conduit flow conditions be avoided. Continuous sample contact with the sample tube wall was required, and interconnected fractures or cracks in the sample were avoided.

The sample interval selected was marked and the sample tube cut through with a hacksaw. The sample itself was cut with a spatula to minimize sample disturbance. Low permeability samples were soaked in de-ionized water for 24 to 48 hours to minimize saturation time on the permeameter. Rubber gaskets with a metal screen attached were placed on both ends of the sample prior to placement in the permeameter.

Indurated core samples were prepared for hydraulic conductivity testing by cutting the sample on a trim saw and encasing the sample in an epoxy resin within a larger diameter plastic tube. Liquid rubber and wax were placed on the ends of the core sample to ensure that resin does not block the ends of the sample. After the epoxy hardened, the wax and liquid rubber layers were removed allowing fluid flow thru the core, but not along the outside.

The assembled permeameter (Figure 5) was placed on a stand and connected to a buret filled with de-ionized water to a level simulating one meter of hydraulic head. The stopcock on the buret is opened and the permeameter is monitored until flow has been achieved thru the sample, at which time the stopcock is closed and the buret refilled. The fluid level is measured from the upper drain port to the top of the buret fluid level. This figure is recorded as the initial head. The time is noted and the stop cock opened. After sufficient head drop (usually 10 centimeters or more) the stopcock is closed and the time is recorded as the end of the test. Tests are conducted in triplicate except where saturation is not achieved. Samples which do not saturate after 31 days are removed. After testing of a sample is complete, the hydraulic conductivity is calculated by PERMCAL (software by Jon Arthur, FGS).

A total of six samples (five from Carlton Reserve, one from South Venice) did not attain full saturation during the test period (over 31 days in each case). Hydraulic conductivity of these

