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Open File Report 37

Core Drilling Project: Lee, Hendry and Collier Counties

by

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INTRODUCTION

In June 1988, the Florida Geological Survey (FGS) and the South Florida Water Management District (District) entered into a contract (#88-188-0675) to conduct a joint project in Lee, Hendry and Collier Counties. The objectives of this project were: to increase the geologic/hydrogeologic well data available in these counties, to translate existing lithologic descriptions of wells within the district to computer format and to add this data to the District computer data base. These objectives were met by the translation of over 180 existing well logs to computer format, by drilling and evaluating the data for six cores, and merging all of this data with the existing FGS and District computer data bases.

Six cores were drilled by the FGS at locations specified by the District (Figure 1). Geophysical logs were run on each core by District personnel. After completion of drilling and logging, five of the coreholes were plugged by District contractors. The remaining corehole was reamed and a monitor well constructed. The cores are listed below:

Lee County

W-16242; South Seas Plantation #1, 760' TD, monitor well

(T45S, R21E, S26)

W-16523; Koreshan #1, 822' TD

(T46S, R25E, S33A)

Hendry County

W-16329; Hilliard Brothers #1, 740' TD

(T44S, R32E, S16B)

W-16387; U.S. Sugar #1, 662' TD

(T44S, R34E, S09B)

Collier County

W-16434; Collier Corp. #1, (Immokalee), 715' TD

(T47S, R30E, S03B)

W-16505; Fakahatchee Strand #1, 702' TD

(T50S, R30E, S06C)

Detailed stratigraphic columns for each core are included as Figures 2-7 (Attached).

LITHOSTRATIGRAPHY

Suwannee Limestone

The Oligocene-age Suwannee Limestone underlies all of Lee, Hendry and Collier Counties, consisting of white to beige recrystallized limestone containing abundant microfossils, quartz sand and trace amounts of phosphate. The top of the Suwannee Limestone is encountered between 550 and 1000 feet below National Geodetic Vertical Datum (NGVD), with the shallowest occurrences being in northwest Lee County and the deepest in central Hendry County (Wedderburn et al., 1982; Peacock, 1983 and Klein et al., 1964). Sediments of the Suwannee Limestone form part of the Floridan aquifer system. The Suwannee was encountered in both Lee County cores (W-16242 and W-16523) (Figures 2, 7-9). The pick for the top of the Suwannee Limestone was based upon an overall

decrease in quartz sand and phosphate, an overall increase in fossil content, and a general increase in carbonate lithology from a mudstone or wackestone to a packstone or grainstone.

Hawthorn Group

The Miocene-Pliocene age Hawthorn Group unconformably overlies the Suwannee Limestone. Scott (1986, 1988) raised the Hawthorn Formation to Group status and erected new formations within the Group statewide. The Hawthorn Group in south Florida consists of two formations: the Arcadia Formation (Hawthorn carbonate unit and Tampa Limestone of previous usage) and the Peace River Formation (Hawthorn siliciclastic unit of previous usage).

Arcadia Formation

The Arcadia Formation consists predominantly of white, light gray and yellowish gray, poorly to well indurated, calcilutitic and very finely crystalline limestone (wackestone to mudstone), dolomitic limestone and dolostone. The Arcadia contains variable amounts of clay, silt, quartz and phosphate sand with occasional phosphate gravel. Beds of clay, silt-sized dolomite and quartz sand are common. The Arcadia is commonly fossiliferous (primarily oysters, pectens and bryozoans, with diatoms and foraminifera in some clayey intervals). The top of the Arcadia is found at approximately 150 feet below NGVD in northwestern Lee County and dips to the southeast to over 400 feet below NGVD in southeastern Collier County (Scott, 1988). The Arcadia Formation was encountered in all six of the cores drilled for this project (Figures 2-10). The top of the Arcadia Formation in these cores

was picked based upon a change from predominantly siliciclastic sediments to predominantly carbonate sediments.

Peace River Formation

The Peace River Formation (Scott, 1988) consists of the "upper Hawthorn siliciclastics" of prior usage as well as the siliciclastics previously placed in the Tamiami Formation (Parker, 1951, Parker et al., 1955) and the Murdock Station and Bayshore Clay Members of the Tamiami Formation (Hunter, 1968). The Peace River Formation consists primarily of white, light gray and light olive, interbedded, poorly to moderately indurated sands, silts, clays and carbonates. The siliciclastic components are dominant. Carbonate material is primarily calcilutite or silt-sized dolomite. All lithologies typically contain variable amounts of quartz and phosphate sand. The top of the Peace River Formation is encountered at approximately 0 feet NGVD in northern Lee County dipping slightly to the south-southeast in Lee and Hendry Counties then to the southwest in Collier County where it is found predominantly between 100 and 150 feet below NGVD (Scott, 1988). The Peace River Formation was encountered in all six cores. In three of the cores (W-16242, W-16387, and W-16523) (Figures 2, 3, 6-10) the top of the Peace River Formation was picked as a change from sandy limestones of the Tamiami Formation to very fine to fine sands, silts, and clays with minor phosphate and carbonate. In the three remaining cores (W-16329, W-16434, and W-16505) (Figures 3-5, 8, 10), the presence of thick sequences of coarse siliciclastics made the picking of the top of the Peace River Formation difficult.

In general, the Peace River Formation pick in these cores was made based upon a decrease in grain size from the medium to very coarse sands of the "Miocene coarse clastics" to very fine to fine sands with minor phosphate and carbonate. This pick is made more difficult in these three cores due to the fact that the recovery of sediments in this interval was generally poor, with most of the samples consisting of bags of cuttings which represented five feet or more of samples.

Sediments of the Hawthorn Group form the both intermediate aquifer system and intermediate confining unit which includes the mid-Hawthorn aquifer and sandstone aquifer, and the lower, mid- and upper Hawthorn confining zones (Wedderburn et al., 1982; Smith and Adams, 1988). The confining characteristics of the Hawthorn Group sediments also serve to confine the Floridan aquifer system. Water from the producing zones in the Hawthorn is better quality in general than the underlying Floridan aquifer system (Wedderburn et al., 1982).

Undifferentiated Coarse Siliciclastics

A thick sequence of coarse quartz sand and gravel is present in Hendry and Collier Counties which, in the past, has been informally called the "Miocene coarse clastics" and placed in the upper part of the Hawthorn Formation (Peacock, 1983) or Peace River Formation of the Hawthorn Group (Knapp et al., 1986; Smith and Adams, 1988; Campbell, 1988). In addition to being informal, the term "Miocene coarse clastics" is misleading as at least part of this unit is probably Pliocene in age. Three cores (W-16329, W-

16434, and W-16505) (Figures 3, 5-6, 8, 10), all had a thick sequence of coarse siliciclastic material present overlying the Peace River Formation. These siliciclastics are uncharacteristically coarse for the Peace River Formation, and have been referred to as undifferentiated sands, clays and shells until further information becomes available for the area.

Smith and Adams (1988) report that these coarse siliciclastics form a northeast-southwest trending trough on top of the fine sands and silts of the Peace River Formation in Hendry and Collier Counties. These three cores fall along the axis of this trough. The top of the coarse siliciclastics in these three cores range from approximately 50 to 70 feet below NGVD, with a thickness of 290 to 300 feet (Figures 8 and 10). These thicknesses are considerably greater than the ones shown by Smith and Adams (1988). This may be due to the fact that large portions of the recovery in the coarse siliciclastic section consists of cuttings which have been homogenized and have potentially had fine grained matrix material washed out during drilling, thus making the contact between the base of the coarse siliciclastic material and the top of the Peace River Formation difficult to pick with certainty.

Tamiami Formation

The Tamiami Formation of Parker (1951) and Parker et al. (1955) has been restricted by later authors (Hunter, 1968; Hunter and Wise, 1980 a and b; Scott, 1988). The Tamiami as used in this report reflects these changes and consists of the Ochopee and Buckingham Limestone Members and the Pinecrest Sand Member. Some

difficulty arises in identifying the Tamiami where sand sediments are devoid of shell material and recognizable limestone units are not present.

The Tamiami consists primarily of yellowish gray, shelly, quartz sandy, slightly phosphatic limestone with calcilutite or recrystallized calcite matrix. Molds of aragonitic fossils are common. Quartz sand, shell content and induration are variable.

The top of the Tamiami Formation in the area ranges from a high of approximately 25 feet above NGVD in eastern Lee County to as much as 45 feet below NGVD along the coastal portions of Lee County (Wedderburn et al., 1982), and as much as 60 feet below NGVD in southeastern Hendry County. Elsewhere the Tamiami is found primarily between 0 feet NGVD and 20 feet above NGVD (Knapp et al., 1986; Smith and Adams, 1988). The Tamiami Formation is missing in the northwest and northeast corners of Hendry County (Smith and Adams, 1988). The Tamiami Formation was encountered in all of the cores except for W-16329 (Figures 2, 4-10), where it is apparently absent. The top of the Tamiami Formation was picked as being a moderately sandy to very sandy yellowish gray shelly limestone with numerous fossil molds. In W-16523, the Tamiami Formation was much sandier than in the other cores. In this core, the Tamiami Formation is a very calcareous, slightly phosphatic, fine grained quartz sand.

Caloosahatchee and Fort Thompson Formations

The Caloosahatchee and Fort Thompson Formations of previous usage are undifferentiated in this report due to the lack of

lithologic characteristics on which to differentiate the units. These units were originally defined based on the fossils they contain. The fossiliferous sands and carbonates of these units are often less than 10-feet thick. The undifferentiated Caloosahatchee and Fort Thompson Formations are present in two of the cores from the study (W-16387 and W-16505) (Figures 4, 6, 8 and 10). These formations are poorly represented in these cores. The tops of these formations were picked as a moderately to highly recrystallized, slightly sandy, fine-grained limestone.

Undifferentiated Sands, Clays and Shells

Undifferentiated Pleistocene-Holocene age sediments overlie the Caloosahatchee-Ft. Thompson sediments or the Tamiami Formation in each of the cores from this study. These sediments vary from unfossiliferous quartz sands to very fossiliferous sands and shell beds, thin "marl" beds and organic-rich sediments. The undifferentiated sediments generally occur as thin beds less than 10-feet thick. However, along the coast these units can exceed 20-feet thick.

Sediments belonging to the undifferentiated coarse siliciclastics, Tamiami, Caloosahatchee and Ft. Thompson Formations and the undifferentiated sands and clays comprise the surficial aquifer system (Wedderburn et al., 1982; Knapp et al., 1986; Smith and Adams, 1988). The surficial aquifer system contains two aquifers, the water table and lower Tamiami which are separated by a leaky confining zone (Tamiami confining beds).

CORE AND CUTTINGS DESCRIPTIONS

Lithologic descriptions utilizing the Well Log Data System were made for the six cores drilled for this study and entered in the Florida Geological Survey's wellfile data base. A binocular microscope was utilized in describing the lithologic characteristics of each of the cores. The major characteristics described and recorded included sample color, porosity, lithology, induration, cement type, accessory minerals, and fossils. Formation tops were determined based primarily on lithologic criteria. Rock colors were based on the Geological Society of America's Rock Color chart (Geological Society of America, 1984). Appendix I contains complete lithologic descriptions of each of the six cores described in this study.

RADIOCHEMISTRY AND X-RAY DIFFRACTION STUDIES

In addition to the microscopic description of the cores, selected samples from one of the cores, W-16242, are currently being analyzed for their uranium concentration and U^{234}/U^{238} activity ratio as part of the research for a Master's thesis at Florida State University. As part of this thesis, it was decided to analyze the bulk mineralogy of these samples in order to determine what relationship, if any, the mineralogy has with the distribution of uranium within the sediments. For this reason, each of the twenty-six samples chosen for uranium work was analyzed for bulk mineralogy by means of an x-ray diffractometer (XRD). The clay-sized fraction from each of these samples will be analyzed in order to determine the specific clay minerals present.

Selected intervals from the remaining five cores from this

study were also sampled for XRD analysis of their bulk mineralogy. Due to the presence of thick intervals of coarse siliciclastic material in three of the cores, (W-16329, W-16434 and W-16505) there are large gaps in the intervals chosen for XRD analyses of bulk mineralogy. In general, the intervals chosen for XRD analysis were those in which the mineralogy was uncertain based upon visual inspection of the core under a binocular microscope. X-ray diffraction studies are useful for the identification of the various minerals in a sample, but are semi-quantitative, at best, for determination of the mineral abundance or percentage. In order to analyze the bulk mineralogy of the samples, approximately 20-30 grams of the sample was ground to a fine powder. This procedure insured homogeneous mixing of the sample and reduced the chance of preferential orientation of certain minerals during analysis. A split from the sample was then placed in a planchet (sample holder) and placed into the x-ray diffractometer. The diffractometer records the x-ray reflections as peaks, both in digital and analog form. Every mineral exhibits a characteristic series of peaks, which are used to determine the presence of the mineral. The x-ray pattern for each sample begins at a 2-theta angle of four degrees so that all major mineral peaks could be identified.

The results of the XRD analysis are listed in Table 1. The sample depth is listed in the first column of each table. The subsequent columns are for the minerals identified. Mineral abundances were determined from the relative peak heights. When possible, estimates of relative abundances were made, with 1, 2,

3... representing abundance in descending order. Two forms of calcium carbonate ($CaCO_3$), calcite and aragonite, are common, and dolomite, a calcium-magnesium carbonate, ($CaMg(CO_3)_2$) is also common. Phosphate minerals are present in numerous samples. The type of phosphate abundant in sediments from the Hawthorn Group in the area is carbonate-fluorapatite, ($Ca_{10}(PO_4)_6(F, OH, CO_3)_2$, commonly known as francolite (Cathcart, 1989). This mineral is a form of apatite in which fluorine and carbonate ions partially substitute for hydroxyl groups.

