



**TEST-HOLE DATA FOR THE  
EDWARDS AQUIFER IN THE  
SAN ANTONIO AREA, TEXAS**

**LP-171**

**Cooperators: TEXAS DEPARTMENT OF WATER RESOURCES  
U.S. GEOLOGICAL SURVEY  
CITY WATER BOARD OF SAN ANTONIO**

**TEXAS DEPARTMENT OF WATER RESOURCES**

**January 1982**

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IN THE SAN ANTONIO AREA, TEXAS



by

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U.S. Geological Survey

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Texas Department of Water Resources  
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City Water Board of San Antonio

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# CONTENTS

	Page
Metric conversions-----	vii
Abstract-----	1
Introduction-----	2
Test-hole program-----	2
Selection of drilling sites-----	5
Examinations of cores-----	5
Descriptive data-----	5
Classification of carbonates-----	5
Classification of porosity-----	23
Classification of color-----	23
Laboratory data-----	23
Porosity-----	26
Permeability-----	26
Pore-size distribution-----	26
Grain density-----	27
Formation factor-----	27
References cited-----	29
Compilations of data (tables 4-38)-----	31

## ILLUSTRATIONS

	Page
Figure 1. Map showing locations of test holes-----	3
2. Lithologic and geophysical logs of Randolph test hole AY-68-30-807-----	7
3. Lithologic and geophysical logs of San Marcos test hole LR-67-09-110-----	9
4. Lithologic and geophysical logs of Devine test hole TD-68-49-813-----	11
5. Lithologic and geophysical logs of Lockhill test hole AY-68-28-404-----	13
6. Lithologic and geophysical logs of Castle Hills test hole AY-68-28-910-----	15
7. Lithologic and geophysical logs of Feathercrest test hole AY-68-29-506-----	17
8. Lithologic and geophysical logs of Rio Medina test hole TD-68-34-506-----	19
9. Lithologic and geophysical logs of Sabinal test hole YP-69-37-402-----	21

TABLES

Page

Table 1.	Carbonate-rock classification system of Dunham (1962)-----	24
2.	Carbonate-rock classification system of Folk (1962)-----	24
3.	Porosity-classification system of Choquette and Pray (1970)-----	25
4-8.	Randolph test hole AY-68-30-807:	
4.	Test-hole completion summary-----	32
5.	Descriptions of test-hole cores-----	35
6.	Descriptions of thin sections of test-hole cores-----	43
7.	Mineralogy of core samples as determined by X-ray- diffraction analysis-----	49
8.	Porosity characteristics of core samples as determined by laboratory tests-----	52
9-12.	San Marcos test hole LR-67-09-110:	
9.	Test-hole completion summary-----	55
10.	Descriptions of test-hole cores-----	57
11.	Descriptions of thin sections of test-hole cores-----	62
12.	Porosity characteristics of core samples as determined by laboratory tests-----	65
13-15.	Devine test hole TD-68-49-813:	
13.	Test-hole completion summary-----	66
14.	Descriptions of test-hole cores-----	68
15.	Descriptions of thin sections of test-hole cores-----	73
16-20.	Lockhill test hole AY-68-28-404:	
16.	Test-hole completion summary-----	76
17.	Descriptions of test-hole cores-----	78
18.	Descriptions of thin sections of test-hole cores-----	82
19.	Mineralogy of core samples as determined by X-ray- diffraction analysis-----	87
20.	Porosity characteristics of core samples as determined by laboratory tests-----	89
21-25.	Castle Hills test hole AY-68-28-910:	
21.	Test-hole completion summary-----	91
22.	Descriptions of test-hole cores-----	94
23.	Descriptions of thin sections of test-hole cores-----	101
24.	Mineralogy of core samples as determined by X-ray- diffraction analysis-----	111
25.	Porosity characteristics of core samples as determined by laboratory tests-----	113
26-28.	Feathercrest test hole AY-68-29-506:	
26.	Test-hole completion summary-----	114
27.	Descriptions of test-hole cores-----	116
28.	Descriptions of thin sections of test-hole cores-----	120
29-31.	Rio Medina test hole TD-68-34-506:	
29.	Test-hole completion summary-----	124
30.	Descriptions of test-hole cores-----	126
31.	Descriptions of thin sections of test-hole cores-----	132

TABLES--Continued

	Page
Tables 32-35. Sabinal test hole YP-69-37-402:	
32. Test-hole completion summary-----	136
33. Descriptions of test-hole cores-----	137
34. Descriptions of thin sections of test-hole cores-----	144
35. Porosity characteristics of core samples as determined by laboratory tests-----	147
36. Descriptions of cores from Texas Department of Water Resources test hole DX-68-23-202, Comal County-----	148
37. Descriptions of cores from Texas Department of Water Resources test hole TD-69-39-504, Medina County-----	149
38. Descriptions of cores from Texas Department of Water Resources test hole YP-69-42-709, Uvalde County-----	152

## METRIC CONVERSIONS

For readers interested in using the metric system, the inch-pound units used in this report may be converted to metric units by the following factors:

From		Multiply by	To obtain	
Unit	Abbrevi- ation		Unit	Abbrevi- ation
foot	--	0.3048	meter	m
inch	--	2.54	centimeter	cm
mile	--	1.609	kilometer	km
pound per square inch	lb/in <sup>2</sup>	0.07031	kilogram per square centimeter	kg/cm <sup>2</sup>

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ABSTRACT

This report contains descriptive geologic data collected by the U.S. Geological Survey during a test-hole program to develop a factual concept of the distribution of porosity and permeability within the framework of the Edwards aquifer in the San Antonio area, Texas. The test-hole program produced more than 4,000 feet (1,219 meters) of rock core from eight holes during May 1972 to April 1974. The selection of test-hole sites was based on considerations of possible water management problems, geologic conditions, and the limitations of the drilling and coring equipment.

Cores were examined for composition, color, hardness, grain size, grain type, sedimentary structure, pore shape and size, and total porosity. Laboratory tests were used to determine porosity, pore-size distribution, permeability, grain density, formation factor, and mineralogy.



## INTRODUCTION

This report is a compilation of test-hole data collected from 1970 to 1978 by the U.S. Geological Survey as a part of a study of the Edwards aquifer in the San Antonio area, Texas. The study was made in cooperation with the City Water Board of San Antonio and the Texas Department of Water Resources.

The San Antonio area, as used in this report, includes parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays Counties that are within or adjacent to the Balcones Fault Zone (fig. 1). This area includes the part of the Edwards aquifer where large amounts of water are withdrawn for irrigation, industrial use, and public supply. Major springs from the aquifer are located in Uvalde, Bexar, Comal, and Hays Counties.

The U.S. Geological Survey has been collecting hydrologic and geologic data in the San Antonio area since the 1930's. Much of this previously collected data is included in reports by Arnow (1959); Bennett and Sayre (1962); DeCook (1963); Garza (1962, 1966); George (1952); Holt (1959); Lang (1954); Livingston, Sayre, and White (1936); Maclay and Small (1976); Petitt and George (1956); and Welder and Reeves (1962).

## TEST-HOLE PROGRAM

A basic part of the hydrogeologic study in the San Antonio area involved exploratory drilling to investigate the subsurface geology. The primary objective of the test-hole program was to obtain data on the lithologic and porosity characteristics of the Edwards aquifer. A secondary objective was to determine the subsurface occurrence and extent of the stratigraphic units identified by Rose (1972) within the San Antonio area. These stratigraphic units provide a basis for interpreting the lateral and vertical extent of porosity development within the Edwards aquifer.

The Geological Survey test-hole program was begun in May 1972, and between May 1972 and April 1974, a total of more than 4,000 feet (1,219 m) of rock was cored in eight test holes (fig. 1). Six test holes were drilled and cored by the Texas Department of Water Resources, and two test holes were drilled and cored by private drilling companies under contract with the Geological Survey. Cores were taken through the entire thickness of the aquifer, and core recovery ranged from 60 to 94 percent. Detailed information on the methods, problems, and techniques involved in test drilling the Edwards aquifer is given by Sieh (1975). Three cores from the Texas Department of Water Resources test-hole program were made available to the Geological Survey and are also described in this report (fig. 1).

## Selection of Drilling Sites

The selection of test-hole sites was based on considerations of possible water-management problems, geologic conditions, and the limitations of the drilling and coring equipment. Three sites, San Marcos (LR-67-09-110), Randolph (AY-68-30-807), and Devine (TD-68-49-813), were selected in areas where saline water may encroach into the freshwater zone. The other sites, Castle Hills (AY-68-28-910), Feathercrest (AY-68-29-506), Lockhill (AY-68-28-404), Sabinal (YP-69-37-402), and Rio Medina (TD-68-34-506), were located in the freshwater zone where knowledge of the storage capacity and transmissivity of the aquifer is minimal.

## Examination of Cores

The cores were examined for composition, color, hardness, grain size, grain type, sedimentary structure, pore shape and size, and total porosity. These observations were made first in the field and then later after the core had been cut longitudinally. Core samples were studied in the laboratory to determine porosity, pore-size distribution, permeability, grain density, formation factor, and mineralogy. Thin sections were made of some of the samples taken for laboratory study. Results of the microscopic examinations of the rocks for mineralogy, pore size, and shape were compared with the laboratory data and nonmagnified visual observations.

Lithologic and geophysical logs of each of the eight test holes are shown on figures 2-9.

## DESCRIPTIVE DATA

Descriptive geologic data are essential for the development of a factual concept of the distribution of porosity and permeability within the framework of the Edwards aquifer. Specifically, lithologic data are needed to understand the processes that have affected porosity development.

Scientific terms and logical classification systems were used to obtain accuracy and consistency. Frequently, some observations made during the course of an investigation may seem extraneous; however, new conceptual models may be developed by using these data at a later time.

## Classification of Carbonates

Carbonates form a large group of sedimentary rocks within a broad spectrum of textural types. For example, carbonate rocks may include hard, dense, microcrystalline rock with no visually apparent porosity; crumbly, coarsely crystalline dolomite with open, interconnected pores between well-formed crystals; or a "hash" formed by a mixture of broken fossils. No texture is representative of all carbonate rocks.

Some carbonate rocks have been subjected to alteration by geochemical process after deposition so that the original texture may not be identifiable; consequently, they are classified as a separate type. These rocks commonly are dolomites or strongly recrystallized limestones.

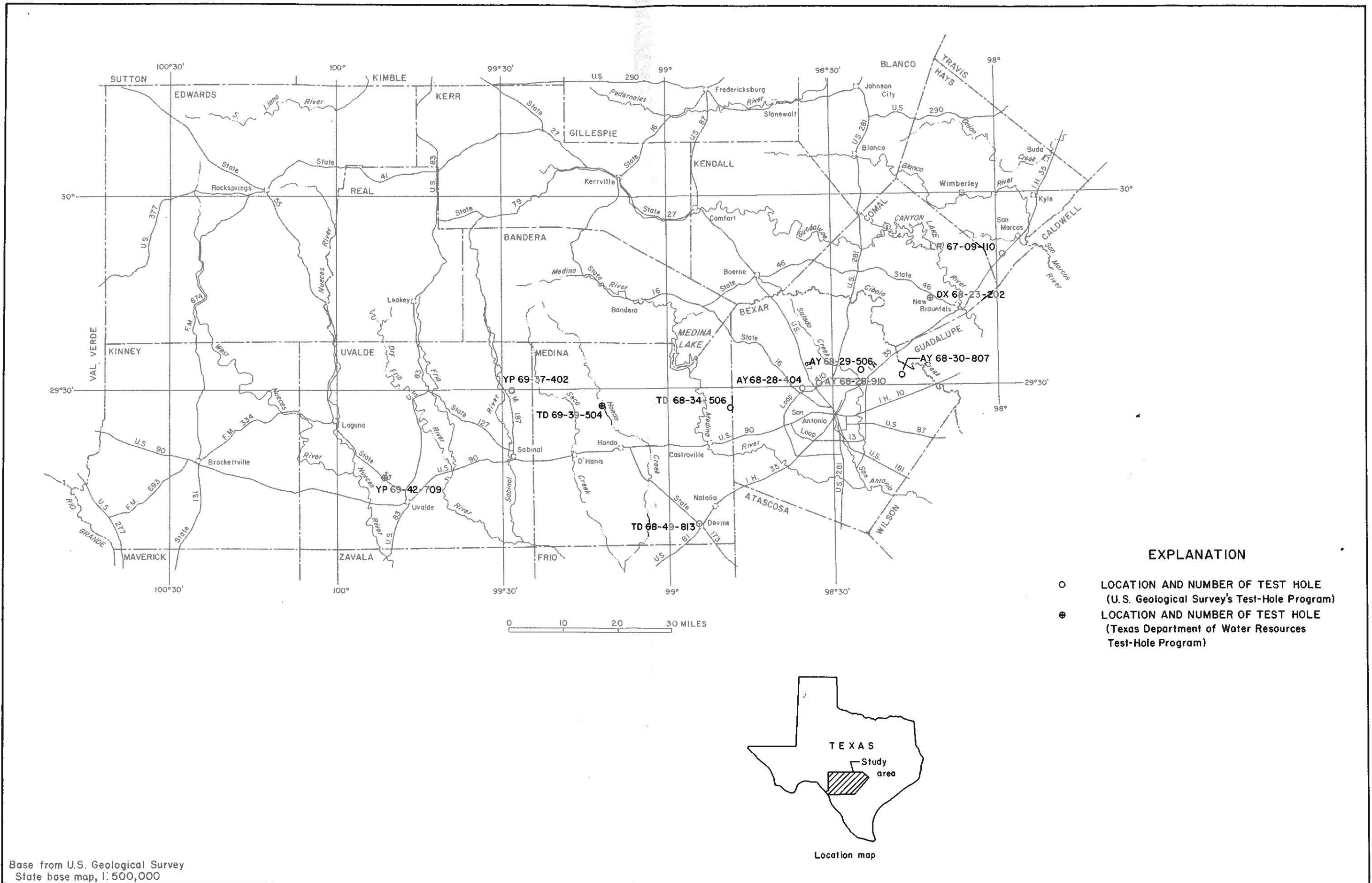
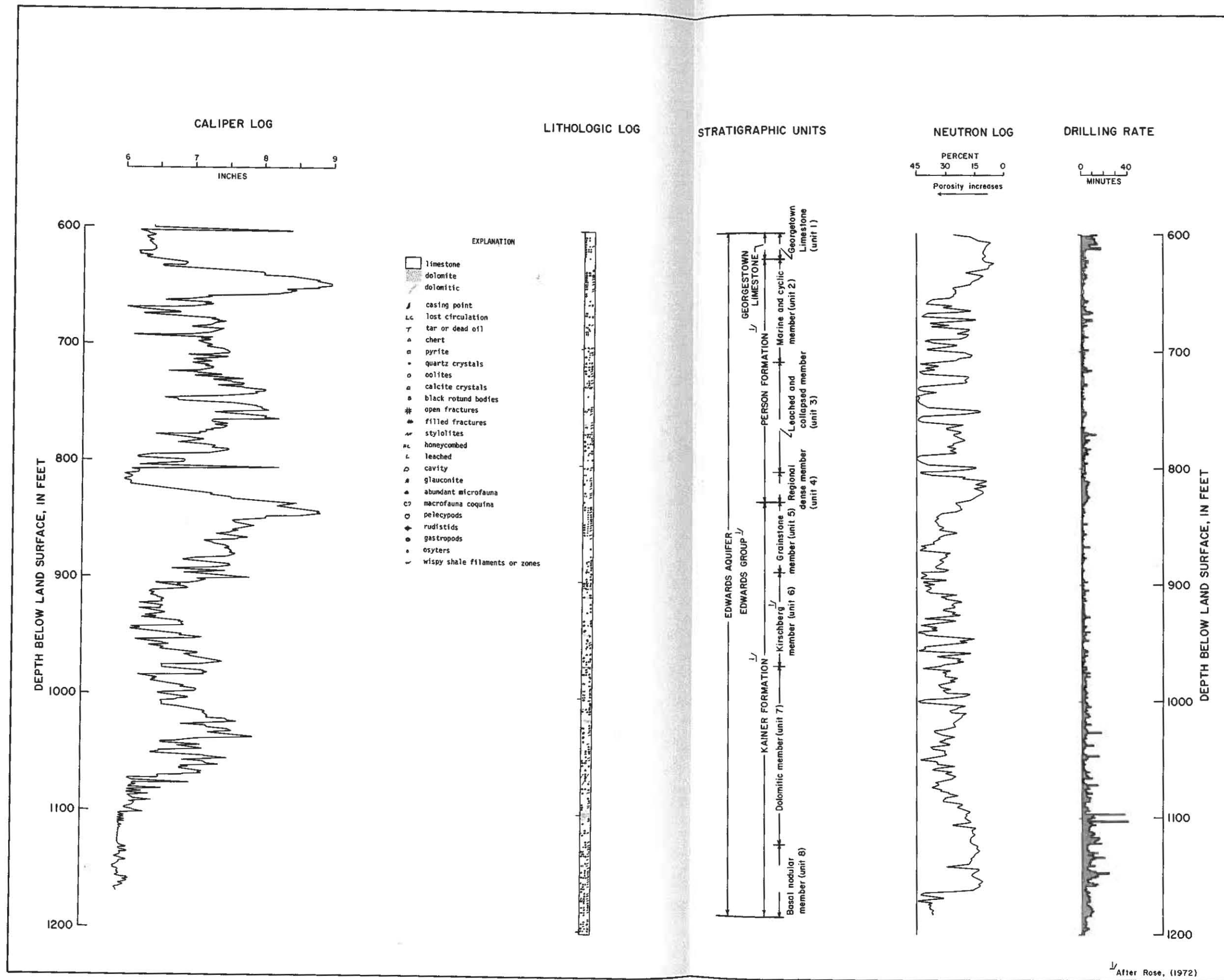