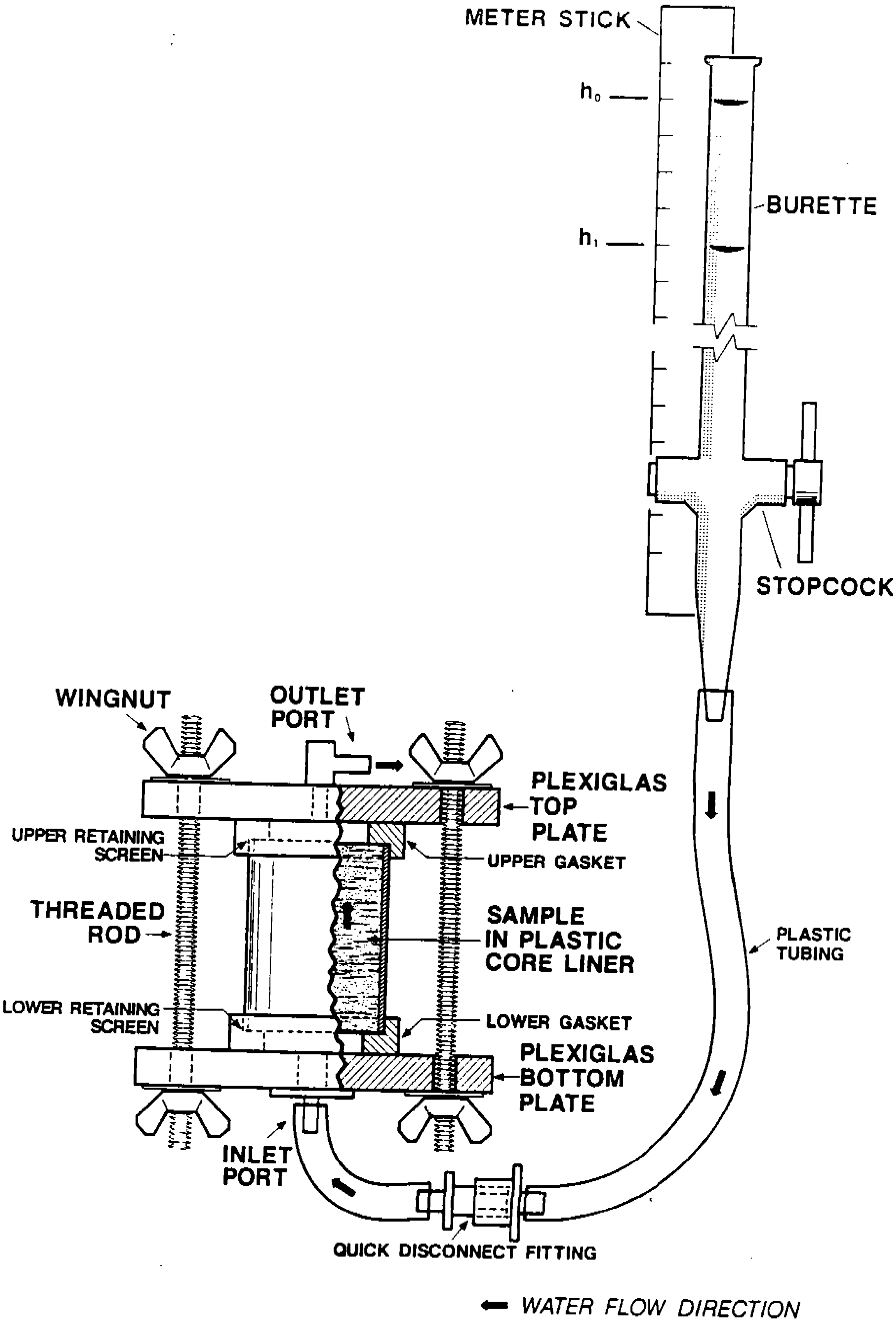


Figure 5. Falling head permeameter (Green et al. 1989).

samples should be considered only in a qualitative sense and are best described as having very low permeability.

Average hydraulic conductivities calculated for those samples which did flow range from $3.7(10^{-8})$ to $2.37(10^{-4})$ centimeters/second (cm/s) [$1.05(10^{-4})$ to $6.73(10^{-1})$ feet/day] for the Carlton Reserve samples and $9.35(10^{-8})$ to $1.15(10^{-3})$ cm/s [$2.65(10^{-4})$ to 3.25 feet/day] for the South Venice samples. Hydraulic conductivity data is presented in Tables 1 and 2.

Acknowledgments

A number of people provided assistance with different aspects of this project. Alex Howell and Donna Gerace prepared microfossil samples. Frank Rupert, Mel Enright and Mitch Covington examined microfossil samples. Paulette Bond, Joel Duncan and Frank Rupert of the FGS edited the text.

TABLE 1

PERMEAMETER ANALYSIS OF CARLTON SPLIT-SPOON AND CORE SAMPLES

SAMPLE # (DEPTH)	HYDRAULIC CONDUCTIVITY (K) CM/S FT/DAY RUN 1	RUN 2	RUN 3	AVERAGE K CM/S FT/DAY
SS 6.5'	1.52E-05*	2.02E-05	1.87E-05	1.80E-05
	4.31E-02	5.72E-02	5.30E-02	5.11E-02
	NOTE: very fine silty sand, desiccation cracks at top of core.			
SS 15'	9.60E-07	7.85E-07	7.23E-07	8.23E-07
	2.72E-03	2.23E-03	2.05E-03	2.33E-03
SS 19'4"	2.84E-04	2.36E-04	1.92E-04	2.37E-04
	8.06E-01	6.69E-01	5.44E-01	6.73E-01
SS 39'	4.15E-08	3.11E-08	3.83E-08	3.70E-08
	1.18E-04	8.81E-05	1.08E-04	1.05E-04
	NOTE: gray silty clay, sample had contracted due to desiccation and was no longer in good contact with core barrel, it had grooves on sides from split spoon process; however, the sample expanded during saturation and appeared to maintain good contact with core barrel.			
C 101'	1.36E-06	1.32E-06	1.49E-06	1.39E-06
	3.87E-03	3.73E-03	4.23E-03	3.94E-03
C 122'	8.43E-07	8.22E-07	8.77E-07	8.48E-07
	2.39E-03	2.33E-03	2.49E-03	2.40E-03
C-165'	5.11E-08	6.67E-08	8.97E-08	6.92E-08
	1.45E-04	1.89E-04	2.54E-04	1.96E-04
C-179'	5.00E-08	5.59E-08	5.84E-08	5.48E-08
	1.42E-04	1.58E-04	1.66E-04	1.55E-04
C-206'	NOTE: This core was on permeameter from 7/8/92 - 8/31/92 and did not reach saturation! Hydraulic conductivity can best be described as very low.			
C-402'	NOTE: This core was on permeameter from 7/16/92 - 8/31/92 and did not reach saturation. Hydraulic conductivity can best be described as very low.			

TABLE 1 continued

SAMPLE # (DEPTH)	HYDRAULIC CONDUCTIVITY (K) CM/S FT/DAY			AVERAGE K CM/S FT/DAY
	RUN 1	RUN 2	RUN 3	
C-413'	NOTE: This core was on permeameter from 7/24/92 - 8/31/92 and did not reach saturation. Hydraulic conductivity can be best described as very low.			
C-426'	5.93E-09	4.29E-09	6.16E-09	5.46E-09
	1.68E-05	1.22E-05	1.75E-05	1.55E-05
	NOTE: This core reached saturation after 23 days.			
C-441'	NOTE: This core was on permeameter from 6/19/92 - 8/31/92 and did not reach saturation. Hydraulic conductivity can be best described as very low.			
C-460'	NOTE: This core was on permeameter from 7/16/92 - 8/31/92 and did not reach saturation. Hydraulic conductivity can best be described as very low.			
C-526'	1.65E-07	1.68E-07	1.64E-07	1.66E-07
	4.67E-04	4.78E-04	4.64E-04	4.69E-04