CONCLUSIONS

This project has resulted in the addition of over 180 additional lithologic descriptions to the computer data bases of the FGS and the District. The cores drilled provide much needed "anchor points" for stratigraphic and hydrogeologic projects and fill critical gaps in the geologic data base. These sample sets will be utilized in future studies, providing an ongoing benefit. The Hendry County cores drilled for this project are the only cores in Hendry County at the present time. Additional core drilling projects are needed in this and other portions of the District to fill the gaps in the geologic data base and provide a better understanding of the geohydrologic framework of southern Florida.

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TABLE 1

BULK X-RAY DATA FOR SELECTED INTERVALS

Well 16242 SOUTH SEAS #1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
41.5	2	1		tr		
47.0	2	1				
52.0		1				
60.0	2	1				
63.0	3	1	2			
70.0	2	1	3			
80.0		1				
85.0	3	1		2		
90.0	1	2			3?	
100.0	tr	1		3?		
115.0	tr	1				2?
159.0	2	3		1		
252.5	2	1		3	tr	
291.0	1	2			tr	tr?
354.0	2	1		3	4	
400.0	tr	1		2	tr	
436.0	2			1		3
515.0	2			1	tr?	
546.0	tr			1	2	
553.0	2	tr		1		
575.0		tr		1		
639.0		1		2		
727.0		1				

KEY

The numbers 1,2,3,4... refer to the relative abundances according to the relative intensities of the XRD pattern in the bulk analyses.

tr=trace amounts ?=probable (not positive ID)

Well 16329 HILLIARD #1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
77.5	1			2	tr	3
415.0	1	2			4	
438.0	2	1			tr?	
470.0	2			3	tr?	1
550.0	2			3	tr?	1
596.8				1		2
645.0	2			1	3?	

Well 16387 U.S. SUGAR #1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
32.0	1	2				
98.0	2	3		1		
141.0	1	2	tr			
204.0	1			2	tr	
262.0	1			2		3
316.0	1	2		3		
378.5	2			1	4	3
443.7	1	5?		2	4	3
511.3	2	3		4	tr	1
581.5						1
608.0	3			2		1
640.0		2		1		

KEY

The numbers 1,2,3,4... refer to the relative abundances according to the relative intensities of the XRD pattern in the bulk analyses.

tr=trace amounts ?=probable (not positive ID)

Well 16434 IMMOKALEE # 1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
140.0	1			2	tr	
188.0	1			2	tr?	3
498.0	3			1	tr	2
510.0	3	1		2	tr	
573.0	2			1		3
631.0	2			1	tr	3

Well 16505 FAKAHATCHEE STRAND # 1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
370.0	2	tr		1		
400.0	1			2	tr	
590.8	2			1		3
673.0	1	3		2	tr?	
681.5	2	1		3		
697.5	tr					1

KEY

The numbers 1,2,3,4... refer to the relative abundances according to the relative intensities of the XRD pattern in the bulk analyses.

tr=trace amounts ?=probable (not positive ID)

Well 16523 KORESHAN # 1 CORE

Depth (feet)	Quartz	Calcite	Aragonite	Dolomite	Francolite	Clay
57.0	1	2		3		
89.0	1	2			tr	
173.0	1				2	
336.5	2			3		1
518.7		2		1		
531.0		1		2		
578.0	tr	3		1		2
793.0	1	2				

KEY

The numbers 1,2,3,4... refer to the relative abundances according to the relative intensities of the XRD pattern in the bulk analyses.

tr=trace amounts ?=probable (not positive ID)

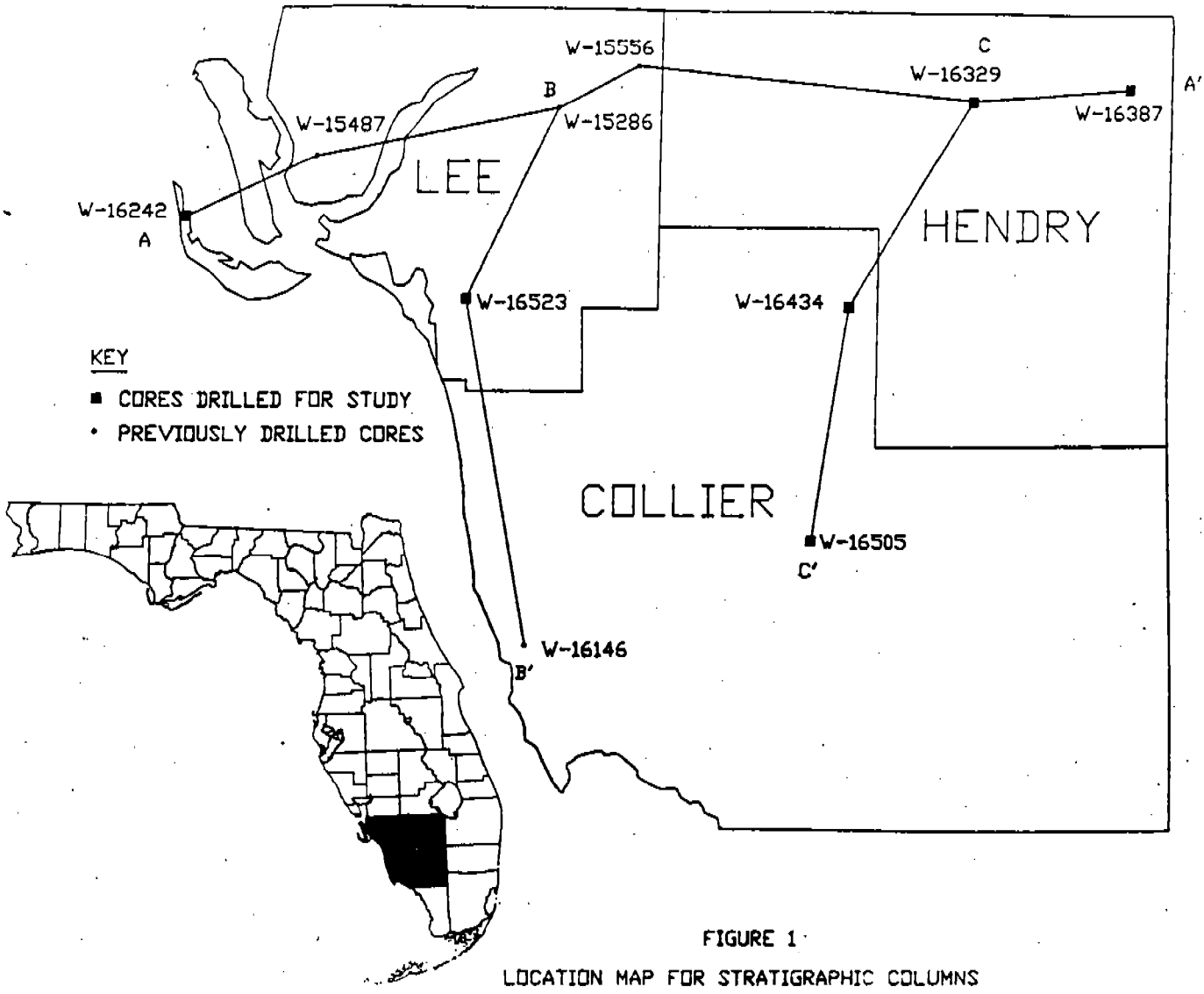
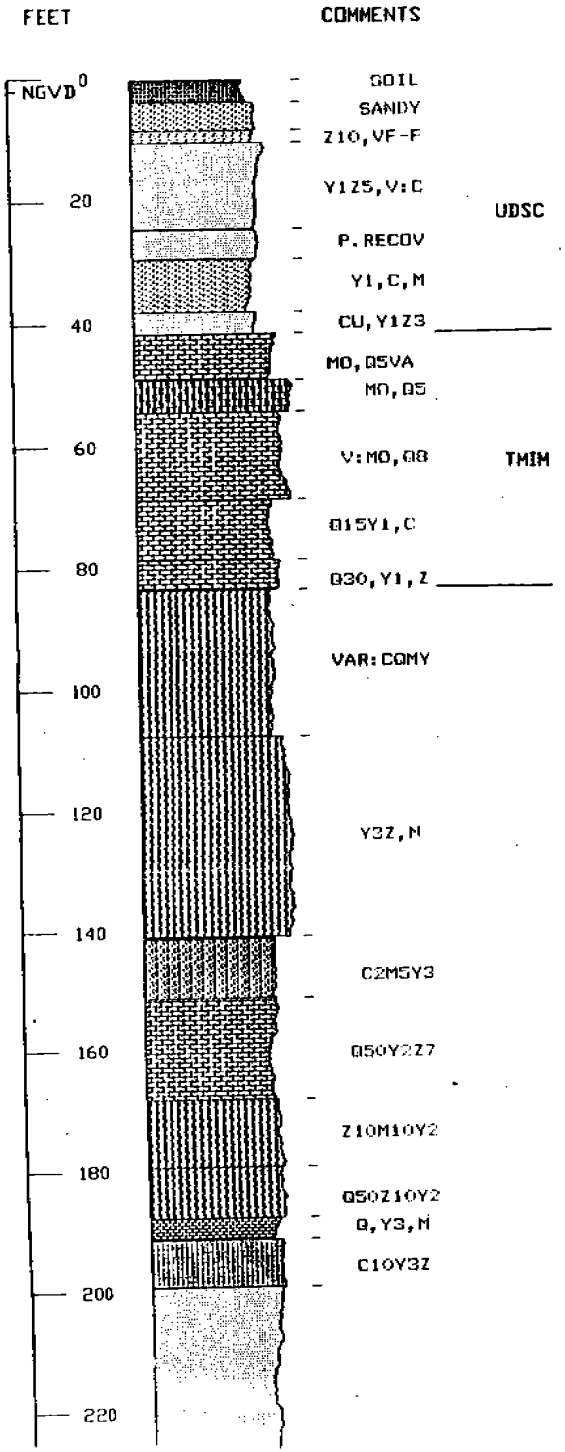


FIGURE 1

LOCATION MAP FOR STRATIGRAPHIC COLUMNS AND CROSS SECTIONS

FIGURE 2

W-16242 SOUTH SEAS #1 CORE



LOCATION:
COUNTY: LEE
T 45S R 21E S 26
LAT= N 26D 31M 29S
LONG= W 82D 11M 29S
T.D. 760'
ELEVATION: 02'