FIGURE 1-Location of test holes



After Rose, (1972)

FIGURE 2.-Lithologic and geophysical logs of Randolph test hole AY-68-30-807

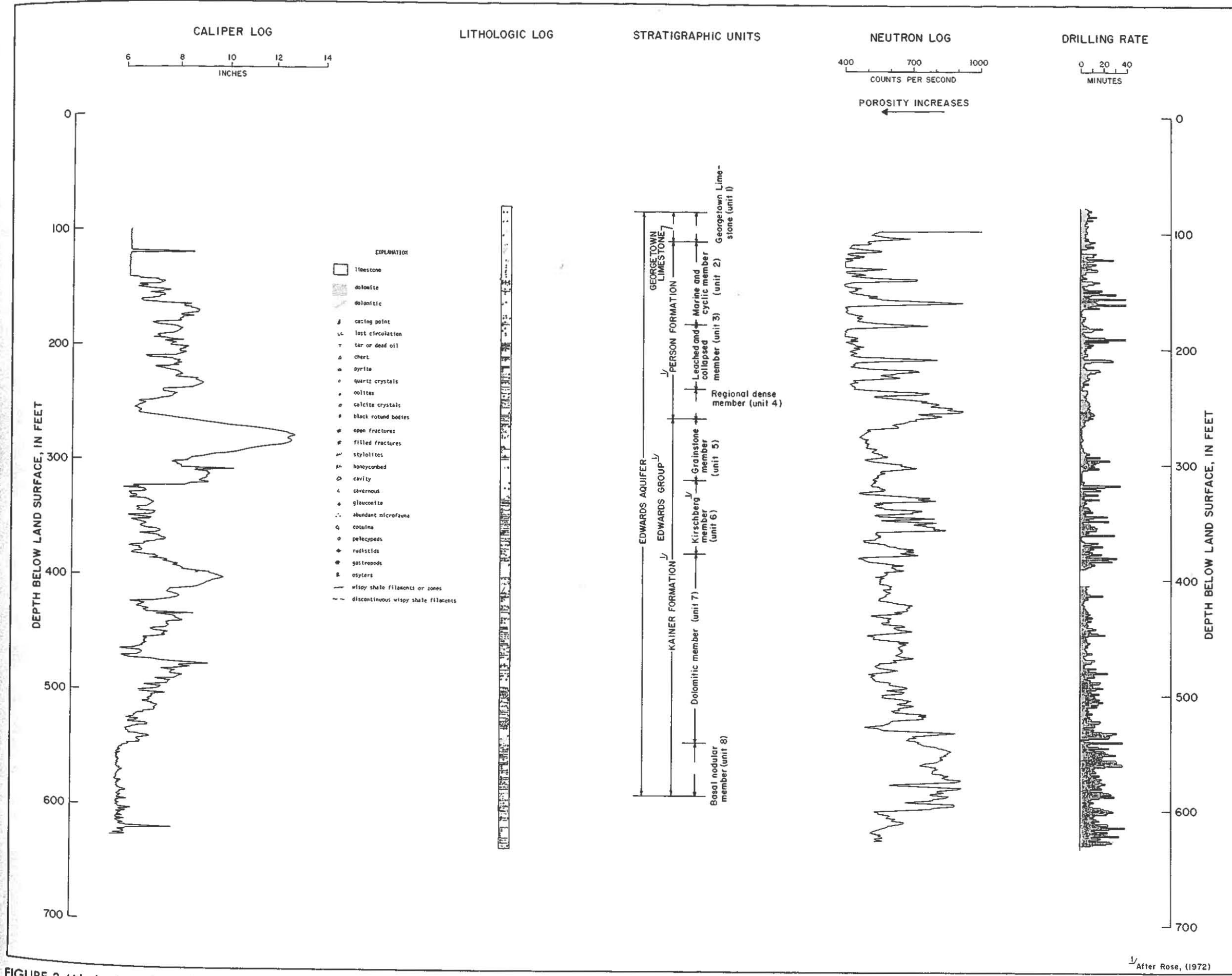
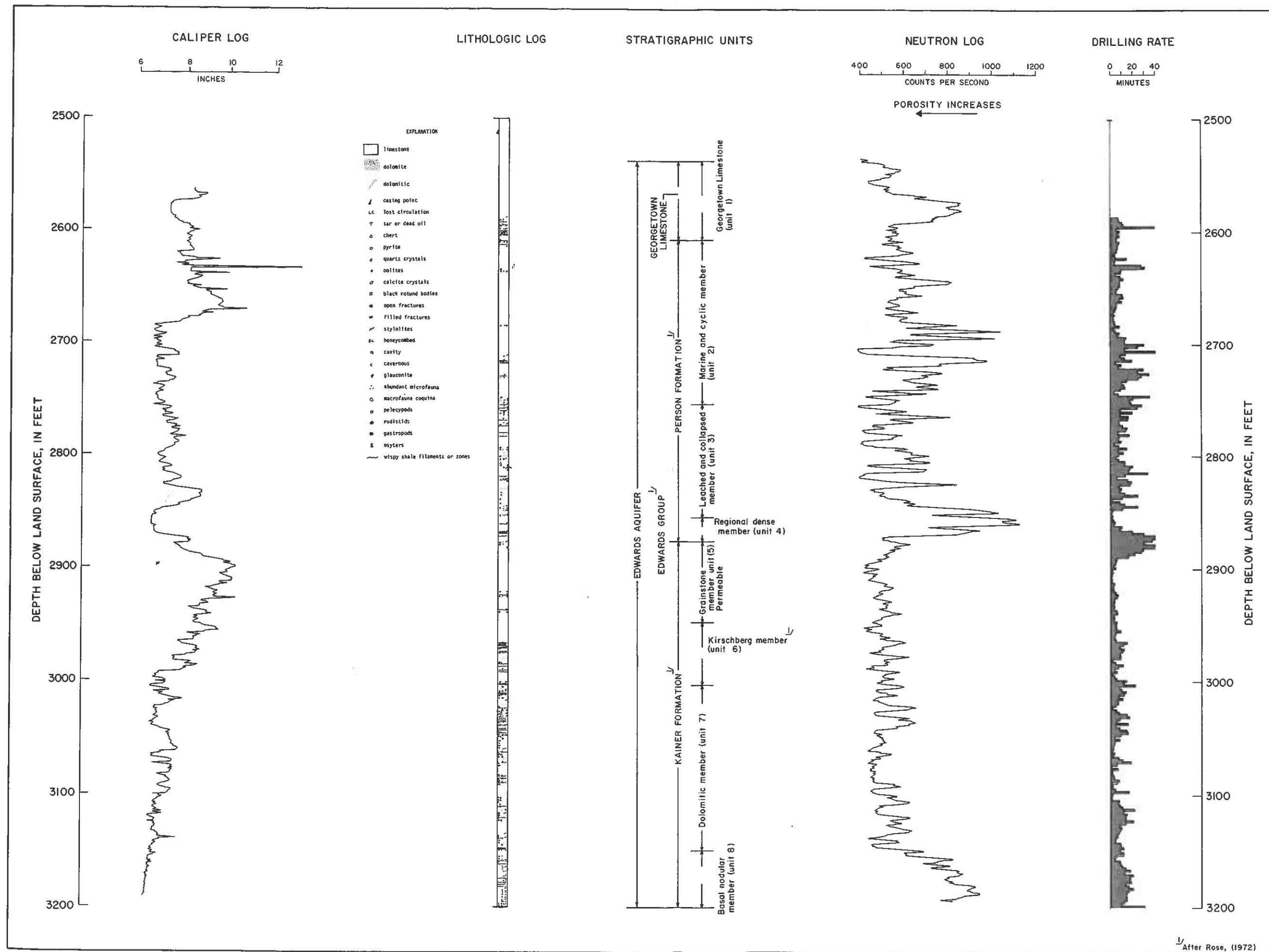


FIGURE 3.-Lithologic and geophysical logs of San Marcos test hole LR-67-09-110

After Rose, (1972)



After Rose, (1972)

FIGURE 4. Lithologic and geophysical logs of Devine test hole TD-68-49-813



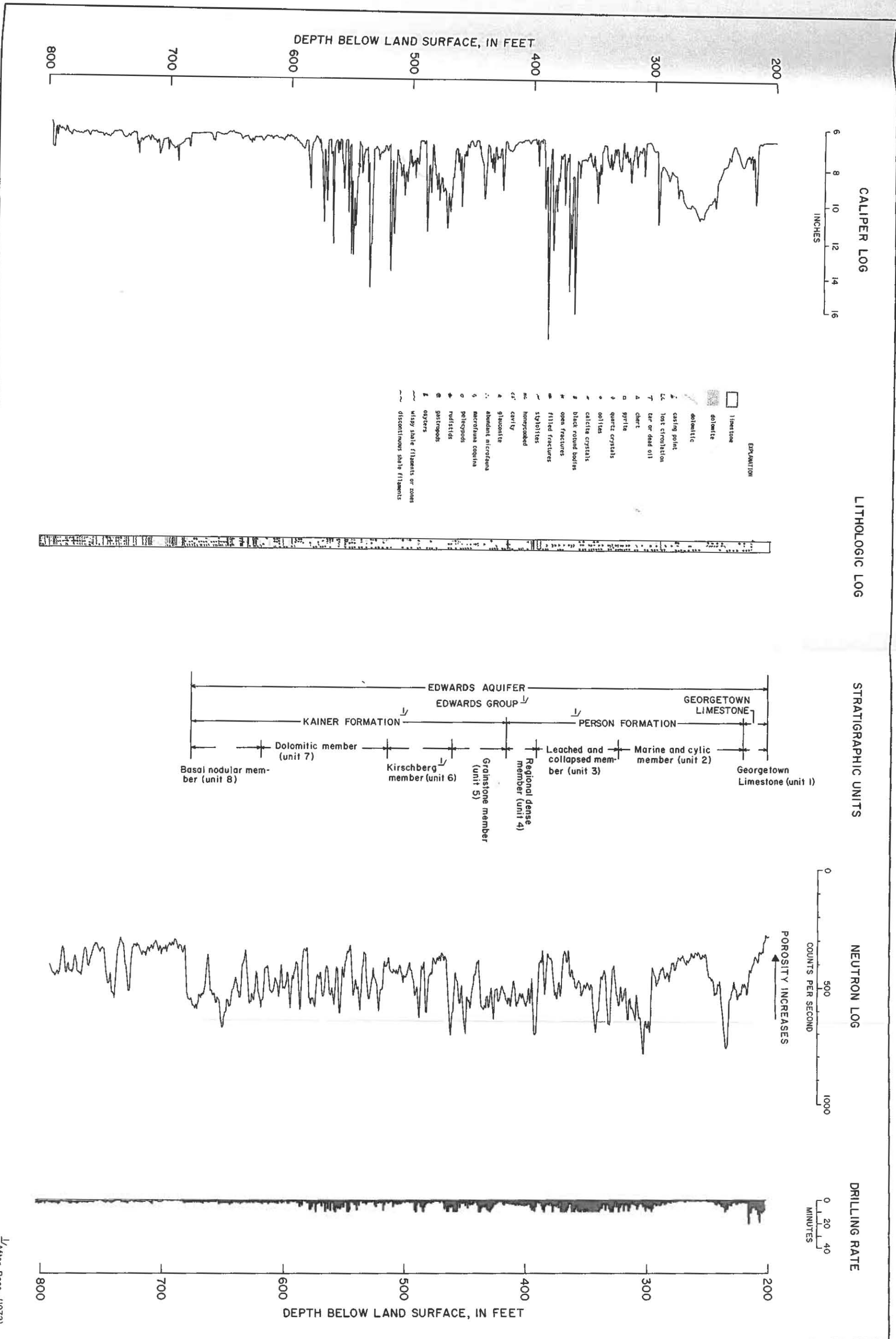
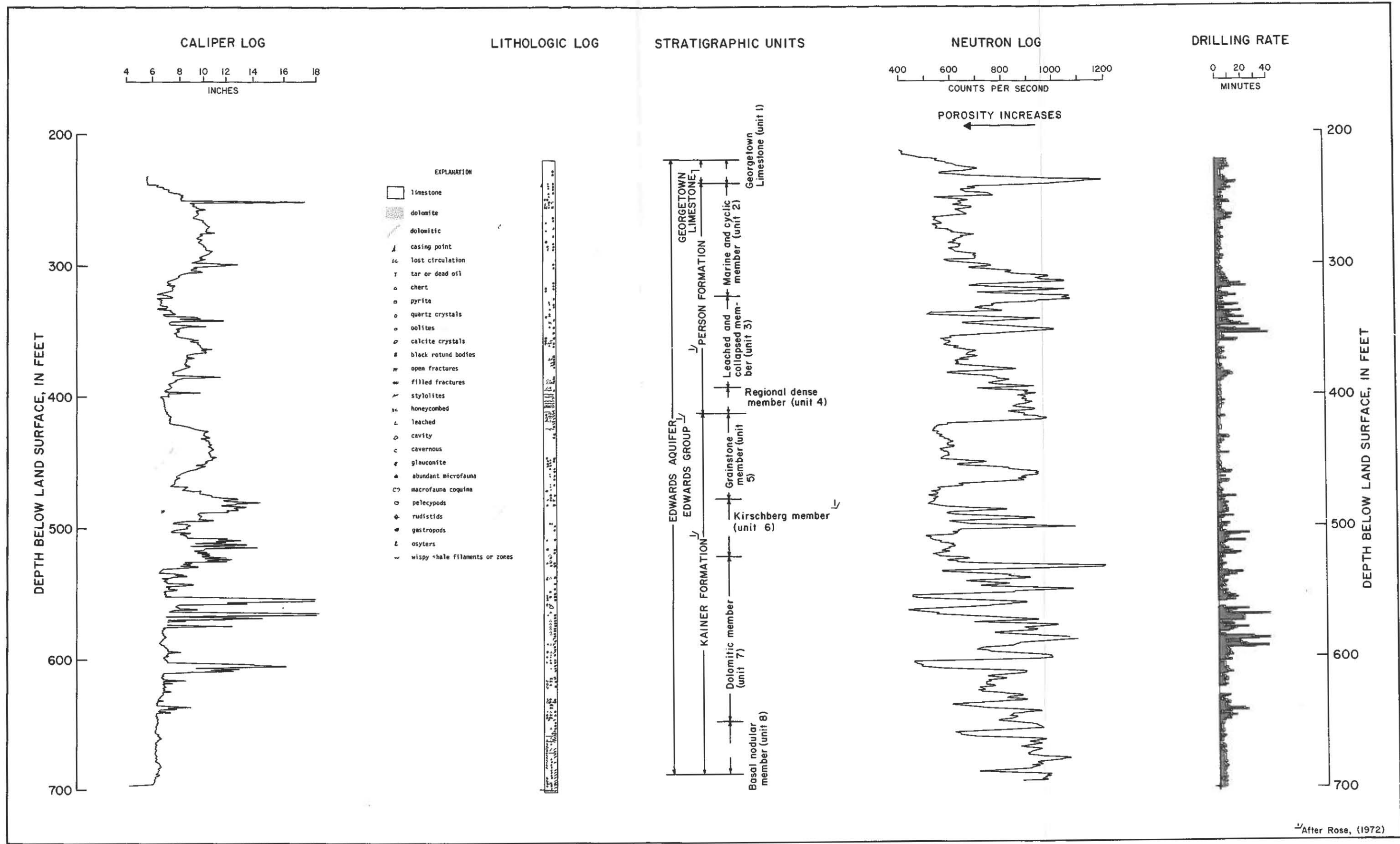


FIGURE 6.-Lithologic and geophysical logs of Castle Hills test hole AY-68-28-910

After Rose, (1972)





After Rose, (1972)