* Exponential notation 'E-05' is equivalent to '(10^{-5})'
SS = SPLIT SPOON SAMPLES
C = CORE SAMPLES

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TABLE 2
PERMEAMETER ANALYSIS OF SOUTH VENICE SPLIT-SPOON AND CORE SAMPLES

SAMPLE # (DEPTH)	HYDRAULIC CONDUCTIVITY (K) CM/S FT/DAY RUN 1	RUN 2	RUN 3	AVERAGE K CM/S FT/DAY
SS 31.5'	1.02E-06*	1.01E-06	9.50E-07	9.93E-07
	2.90E-03	2.85E-03	2.69E-03	2.82E-03
SS 38'	1.47E-06	1.33E-06	1.28E-06	1.36E-06
	4.17E-03	3.77E-03	3.62E-03	3.85E-03
SS 44.5'	1.17E-03	1.16E-03	1.10E-03	1.15E-03
	3.32E+00	3.29E+00	3.13E+00	3.25E+00
	NOTE: Core was grooved and may be disturbed.			
SS 59'	1.51E-06	1.56E-06	2.24E-06	1.77E-06
	4.27E-03	4.43E-03	6.36E-03	5.02E-03
SS 76'	2.14E-06	2.15E-06	1.97E-06	2.09E-06
	6.08E-03	6.09E-03	5.59E-03	5.92E-03
C 111'	3.04E-06	2.77E-06	2.96E-06	2.92E-06
	8.61E-03	7.85E-03	8.39E-03	8.28E-03
C 126'	1.08E-07	9.33E-08	7.91E-07	9.35E-08
	3.07E-04	2.64E-04	2.24E-04	2.65E-04
	NOTE: Core had grooves which disappeared after clay became saturated and swelled; disturbed?			
C 246'	6.35E-08	7.63E-08	8.12E-08	7.37E-08
	1.80E-04	2.16E-04	2.30E-04	2.09E-04
C 416'	1.66E-06	1.78E-06	2.10E-06	1.85E-06
	4.71E-03	5.04E-03	5.94E-03	5.23E-03
C 543'	1.05E-07	1.22E-07	1.25E-07	1.17E-07
	2.97E-04	3.45E-04	3.55E-04	3.32E-04
C 636'	This core was on permeameter for approximately 2.5 months and did not completly saturate.			

* Exponential notation 'E-06' is equivalent to '(10^{-6})'
SS = Split spoon samples
C = Core samples

References

Braunstein, J., Huddlestun, P., and Biel, R., 1988, Gulf Coast Region, Correlation of Stratigraphic Units of North America (COSUNA) Project: American Association of Petroleum Geologists, 1 chart.

Evans, M.W., and Hine, A.C., 1988, Late Miocene to Quaternary seismic and lithologic sequence stratigraphy of the Charlotte Harbor area: Southwest Florida: Final report to the South Florida Water Management District, 90 p.

Geosys, Inc., 1992, The Well Log Data System, version 3.0, Gainesville Fl, 38 p.

Green, R., Duncan, J., Seal, T., Weinberg, J.M., and Rupert, F., 1989, Characterization of the sediments overlying the Floridan aquifer system in Alachua County, Florida: Florida Geological Survey Open File Report 29, 80 p.

Hutchinson, C.B., 1991, Assessment of hydrogeologic conditions with emphasis on water quality and wastewater injection, southwest Sarasota and west Charlotte Counties, Florida: United States Geological Survey Open-file Report 90-709, 101 p.

Joyner, B.F. and Sutcliffe, H., Jr., 1976, Water resources of the Myakka River Basin area, southwest Florida: United States Geological Survey Water Resources Investigation 76-58, 87 p.

Missimer, T.M., and Gardner, R.A., 1976, High-resolution seismic reflection profiling for mapping shallow aquifers in Lee County, Florida: U.S. Geological Survey Water Resources Investigations IN-TIS, WRI 76d-45, 30 p.

Scott, T.M., 1988, The lithostratigraphy of the Hawthorn Group (Miocene) of Florida: Florida Geological Survey Bulletin 59, 148 p.

___________, 1992, Neogene lithostratigraphy of the Florida peninsula-problems and prospects: in Abstract volume, the third Bald Head Island Conference on Coastal Plains Geology, p. 34-35.

Sproul, C.R., Boggess, D.H., and Woodard, H.J., 1972, Saline-water intrusion from deep artesian sources in the McGregor Isles area of Lee County, Florida: Florida Bureau of Geology Information Circular 75, 30 p.