HATCHING PATTERN KEY

NO SAMPLES

FILL

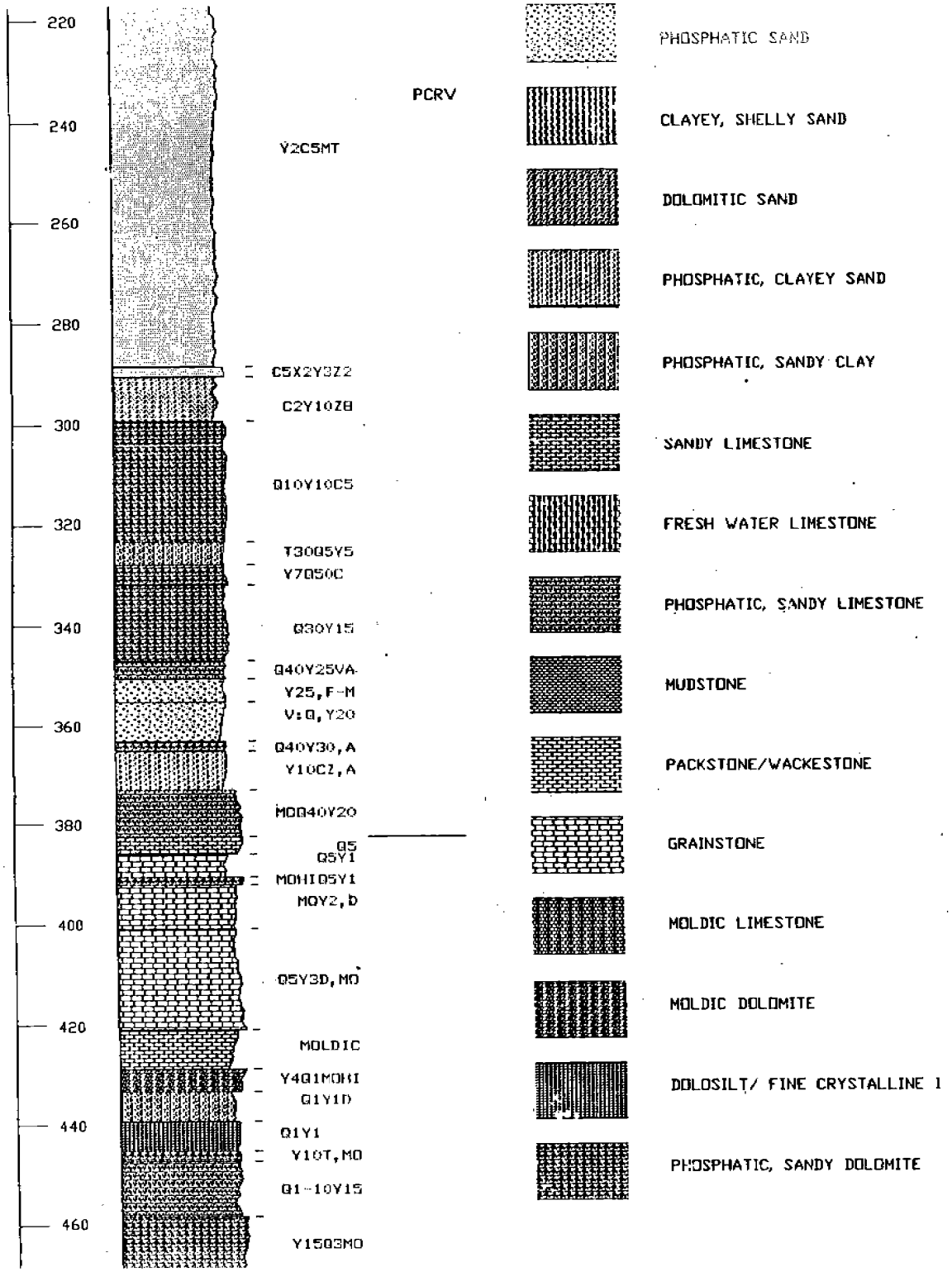
SILT/ V.F. SAND

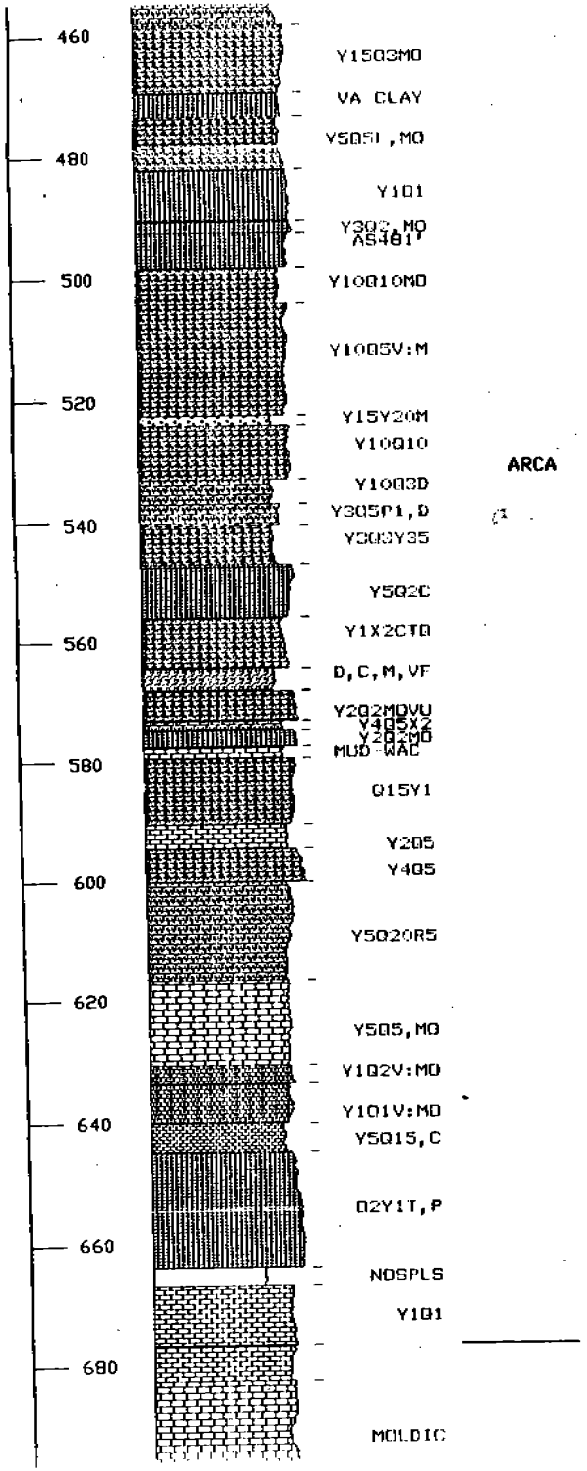
FINE SAND

SANDY SHELL BEDS

SHELLY SAND

PHOSPHATIC SAND


220
240
260
280
300
320
340
360
380
400
420
440
460
PCRV
Y2C5MT
C5X2Y3Z2
C2Y10Z8
Q10Y10C5
T30Q5Y5
Y7Q5OC
Q30Y15
Q40Y25VA
Y25,F-M
V:Q,Y20
Q40Y30,A
Y10C2,A
MQQ40Y20
Q5
Q5Y1
MOHI05Y1
MOY2,b
Q5Y3D,MO
MOLDIC
Y4Q1MOHI
Q1Y1D
Q1Y1
Y10T,MO
Q1-10Y15
Y1503MO
PHOSPHATIC SAND
CLAYEY, SHELLY SAND
DOLOMITIC SAND
PHOSPHATIC, CLAYEY SAND
PHOSPHATIC, SANDY CLAY
SANDY LIMESTONE
FRESH WATER LIMESTONE
PHOSPHATIC, SANDY LIMESTONE
MUDSTONE
PACKSTONE/WACKESTONE
GRAINSTONE
MOLDIC LIMESTONE
MOLDIC DOLOMITE
DOLOSILT/ FINE CRYSTALLINE I
PHOSPHATIC, SANDY DOLOMITE



FORMATION ABBREVIATIO

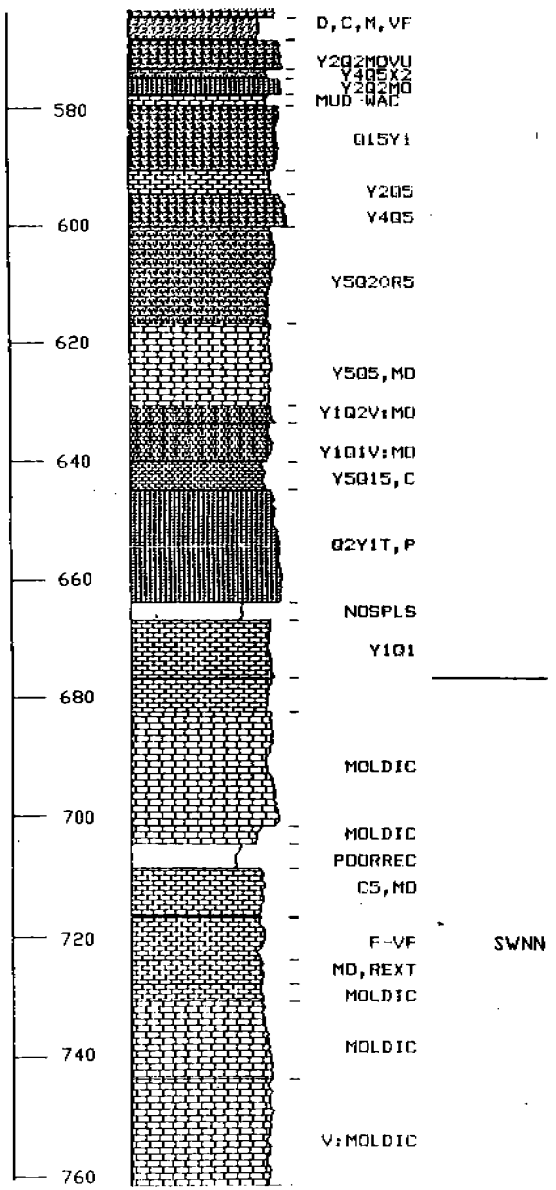
UDSC = UNDIFFERENTIATED SAND, CLAY AND S

TMIM = TAMIAMI FORMATION

PCRV = PEACE RIVER FORMATION

ARCA = ARCADIA FORMATION

SWNN = SUWANNEE LIMESTONE



COMMENT KEY

A= CALCAREOUS
B= CHERT
C= CLAY
D= DOLOMITE
G= GYPSUM
H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. V=MO= VERY MO
00= TRACE
?= QUESTIONABLE
VA= VARIABLE
HI= HIGHLY RECRYSTALLIZED
LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
C-G= COARSE TO GRANULE SIZE
M-C= MEDIUM TO COARSE SIZE R
V-C= VERY FINE TO MICROCRYST
PERM= POSSIBLY HIGH PERMEABILI
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

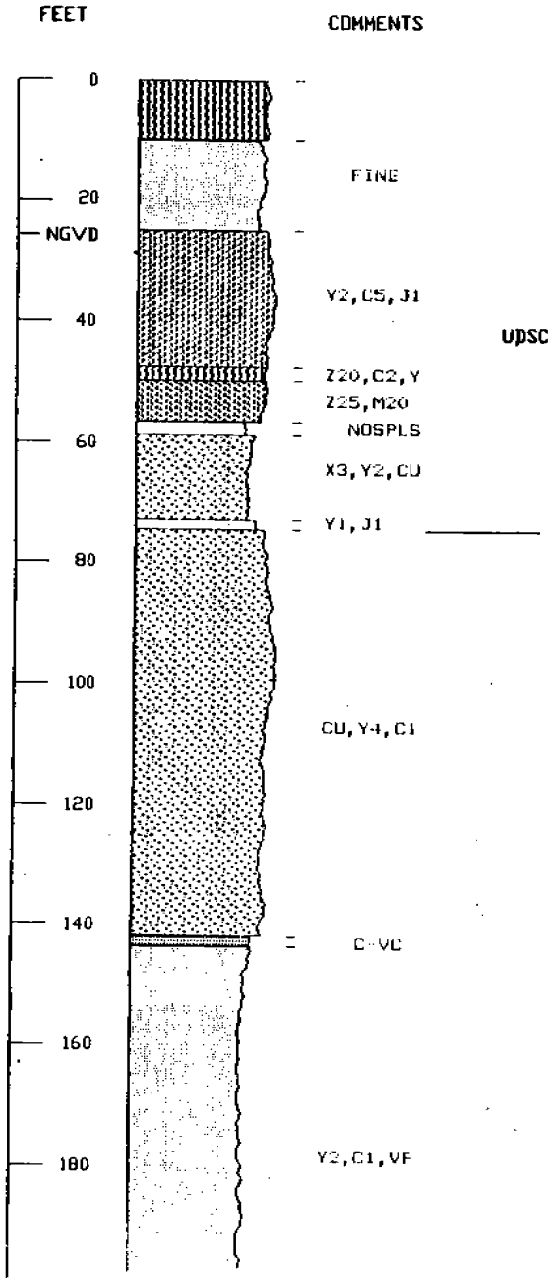
ALL NUMBERS IN COMMENTS
REFER TO PERCENTAGES

NGVD= NATIONAL GEODETIC VERTICAL

FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.

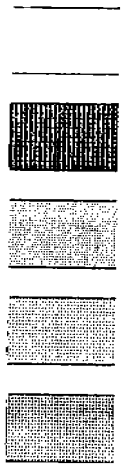
FIGURE 3

W-16329 HILLIARD #1 CORE



LOCATION:
COUNTY: HENDRY
T 44S R 32E S 16 B
LAT= N 26D 39M 50S
LONG= W 81D 08M 18S
T.D. 740'
ELEVATION: 25'