FIGURE 7. Lithologic and geophysical logs of Feathercrest test hole AY-68-29-506

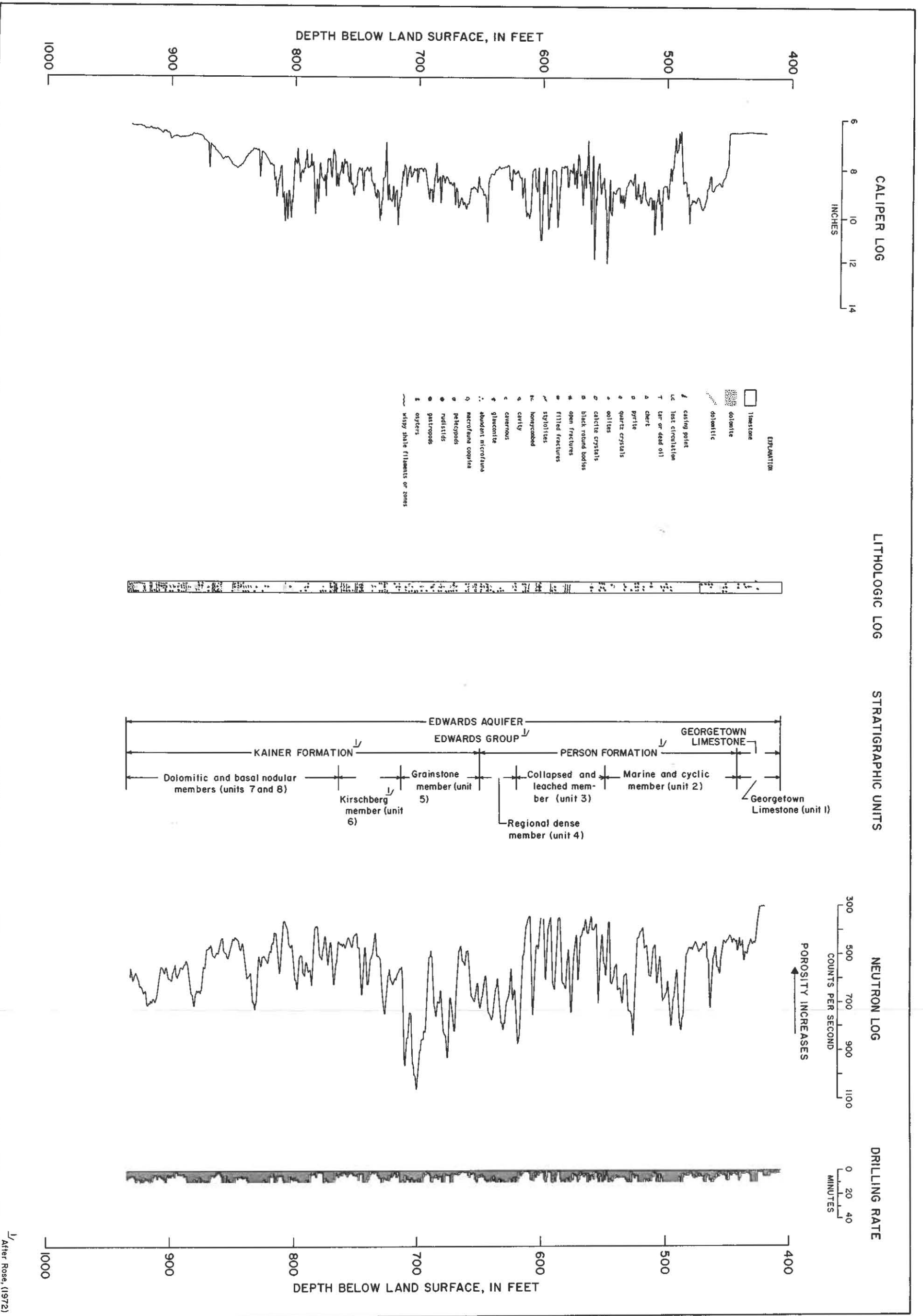
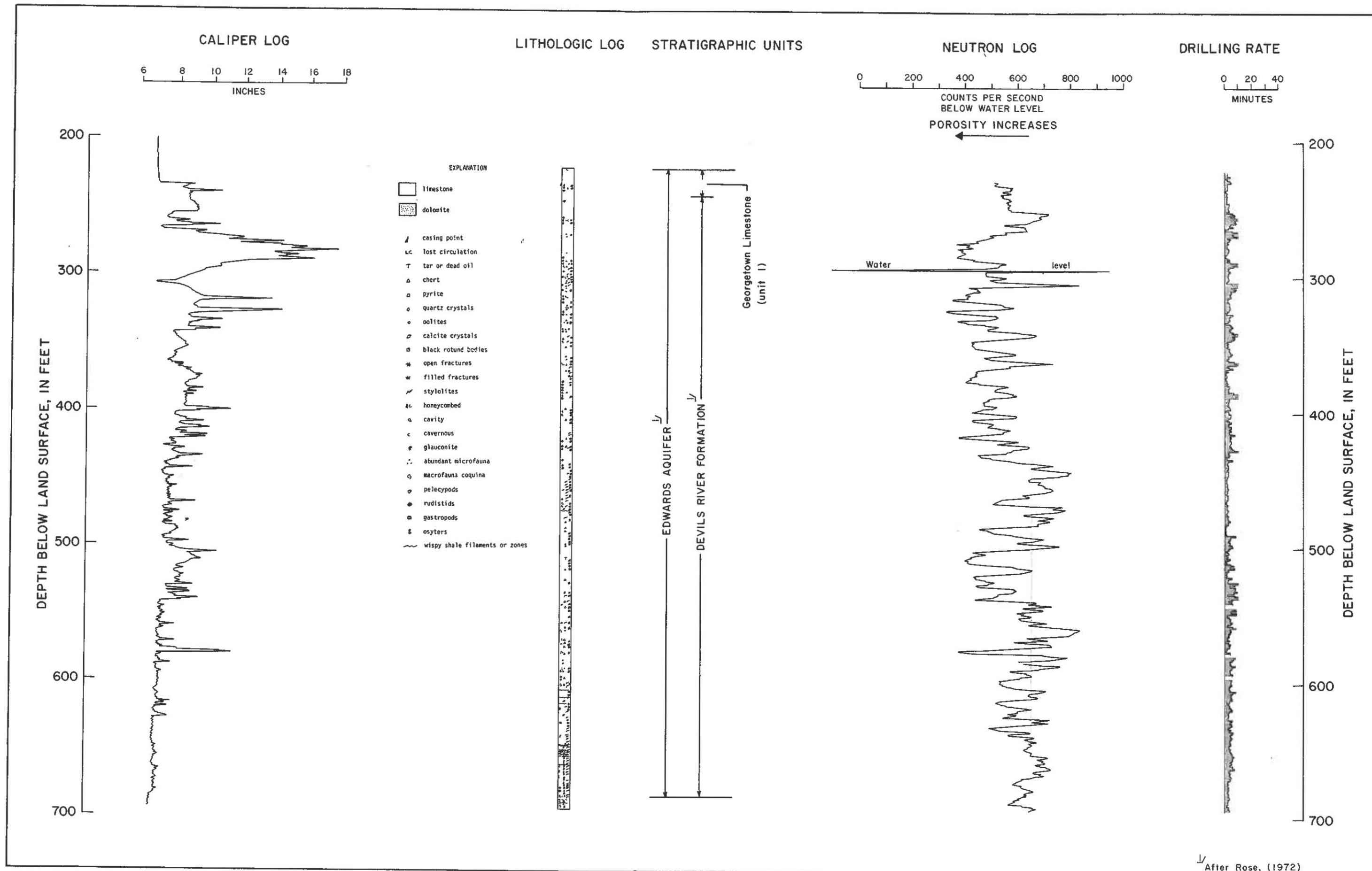


FIGURE 8. Lithologic and geophysical logs of Rio Medina test hole TD-68-34-506



After Rose, (1972)

FIGURE 9.-Lithologic and geophysical logs of Sabinal test hole YP-69-37-402

Because of the complexity of classification of carbonate rocks, all published descriptive systems for classifying carbonate rocks were reviewed to select a system that was comprehensive, yet practical. The classification systems by Dunham (1962) and by Folk (1962) were selected for describing the rocks obtained from the test-hole cores. These systems of classification are given in tables 1 and 2.

Most carbonate rocks can be classified by first estimating the percentage of space occupied by individual allochems (grains) and then by identifying the type of material filling the space between the grains. Two types of solid material commonly fill the interparticle space: (1) Microcrystalline material, which consists of particles having the size of fine silt or smaller; and (2) cement that is commonly a mosaic of interlocking crystals of sparry calcite. Study of these materials commonly requires magnification either by a hand lens or a microscope.

#### Classification of Porosity

Careful study of the pore space, in relation to rock fabric, shows that most porosity is commonly controlled by textural properties. This concept, called fabric selective, which was formulated by Choquette and Pray (1970) is given in table 3. All of the pore types in table 3 occur in the rocks of the Edwards aquifer, and commonly a combination of types occurs within a single rock sample.

#### Classification of Color

The color of a rock is an important characteristic because coloration is indicative of the hydrochemical environment and (or) circulation within the aquifer. White and orange-stained rocks occur within the aquifer where the water contains dissolved oxygen. Darker shades of rocks occur in the aquifer where the water is lacking in dissolved oxygen. Permeable rocks tend to be a light shade, and poorly permeable rocks tend to have darker shades.

The rock-color chart published by the Geological Society of America (1951) was used to distinguish colors of the cores obtained from the test holes. This chart is based on the Munsell (1967) system for color notation, which is accepted as a standard classification by the geologic profession. Munsell's system uses hue, value, and chroma to identify color. Hue is a color family such as red or green; value distinguishes a light shade from a darker one; and chroma is the degree of departure of the color from gray or white.

#### LABORATORY DATA

Laboratory data obtained from rock samples of the test-hole cores were porosity, permeability, pore-size distribution, grain density, and formation factor. These data are used to measure rock properties that are related to the transmissivity and storage coefficient or to calibrate petrophysical measurements made by borehole-geophysical methods.

Table 1.--Carbonate-rock classification system of Dunham (1962)

DEPOSITIONAL TEXTURE RECOGNIZABLE				DEPOSITIONAL TEXTURE NOT RECOGNIZABLE
Original components not bound together during deposition		Original components were bound together during deposition... as shown by intergrown skeletal matter, lamination contrary to gravity, or sediment-floored cavities that are roofed over by organic or questionably organic matter and are too large to be interstices.		
Contains mud (particles of clay and fine silt size)				Lacks mud and is grain-supported
Mud-supported	Grain-supported			
Less than 10 percent grains	More than 10 percent grains			
<u>Mudstone</u>	<u>Wackestone</u>	<u>Packstone</u>	<u>Grainstone</u>	<u>Boundstone</u>

-24-

Table 2.--Carbonate-rock classification system of Folk (1962)

Percent Allochems	OVER 2/3 LIME MUD MATRIX				SUBEQUAL SPAR & LIME MUD	OVER 2/3 SPAR CEMENT		
	0-1%	1-10%	10-50%	OVER 50%		SORTING POOR	SORTING GOOD	ROUNDED & ABRADED
Representative Rock Terms	MICRITE & DISMICRITE	FOSSILIFEROUS MICRITE	SPARSE BIOMICRITE	PACKED BIOMICRITE	POORLY-WASHED BIOSPARITE	UNSORTED BIOSPARITE	SORTED BIOSPARITE	ROUNDED BIOSPARITE
1959 Terminology	Micrite & Dismicrite	Fossiliferous Micrite	Biomicrite		Biosparite			
Terrigenous Analogues	Claystone		Sandy Claystone	Clayey or Immature Sandstone	Submature Sandstone	Mature Sandstone	Supermature Sandstone	



## Porosity

The porosity of a rock is its property of containing voids or interstices. Total porosity is expressed quantitatively as the ratio of the volume of the interstices to the total or bulk volume of the sample. Effective porosity is expressed as a percentage of the total volume occupied by the interconnecting interstices. Therefore, the effective porosity is usually somewhat less than the total porosity. The majority of the carbonate rocks of the Edwards aquifer have total porosities ranging from about 5 percent to about 35 percent.

## Permeability

Permeability is a measure of the relative ease with which a porous medium can transmit a liquid under a potential gradient. The darcy is a unit of permeability defined as the volume in cubic centimeters of water of 1 centipoise viscosity flowing in 1 second through an area of 1 square centimeter under a pressure gradient of 1 atmosphere per square centimeter per centimeter (Lohman and others, 1972, p. 10). One darcy is equivalent to the coefficient of permeability multiplied by 18.2. The coefficient of permeability is expressed in gallons per day per foot squared at 60°F (gal/day<sup>-1</sup>/ft<sup>2</sup> at 60°F).

## Pore-Size Distribution

The pore structure of carbonate rocks is a complicated maze of different size openings, which may or may not be interconnected. The size of the connecting pore throats exerts a major control on the drainability and intrinsic permeability of the rock matrix.

The pore diameter can be computed by the equation:

$$d_c = 4 \cos \theta / P_c$$

where  $d_c$  = capillary-pore diameter, in centimeters;  
= surface tension of mercury, 480 dynes/cm<sup>2</sup> or 0.0005 kg/cm<sup>2</sup>;  
 $\theta$  = contact angle of wetting surface between mercury and rock (140 degrees); and  
 $P_c$  = minimum pressure required to inject mercury, in dynes per square centimeter or kilograms per square centimeter.

This equation and the application of capillary-pressure tests to the determination of pore-throat size and rock permeability are given in detail by Chilingar and others (1972).

The procedure for determining the pore sizes of carbonate rocks was the mercury-injection method, in which mercury is forced (under pressure) into the rock sample. Injection pressures are increased in incremental steps, and the volume of mercury injection for each pressure is measured.

The diameter of a pore throat that will hold water by capillary tension at atmospheric pressure (14.7 lb/in<sup>2</sup> or 1.0 kg/cm<sup>2</sup>) is 2.87 microns. Any interconnected void system having a minimum pore diameter that is larger than 2.87 microns would drain by gravity flow. If the column of interconnected pores were restricted at any point by a pore diameter smaller than 2.87 microns, complete drainage of the column could not occur.

#### Grain Density

Grain density is the density of the solid constituents of a rock. Typical grain densities for various rock types are: Limestone, 2.71 g/cm<sup>3</sup>; dolomite, 2.87 g/cm<sup>3</sup>; and chert, 2.65 g/cm<sup>3</sup>.

Bulk density is the density of a unit volume of material. The volume includes the space occupied by the void and solids. Measurements of bulk density are made by borehole-geophysical methods. If the grain and fluid densities are known, porosity can be determined by the following equation:

$$\text{Porosity} = (\text{grain density} - \text{bulk density}) / (\text{grain density} - \text{fluid density}).$$

#### Formation Factor

Formation factor is the ratio of the resistivity of a rock saturated with an electrically conductive fluid to the resistivity of the conductive fluid. Formation factor is determined in the laboratory by measuring the electrical resistance of the rock sample saturated with a fluid of known resistance. Formation factor is related to porosity, mineral character of the solids, tortuosity of the pore space, and other factors. An equation that relates porosity to formation factor is:

$$F = \phi^{-m}$$

where  $\phi$  = porosity and

$m$  = a number (cementation factor) that is related to the petrophysical characteristics of the rock.

The  $m$  factor for most rocks of the Edwards aquifer ranges from 2 to 2.3



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Compilations of data (tables 4-38)

Table 4.--Test-hole completion summary: Randolph (AY-68-30-807)

Location: Bexar County, Tex., on Loop 1604, across road from Randolph Air Force Base, about 1 mile south of Randolph High School (Schertz quadrangle).

Elevation of land surface: 755 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources (Failing 1500 core-drilling rig, modified).

Spudded: May 23, 1972.

Completed: July 25, 1972.

Casing: 6-1/4-inch inside diameter to 604 feet. Cemented with 125 sacks of 4-percent gel, cement not circulated.

Total depth: 1202 feet (driller); 1170 feet (log).

Coring equipment: Acker 10-foot double-wall core barrel 5-1/2 x 4 inches, 604-1200 feet. Diamond-core bits of 70 to 80 carats, 20 stones per carat. Bottom discharge.

Core-recovery summary: Total footage cored, 598 feet; total core recovered, 562.6 feet; and percentage of recovery, 94 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
604- 612	8.0	7.1	7.1
612- 612.5	0.5	0.4	7.5
618	5.5	5.5	13.0
628	10.0	10.0	23.0
638	10.0	9.6	32.6
648	10.0	9.0	41.6
658	10.0	9.5	51.1
668	10.0	10.0	61.1
678	10.0	8.5	69.6
688	10.0	10.0	79.6
698	10.0	10.0	89.6
708	10.0	9.5	99.1
718	10.0	10.0	109.1
728	10.0	10.0	119.1
738	10.0	10.0	129.1
748	10.0	9.8	138.9
758	10.0	10.0	148.9
768	10.0	9.9	158.8
778	10.0	10.0	168.8
788	10.0	9.6	178.4

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
798	10.0	9.5	187.9
798- 808	10.0	9.6	197.5
818	10.0	10.0	207.5
828	10.0	10.0	217.5
838	10.0	10.0	227.5
848	10.0	10.0	237.5
858	10.0	10.0	247.5
868	10.0	10.0	257.5
878	10.0	10.0	267.5
888	10.0	10.0	277.5
898	10.0	10.0	287.5
898- 908	10.0	7.5	295.0
918	10.0	8.4	303.4
928	10.0	9.9	313.3
938	10.0	10.0	323.3
948	10.0	10.0	333.3
958	10.0	9.5	342.8
968	10.0	9.3	352.1
978	10.0	9.3	361.4
988	10.0	10.0	371.4
998	10.0	9.0	380.4
998-1008	10.0	9.4	389.8
1018	10.0	8.0	397.8
1028	10.0	10.0	407.8
1038	10.0	10.0	417.8
1038-1047	9.0	9.0	426.8
1057	10.0	9.0	435.8
1066	9.0	8.9	444.7
1076	10.0	10.0	454.7
1086	10.0	10.0	464.7
1096	10.0	9.9	474.6
1096-1102	6.0	1.6	476.2
1103	1.0	0.7	476.9
1112	9.0	5.0	481.9
1122	10.0	5.0	486.9
1132	10.0	8.6	495.5
1142	10.0	9.8	505.3
1152	10.0	9.8	515.1
1162	10.0	9.8	524.9
1172	10.0	10.0	534.9
1182	10.0	9.7	544.6
1192	10.0	10.0	554.6
1192-1202	10.0	8.0	562.6

Notes: The core recovery of 94 percent was excellent. The Acker-type barrel, with the stabilized nonrotating inner barrel, is an excellent barrel and there were no problems with it in this test hole.

The small bottom-discharge diamond core bits (from the Corps of Engineers) gave good service and good penetration rates.

The main reasons for core losses were probably the occurrences of fractured rock and very soft, poorly cemented rock. Fractured rock may turn sideways in the core barrel, bind against the inner barrel, and cause the inner barrel to rotate and grind the core. Soft, poorly cemented rock may be washed away by a combination of the coring action and circulation of the drilling fluid.

Table 5.--Description of test-hole cores: Randolph (AY-68-30-807)

Depth (feet)	
604-621.5	<p>Limestone; color, 10YR 7/1; texture, mudstone; bluish-gray, clayey, sparse biomicrite with an abundance of small pyrite crystals. The upper 8 feet is highly burrowed. Complete faunal preservation is much better in the lower 9.5 feet; <u>Kingena</u>, <u>Gryphaea</u> and other oysters, clam and snail steinkerns; pectins and ostracods were identified. Burrows do not cut the abundant clay seams that occur in this zone.</p> <p>-- at 606 - X-ray diffraction analysis (table 7).</p> <p>-- at 614 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 617 - Thin-section description (table 6).</p> <p>-- at 620.1-620.5 - Small megapore vugs and small fractures with drusy calcite.</p> <p>-- at 621 - X-ray diffraction analysis (table 7).</p> <p>-- at 621.5 - Uppermost <u>Edwards Group</u>, pyritic partially recrystallized <u>Toucasia</u>-miliolid limestone with an angular, etched upper surface of 1/4-1/2 inch in relief, Georgetown material fills the voids.</p>
621.5-634	<p>Limestone; color, 10YR 8/1; texture recrystallized miliolid grainstone with some sparse biomicrite. Carbonaceous with large clasts, wispy laminae, and dead oil accumulations. <u>Toucasia</u> and other fossil fragments common, some burrows. Porosity, intergranular and drusy megapore vugs, is medium to high.</p> <p>-- at 622 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 624-625 - Clay stringers and carbonaceous stylolites.</p> <p>-- at 628-629 - Hydrocarbon saturated <u>Toucasia</u> and miliolid grainstone.</p>
634-656.6	<p>Limestone; color, 10YR 7/2; texture, <u>Toucasia</u> and caprinid biolithite and talus grainstone with large caprinids, oysters, snail and clam steinkerns, fossil fragments, carbonaceous clasts and hydrocarbon-stained stylolites. High porosity; moldic after caprinids and fossil fragments, some interparticle porosity.</p> <p>-- at 634.8 - X-ray diffraction analysis (table 7).</p> <p>-- at 637.4 - X-ray diffraction analysis (table 7).</p> <p>-- at 642 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 643 - Thin-section description (table 6); laboratory test (table 8).</p>
656.5-682	<p>Dolomite; color, 10YR; texture, crystalline carbonate, fine to medium crystalline dolomite after a sparse miliolid fossil fragment biomicrite and a thinly bedded intraclastic mixed fossil grainstone. Carbonaceous clasts, thin wavy laminations and disseminated hydrocarbons. Good porosity; intercrystalline and moldic after fossil fragments.</p> <p>--at 657-657.5 - Wavy stromatolitic interval, irregular erosion surfaces with breccia and calcite-filled fenestral pores.</p> <p>-- at 658.5 - X-ray diffraction analysis (table 7).</p> <p>-- at 659 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 659.5 - Megapore vug with large calcite crystals in fracture complex.</p> <p>-- at 662.5-662.9 - Brecciated zone with carbonaceous fragments.</p> <p>-- at 662.8-664.4 - Collapse breccia of poorly sorted, angular clasts of fine dolomite partly cemented by very coarsely crystalline calcite.</p> <p>-- at 664 - X-ray diffraction analysis (table 7).</p> <p>-- at 665-667.5 - Dolomitized miliolid and fossil fragment biosparite cut by scour surface with 2-1/2 inches of relief overlain by thinly bedded sparse biomicrite and grainstone with rudist debris.</p> <p>-- at 667.5-672.5 - Fossil molds and vugs filled with bluish calcite.</p> <p>-- at 671 - X-ray diffraction analysis (table 7).</p> <p>-- at 672 - Laboratory test (table 8).</p> <p>-- at 672.5-676 - Highly irregular dark chert.</p> <p>-- at 675.7 - X-ray diffraction analysis (table 7).</p> <p>-- at 672.5-677 - Relict flaser type bedding with some small burrows.</p> <p>-- at 677 - Thin-section description (table 6).</p> <p>-- at 677-677.7 - Wavy stromatolitic interval irregular erosion surfaces with breccia and calcite-filled fenestral pores.</p> <p>-- at 678 - X-ray diffraction analysis (table 7).</p> <p>-- at 679 - Thin-section description (table 6).</p> <p>-- at 679.5 - X-ray diffraction analysis (table 7).</p> <p>-- at 680 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 681-682 - Dolomitized intraclastic fossil fragment grainstone with calcite snail steinkerns, vugs and burrows.</p> <p>-- at 683 - Thin-section description (table 6); laboratory test (table 8).</p>

Depth (feet)	
682-691	Dolomitic limestone; color, 10YR 7/2; texture, grainstone; hydrocarbon stained <u>Toucasia</u> -caprinid biolithite and intraclastic fossil fragment grainstone. Biolithite matrix is recrystallized fossil fragment biomicrite. Grainstone has <u>Toucasia</u> , caprinids, clams, oysters, miliolids, fragments, and is dolomitic in part. Porosity (moldic after fossils, megapore vugs, small, high-angle fractures) is medium. -- at 682-685 - Small chert nodules.
691-702	Dolomite; color, 10YR 8/2; texture, fine to medium grained crystalline dolomite. Light brown color because of disseminated hydrocarbons, small carbonaceous fragments, and laminae. High porosity in the form of intercrystalline, vugs and moldic after fossils. -- at 691.4-695 - Dolomite after a mollusc packstone with large megapore vugs and horizontal partings infilled with very coarse calcite. -- at 691.5 - X-ray analysis (table 7). -- at 695-695.6, 696-698 - <u>Toucasia</u> , oyster, and fragments in relict burrowed biomicrite and grainstone. -- at 698-702 - Jagged chert.
702-709.5	Limestone; color, 10YR 6/7; texture, grainstone; <u>Toucasia</u> biolithite and miliolid-fossil fragment grainstone with very fine interparticle material. Some megapore vugs containing coarse calcite. Numerous molds after fossil fragments. Porosity is low to medium. -- at 703 - Thin-section description (table 6); laboratory test (table 8). -- at 708 - Thin-section description (table 6).
709-721.5	Dolomite; color, 10YR 8/2; texture, crystalline carbonate; hydrocarbon-stained medium crystalline dolomite with several chert horizons. Relict <u>Toucasia</u> and oyster fragments. Many fine calcite veins in lower section. -- at 709 - Thin-section description (table 6). -- at 710 - Very large oysters. -- at 713.5-716 - Moldic porosity after clams and snails. -- at 718-720.5 - Caprinid biolithite.
721.5-730.2	Limestone; color, 10YR 6/2; texture, grainstone to wackestone; recrystallized miliolid and fossil fragment grainstone and wackestone with some carbonaceous stylolites. Some grains are densely encrusted with carbonates. Porosity (moldic after grains) is medium. -- at 721.5-723 - Caprinid oyster biolithite. -- at 722.8 - X-ray diffraction analysis (table 7). -- at 723-726 - Grainstone with caprinids, mollusc steinkerns, oysters, miliolids and fossil fragments. -- at 729.5 - Dolomite is interbedded.
730.2-751.5	Dolomite; color, 10YR 8/2, 6/2; texture, crystalline carbonate, medium crystalline dolomite light to dark brown (oil is present) with wispy carbonaceous stringers and calcite-filled fractures. High intercrystalline porosity. -- at 730.2-733 - Heavily oil stained. -- at 731 - Thin-section description (table 6); laboratory test (table 8). -- at 730.5 - Breccia zone. -- at 731.5 - X-ray diffraction analysis (table 7). -- at 732 - Thin-section description (table 6); laboratory test (table 8). -- at 733.5-734.5 - Breccia zone. -- at 733.6 - Chert. -- at 736 - Thin-section description (table 6); laboratory test (table 8). -- at 736-736.3 - Wavy stromatolites with intercalated thin breccia zone. -- at 736.4 - Chert. -- at 737-738 - Bluish calcite fills random fractures. -- at 738 - Thin-section description (table 6); laboratory test (table 8). -- at 740 - Thin-section description (table 6); X-ray diffraction analysis (table 7); laboratory test (table 8). -- at 740.6-740.9 - Oysters, shale seams. -- at 742-744 - Dense resistant dolomite patches. -- at 745.5 - X-ray diffraction analysis (table 7). -- at 746 - Chert. -- at 748-750 - Bluish-white calcite fills fossil molds and vugs. -- at 749 - Thin-section description (table 6); laboratory test (table 8).
751.5-755.5	Dolomitic limestone; color, 10YR 7/2; texture, wackestone to grainstone, <u>Toucasia</u> biolithite overlain by recrystallized, burrowed and dolomitic fossiliferous grainstone to wackestone. Oysters, miliolids, carbonaceous stylolites.



Depth (feet)	
755.5-762	<p>Dolomite; color, 10YR 7/1; texture, crystalline carbonate. Medium grain crystalline dolomite, light to medium brown color with carbonaceous laminae. High intercrystalline and moldic porosity.</p> <p>-- at 755-756.5 - <u>Toucasia</u> biolithite.</p> <p>-- at 758 - X-ray diffraction analysis (table 7).</p> <p>-- at 761 - Thin-section description (table 6); laboratory test (table 8).</p>
762-780.5	<p>Dolomitic limestone; color, 10YR 7/1; texture, grainstone to wackestone. Recrystallized, dolomitic and fossiliferous with miliolids, oysters and other fossil fragments. Porosity is low.</p> <p>-- at 763.5-764.5 - Microfaults and breccia.</p> <p>-- at 771 - X-ray diffraction analysis (table 7).</p> <p>-- at 774.5-780.5 - Calcite crystals in megapore vugs.</p> <p>-- at 776 - Thin-section description (table 6); X-ray diffraction analysis (table 7); laboratory test (table 8).</p>
780.5-789	<p>Limestone; color, 10 YR 7/1; texture, wackestone to grainstone. Caprinid biolithite to rudist grainstone/wackestone with carbonaceous stringers and <u>Toucasia</u>. Partially dolomitized with some dense, very fine interframework material. Calcite crystals are scattered throughout this interval.</p> <p>-- at 784-785 - Partial infilling by chert of caprinid mold.</p> <p>-- at 785 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 788 - X-ray diffraction analysis (table 7).</p>
789-805	<p>Limestone; color, 10YR 7/1 to 8/1; texture, wackestone to grainstone. Recrystallized fossil fragment with some dolomite, miliolids, <u>Toucasia</u>, oysters and other fossil fragments. Hydrocarbon stains, thin carbonaceous stringers and calcite crystals are scattered throughout this interval. Porosity is variable.</p> <p>-- at 790.8 - Chert.</p> <p>-- at 791 - Dense fractured layer.</p> <p>-- at 791.5 - Chert.</p> <p>-- at 794 - Quartz crystals in megapore vugs.</p> <p>-- at 797.5 - Quartz crystals in megapore vugs; X-ray diffraction analysis (table 7).</p> <p>-- at 800.8-805 - Dense and nonporous.</p> <p>-- at 804.5 - Chert.</p>
805-810	<p>Dolomite; color, 10YR 7/1 to 6/2; texture, crystalline carbonate. Medium crystalline dolomite, light to medium brown in color, containing oil stains and small calcite-healed fractures. The high porosity is intercrystalline and moldic after fossils.</p> <p>-- at 805-806.5 - Heavily oil stained, carbonaceous fragments and stringers.</p> <p>-- at 807.3-810 - Oyster, fossil fragments and molds; bluish calcite fills megapore vugs.</p>
810-830.5	<p>Limestone; color, 10YR 7/1; texture, mudstone. Clayey, sparse biomicrite with clams, snails, fossil fragments and small carbonaceous fragments containing pyrite vugs. Slightly dolomitic in some areas.</p> <p>-- at 811 - X-ray diffraction analysis (table 7).</p> <p>-- at 811.2-812 - Very clayey.</p> <p>-- at 812 - X-ray diffraction analysis (table 7).</p> <p>-- at 816 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 817-817.2 - Very clayey.</p> <p>-- at 818-818.3 - Partly washed miliolid-snail biomicrite.</p> <p>-- at 820 - Very clayey.</p> <p>-- at 822-830 - Homogenously lensed, mottled (gray and white) on a light brown background with wispy shale stringers.</p>
830.5-871	<p>Limestone; 10YR 7/1; texture, grainstone. Miliolid, fossil-fragment grainstone with dense, finely crystalline biosparite. Miliolids, oysters, gastropods, caprinids, fossil fragments, oil-stained stylolites, wispy carbonaceous laminae and fine crystalline interclasts. Porosity (intergranular, moldic after fossils) is medium.</p> <p>-- at 830.5 - Caprinid.</p> <p>-- at 833 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 839 - X-ray diffraction analysis (table 7).</p> <p>-- at 844 - Thin-section description (table 6); laboratory test (table 8).</p> <p>-- at 847.5-844 - Blue-green algae containing small grains.</p> <p>-- at 850.5-871 - Intercalated thin beds and lenses of miliolid wackestone and slightly burrowed packstone.</p> <p>-- at 853 - X-ray diffraction analysis (table 7).</p> <p>-- at 862 - Chert.</p> <p>-- at 870 - Thin-section description (table 6); laboratory test (table 8).</p>

- Depth  
(feet)
- 871-879.5 Dolomitic limestone; color, 10YR 6/2-5/2; texture, grainstone. Dolomitized grainstone to wackestone; thinly bedded miliolid grainstones and sparse miliolid-oyster fragment biomicrite with carbonaceous laminae and calcite-filled fractures. The wackestone is slightly burrowed. Porosity (intercrystalline and vugular) is high.  
 -- at 871-874 - Calcite veins.  
 -- at 874 - Irregular mosaic of megapore vugs.  
 -- at 874-876 - Chert nodules.
- 879.5-897 Limestone; color, 10YR 7/2-6/2-6/1; texture, grainstone. Miliolid grainstone with fossil fragments, micrite intraclasts, and abundant miliolids. Porosity (intergranular) is medium to high and calcite fills voids.  
 -- at 879.5-891 - Well sorted miliolid and fossil fragment grainstone.  
 -- at 881 - X-ray diffraction analysis (table 7).  
 -- at 891-894.2 - Unsorted grainstone with miliolids, large snail and clam steinkerns cemented with calcite.  
 -- at 894-897 - Unsorted intraclastic miliolid grainstone with dense, gray, sparse biomicrite layers.
- 897-918 Dolomite; color, 10YR 6/2,8/1,6/3; texture, grainstone. Light to medium brown, fine to medium crystalline dolomite with medium to high intercrystalline porosity.  
 -- at 897-898 - Recrystallized oysters, Toucasia and numerous carbonaceous laminae.  
 -- at 898.5 - X-ray diffraction analysis (table 7).  
 -- at 899, 900, 902 - Chert.  
 -- at 899-903 - Branched bluish calcite veins.  
 -- at 900 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 901-901.5 - Caprinids and whole clams.  
 -- at 903-904 - Nonporous, dolomitized miliolid grainstone.  
 -- at 904 - X-ray diffraction analysis (table 7).  
 -- at 904-905 - Dolomitized blue-green algal fragment, breccia.  
 -- at 908-917.5 - Dolomite after thinly bedded, unburrowed, sparse biomicrite with some relict packstone to grainstone.  
 -- at 912 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 912.5 - X-ray diffraction analysis (table 7).
- 918-934 Dolomite-dolomitic limestone; color, 10YR 6/1,6/2,5/1; texture, grainstone. Dolomitized miliolid and fossil fragment grainstone with miliolids, snails, clams, oysters, fragments and carbonaceous laminae. Few burrows in thinly bedded zones. Porosity (intercrystalline and vugs) is low to medium.  
 -- at 918-920 - Enlarged megapore vugs elongated parallel to bedding, some brecciation.  
 -- at 920-920.7, 927-929, 931.5-933 - Dense dolomite after a sparse fossil fragment biomicrite  
 -- at 924 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 924-925 - Dense and nonporous.  
 -- at 926 - Chert.  
 -- at 931 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 932 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 933.5 - X-ray diffraction analysis (table 7); snail rich coquina.
- 934-966.5 Dolomite-dolomitic limestone; color, 10YR 7/2,8/1,6/1; texture, crystalline carbonate wackestone to grainstone. Thinly bedded with few burrows, stromatolites, breccia and carbonaceous laminae. Porosity (intercrystalline, vugs, moldic after fossils) is low to medium. Some small fractures are partially healed, some vugs contain calcite.  
 -- at 934.7, 951.5-952, 958-958.5, 960-964 - Breccia.  
 -- at 936 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 936.5, 948.4, 955-955.6, 958-958.5, 962 - Chert nodules, some with vertical fractures.  
 -- at 936.5-937, 940.2-941.2 - Oysters.  
 -- at 937-938 - Dolomite after a sparsely rudaceous, whole mollusc biomicrite.  
 -- at 938 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 939 - X-ray diffraction analysis (table 7).  
 -- at 943 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 946.3 - Dense, finely crystalline with near vertical fractures.  
 -- at 951 - Thin-section description (table 6); X-ray diffraction analysis (table 7); laboratory test (table 8).  
 -- at 953 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 956 - Thin-section description (table 6); laboratory test (table 8).  
 -- at 957-957.5, 960-962.2 - Stromatolitic.  
 -- at 958-958.5 - Brecciated texture with irregularly shaped chert.  
 -- at 958.5-960 - Dense, nonporous, dolomitized and thinly bedded small fossil fragment grainstone.  
 -- at 960 - Thin-section description (table 6); laboratory test (table 8).