HATCHING PATTERN KEY



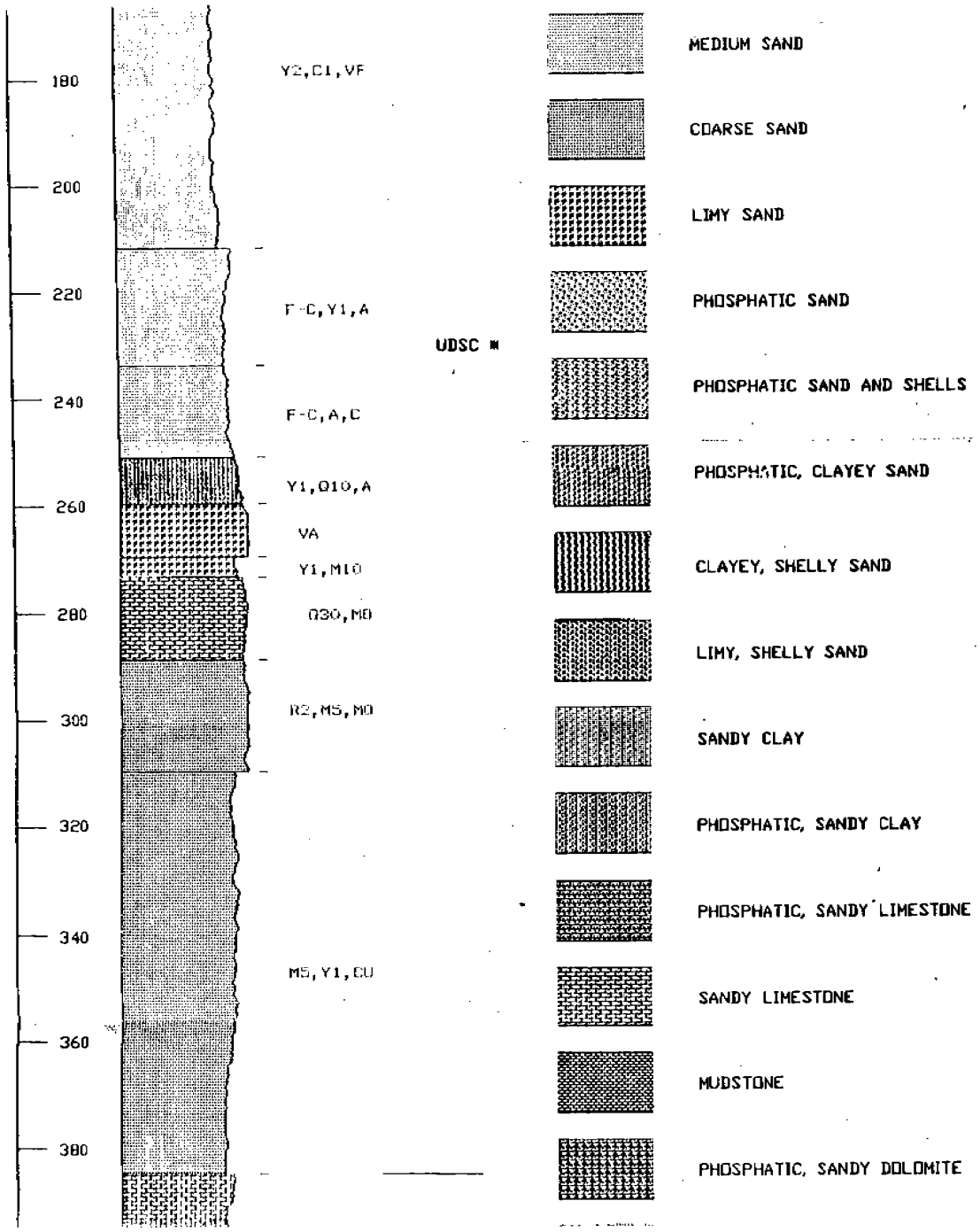
NO SAMPLES

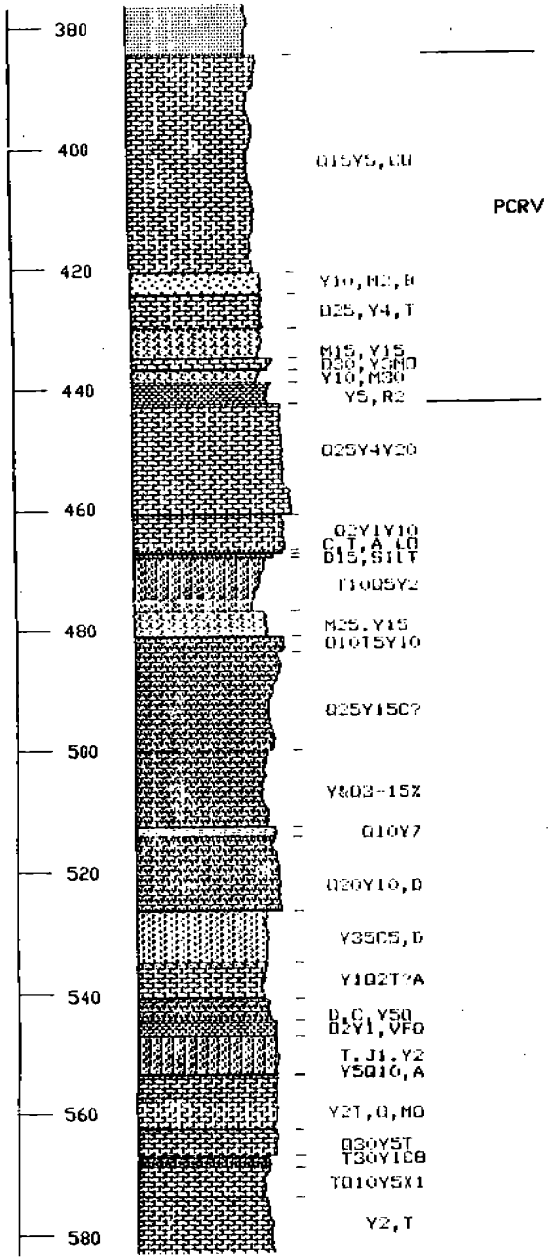
SILT/ V.F. SAND

FINE SAND

MEDIUM SAND

COARSE SAND


180
200
220
240
260
280
300
320
340
360
380
Y2,C1,VF
F-C,Y1,A
UDSC
F-C,A,C
Y1,Q10,A
VA
Y1,M10
Q30,M0
R2,M5,M0
M5,Y1,CU
MEDIUM SAND
COARSE SAND
LIMY SAND
PHOSPHATIC SAND
PHOSPHATIC SAND AND SHELLS
PHOSPHATIC, CLAYEY SAND
CLAYEY, SHELLY SAND
LIMY, SHELLY SAND
SANDY CLAY
PHOSPHATIC, SANDY CLAY
PHOSPHATIC, SANDY LIMESTONE
SANDY LIMESTONE
MUDSTONE
PHOSPHATIC, SANDY DOLOMITE



PHOSPHATIC, SANDY DOLOMITE

PHOSPHATIC, SANDY, CLAYEY DOLOMITE

DOLOSILT/ FINE CRYSTALLINE DOLOMITE

FORMATION ABBREVIATIONS:

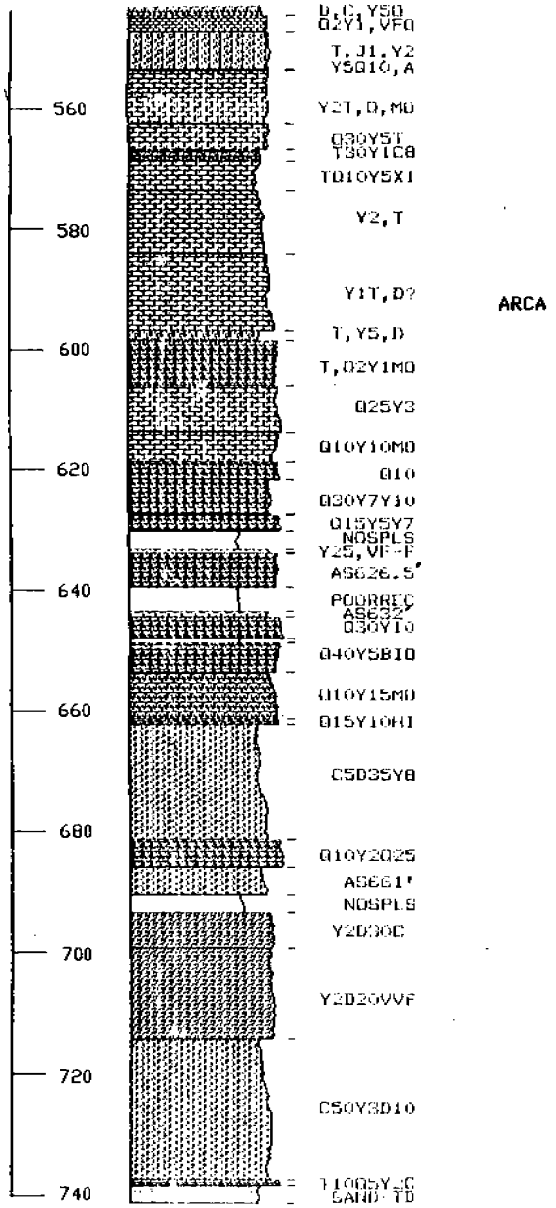
UDSC = UNDIFFERENTIATED SAND, CLAY AND SHELLS

PCRV = PEACE RIVER FORMATION

ARCA = ARCADIA FORMATION

* NOTE:

THE SEDIMENTS IN THIS INTERVAL ARE UNCHARACTERISTICALLY COARSE FOR THE PEACE RIVER FORMATION. FOR THIS REASON, THEY HAVE BEEN DESIGNATED AS UNDIFFERENTIATED SANDS, CLAYS AND SHELLS UNTIL MORE INFORMATION FROM THE AREA IS AVAILABLE.



ARCA

COMMENT KEY

A= CALCAREOUS
B= CHERT
C= CLAY
D= DOLOMITE
G= GYPSUM
H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. V-MO= VERY MOLDIC
00= TRACE
?= QUESTIONABLE
VA= VARIABLE
HI= HIGHLY RECRYSTALLIZED
LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
C-G= COARSE TO GRANULE SIZE RANGE
M-C= MEDIUM TO COARSE SIZE RANGE
V-O= VERY FINE TO MICROCRYSTALLINE
PERM= POSSIBLY HIGH PERMEABILITY
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

ALL NUMBERS IN COMMENTS
REFER TO PERCENTAGES

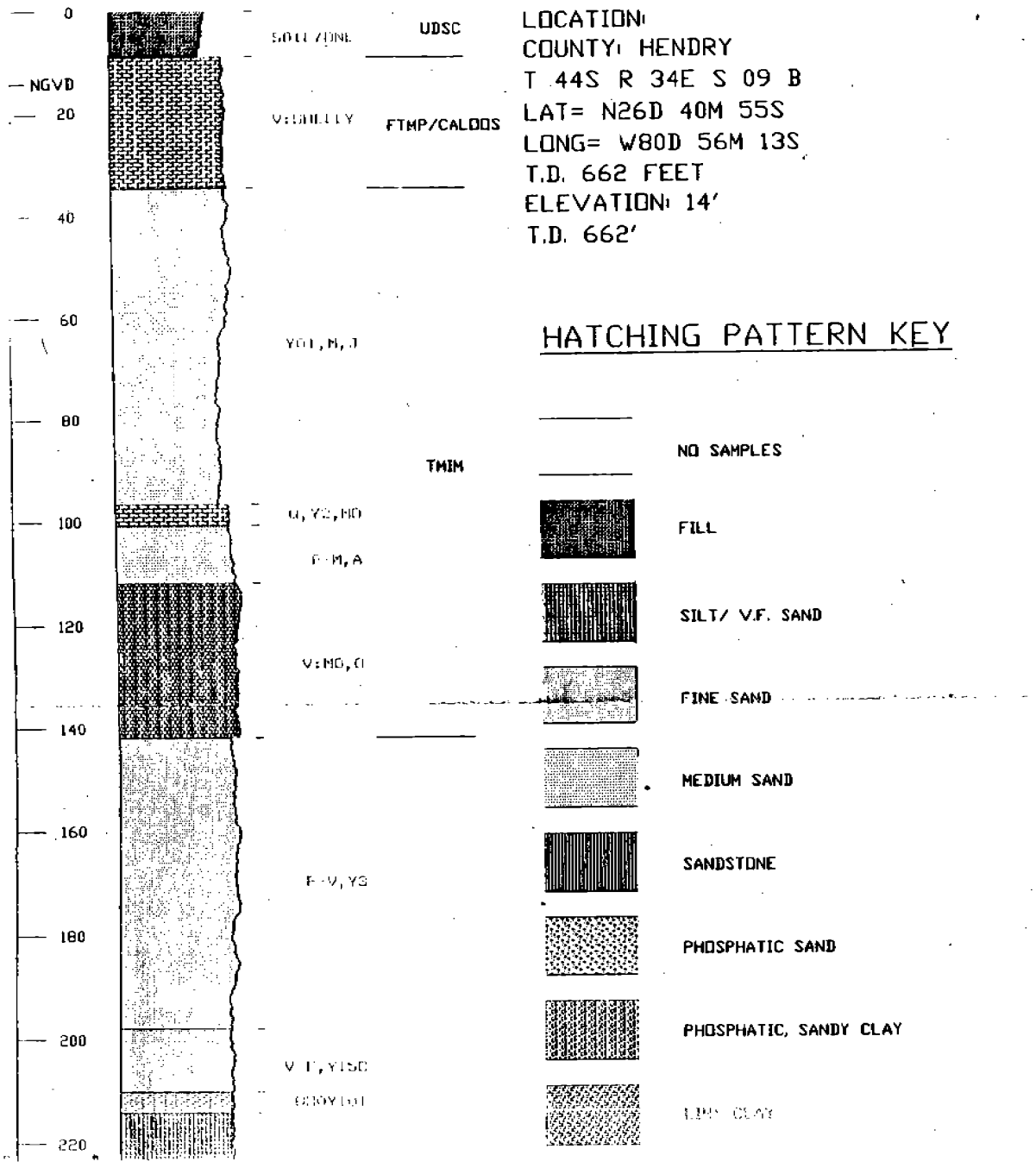
NGVD= NATIONAL GEODETIC VERTICAL DATUM

FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.

FIGURE 4

W-16387

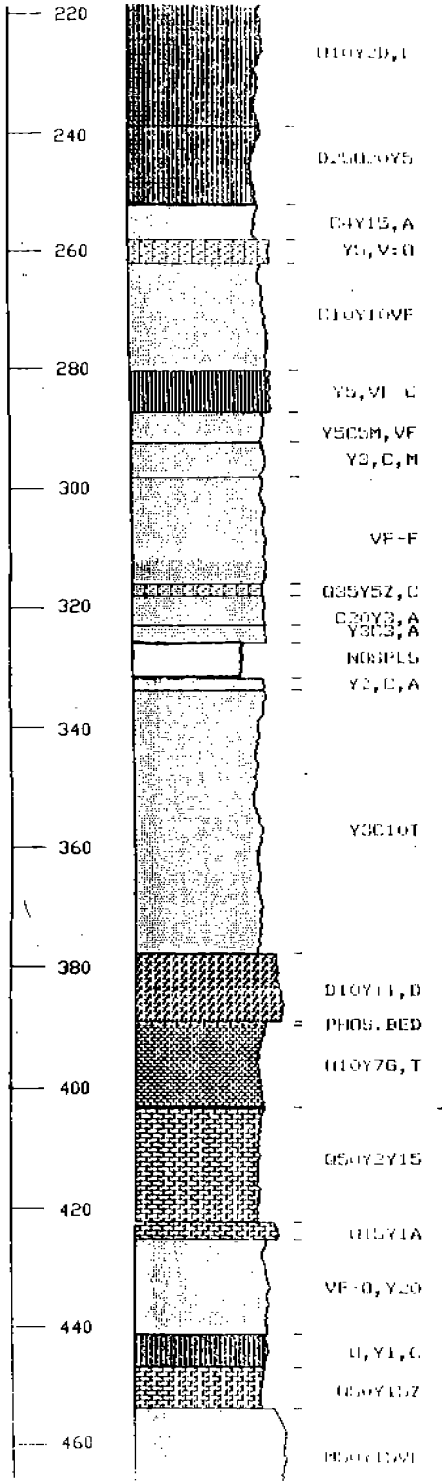
U.S. SUGAR #1 CORE



LOCATION:
COUNTY: HENDRY
T 44S R 34E S 09 B
LAT= N26D 40M 55S
LONG= W80D 56M 13S
T.D. 662 FEET
ELEVATION: 14'
T.D. 662'

HATCHING PATTERN KEY

- NO SAMPLES
- FILL
- SILT/ V.F. SAND
- FINE SAND
- MEDIUM SAND
- SANDSTONE
- PHOSPHATIC SAND
- PHOSPHATIC, SANDY CLAY
- LIME CLAY



DOLOMITIC CLAY

SANDY CLAY

SANDY LIMESTONE

MOLDIC LIMESTONE

MUDSTONE

PACKSTONE/WACKESTONE

CLAYEY LIMESTONE

INTERBEDDED LS. AND DOLOMITE

SANDY DOLOMITE

DOLOSILT/ FINE CRYSTALLINE DOLOMITE

FORMATION ABBREVIATIONS:

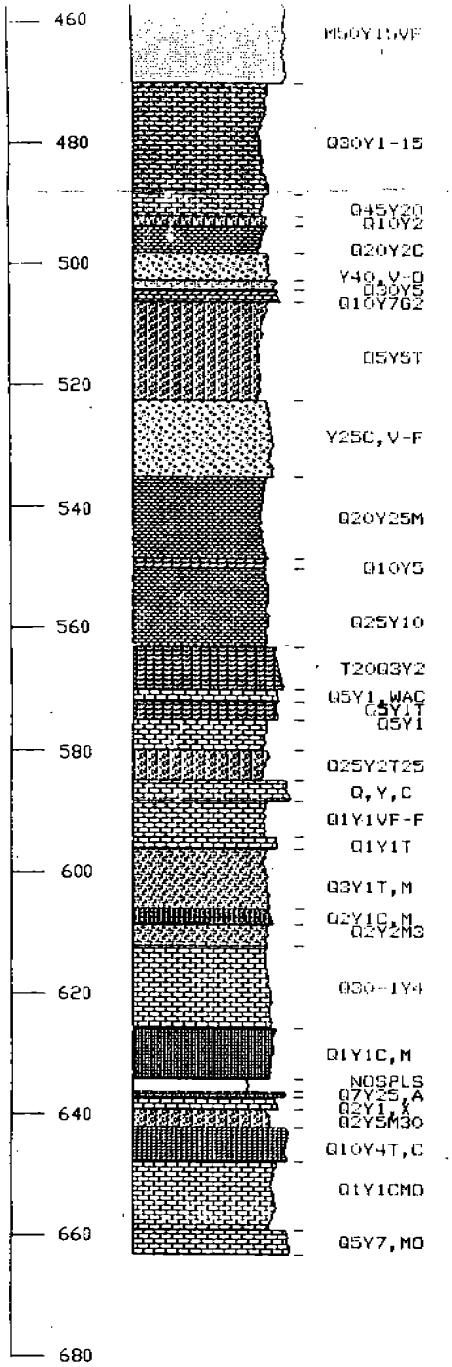
UDSC = UNDIFFERENTIATED SAND, CLAY AND SHELLS

FTMP/CALOOS = UNDIFFERENTIATED FORT THOMPSON/ CALOOSAHATCHEE FORMATIONS

TMIM = TAMIAMI FORMATION

PCRV = PEACE RIVER FORMATION

ARCA = ARCADIA FORMATION



ARCA

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H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. VMO= VERY MOLDIC
00= TRACE
?= QUESTIONABLE
VA= VARIABLE
HI= HIGHLY RECRYSTALLIZED
LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
C-G= COARSE TO GRANULE SIZE RANGE
M-C= MEDIUM TO COARSE SIZE RANGE
V-D= VERY FINE TO MICROCRYSTALLINE
PERM= POSSIBLY HIGH PERMEABILITY
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

ALL NUMBERS IN COMMENTS
REFER TO PERCENTAGES

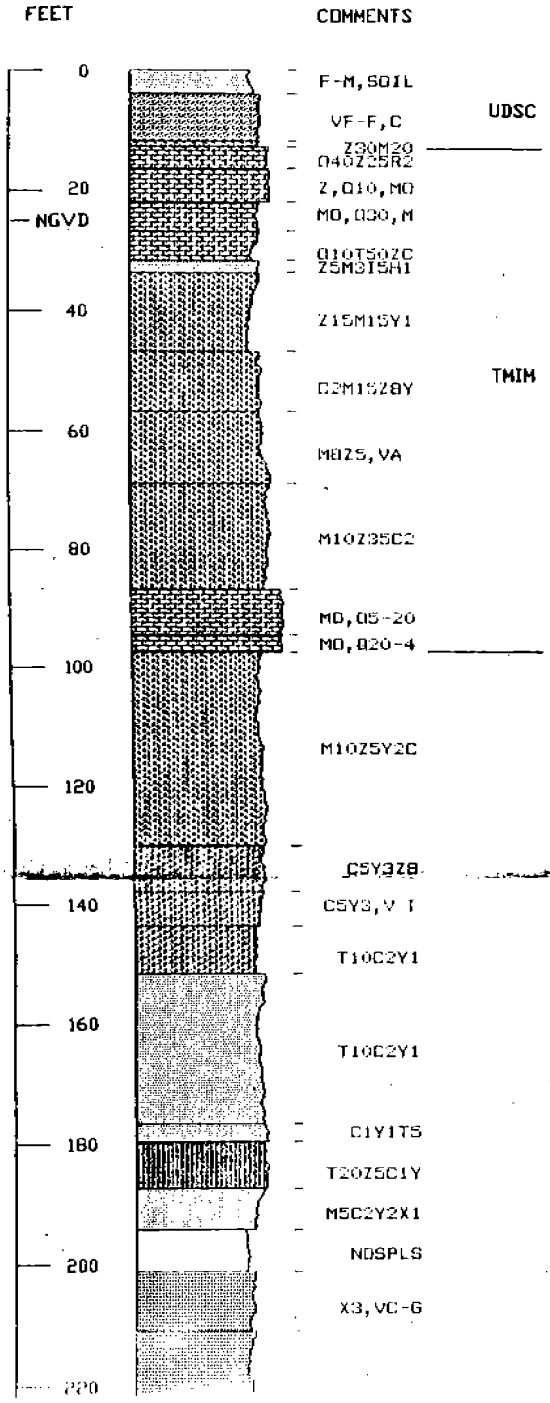
NGVD= NATIONAL GEODETIC VERTICAL DATUM

FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.

FIGURE 5

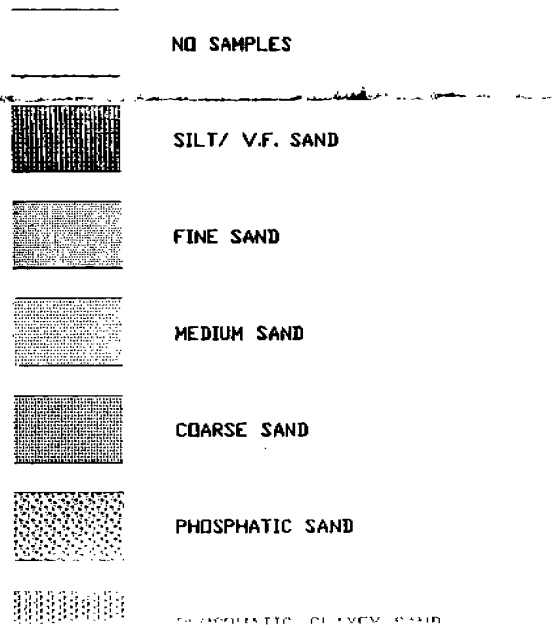
W-16434

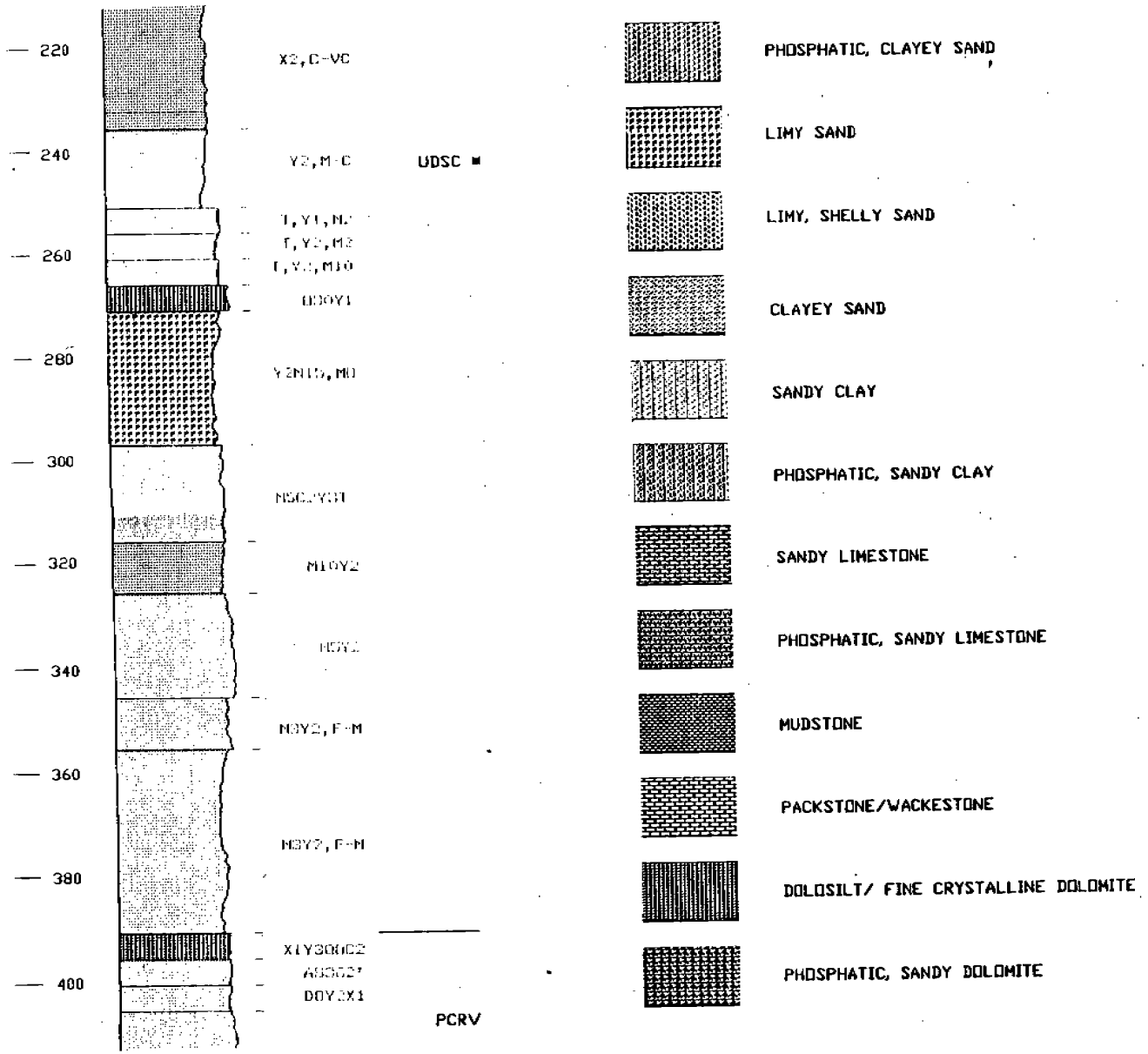
IMMOKALEE #1 CORE

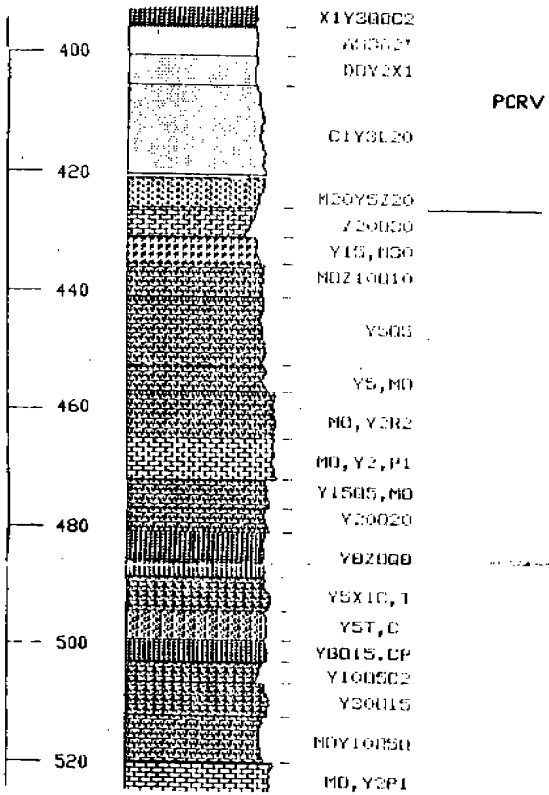


LOCATION:
COUNTY: COLLIER
T 47S R 30E S 03 B
LAT= N 26D 25M 28S
LONG= W 81D 18M 28S
T.D. 715'
ELEVATION: 25'

HATCHING PATTERN KEY




220
240
260
280
300
320
340
360
380
400
X2,C-VC
Y2,M-C
UDSC
PCRV
PHOSPHATIC, CLAYEY SAND
LIMY SAND
LIMY, SHELLY SAND
CLAYEY SAND
SANDY CLAY
PHOSPHATIC, SANDY CLAY
SANDY LIMESTONE
PHOSPHATIC, SANDY LIMESTONE
MUDSTONE
PACKSTONE/WACKESTONE
DOLOSILT/ FINE CRYSTALLINE DOLOMITE
PHOSPHATIC, SANDY DOLOMITE



PHOSPHATIC, SANDY DOLOMITE

FORMATION ABBREVIATIONS:

UDSC = UNDIFFERENTIATED SAND, CLAY AND SHELLS

TMIM = TAMIANI FORMATION

PCRV = PEACE RIVER FORMATION

ARCA = ARCADIA FORMATION

* NOTE:

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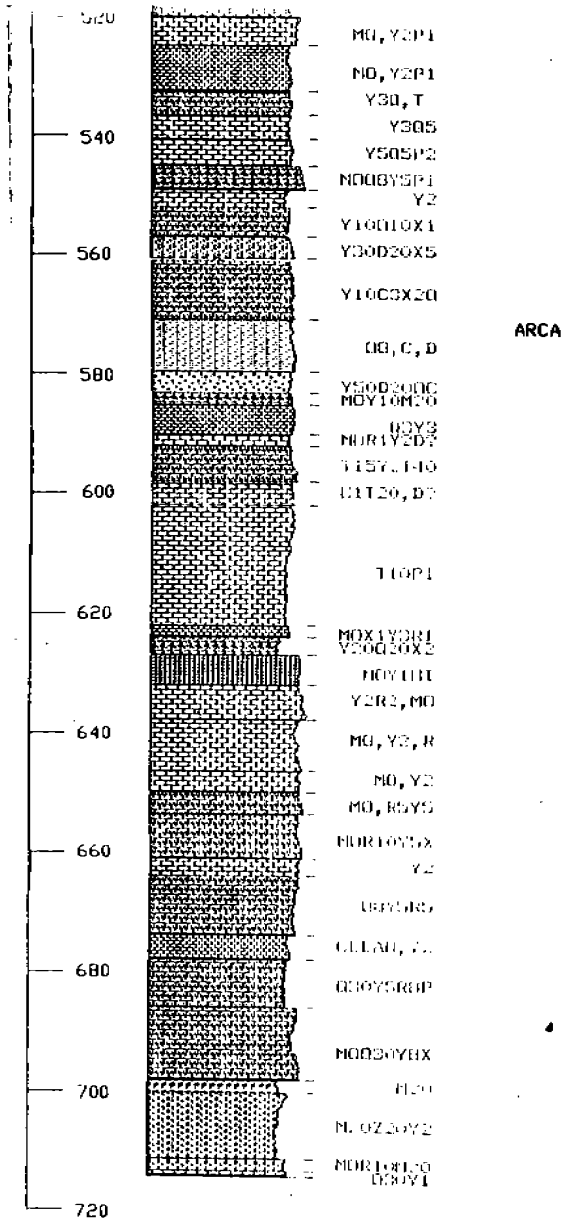

COMMENT KEY

A= CALCAREOUS
B= CHERT
C= CLAY
D= DOLOMITE
G= GYPSUM
H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. V-MO= VERY MOLDIC
00= TRACE
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VA= VARIABLE
HI= HIGHLY RECRYSTALLIZED
LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
C-G= COARSE TO GRANULE SIZE RANGE
M-C= MEDIUM TO COARSE SIZE RANGE
V-0= VERY FINE TO MICROCRYSTALLINE
PERM= POSSIBLY HIGH PERMEABILITY
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

ALL NUMBERS IN COMMENTS
REFER TO PERCENTAGES

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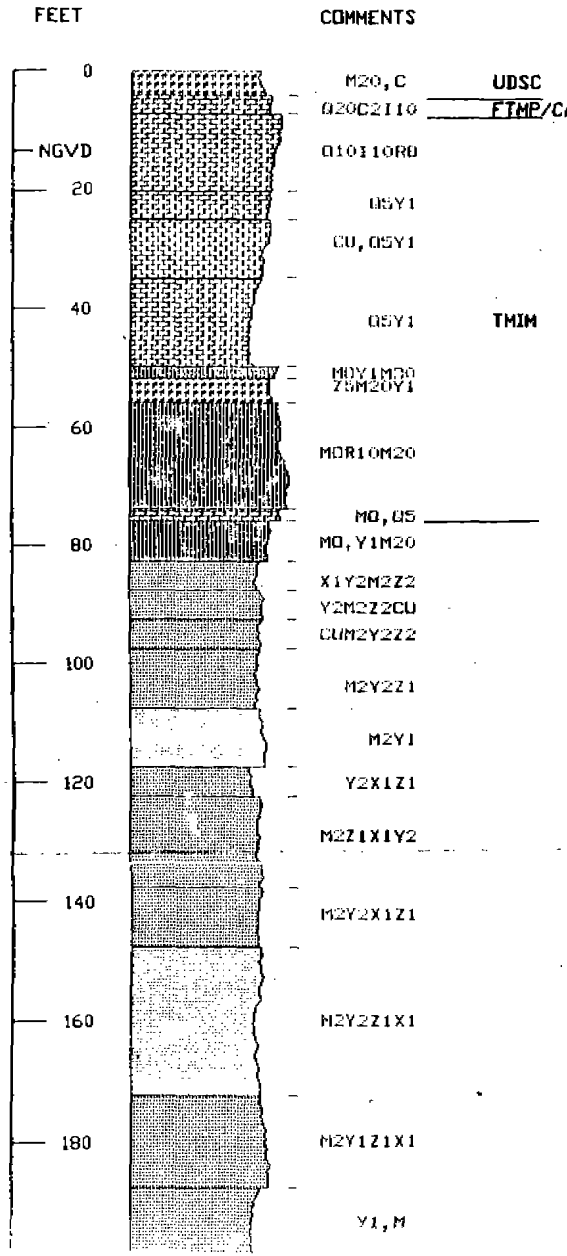
FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.

FIGURE 6

W-16505 FAKAHATCHEE STRAND #1 CO



LOCATION:
COUNTY: COLLIER
T 50S R 30E S 06 C
LAT= N 26D 08M 52S
LONG= W 81D 21M 28S
T.D. 702'
ELEVATION: 13'

HATCHING PATTERN KEY

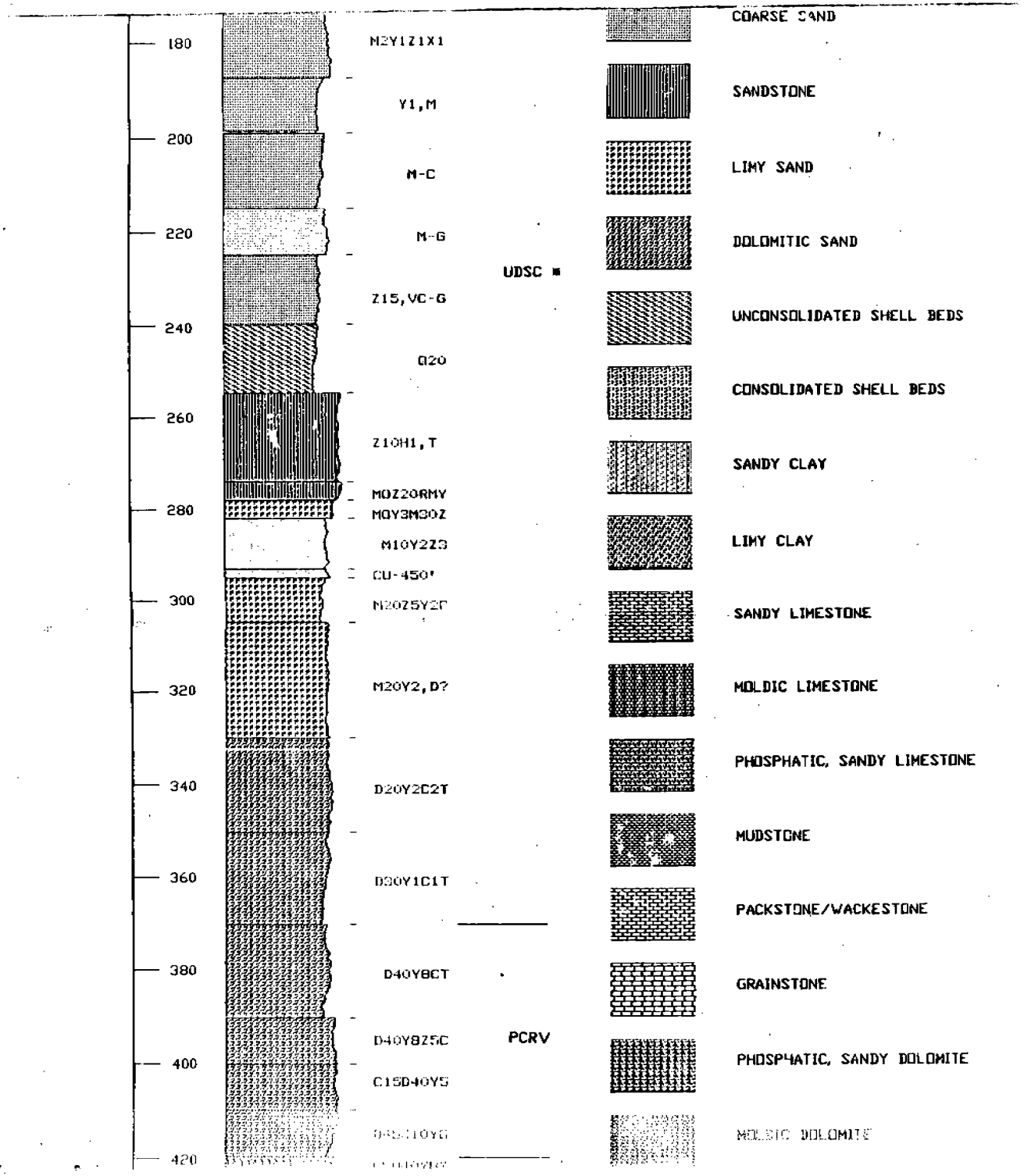
NO SAMPLES

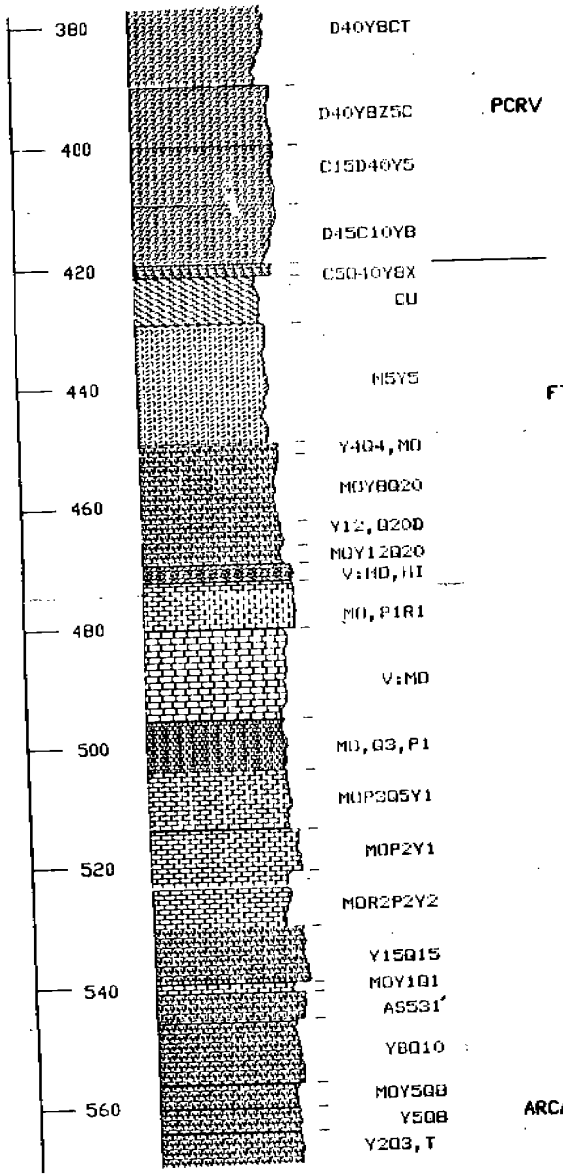
FINE SAND

MEDIUM SAND

COARSE SAND

SANDSTONE


180
200
220
240
260
280
300
320
340
360
380
400
420
M2Y1Z1X1
Y1,M
M-C
M-G
UDSC
Z15,VC-G
G20
Z10H1,T
MOZ20RMY
MOY3M30Z
M10Y2Z3
CU-450'
M20Z5Y2C
M20Y2,D?
D20Y2C2T
D30Y1C1T
D40Y8CT
D40Y8Z5C
PCRV
C15D40Y5
COARSE SAND
SANDSTONE
LIMY SAND
DOLOMITIC SAND
UNCONSOLIDATED SHELL BEDS
CONSOLIDATED SHELL BEDS
SANDY CLAY
LIMY CLAY
SANDY LIMESTONE
MOLDIC LIMESTONE
PHOSPHATIC, SANDY LIMESTONE
MUDSTONE
PACKSTONE/WACKESTONE
GRAINSTONE
PHOSPHATIC, SANDY DOLOMITE
MOLDIC DOLOMITE



GRAINSTONE

PHOSPHATIC, SANDY DOLOMITE

MOLDIC DOLOMITE

FORMATION ABBREVIATIONS:

UDSC = UNDIFFERENTIATED SAND, CLAY AND SHELLS

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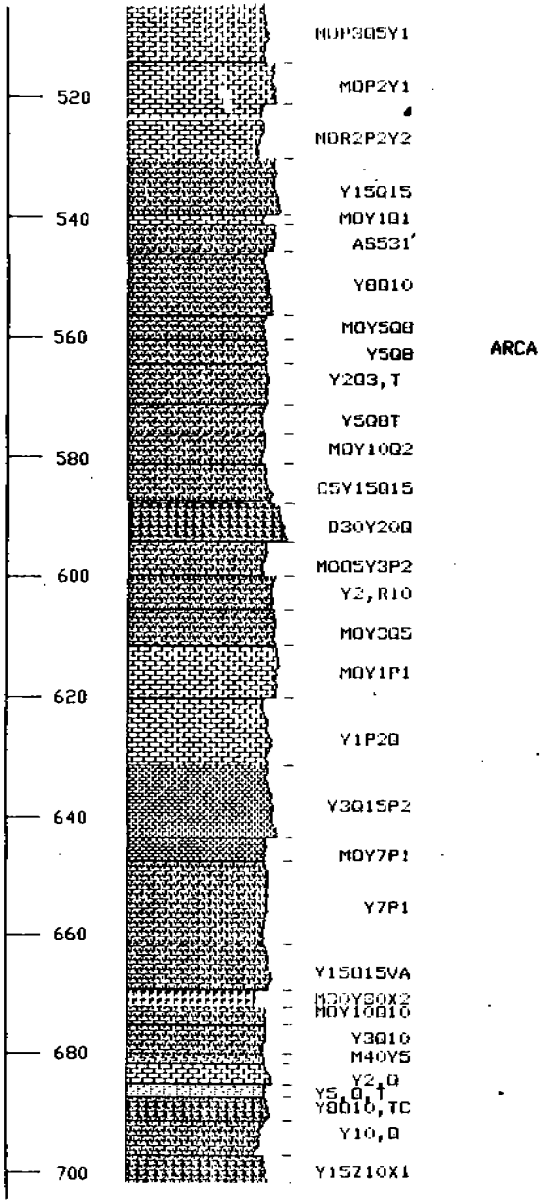