Depth  
(feet)

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ved.
- at 961 - Thin-section description (table 6); laboratory test (table 8).
  - at 960-962.2 - Semi-stratified dolomite breccia.
  - at 962 - X-ray diffraction analysis (table 7).
  - at 962.2-964, 966-966.5 - Brecciated dolomite with branching, bluish calcite veins.
  - at 964 - Thin-section description (table 6); laboratory test (table 8).
- 66.5-971.5     Lower Dolomitic Member--  
Dolomitic limestone; color, 10YR 7/3; texture, grainstone. Cherty, unsorted fossiliferous grainstone.
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- at 966.5-968 - Unsorted coquina; large clams, snails and small fragments. Porosity is moldic and in a dense, very fine network.
  - at 968 - Thin-section description (table 6).
  - at 968.5 - X-ray diffraction analysis (table 7).
  - at 968-971.5 - Dense, dolomitized grainstone with many tiny fossil fragments and some large oysters, groups of carbonaceous laminae and a few burrows.
  - at 969.5 - X-ray diffraction analysis (table 7).
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- 971.5-976.5     Dolomite; color, 10YR 6/2; texture, crystalline carbonate. Tan, medium to fine crystalline dolomite with wavy laminae and few relict intraclasts. Porosity (intercrystalline and moldic after fossils) is high.
- at 971.8 - Mottled and burrowed.
  - at 972.6, 972.8, 974.2, 974.8, 975.7 - Carbonaceous laminae, layers with abundant oysters.
  - at 973-975 - Slightly enlarged vertical fractures.
  - at 973.6 - Silicified interval up to 2 inches.
  - at 975 - Thin-section description (table 6); laboratory test (table 8).
- 978-982.5     Dolomitic limestone; color, 10YR 5/3; texture, grainstone. Dolomitic miliolid and oyster grainstone with several thin oyster zones. Porosity (interparticle) is low to medium.
- at 978.1 - Carbonaceous interval.
  - at 979.1 - 1-inch layer of flint.
- 982.5-986     Dolomite; color, 10YR 6/2,6/3; texture, crystalline carbonate. Tan, medium to fine crystalline dolomite with variably thick, irregular laminae and relict intraclasts. Porosity (intercrystalline, moldic after snails, clams, fossil fragments) is high. Vertical fractures filled with calcite.
- at 982.5-987.9 - Thin, wavy, carbonaceous laminae.
  - at 985.5-985.7 - Intraclastic oyster zone with calcite-filled fenestral porosity.
  - 986-990.5 - Dolomitized miliolid and oyster grainstone; several 1- to 3-inch oyster layers resting on a scoured miliolid and fossil fragment biomicrite.
  - at 987.5 - Very carbonaceous interval.
  - at 990 - Thin-section description (table 6); laboratory test (table 8).
  - at 992 - X-ray diffraction analysis (table 7).
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- 990.5-996     Dolomite; color, 10YR 7/1,6/2,5/2; texture, crystalline carbonate. Light tan to gray, fine to medium crystalline dolomite with small fossil fragments, some intraclastic layers, burrows and thin unburrowed laminae. Porosity (intercrystalline and moldic after fossils) is medium to high.
- at 991.8-992, 993.9-994, 994.7-994.9 - Carbonaceous laminae.
  - at 993-994.5 - Dolomitized small fossil fragment grainstone with many oysters.
  - at 995-995.5 - Burrowed fossil fragment wackestone brecciated by dessication.
- 996-1002     Limestone; color, 10YR 7/1,6/2; texture, grainstone. Dolomitized coquina with fragments of caprinids, oysters, clams, snails, echinoids, miliolids, Toucasia, bryozoa and burrows. Porosity (interparticle) is high.
- at 998 - X-ray diffraction analysis (table 7).
  - at 999 - Thin-section description (table 6); laboratory test (table 8).
  - at 1000.5-1001 - Caprinid biolithite with Toucasia.
- 1002-1008.7     Dolomite; color, 10YR 6/2,5/3/3/1,4/2; texture, crystalline carbonate. Medium crystalline dolomite with thin, irregular layering unbroken by burrows. Porosity (intercrystalline, moldic after fossils) is high.
- at 1002.2, 1002.9, 1004.5-1004.9 - Carbonaceous laminae.
  - at 1002.4, 1008.7 - Chert lenses up to 1/2 inch.
  - at 1002.9-1004 - Shell lenses primarily composed of dolomicrite intraclasts and snail steinkerns.
  - at 1004-1005 - Stromatolitic interval.
  - at 1005 - X-ray diffraction analysis (table 7).
  - at 1005-1005.8 - Boxwork and breccia with large megapore vugs.
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Depth (feet)	
1008.7-1013	Dolomite shale; color, 10YR 7/1,6/1,4/1; texture, crystalline carbonate. Thin layering of intercalated carbonaceous and dolomite laminae with low porosity. -- at 1009 - Chert nodule. -- at 1010-1011 - Microfault or high-angle fracture. -- at 1012-1013 - Some burrow mottling.
1013-1028	Dolomite; color, 10YR 4/2,5/2,6/2,7/1,5/1; texture, crystalline carbonate. Tan and gray medium crystal dolomite with finely laminated zones (occasionally carbonaceous), shell fragment zones, and burrowed zones. Porosity (intercrystalline, moldic after fossils) is high. -- at 1013-1018, 1019-1020 - Many burrows and small fossil fragments, some small clams. -- at 1015.5 - X-ray diffraction analysis (table 7). -- at 1017 - Thin-section description (table 6); laboratory test (table 8). -- at 1018-1019, 1025-1028 - Fine undisturbed laminae. -- at 1020, 1022.0-1022.5, 1024.5-1025, 1027.5-1028 - Numerous thin carbonaceous laminae. -- at 1020-1021.5, 1022.5-1023 - Odd mottling. -- at 1021.5-1022, 1023.2-1025.5 - Dolomitic lenses of miliolid oyster coquina. -- at 1026.5 - X-ray diffraction analysis (table 7). -- at 1028 - X-ray diffraction analysis (table 7).
1028-1038.5	Dolomitic limestone; color, 10YR 6/1,7/1; texture, mudstone to wackestone. Burrow mottled, dolomitic fossil fragment biomicrite. Porosity is poor. -- at 1028-1028.5, 1031.2-1031.5, 1037-1037.8 - Stylolites and thin carbonaceous laminae. -- at 1030 - Thin-section description (table 6); laboratory test (table 8). -- at 1031 - X-ray diffraction analysis (table 7).
1038.5-1040	Dolomite; color, 10YR, 6/2; texture, crystalline carbonate. Medium to finely crystalline dolomite, burrows in finely crystalline gray dolomite are filled with medium crystalline tan dolomite. Porosity (moldic after fossil fragments in burrow) is high. -- at 1039.5 - X-ray diffraction analysis (table 7).
1040-1045	Dolomitic limestone; color, 10YR 7/2; texture, grainstone. Dolomitized coquina with layers of abundant high-spired snail steinkerns, oysters and other fossil fragments. Some layers are burrowed. Porosity (interparticle) is high. -- at 1042 - Thin-section description (table 6); laboratory test (table 8). -- at 1044.5 - X-ray diffraction analysis (table 7).
1045-1047.8	Dolomite; color, 10YR 7/2,6/2,4/1; texture, crystalline carbonate. Finely crystalline brown to gray dolomite with numerous small bluish chert nodules. Relict texture indicates previously dolomitized fossil fragment grainstone. Porosity (intercrystalline) is high.
1047.8-1059	Dolomitic limestone; color, 10YR 6/2,7/1; texture, grainstone to packstone to wackestone. Dolomitized coquina with dolomitic intraclasts, <u>Toucasia</u> , clams, snails, oysters, bryozoa echinoids, miliolids and other debris. Much of the coquina occurs in irregular 1-inch layers. Porosity (interparticle, moldic, intercrystalline) is medium to high. -- at 1048.2, 1054.6 - Chert nodules. -- at 1049.5-1050 - <u>Monopleura</u> . -- at 1050.5-1052.2, 1052.8 - Carbonaceous stylolites. -- at 1050.5-1051.5, 1055.5-1056, 1057-1057.8 - <u>Toucasia</u> boundstone with <u>Monopleura</u> . -- at 1053-1054 - Incipient vertical fractures. -- at 1059 - Thin-section description (table 6); laboratory test (table 8).
1059-1073.5	Dolomite; color, 10YR 5/1,4/2; texture, crystalline carbonate. Medium to finely crystalline dolomite with variegated lenticular bedding. Thin wavy laminae in former packstone-wackestone sequence intercalated with former shell fragment grainstone lenses. -- at 1060-1062.5, 1065-1065.5, 1066, 1067-1068, 1069-1070 - Bluish chert and fossil fragments -- at 1065 - Thin-section description (table 6); laboratory test (table 8). -- at 1068 - X-ray diffraction analysis (table 7). -- at 1071-1073.5 - Some thin, wavy carbonaceous laminae. -- at 1072.7-1073.2 - Stromatolite and intraclasts.
1073.5-1074.5	Dolomite; color, 10YR 6/2; texture, crystalline carbonate. Finely crystalline dolomite, very finely laminated with numerous carbonaceous stringers. Several near vertical fractures with no evidence of solution.
1074.5-1096.5	Dolomitic limestone; color, 10YR 7/1,7/2,6/1; texture, grainstone to packstone to wackestone. Dolomitized fossil fragment grainstone with wackestone and packstone. Diverse fossil debris includes rudists. Thinly bedded dolomite to intraclastic coquina containing burrows. Small nearly vertical fractures show some solution; thin carbonaceous laminae. Porosity (intercrystalline, interparticle, moldic) is high.

Depth  
(feet)

- at 1076-1077 - Chert nodules with finely crystalline, gray dolomite.
- at 1077-1079 - Medium to dark brown dolomite fills burrows in a light brown dolomite fossil fragment matrix with dolomicrite intraclasts, caprinid debris and a few vugs.
- at 1079-1080 - Thin bedded, fine dolomite and snail rich coquina layers.
- at 1080-1081.5, 1087.5-1096.5 - Mostly a small fossil fragment coquina with a few large snail fragments.
- at 1080, 1081 - X-ray diffraction analysis (table 7).
- at 1088 - Thin-section description (table 6); laboratory test (table 8).
- at 1094.5 - X-ray diffraction analysis (table 7).

1096.5-1122

- Dolomite; color, 10YR 6/3,4/2,7/2; texture, crystalline carbonate. Medium crystalline dolomite. Pore core recovery in this interval.
- at 1096.5-1103- Poor recovery. Brownish dolomite with mottled gray zones. Porosity (intercrystalline, moldic after fossils) is high.
  - at 1101.5 - X-ray diffraction analysis (table 7).
  - at 1103-1112 - Dolomitized fossil fragment wackestone with some near-vertical fractures and carbonaceous laminae.
  - at 1105 - X-ray diffraction analysis (table 7).
  - at 1106 - Thin-section description (table 6); laboratory test (table 8).
  - at 1112-1122 - (only 5 feet of core were recovered) The upper 2 feet of core resembles dolomitized fossil fragment wackestone. The middle foot is a dolomitized small fossil fragment packstone with very finely disseminated pyrite on fossil molds. The lower 2 feet has resistant gray mottling in brown dolomite. Also, wavy carbonaceous laminae

1122-1142

- Dolomitic limestone; color, 10YR 6/1,6/3,5/1,7/1; texture, mudstone. Dolomitized and burrowed biomicrite and rudist biolithite with some large oysters, *Exogyra texana*(?), clams, snails, rudists, and fossil fragments. Porosity (megapore vugs with calcite crystals, many small fractures) is low.
- at 1122-1125 - Dolomitized and carbonaceous, sparse oyster biomicrite with clay seams.
  - at 1123 - Laboratory test (table 8).
  - at 1125 - X-ray diffraction analysis (table 7).
  - at 1125-1131 - Mottled texture, gray dolomitized blotches that are more resistant than the brown dolomite burrows.
  - at 1128 - X-ray diffraction analysis (table 7); laboratory test (table 8).
  - at 1131-1134 - Dolomitized caprinid biolithite with *Toucasia* and mottled texture.
  - at 1133 - Laboratory test (table 8).
  - at 1134 - X-ray diffraction analysis (table 7).
  - at 1136 - *Toucasia* in mottle texture.
  - at 1137 - Thin-section description (table 6); laboratory test (table 8).
  - at 1138-1140 - *Toucasia* with large snails and oysters.
  - at 1140 - Thin-section description (table 6); laboratory test (table 8).
  - at 1140.5 - X-ray diffraction analysis (table 7).
  - at 1140-1142 - Dolomitized and burrowed sparse oyster biomicrite.
  - at 1142 - Thin-section description (table 6); laboratory test (table 8).

1142-1183.7

- Dolomitic limestone; color, 10YR 7/1; texture, mudstone to wackestone to packstone to grainstone. Burrowed dolomitic *Exogyra* biomicrite with zones of thin clayey and carbonaceous seams along with some flaser bedding. More resistant limestone layers are variably dolomitic, with stylolites, mottling and soft, brown dolomite infilling burrows in the more resistant biomicrite. Porosity (very large megapore vugs and enlarged fractures) is low.
- at 1145 - Thin-section description (table 6); laboratory test (table 8).
  - at 1146.5 - X-ray diffraction analysis (table 7).
  - at 1148 - Thin-section description (table 6); laboratory test (table 8).
  - at 1152 - Thin-section description (table 6); laboratory test (table 8).
  - at 1152-1155 - Dolomitic and burrowed fossil fragment grainstone.
  - at 1153 - Thin-section description (table 6); laboratory test (table 8).
  - at 1154 - Thin-section description (table 6); laboratory test (table 8).
  - at 1155 - Laboratory test (table 8).
  - at 1157 - Thin-section description (table 6); laboratory test (table 8).
  - at 1158 - Thin-section description (table 6); laboratory test (table 8).
  - at 1159.5-1160.2 - Burrowed miliolid and fossil fragment grainstone.
  - at 1161 - Interbedded dense, gray finely crystalline dolomite. Thin-section description (table 6); laboratory test (table 8).
  - at 1162-1162.7 - Semi-indurated fine dolomite, brecciated and vuggy in part.
  - at 1172 - X-ray diffraction analysis (table 7).
  - at 1181.7-1182.4 - Large snails and miliolids abundant.
  - at 1182 - X-ray diffraction analysis (table 7).

Depth  
(feet)

1183.7-1192  
(bottom of hole)

Dolomite; color, 10YR 7/1,5/2,6/2,4/1; texture, crystalline carbonate; mudstone to wackestone. Fine to medium crystalline orange-brown to medium brown dolomite. Dolomitized intraclastic miliolid grainstone, sparse miliolid and fossil fragment biomicrite, and sparse whole mollusc biomicrite. Calcite-filled fractures. Porosity (intercrystalline, fractures, vugs, moldic after fossils) is high.  
-- at 1189.5 - X-ray diffraction analysis (table 7).  
-- at 1191 - X-ray analysis (table 7).