COMMENT KEY

A= CALCAREOUS
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C= CLAY
D= DOLOMITE
G= GYPSUM
H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. VMO= VERY MOLDIC
OO= TRACE
?= QUESTIONABLE
VA= VARIABLE
HI= HIGHLY RECRYSTALLIZED
LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
C-G= COARSE TO GRANULE SIZE RANGE
M-C= MEDIUM TO COARSE SIZE RANGE
V-O= VERY FINE TO MICROCRYSTALLINE
PERM= POSSIBLY HIGH PERMEABILITY
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

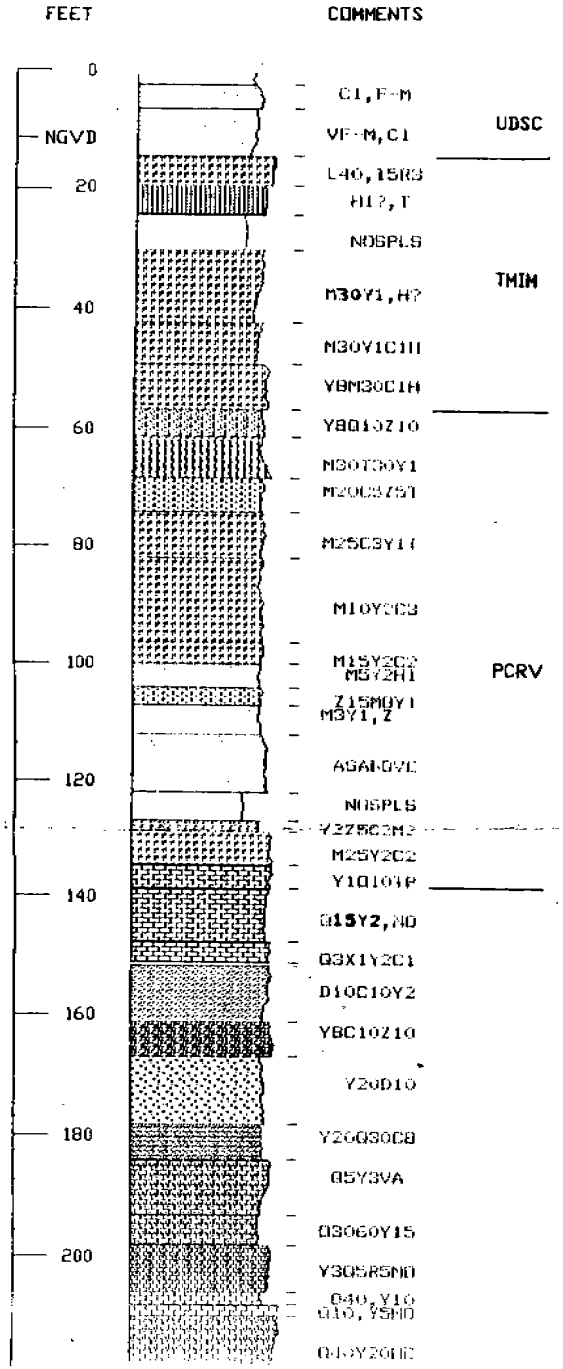
ALL NUMBERS IN COMMENTS REFER TO PERCENTAGES

NGVD= NATIONAL GEODETIC VERTICAL DATUM

FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.

FIGURE 7

W-16523 KORESHAN #1 CORE



LOCATION:
COUNTY: LEE
T 46S R 25E S 33 A
LAT= N 26D 25M 58S
LONG= W 81D 49M 08S
T.D. 822'
ELEVATION: 11'

HATCHING PATTERN KEY

NO SAMPLES

FINE SAND

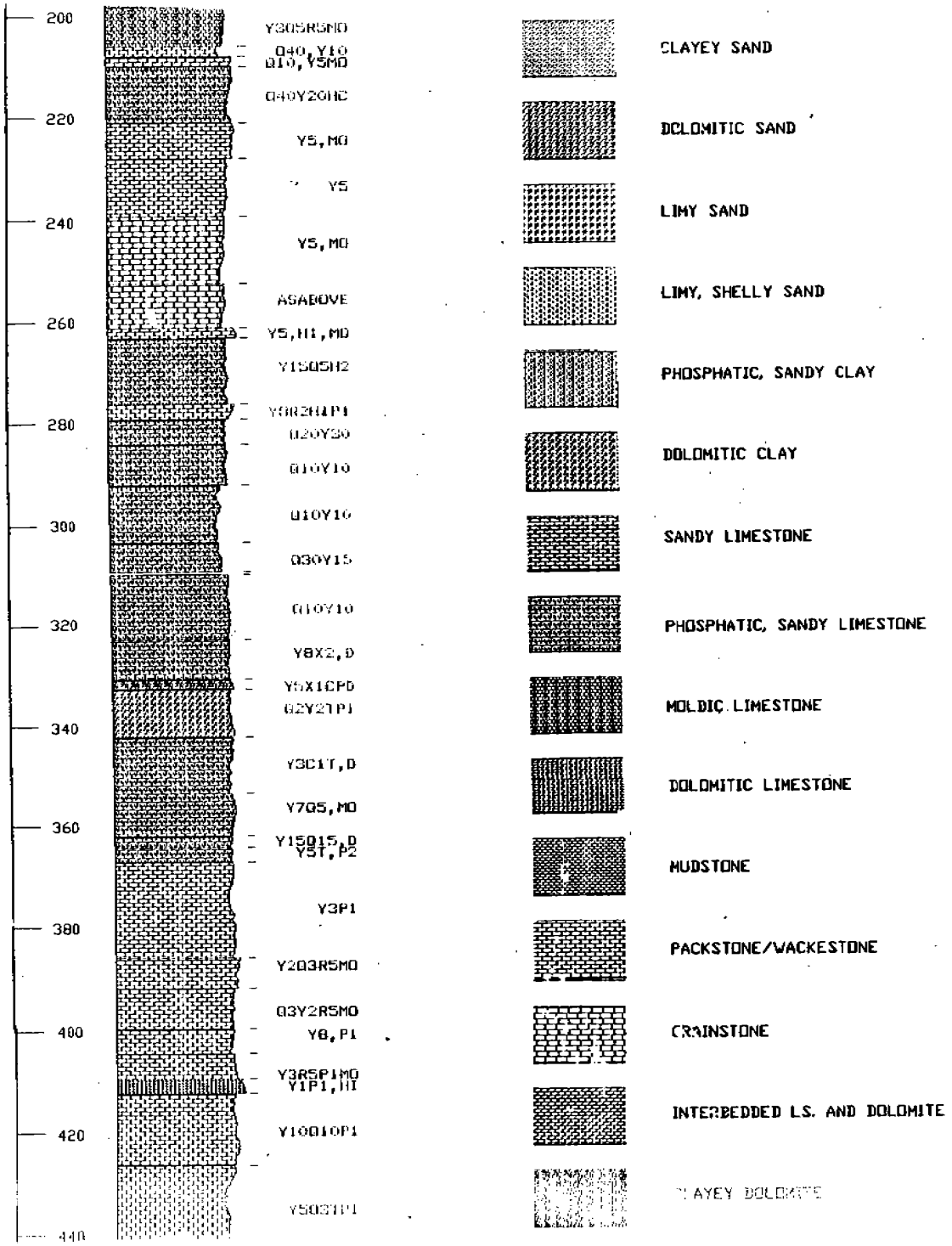
SHELLY SAND

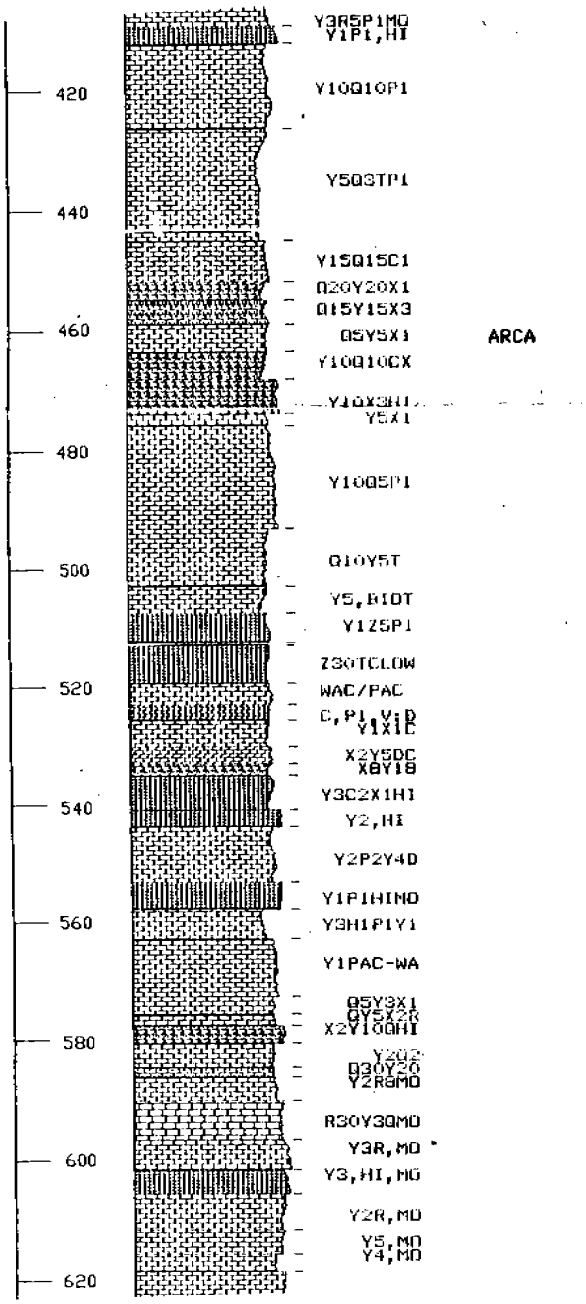
CLAYEY, SHELLY SAND

PHOSPHATIC SAND

CLAYEY SAND

113C


200
220
240
260
280
300
320
340
360
380
400
420
440
Y305R5MD
Q40,Y10
Q10,Y5MD
Q40Y20HC
Y5,MD
Y5
Y5,MD
ASABOVE
Y5,MI,MD
Y15Q5H2
Y8R2H1P1
Q20Y30
Q10Y10
Q10Y10
Q30Y15
Q10Y10
Y8X2,D
Y6X1CPD
Q2Y2TP1
Y3C1T,D
Y7Q5,MD
Y15Q15,D
Y5T,P2
Y3P1
Y2Q3R5MD
Q3Y2R5MD
Y8,P1
Y3R5P1MD
Y1P1,MI
Y10Q10P1
Y5Q3TP1
CLAYEY SAND
DOLOMITIC SAND
LIMY SAND
LIMY, SHELLY SAND
PHOSPHATIC, SANDY CLAY
DOLOMITIC CLAY
SANDY LIMESTONE
PHOSPHATIC, SANDY LIMESTONE
MOLDIC LIMESTONE
DOLOMITIC LIMESTONE
MUDSTONE
PACKSTONE/WACKESTONE
GRAINSTONE
INTERBEDDED LS. AND DOLOMITE
CLAYEY DOLOMITE



INTERBEDDED LS. AND DOLOMITE

CLAYEY DOLOMITE

SANDY DOLOMITE

PHOSPHATIC, SANDY DOLOMITE

PHOSPHATIC, SANDY, CLAYEY DOLI

DOLOSILT/ FINE CRYSTALLINE DI

FORMATION ABBREVIATIC

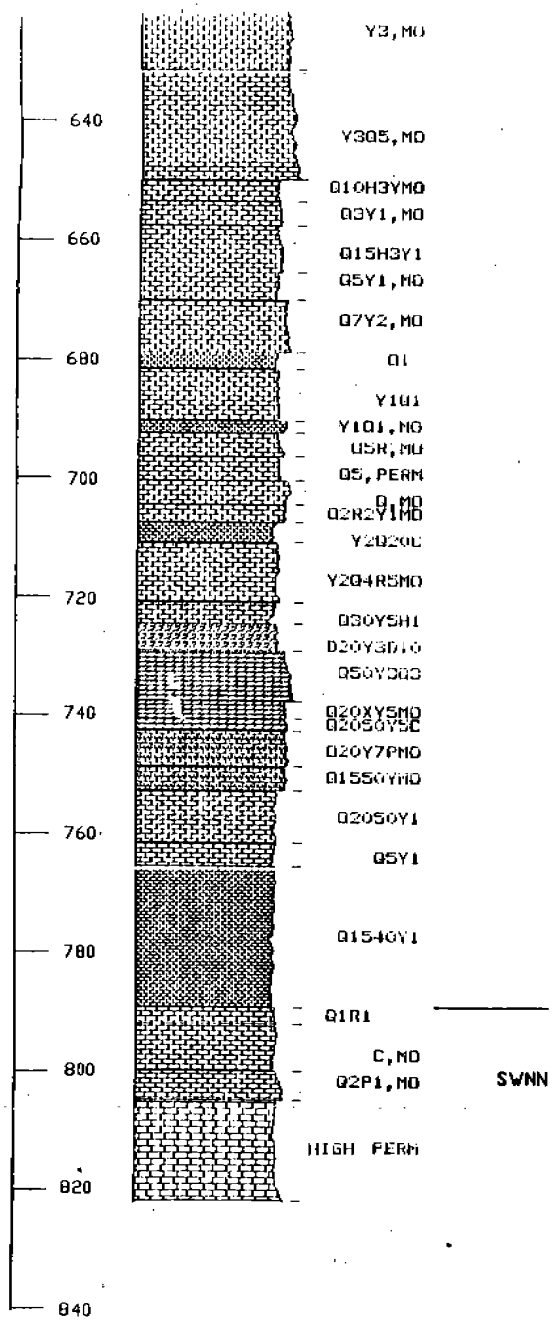
UDSC = UNDIFFERENTIATED SAND, CLAY AND S

TMIM = TAMIAMI FORMATION

PCRV = PEACE RIVER FORMATION

ARCA = ARCADIA FORMATION

SWNN = SUWANNEE LIMESTONE



COMMENT KEY

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G= GYPSUM
H= HEAVY MINERALS
I= IRON STAIN
J= MICA
L= LIMESTONE
M= CALCAREOUS MUD
P= PYRITE
Q= QUARTZ SAND
R= CALCITE SPAR
T= SILT
X= PHOSPHATE GRAVEL
Y= PHOSPHATE SAND
Z= SHELLS
BIOT= BIOTURBATED
CU= CUTTINGS
MO= MOLDIC POROSITY
VU= VUGULAR POROSITY
V= VERY, e.g. V-MO= VERY MOLDIC
Q0= TRACE
?= QUESTIONABLE
VA= VARIABLE
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LOW= LOW RECRYSTALLIZATION
REXT= RECRYSTALLIZED
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M-C= MEDIUM TO COARSE SIZE RANGE
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PERM= POSSIBLY HIGH PERMEABILITY
MUD= MUDSTONE
WAC= WACKESTONE
PAC= PACKSTONE

NOTE:

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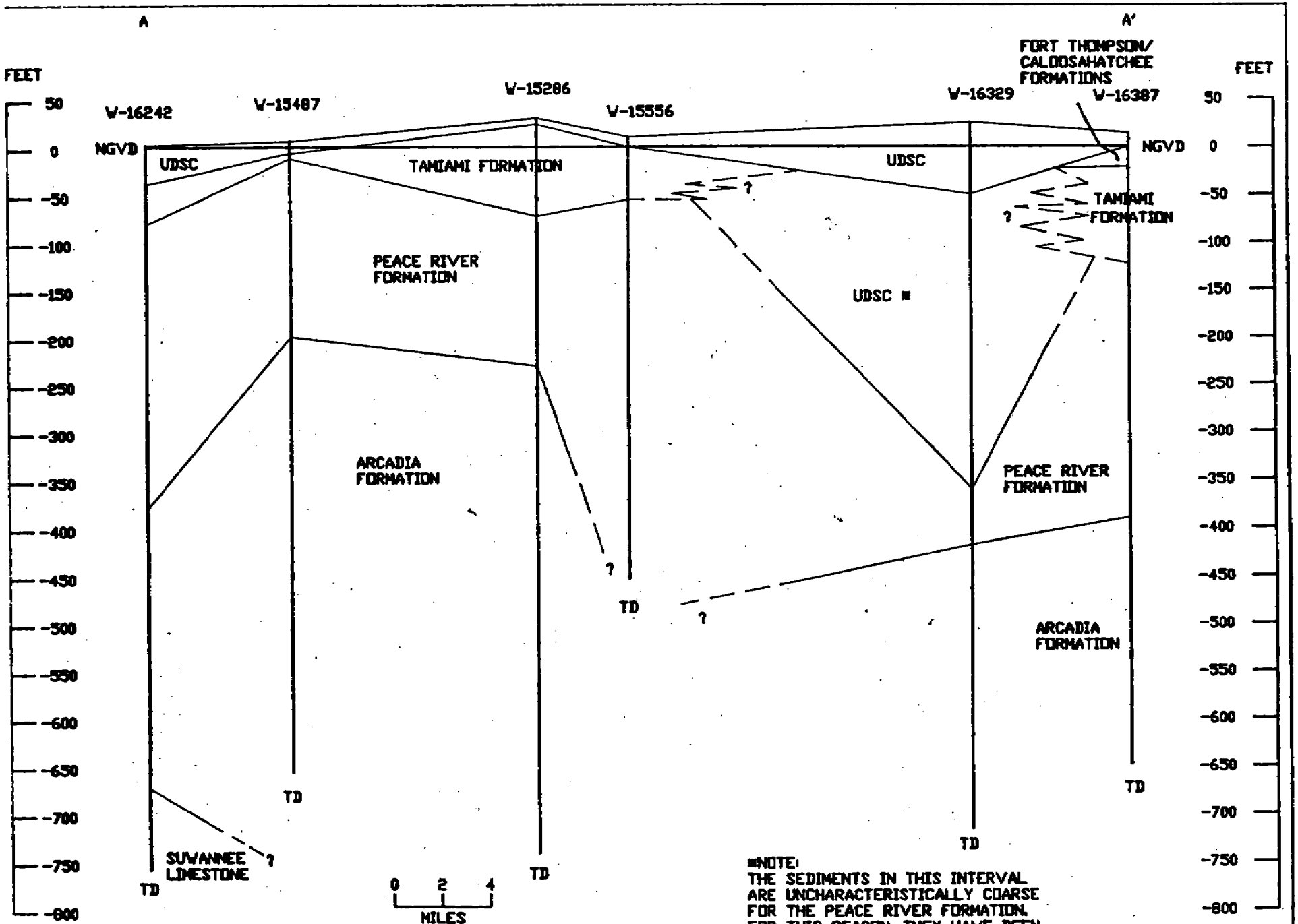
REFER TO PERCENTAGES

NGVD= NATIONAL GEODETIC VERTICAL DATUM

FOR MORE DETAILED INFORMATION
CONSULT CORE DESCRIPTION.



VERTICAL SCALE 416 TIMES HORIZONTAL SCALE

FIGURE 8 CROSS SECTION A A'

*NOTE:
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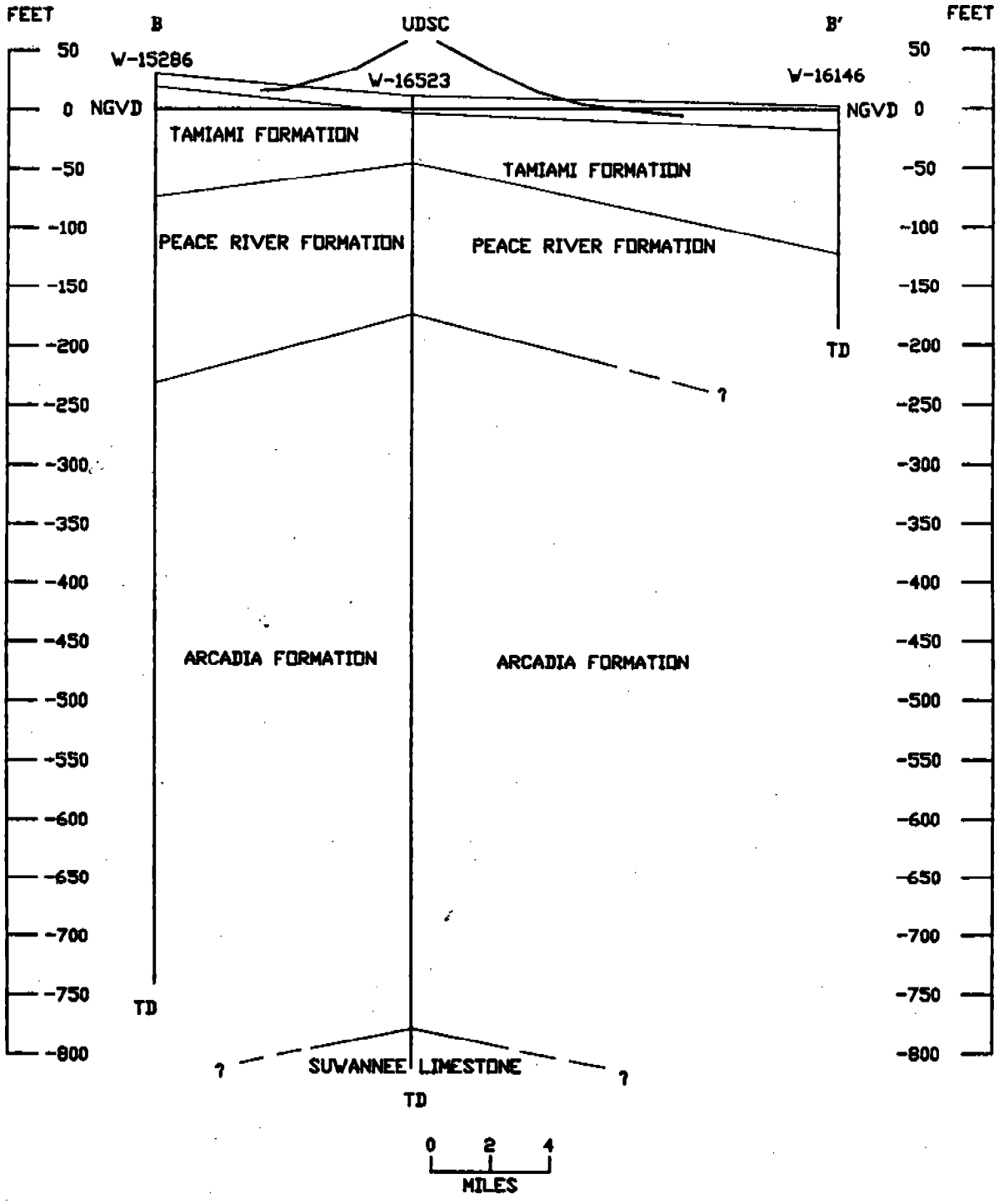

VERTICAL SCALE 416 TIMES HORIZONTAL SCALE

FIGURE 9 CROSS SECTION B B'

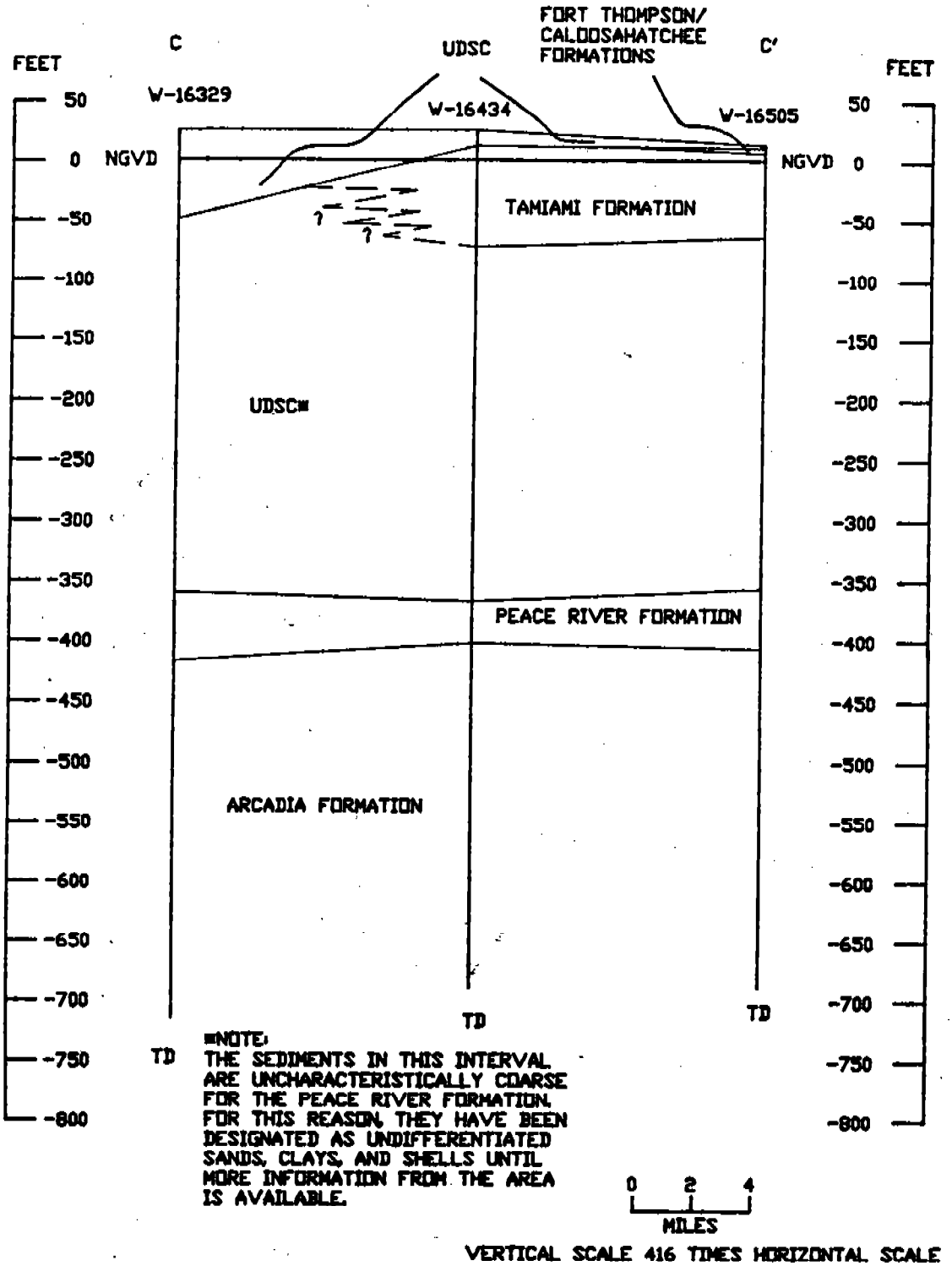

FIGURE 10 CROSS SECTION C C'