Table 6.--Description of thin sections of test-hole cores:  
Randolph (AY-68-30-807)

Depth (feet)	
614	<u>Limestone</u> ; wackestone; caprinid mollusc fragments, foraminifera, stylolites, pyrite and preserved fine detail; porosity is low; permeability is low.
617	<u>Limestone</u> ; wackestone; miliolids and skeletal debris; sparite-filled fracture; microspar; porosity is low; permeability is low.
622	<u>Limestone</u> ; wackestone (partially micritized); miliolids, mollusc fragment; calcite-filled fractures; porosity is low; permeability is low.
642	<u>Limestone</u> (dolomitized); wackestone; caprinid mollusc fragments; numerous voids; microsparite groundmass; ghosts of micritized particles; vugs up to 500 microns; porosity (moldic after skeletal fragments) is greater than 30 percent; permeability is high.
643	<u>Limestone</u> ; wackestone; highly leached mollusc fragments; well connected vugs; partly dolomitized groundmass; porosity (intercrystal and moldic after skeletal debris) is greater than 25 percent; permeability is medium to high.
659	<u>Dolomite</u> (limy); dolomitized mudstone; vugs up to 400 microns (possibly moldic after particles); porosity is 10 to 15 percent; permeability is medium.
672	<u>Dolomite</u> (limy); mudstone replaced by dolomite rhombs (20 to 40 microns in size); porosity (vugs, moldic and intercrystal) is greater than 20 percent; permeability is high.
679	<u>Limestone</u> (slightly dolomitic); mudstone; micritized mollusc fragments and fine skeletal debris; porosity (vugs, moldic) is medium; permeability is medium.
680	<u>Dolomite</u> ; no original texture; dolomite rhombs (20 to 60 microns); porosity (intercrystal) is greater than 20 percent; permeability is high.
683	<u>Limestone</u> (slightly dolomitic); mudstone; mollusc fragments, chert, oil-stained particles; micrite groundmass with some microspar; porosity (vugs, channels, intercrystal) is medium to high; permeability is low to moderate.
687	<u>Limestone</u> (slightly dolomitic); packstone; mollusc fragments, miliolids, algal lumps to 1,000 microns; micritized grains; microspar and chert in groundmass; porosity (vugs, intercrystal, intraparticle) is 10 percent; permeability is medium.

Depth  
(feet)

- 703 Limestone (altered); wackestone; miliolids, molluscs; stylolites; sparite-filled vugs (up to 500 microns); porosity (vugs, moldic, intercrystal) is 5 to 10 percent; permeability is low to medium.
- 708 Limestone and dolomite; grainstone; miliolids, micritized particles; porosity (vugs, intraparticle) is 5 to 10 percent; permeability is low to medium.
- 709 Limestone; grainstone; micritized particles; miliolids, foraminifera, mollusc fragment replaced by chert; porosity (interparticle, intraparticle) is about 10 percent; permeability is low.
- 724 Limestone; wackestone and packstone (highly micritized); mollusc fragments, algal lumps; angular particles; microsparite forms a reticulated network through the groundmass; porosity (vugs, intercrystal) is 15 to 20 percent; permeability is medium.
- 727 Limestone; wackestone (leached); partly preserved mollusc fragments, chert replaced mollusc; vugs lined with microsparite; porosity (vugs, moldic, intercrystal) is 15 to 20 percent; permeability is medium.
- 731 Dolomite (recrystallized); subhedral to euhedral rhombs (20 to 40 microns); iron staining; porosity (intercrystal) is greater than 20 percent; permeability is medium to high.
- 732 Dolomite (recrystallized); original particles have been leached; vugs encrusted by euhedral rhombs up to 40 microns; groundmass of smaller, anhedral crystals; interlacing network of coarser crystals; porosity (vugs, intercrystal) is 15 to 20 percent; vugs up to 300 microns; permeability is medium.
- 736 Limestone (dolomitic); mudstone (recrystallized); no fossils; groundmass recrystallized to very fine rhombs; stylolite relicts; porosity (vugs smaller than 100 microns, intercrystal) is 10 to 15 percent; permeability is low to medium.
- 738 Dolomite (recrystallized); vugs possibly moldic after miliolids; rhombs up to 60 microns; porosity (vugs and intercrystal) is greater than 30 percent; permeability is high.
- 740 Dolomite (recrystallized); rhombs up to 60 microns; large crystals in vugs; porosity (vugs and intercrystal) is greater than 30 percent; permeability is high.
- 749 Dolomite (recrystallized); rhombs up to 30 microns (smaller rhombs within the larger rhombs); calcite-filled fractures; porosity (vugs, intercrystal) is greater than 25 percent; permeability is high.
- 761 Dolomite (recrystallized); no original texture; subhedral to euhedral rhombs up to 30 microns; porosity (vugs, intercrystal) is 10 to 15 percent; permeability is medium.



Depth  
(feet)

- 776 Limestone (slightly dolomitized); wackestone; mollusc fragments, miliolids, foraminifera; micrite with small patches of microspar; mollusc fragments partially replaced by chert; vugs filled with calcite spar; porosity (vugs, intercrystal) is 10 to 15 percent; permeability is medium.
- 785 Limestone (dolomitic); wackestone; few mollusc fragments, micritized particles; groundmass contains an interlaced network of microspar; porosity (vugs, intercrystal) is about 10 percent; permeability is medium.
- 816 Limestone; mudstone and wackestone; foraminifera; scattered, fine debris; fractures filled with sparite; large calcite mosaic with chert flakes; stylolites; porosity (isolated vugs) is less than 5 percent; permeability is low.
- 833 Limestone; mudstone and wackestone; most particles are leached; mollusc fragments replaced with chert; oil-stained fractures in spar and micrite; porosity is variable.
- 844 Limestone (micritized); grainstone; small miliolids and foraminifera, algal fragments; microspar cement; porosity (vugs, intercrystal, intraparticle) is 5 to 10 percent; permeability is medium.
- 870 Limestone (micritized); grainstone; miliolids, algal lumps; microspar cement; porosity (vugs, intraparticle, interparticle, intercrystal) is 5 to 10 percent; permeability is medium.
- 888 Limestone; grainstone; miliolids up to 500 microns, algal lumps, pellets, dolomite-filled burrow; microspar cement; porosity (vugs, interparticle, intraparticle, intercrystal) is about 10 percent; permeability is medium.
- 900 Limestone (dolomitic); mudstone; dolomitized particles have been leached; rhombs (up to 50 microns) replace coarse spar; chert replaces spar; miliolid ghosts; micrite groundmass with interlacing network of coarser dolomite rhombs; porosity (vugs, moldic, intercrystal) is 10 to 15 percent; permeability is medium.
- 912 Dolomite (limy); subhedral rhombs (40 to 60 microns); network of interlocking channels lined with dolomite crystals; porosity (vugs, intercrystal) is about 20 percent; permeability is high.
- 924 Limestone (dolomitized); packstone or grainstone; miliolids; micritized particles tightly packed and squashed; microspar cement; porosity (vugs, channels, intercrystal, intraparticle) is 15 to 20 percent; permeability is medium.
- 931 Limestone (dolomitic); grainstone; miliolid ghosts, mollusc fragments; rhombs (50 to 100 microns) replace groundmass and particles; many rhombs have hollow and corroded centers; porosity (vugs, intercrystal) is medium; permeability is medium.

Depth  
(feet)

- 932 Dolomite; euhedral rhombs (up to 100 microns); porosity (interparticle) is more than 30 percent; permeability is high.
- 936 Dolomite (limy); wackestone; miliolid ghosts, dolomite rhombs, patches of micrite; porosity (intercrystal, vugs, channels, intraparticle) is 10 to 15 percent; permeability is medium.
- 938 Dolomite; euhedral rhombs (30 to 80 microns); porosity (vugs, intercrystal) is greater than 30 percent; permeability is high.
- 943 Dolomite; mudstone(?); network of coarse rhombs (30 to 60 microns) in a groundmass of anhedral, smaller, dark rhombs; porosity is 10 to 15 percent; permeability is medium.
- 951 Dolomite; mudstone(?); miliolid ghosts; euhedral rhombs (30 to 80 microns); porosity (vugs, intercrystal) is 15 percent; permeability is medium.
- 953 Dolomite; euhedral rhombs (30 to 80 microns); fracture; porosity (vugs, intercrystal) is more than 20 percent; permeability is medium.
- 956 Dolomite; two zones of different dolomitization; porosity (vugs, intercrystal) is greater than 20 percent; permeability is medium.
- 960 Dolomite (limy); packstone; algal lumps, foraminifera; rhombs (50 to 80 microns); dolomite replaces microspar; porosity (vugs, intercrystal) is 5 to 10 percent; permeability is low.
- 961 Dolomite; mudstone; rhombs (40 to 70 microns); porosity (vugs, channels, intercrystal) is greater than 30 percent; permeability is high.
- 964 Dolomite; rhombs (to 100 microns); porosity (vugs, intercrystal) is 25 percent; permeability is high.
- 968 Dolomite; wackestone; mollusc fragments, miliolids, algal crusts, relict stylolites; porosity (moldic, vugs, intercrystal) is more than 30 percent; permeability is high.
- 975 Dolomite (limy); wackestone(?); miliolid ghosts; euhedral rhombs (50 to 100 microns); porosity (vugs, intercrystal) is about 10 percent; permeability is low.
- 990 Limestone; packstone; miliolids, foraminifera, mollusc fragments; groundmass recrystallized to microspar; porosity (vugs, interparticle, intraparticle) is 10 to 15 percent; permeability is medium.
- 999 Limestone; wackestone; mollusc fragments (to 1,000 microns), algal lumps; isolated large dolomite replacement rhombs; microspar; porosity (vugs, moldic, intercrystal) is about 10 to 15 percent; permeability is medium.

Depth  
(feet)

- 1017 Dolomite; euhedral rhombs (40 to 80 microns); porosity (vugs, intercrystal) is 15 to 20 percent; permeability is medium.
- 1030 Limestone (dolomitic); wackestone; mollusc fragments, foraminifera; zone of isolated dolomite rhombs; porosity (vugs, intercrystal) is about 5 percent; permeability is low.
- 1042 Limestone (dolomitic); packstone; foraminifera, gastropods, mollusc fragments, pellets; coarse sparite fills intraparticle space; porosity (vugs) is about 10 percent; permeability is medium.
- 1059 Limestone; mudstone; mollusc fragments; abundant microspar in groundmass; porosity (vugs, intercrystal) is 10 to 15 percent; permeability is medium.
- 1065 Dolomite; euhedral rhombs (50 to 100 microns); porosity (intercrystal) is more than 25 percent; permeability is high.
- 1088 Limestone; grainstone; miliolids, lumps, algal bits; micritized particles; microspar cement; porosity (vugs, intraparticle, intercrystal) is 15 to 20 percent; permeability is medium.
- 1106 Dolomite; euhedral rhombs (50 to 100 microns); porosity (vugs, intercrystal) is about 20 percent; permeability is high.
- 1120 Limestone (dolomitic); mudstone; mollusc fragments; isolated rhombs (up to 100 microns) replace micrite; porosity is less than 5 percent; permeability is low.
- 1123 Limestone (dolomitic); mudstone; highly micritized foraminifera; large isolated rhombs; open fracture; porosity (vugs) is about 5 percent; permeability is low.
- 1128 Dolomite; euhedral rhombs in a bimodal size distribution divided by a stylolite; porosity (vugs, intercrystal) is 15 to 20 percent; permeability is medium.
- 1133 Limestone (dolomitic); wackestone; mollusc fragments; open fractures; patches of sucrosic dolomite; isolated rhombs in micrite; porosity (fractures, intercrystal) is about 5 percent; permeability is low.
- 1137 Limestone (dolomitic); mudstone; mollusc fragments; organic staining; isolated rhombs; porosity is less than 5 percent; permeability is low.
- 1140 Dolomite (limy); mudstone; mollusc fragments; iron stains; organics; pyrite; rhombs (to 80 microns); porosity is less than 5 percent; permeability is low.
- 1142 Limestone (dolomitic); wackestone; skeletal fragments, foraminifera; dolomitization along stylolite; porosity is about 5 percent; permeability is low.

Depth  
(feet)

- 1145 Limestone (dolomitic); mudstone; mollusc fragment; abundant rhombs; organic material; stylolite; porosity is less than 5 percent; permeability is low.
- 1148 Limestone (dolomitic); mudstone; foraminifera ghosts stained with organic materials, mollusc fragments; stylolites; porosity is less than 5 percent; permeability is low.
- 1152 Limestone (dolomitic); wackestone; micritized foraminifera; leached; vugs; dolomitized groundmass; porosity is 10 to 15 percent; permeability is low.
- 1153 Limestone; wackestone; micritized particles (foraminifera?); skeletal fragments; microspar between grains; porosity (vugs) is medium; permeability is low.
- 1154 Limestone (dolomitic); mudstone; micritized; dolomitized along stylolites; mollusc fragments, foraminifera ghosts; porosity is less than 5 percent; permeability is low.
- 1157 Limestone (dolomitic); wackestone; miliolid ghosts, mollusc fragments; chert; dolomitized groundmass; porosity (vugs, intercrystal) is less than 5 percent; permeability is low.
- 1158 Dolomite (limy); grainstone; miliolid, mollusc fragments; oil stains; microspar cement; porosity (vugs, channels) is about 5 percent; permeability is low.
- 1161 Dolomite (limy); grainstone(?); miliolid ghosts; limonite; oil stains; porosity (vugs, intraparticle) is about 5 percent; permeability is low.

Table 7.--Mineralogy of core samples as determined by X-ray diffraction analysis<sup>1</sup>:  
Randolph (AY-68-30-807)

Depth (feet)	Lithologic description	Mineral composition (percent)								
		Calcite CaCO <sub>3</sub>	Dolomite CaMg(CO <sub>3</sub> ) <sub>2</sub>	Quartz SiO <sub>2</sub>	Gypsum CaSO <sub>4</sub> , 2H <sub>2</sub> O	Pyrite FeS <sub>2</sub>	Fluorite CaF <sub>2</sub>	Kaolinite Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	Celestite SrSO <sub>4</sub>	Goethite FeO(OH)
606	biomicrite	70	10	10	<2	5	--	--	--	--
621	organic zone	50	--	40	<5	<5	--	<5	--	--
634.8	biopelmicrite	95	<2	<2	<2	--	--	--	--	---
637.4	macrobiopelmicrite	45	--	30	<5	--	--	--	--	--
658.5	dolcalcimicrite	30	50	20	--	--	--	--	--	--
664	clastic dolosparite	30	50 <sup>1</sup>	20	--	--	--	--	--	--
671	porous dolosparite	20	60	20	--	--	--	--	--	--
675.7	caldolosparite	50	30	20	--	--	--	--	--	--
678	dolosparite	15	75	10	--	--	--	--	--	--
679.5	dolarenite	3	95	2	--	--	--	--	--	--
691.5	dolosparite	31	69	--	--	--	--	<5	<5	--
722	dolbiolutite	2	98	--	--	--	--	--	--	--
722.8	dolbiolutite	2	98	--	--	--	--	--	--	--
731.5	dolosparite	--	75	20	<5	--	--	<5	--	--
740	dolcalcimicrosparite	30	30	10	10	--	--	<5	--	--
745.5	dolcalcisparite	30	50	10	--	--	--	10	--	--
758	dolomicrite	?	90	10	--	--	--	--	--	--
771	caldolomicrosparite	70	20	10	--	?	?	<2	--	--
776	calcibiosparudite	70	2	10	--	--	--	<2	--	--
788	calcibiosparmicrite	60	30	10	<2	--	--	--	--	--
797.5	dolcalcimicrosparite	2	78	20	--	--	--	<2	--	--
811	dolcalcisparmicrite	25	55	5	5	<5	<2	<5	--	--

<sup>1</sup>Analyses by Ruth Deike, U.S. Geological Survey, Reston, Va.

Depth (feet)	Lithologic description	Mineral composition (percent)								
		Calcite CaCO <sub>3</sub>	Dolomite CaMg(CO <sub>3</sub> ) <sub>2</sub>	Quartz SiO <sub>2</sub>	Gypsum CaSO <sub>4</sub> , 2H <sub>2</sub> O	Pyrite FeS <sub>2</sub>	Fluorite CaF <sub>2</sub>	Kaolinite Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	Celestite SrSO <sub>4</sub>	Goethite FeO(OH)
812	caldolarenite	30	10	30	10	10	--	10	--	--
839	biosparmicrite	50	<2	30	<5	<5	--	10	--	--
853	forambiomicro	90	--	<5	<5	?	--	5	--	--
881	biocalcarenite	100	--	--	--	--	--	--	--	--
898.5	dolosparite	3	97	--	--	--	--	--	--	--
904	biomicrite	84	16	--	--	--	--	--	--	--
912.5	dolmicrosparite	2	70	<5	<5	--	--	--	15	--
933.5	biosparmicrite	75	10	?	<5	--	--	<2	10	--
939	dolmicrosparite	40	30	?	--	?	?	--	20	--
951	dolocalcisp	35	50	?	<2	--	<2	<2	<5	--
962	dolosparite	<2	95	--	--	--	--	<2	--	--
968.5	quartz biosparite	15	40	40	--	--	--	<2	?	--
969.5	microsparite micrite	35 85	55 <5	-- --	<2 --	-- --	-- --	-- --	-- 10	-- --
992.5	dolomicrite	3	85	<2	<2	--	--	--	10	--
998	biocalcarenite	90	5	--	--	--	--	--	--	--
1005	dolosparite	5	85	<2	<2	--	--	<2	5	--
1015.5	dolosparite	2	85	5	--	--	--	--	10	--
1026.5	dolomicrite	5	90	<5	--	--	--	--	?	--
1028	calmicrite	70	20	10	--	?	--	--	--	--
1031	biomicrocalcarenite	80	10	5	2	?	--	<2	--	--
1039.5	calcimicrite	80	10	5	--	--	--	<2	?	--
1044.5	(macro) biocalcarenite	60	30	5	--	--	--	<2	--	--
1068	dolosparite	5	85	<2	--	?	--	--	5	<2
1080	microbiocalcarenite	90	5	<5	--	--	--	<2	--	--

Depth (feet)	Lithologic description	Mineral composition (percent)								
		Calcite CaCO <sub>3</sub>	Dolomite CaMg(CO <sub>3</sub> ) <sub>2</sub>	Quartz SiO <sub>2</sub>	Gypsum CaSO <sub>4</sub> , 2H <sub>2</sub> O	Pyrite FeS <sub>2</sub>	Fluorite CaF <sub>2</sub>	Kaolinite Al <sub>2</sub> Si <sub>2</sub> O <sub>5</sub> (OH) <sub>4</sub>	Celestite SrSO <sub>4</sub>	Goethite FeO(OH)
1081	organic layer	30	10	10	25	5	--	20	--	--
1094.5	biocalcarenite	75	25	?	--	--	--	--	--	--
1101.5	dolosparite	25	75	5	--	--	--	--	--	--
1105	dolosparite	25	75	5	--	--	--	--	--	--
1125	dolocalcarenite	45	45	10	--	--	--	--	--	--
1128	dolosparmicrite	45	45	10	--	--	--	--	--	--
1134	dolocalmicrite	45	45	5	--	--	--	5	--	--
1140.5	dolocalmicrite	40	40	10	5	<2	--	2	--	--
1146.5	calmicrite	45	20	20	5	?	--	5	--	--
1150	biodolmicrite	30	50	15	--	--	--	5	--	--
1158	dolbiocalcarenite	60	20	20	--	--	--	--	--	--
1172	dolbiocalmicrite	90	5	5	--	--	--	--	--	--
	caldolomicrite	20	70	5	--	--	--	<2	--	--
1182	biodolmicrite	15	60	15	10	--	--	<2	--	--
1189.5	dolosparite	20	60	15	--	?	--	?	--	--
1196	dolosparite	--	95	5	--	--	--	--	--	--
1196	dolosparite	15	70	10	?	--	--	<5	--	--

Table 8.--Porosity characteristics of core samples as determined by laboratory tests: Randolph (AY-68-30-807)

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury <sup>1</sup> )						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden <sup>2</sup> of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury-injection test	Air-injection test	Air-injection pressure atmosphere			500	1000	2000
614	--	8.0	0.0	0.0	0.0	0.0	0.0	44.4	0.02	--	--	2.67	--	--	--	--
622	2.1	--	--	--	--	--	--	--	<0.01	--	--	2.70	--	48.9	48.8	48.5
642	25.3	24.0	36.5	54.9	65.9	74.9	93	97.1	242	--	--	2.69	28.9	81.0	78.3	74.8
643	--	24.0	23.2	46.4	58.7	70.10	87.50	99.93	101.0	--	--	2.69	--	--	--	--
659	39.2	37.8	0.0	0.0	0.0	0.0	89.9	93.8	3.5	--	--	2.80	22.0	83.4	82.1	80.0
672	--	42	0.0	7.0	25.7	43.4	79.9	91.5	75.0	--	--	2.81	--	--	--	--
680	--	45	0.0	41.2	64.3	73.8	95.4	97.2	364	--	--	2.83	--	--	--	--
683	13.2	--	--	--	--	--	--	--	7.4	--	--	2.70	--	60.5	60.2	59.9
703	13.8	13.6	3.6	16.9	30.2	43.1	80.8	96.1	4.5	--	--	2.70	61.9	65.4	64.0	62.6
709	19.0	--	--	--	--	--	--	--	8.1	--	--	2.70	--	--	--	--
717	21.0	20.2	0	8	33	54	92	96	--	39	0.1	2.83	--	--	--	--
719	27.6	23.8	4.2	10	18	36	73	86	--	1300	0.05	2.88	--	--	--	--
724	19.6	18.2	0	0	2	6	80	92	--	0.77	0.75	2.73	--	--	--	--
727	23	20.5	0	13	29	46	76	88	--	13.8	0.1	2.77	--	--	--	--
728	14.9	13.1	0	0	0	0	64	86	--	0.45	1.0	2.75	--	--	--	--
731	17.7	16.2	2	8	54	78	90	91	--	9.0	0.1	2.85	--	--	--	--
732	35.9	35.0	12	6	46	80	90	91	--	73	0.1	2.89	--	--	--	--
736	47.9	47.5	0	1	4	40	91	99	--	31.0	0.10	2.82	--	--	--	--
738	27.8	27.1	26	64	79	86	94	98	--	220	0.1	2.82	--	--	--	--
740	30.4	28.5	10	64	80	88	91	94	--	30.1	0.1	2.84	--	--	--	--
742	33.6	29.8	0	1	62	68	87	88	--	95	0.1	2.89	--	--	--	--
749	30.3	--	0.0	0.0	3.0	23.5	72.4	89.4	3.1	--	--	2.75	30.2	76.8	75.5	74.7
761	36.5	35.1	0.0	0.0	23.0	77.5	95.7	98.0	53.0	00	00	2.81	8.21	93.4	89.7	87.4
776	--	9.7	18.1	26.3	34.3	40.6	84.2	93	3.8	--	--	2.69	13.2	--	--	--

-52-

<sup>1</sup>Percent of effective porosity intruded by mercury =  $\frac{\text{injection pressure}}{\text{pore throat radius}}$  /  $\frac{\text{pore throat radius}}{\text{pore throat radius}}$   
(pounds per square inch) (microns)

<sup>2</sup>Effective overburden in pounds per square inch.



Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury)						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot with effective overburden of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury- injection test	Air- injection test	Air-injection pressure atmosphere			500	1000	2000
785	--	22.1	1.8	4.6	14.9	34.2	92.8	96.3	7.1	--	--	2.70	--	--	--	--
816	6.2	5.9	0.0	0.0	0.0	0.0	0.0	8.3	0.71	--	--	2.70	149.0	53.9	53.8	53.6
833	20.2	--	0.0	0.0	5.3	46.5	90.1	96.8	7.3	--	--	2.71	29.9	71.7	71.5	71.5
844	30.6	29.4	0.0	27.7	53.5	65.2	90	97.7	90.0	--	--	2.69	15.9	88.6	87.7	87.4
870	--	29.3	0.0	0.0	39.8	61.2	90.0	95.3	49.0	--	--	2.69	10.2	82.8	82.1	80.6
888	26.6	24.6	0.0	16.1	36.2	52.0	83.3	92.4	45	238	--	2.67	16.3	78.5	77.1	76.8
900	--	43.0	1.3	32.4	68.2	82.0	93.4	94.9	422	--	--	2.80	--	--	--	--
912	--	38.2	0.0	33.0	64.7	80.7	95.4	97.0	332	--	--	2.81	--	97.1	93.5	91.4
924	--	12.4	0.0	0.0	0.0	3.5	56.6	76.5	0.08	--	--	2.71	--	--	--	--
931	33.9	30.6	4	15	40	61	88	90	--	87	0.1	2.88	--	--	--	--
932	29.6	27.9	10	50	60	67	90	94	--	--	--	2.87	--	--	--	--
936	22.3	18.2	2	4	8	20	78	82	--	6.7	0.5	2.80	--	--	--	--
938	34.0	36.0	26.3	72.7	81.1	85.1	94.7	98.3	944	380	0.1	2.81	--	--	--	--
943	22.4	19.9	0	1	30	42	85	89	--	22.8	0.10	2.87	--	--	--	--
951	22.1	20.1	2	6	46	80	90	91	--	73	0.1	2.89	--	--	--	--
953	34.5	31.1	8	50	70	76	86	90	--	220	0.1	2.88	--	--	--	--
956	20.6	19.3	2	24	54	70	88	93	--	61.1	0.1	--	--	--	--	--
960	14.4	12.4	0	0	1	12	73	88	--	1.36	1.0	2.77	--	--	--	--
961	27.0	23.5	0	4	26	58	80	86	--	40	0.1	2.90	--	--	--	--
964	--	31.0	7.7	45.9	60.4	70.3	93.7	97.5	240	--	--	2.81	--	--	--	--
975	11.3	--	--	--	--	--	--	--	<0.01	--	--	2.78	209.0	59.5	58.0	57.0
990	--	24.7	0.0	0.0	8.8	44.7	90.5	96.8	13.0	--	--	2.69	--	--	--	--
999	--	27.1	0.0	11.5	42.0	60.6	94.8	96.1	29.0	--	--	2.69	--	--	--	--
1017	--	27.2	0.0	44.6	63.4	70.3	85.7	92.5	99.0	--	--	2.86	--	--	--	--
1024	32.6	30.8	0.0	1	30	50	89	94	--	--	--	--	--	--	--	--
1030	--	18.6	0.0	0.0	0.0	0.0	54.7	77.7	0.81	--	--	2.70	--	--	--	--

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury)						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden of:		
			Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury- injection test			Air- injection test	Air-injection pressure atmosphere	500
1042	--	19.0	2.4	11.5	25.2	36.3	70.9	95.6	15.0	--	--	2.69	--	--	--	--
1059	--	30.5	0.0	0.0	0.0	33.1	95	99.1	16	--	--	2.68	--	--	--	--
1065	30.1	--	--	--	--	--	--	--	188	--	--	2.81	10.6	79.5	76.9	75.4
1088	--	29.5	14.1	37.5	48.7	60.2	90.5	97.4	233	--	--	2.69	--	--	--	--
1106	--	28.6	3.2	64.1	83.8	90.5	96.4	99.1	401	--	--	2.80	--	--	--	--
1120	14.0	--	--	--	--	--	--	--	6.9	--	--	2.76	33.7	61.6	60.1	58.3
1123	--	9.9	0.0	0.0	0.0	0.0	37.4	86.0	0.07	--	--	2.75	--	--	--	--
1128	--	12.6	15.2	25.7	35.4	44.2	59.6	75.1	15	--	--	2.83	--	--	--	--
1133	--	12.4	5.2	8.5	6.5	21.3	48.3	91.8	1.9	--	--	2.74	--	--	--	--
1137	13.7	9.1	0.0	0.0	0.0	0.0	10	62	--	0.23	1.0	2.77	--	--	--	--
1140	14.4	9.6	0.0	0.0	0.0	0.0	40	65	--	0.24	1.0	2.81	--	--	--	--
1142	15.5	13.7	1	2	2	4	54	77.5	0.17	2.34	1.0	2.76	--	--	--	--
1145	11.7	7.9	0.0	0.0	0.0	0.0	0.0	26	0.03	0.05	1.0	2.72	--	--	--	--
1148	11.6	7.3	0.0	0.0	0.0	0.0	22	56	--	0.11	0.75	2.77	--	--	--	--
1152	11.7	6.7	0.0	0.0	0.0	3	26	76	--	0.238	1.0	2.79	--	--	--	--
1153	17.6	13.7	0.0	0.0	10	36	66	76	--	3.56	1.0	2.79	--	--	--	--
1154	--	15.6	0.0	0.0	12.4	37.9	70.7	84.2	3.6	--	--	2.70	--	--	--	--
1155	19.6	12	0.0	0.0	0.0	6	48	62	--	0.28	1.0	2.82	--	--	--	--
1157	14.6	10.5	2	3	5	10	42	70	--	2.36	1.0	2.83	--	--	--	--
1158	17.2	12.3	0.0	0.0	5	20	54	64	--	1.6	1.0	2.81	--	--	--	--
1161	15.6	12.8	0.0	0.0	1	6	50	80	--	2.6	1.0	2.82	--	--	--	--

Table 9.--Test-hole completion summary: San Marcos (LR-67-09-110)

Location: Hays County, Tex., just south of Hunter Road, 2.4 miles southwest of San Marcos, at the Southwest Texas State University Experimental Farm.

Elevation of land surface: 685 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources.

Spudded: November 17, 1972.

Completed: January 8, 1973.

Casing: 6-1/4-inch inside diameter to 141 feet. Cemented with 35 sacks of 4-percent gel, cement circulated.

Total depth: 634 feet

Coring equipment: Acker double-wall mining-type core barrel 5x4x10 inches. Diamond core heads, 5-1/2x4 inches, of 75-80 carats, 25 stones per carat. Bottom discharge.

Core-recovery summary: Total footage cored, 484 feet; total core recovered, 347.3 feet; and percentage of recovery, 72 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
142-149	7.0	2.3	2.3
151	2.0	0.4	2.7
161	10.0	2.0	4.7
162	1.0	1.0	5.7
172	10.0	2.1	7.8
177	5.0	2.1	9.9
187	10.0	3.8	13.7
196	9.0	3.2	16.9
206	10.0	6.8	23.7
216	10.0	7.4	31.1
226	10.0	9.8	40.9
236	10.0	9.2	50.1
246	10.0	9.0	59.1
256	10.0	9.0	68.1
266	10.0	9.7	77.8
276	10.0	9.0	86.8
286	10.0	3.5	90.3
294	8.0	5.6	95.9
304	10.0	4.1	100.0
316	12.0	1.4	101.4
319	3.0	0.2	101.6

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
329	10.0	4.5	106.1
339	10.0	10.0	116.1
349	10.0	9.7	125.8
359	10.0	7.0	132.8
360	1.0	0.6	133.4
370	10.0	9.5	142.9
380	10.0	9.0	151.9
390	10.0	5.8	157.7
395	5.0	3.8	161.5
413	10.0	1.2	162.7
414	1.0	1.0	163.7
424	10.0	8.4	172.1
434	10.0	7.7	179.8
444	10.0	10.0	189.8
454	10.0	7.6	197.4
464	10.0	8.5	205.9
474	10.0	6.5	212.4
474-484	10.0	10.0	222.4
494	10.0	4.5	226.9
500	6.0	6.0	232.9
510	10.0	10.0	242.9
516	6.0	6.0	248.9
526	10.0	9.0	257.9
536	10.0	6.8	264.7
546	10.0	9.0	273.7
556	10.0	9.6	283.3
566	10.0	10.0	293.3
576	10.0	9.8	303.1
586	10.0	9.4	312.5
596	10.0	9.7	322.2
606	10.0	9.0	331.2
616	10.0	4.5	335.7
626	10.0	4.0	339.7
630	4.0	3.6	343.3
634	4.0	4.0	347.3

Notes: The stepface core bit, which was used to prevent reaming, was unsatisfactory. A core run of 39 feet produced only 15.7 feet (40-percent recovery). The larger-diameter bit caused a wobble that reduced the amount of intact core sample.

Table 10.--Description of test-hole cores: San Marcos (LR-67-09-110)

Depth (feet)	Description
142-151	Limestone; color, 10YR; texture, mudstone to wackestone to packstone to crystalline carbonate. Hard, dense micrite to biomicrite and dolomitic crystalline carbonate that is fractured and contains rudists and wispy shale. -- at 142.6 - Pyrite trace. -- at 143 - Finely sucrosic dolomite. -- at 143, 144, 149 - Chert. -- at 143-144, 149 - Open fracture. -- at 143.5, 144.3 - Rudists. -- at 144 - 2-inch wispy shale zone with many fossil fragments.
151-172	Dolomitic limestone; color, 10YR 5/2,6/2; texture, mudstone to wackestone to crystalline carbonate. Hard, dense micrite to biomicrite with dolomitized burrows and disturbed bedding. -- at 151, 152 - Chert. -- at 161 - Finely sucrosic dolomite. -- at 161-163 - Abundant miliolids and rudists. -- at 164 - Wispy shale.
172-196	Dolomite and limestone; color, 10YR 5/3,4/2; texture, crystalline carbonate to mudstone. Medium hard, finely sucrosic dolomite and dense micrite with vugs and molds. Good moldic porosity after gastropods and pelecypods in the dolomite. -- at 172 - Well cemented finely sucrosic dolomite with high moldic porosity. -- at 172.8 - Thin, black shale partings. -- at 173-174 - Open fracture. -- at 178-178.5 - Stromatolitic. -- at 179.6-179.8, 188.5, 189 - Chert. -- at 179.8-180.8 - Dark shaly mudstone with high spired gastropods. -- at 180 - Thin-section description (table 11); laboratory test (table 12). -- at 187 - Shaly, fine sucrosic dolomite with high moldic porosity. -- at 188.7 - Wispy shale. -- at 189 - Limestone in transitional zone. -- at 190 - 1-inch blue-gray shale seam with pyrite trace.
196-208	Dolomite; color, 10YR 5/3; texture, crystalline carbonate. Medium hard, fine sucrosic dolomite with zones of high moldic porosity, wispy shale and scattered chert. -- at 196, 196.5, 197, 198, 199, 202.8 - Chert. -- at 197, 198, 198.5-199, 200, 201, 202 - Wispy shale. -- at 199, 202 - Chert and limestone fragments (collapse zone?). -- at 200 - Thin-section description (table 11); laboratory test (table 12). -- at 206-208 - Fine sucrosic dolomite with high moldic porosity.
208-222	Dolomite and limestone; color, 10YR 6/1,5/3,7/3; texture, crystalline carbonate to mudstone to wackestone. Hard, dense, fossiliferous, shaly micrite and fine sucrosic dolomite. Selective dolomitization of burrows. Moldic porosity in dolomite creates spongy appearance. -- at 208.5-211 - Shaly mudstone with wispy shale. -- at 210-211 - Weakly mottled. -- at 210.5 - Pyrite nodules. -- at 211-212 - Fine sucrosic dolomite, slightly burrowed, with moldic porosity and wispy shale. -- at 212-213.5 - Sucrosic dolomite with high moldic porosity and spongy in appearance. -- at 216-217 - Wispy shale zones in shaly sucrosic dolomite. -- at 218-218.3 - Erratic wispy shale. -- at 218.3-222 - Hard, dense rudist wackestone. -- at 220 - Thin-section description (table 11); laboratory test (table 12).
222-242	Dolomite and limestone; color, 10YR 5/2,6/2; texture, mudstone to wackestone to packstone to crystalline carbonate. Medium hard, fine sucrosic dolomite with algal mats, wispy shale and hard, dense rudist fossiliferous mudstone to packstone. -- at 222 - Clayey, shaly dolomitic limestone. -- at 224 - Miliolid packstone. -- at 226 - Wispy shale in chalky wackestone. -- at 226.5-227, 227.5-228 - Fractures. -- at 228.5 - Fine sucrosic dolomite with wispy shale and possible collapse breccia. -- at 229.5, 235, 237, 240.8 - Wispy shale. -- at 230 - Algal mat and chalcedony; thin-section description (table 11); laboratory test (table 12). -- at 231-232 - Shaly, sucrosic dolomite with mollusc molds.

Depth  
(feet)

- at 236-237 - Vugular, burrowed and solutioned sucrosic dolomite.
  - at 237 - Pyrite.
  - at 238 - Detrital zone.
  - at 240 - Thin-section description (table 11); laboratory test (table 12).
  - at 240.6-242 - Fine sucrosic and mottled dolomite with discontinuous shale fragments.
- 242-263 Limestone and dolomite; color, 10YR 7/3,6/1; texture, mudstone to wackestone to packstone to crystalline carbonate. Dense clayey mudstone, dolomitic mudstone, and very fine sucrosic dolomite variably mottled, with some finely disseminated pyrite. Wispy shale and discontinuous shale filaments are common.
- at 242.5 - Shaly mudstone.
  - at 243 - Discontinuous shale filaments.
  - at 246-247.5 - Wispy shale.
  - at 247.5-248 - Fine sucrosic dolomite.
  - at 250 - Shiny black tar.
  - at 250-251 - Stromatolite.
  - at 252, 253, 261.5 - Stylolites.
  - at 253-253.5, 259.6, 261 - Wispy shale.
  - at 255 - Thin-section description (table 11); laboratory test (table 12).
  - at 261 - Shaly, fossiliferous limestone.
- 263-320 Limestone and dolomite; color, 10YR 7/1,7/3,7/6; texture, grainstone to packstone to crystalline carbonate. Miliolid and fossil fragment biosparite, occasionally a rudist coquina, with wispy shale and burrowed zones.
- at 264, 274.5 - Shaly.
  - at 264.5, 266-268, 296.2, 296.4 - Wispy shale.
  - at 268-268.5 - Rudist coquina.
  - at 268-270 - Open fracture.
  - at 270-270.5 - Shaly coquina.
  - at 276-279.5 - Dolomite and fossil fragment coquina.
  - at 277 - Ammonite mold, stylolite.
  - at 280 - Thin-section description (table 11); laboratory test (table 12).
  - at 286-288 - Dolomite and rudist coquina.
  - at 288, 295.9 - Chert.
  - at 289.5 - 1/2-inch shale seam.
  - at 294 - Intraformational breccia with lithocasts.
  - at 296.2-296.4 - Laminated dolomite.
  - at 298.1 - Stromatolitic.
  - at 300 - Thin-section description (table 11); laboratory test (table 12).
  - at 302 - Partly dolomitized breccia with vuggy porosity.
  - at 304 - Hard dense mudstone.
  - at 316 - Dolomite.
- 320-351 Limestone and dolomite; color, 10YR 7/2,7/3,6/2; texture, crystalline carbonate to grainstone to wackestone to mudstone. Very fine sucrosic dolomite with wispy shale partings. Variably mottled, with some grainstone and clayey mudstone and few fossils and fractures.
- at 320 - Thin-section description (table 11); laboratory test (table 12).
  - at 322.3 - Chert.
  - at 329-330.5 - Dolomitic limestone, poorly sorted grainstone.
  - at 329.2 - Stylolite.
  - at 330 - Fracture lined with small calcite crystals.
  - Note: H<sub>2</sub>S odor in all core below 330 feet.
  - at 330.5-337 - Sucrosic dolomite and miliolid grainstone.
  - at 332.1-332.3, 333.7-333.9, 335-335.5, 345.7-345.9 - Wispy shale.
  - at 333.8-334.6, 336.6-336.8 - Detrital zone.
  - at 335 - Thin-section description (table 11); laboratory test (table 12).
  - at 337 - H<sub>2</sub>S odor from fresh fracture.
  - at 337-337.7, 337.8, 338.4 - Stromatolitic zone.
  - at 339-341.3 - Fossiliferous sucrosic dolomite.
  - at 341 - Dolomite and laminated shale.
  - at 343 - Thin-section description (table 11); laboratory test (table 12).
  - at 344.5 - Dense miliolid wackestone.
  - at 345 - Thin-section description (table 11).
  - at 346.6-347.9 - Burrowed and fractured sucrosic dolomite.
  - at 348.5, 349 - Stromatolitic.
  - at 349-350.5 - Fine sucrosic dolomite.
  - at 350.5-350.8 - Poorly sorted miliolid and fossil fragment grainstone.

Depth  
(feet)

- 351-380 Limestone and dolomite; color, 10YR 6/1,7/2,5/3; texture, grainstone to mudstone to crystalline carbonate. Dense biomicrite and interbedded mudstone with mudstone intraclasts in the grainstone. Vugular sucrosic dolomite, some highly disturbed and burrowed, with black organic blotches.  
-- at 351.2-355.3 - Miliolid and fossil fragment grainstone.  
-- at 351.5 - Chert.  
-- at 353 - 2-inch detrital zone and wispy shale in dolomite.  
-- at 355.3-356 - Fine sucrosic dolomite, sponge-like in appearance.  
-- at 359-360 - Vuggy, fine sucrosic dolomite; vugs appear to be gastropod molds.  
-- at 359 - Wispy shale.  
-- at 359.8, 367 - Glassy black chert.  
-- at 360 - Thin-section description (table 11); laboratory test (table 12).  
-- at 360, 363, 366, 367, 368.5, 382.3 - Wispy shale.  
-- at 367 - Burrowed.  
-- at 368-370 - Calcite-lined fracture.  
-- at 370 - Thin-section description (table 11); laboratory test (table 12).  
-- at 370.8, 376.2, 376.8, 380 - Chert.  
-- at 370.8-373.5 - Miliolid biomicrite with dictyconids.  
-- at 371 - Thin-section description (table 11).  
-- at 373.3 - Laminated shale and limestone.  
-- at 375 - Laminated shale and dolomite.  
-- at 375.4 - Abundant rudists.  
-- at 377-379 - Fossiliferous, fine sucrosic dolomite with many rudist molds.  
-- at 380.6-381.2 - Shaly, sucrosic dolomite with limestone clasts.  
-- at 381.2-382.6 - Miliolid grainstone.
- 382.6-416 Dolomite; color, 10YR 5/3,6/1,7/1,8/2; texture, crystalline carbonate to mudstone to wackestone. Dense, shaly dolomite predominantly fine sucrosic mudstone, rarely a grainstone (coquina) with chert and wispy shale.  
-- at 382.6 - Laminated shale and shaly dolomite.  
-- at 384, 402, 414 - Chert.  
-- at 384.6 - Detrital zone.  
-- at 384.6, 390.5, 413.8 - Wispy shale.  
-- at 385 - Thin-section description (table 11).  
-- at 386 - Thin-section description (table 11); laboratory test (table 12).  
-- at 390.5 - Rip-up clasts.  
-- at 395 - Thin-section description (table 11); laboratory test (table 12).  
-- at 402, 403 - Fractures.  
-- at 405 - Thin-section description (table 11).  
-- at 407 - Thin-section description (table 11); laboratory test (table 12).  
-- at 410 - Thin-section description (table 11); laboratory test (table 12).
- 416-426 Limestone and dolomite; color, 10YR 8/1,7/2; texture, grainstone to mudstone to crystalline carbonate. Porous, reefal grainstone, partially to completely dolomitized with large rudist molds.  
-- at 416 - Dense mudstone, chert.  
-- at 416-417 - Very shaly.  
-- at 420 - Thin-section description (table 11).  
-- at 424 - Thin-section description (table 11); laboratory test (table 12).  
-- at 424-426 - Very fine sucrosic dolomite with laminated mudstone.
- 426-444 Dolomite and dolomitic limestone; color, 10YR 6/7,6/3,8/1; texture, crystalline carbonate grainstone. Tan, medium hard, sucrosic, laminated mudstone and wackestone with thin seams of intraformational conglomerate. Porous to dense, wispy and variably burrowed with some dessication fractures.  
-- at 435.4 - Stromatolitic.  
-- at 435.7, 442-444 - Wispy shale.  
-- at 436-437 - Stylolites.  
-- at 438-439, 441-442 - Fractured.
- 444-458 Shaly, dolomitic limestone; color, 10YR 5/3,6/2; texture, mudstone to wackestone. Medium hard nodular mudstone, dense to chalky and very fine to fine sucrosic dolomite with wispy shale, chert, fractures and disturbed bedding.  
-- at 444.5 - Wispy shale.  
-- at 445-448 - Nodular and burrowed.  
-- at 447 - Rudist.  
-- at 457-458 - Nodular and dolomitic with burrows and wispy shale.

Depth (feet)	
458-484	<p>Limestone and dolomite; color, 10YR 5/3,6/2; texture, mudstone to wackestone. Medium hard to hard, chalky to shaly dolomitized mudstone and wackestone with some leached grainstone. Bedding planes in the mudstone are disturbed. Wispy shale zones, some chert and pyrite and a few burrows are also present.</p> <ul style="list-style-type: none"> <li>-- at 458.3-458.4 - Stromatolitic.</li> <li>-- at 458.8 - Many pelecypod fragments.</li> <li>-- at 459-461 - Fractures.</li> <li>-- at 460-462 - Stylolites.</li> <li>-- at 462, 475.5, 476 - Chert.</li> <li>-- at 462.5 - Rip-up clasts.</li> <li>-- at 464-468 - Fossil fragment grainstone.</li> <li>-- at 468-469 - Laminated shale and dolomite.</li> <li>-- at 469 - Laminated shale and dolomite.</li> <li>-- at 469, 483 - Stylolites.</li> <li>-- at 479.5, 483 - Wispy shale.</li> <li>-- at 483-484 - Stromatolitic.</li> </ul>
484-506	<p>Limestone and shaly dolomite; color, 10YR 4/2,7/1; texture, mudstone to wackestone to packstone to grainstone to crystalline dolomite. Chalky, dolomitic limestone; mostly a wackestone with some packstone or grainstone, and fine sucrosic dolomite. Variably shaly with dolomitized burrows.</p> <ul style="list-style-type: none"> <li>-- at 484 - Abundant fossil molds.</li> <li>-- at 485-486 - Fractures.</li> <li>-- at 488-489 - Rudists.</li> <li>-- at 494 - Thin-section description (table 11); laboratory test (table 12).</li> <li>-- at 495, 498.5, 500, 504-506 - Wispy shale.</li> <li>-- at 500-504 - Burrowed and nodular, fine sucrosic dolomite.</li> <li>-- at 502-504 - Fossiliferous, mainly gastropods and pelecypods, fractures filled with calcite crystals.</li> <li>-- at 503 - Milky quartz nodules.</li> <li>-- at 504 - Stylolite.</li> <li>-- at 505-506 - Burrowed and nodular.</li> </ul>
506-526	<p>Dolomitic limestone and dolomite; color, 10YR 7/1,7/2,5/3,6/4; texture, crystalline carbonate to wackestone to mudstone. Fine, sucrosic, burrowed wackestone and mudstone with scattered grainstone lenses, lithoclasts, open vertical fractures and disturbed bedding.</p> <ul style="list-style-type: none"> <li>-- at 507-508.5 - Fine sucrosic dolomite.</li> <li>-- at 508.5-516 - Silty, fossiliferous packstone.</li> <li>-- at 511-512 - Very shaly.</li> <li>-- at 514.5 - Dark gray shale streak.</li> <li>-- at 516, 518.8 - Stylolites.</li> <li>-- at 518.2-518.7 - Detrital.</li> <li>-- at 521-521.7 - Stromatolitic.</li> <li>-- at 524.2 - Possible collapse zone.</li> </ul>
526-545	<p>Dolomite; color, 10YR 7/3,7/1,6/3; texture, crystalline carbonate to mudstone. Silty to chalky, finely sucrosic to crumbly dolomite and mudstone with random celestite crystals and moldic pores after gypsum. Laminated and mottled with oxidation along dessication partings. Pronounced algal stromatolites occur in the mudstone.</p> <ul style="list-style-type: none"> <li>-- at 526, 527.2-527.8 - Wispy shale.</li> <li>-- at 529 - Laminated shale and dolomite.</li> <li>-- at 531-532 - Many vugs with calcite crystals and milky white drusy quartz.</li> <li>-- at 532 - Celestite crystals.</li> <li>-- at 535.2-536 - Stromatolitic zone in sucrosic dolomite.</li> <li>-- at 536 - Thin-section description (table 11).</li> <li>-- at 538-539 - Shaly, fine sucrosic dolomite.</li> <li>-- at 539-545 - Miliolid and fossil fragment grainstone.</li> <li>-- at 544-545 - Stylolites.</li> </ul>
545-555	<p>Limestone and dolomite; color, 10YR 7/2,6/1; texture, mudstone to grainstone to crystalline carbonate. Medium hard to hard, silty dense mudstone and some grainstone. Mudstone is very dense and has disturbed bedding. Grainstone has some leached porosity.</p> <ul style="list-style-type: none"> <li>-- at 546.3 - Collapse breccia.</li> <li>-- at 548 - Stylolites.</li> <li>-- at 548-552, 552.6 - Wispy shale.</li> <li>-- at 548-548.5 - Open vertical fracture.</li> <li>-- at 550 - Dictyconid foraminifer.</li> <li>-- at 552.6 - Possible collapse zone.</li> <li>-- at 555.2 - Soft, black calcareous shale.</li> </ul>



Depth  
(feet)

556-592

Limestone and silty dolomite; texture, mudstone. Hard, dense nodular and mottled mudstone with wispy shale partings, stylolites, disturbed bedding and large, isolated, partially calcite-filled vugs. Black rotund bodies are common in the lower part of this interval.

- at 555.8, 560-562, 568-570.8, 578-579, 583 - Wispy shale.
- at 556, 559-559.5, 564, 566-571 - Stylolite.
- at 556-560 - Heavily burrowed and nodular.
- at 556.5, 558 - Large vugs lined with calcite crystals.
- at 564, 565 - Large vugs partially filled with celestite.
- at 571-575.8 - Shale unit with wispy shale common.
- at 571 - Large vugs that are partially filled with calcite.
- at 574 - Black rotund bodies are rare to common.
- at 576 - Fossiliferous (large rudists).
- at 578, 579-581 - Black rotund bodies common to abundant.
- at 581-582 - Shaly, silty dolomite and dolomitic shale.
- at 582-583 - Very fine sucrosic dolomite.
- at 586.5-588.5 - Large, irregular black limestone nodules in fine sucrosic dolomite.
- at 588.5-592 - Fossiliferous granular dolomite with abundant miliolids.

592-634

Limestone and dolomite; color, 10YR 7/1,6/1,5/1; texture, mudstone to wackestone to grainstone to crystalline carbonate. Hard, dense mudstone and wackestone with some grainstone and sucrosic dolomite with wispy shale. Some nodular and mottled wackestone with intraformational conglomerate.

- at 592-593 - Dark gray shaly dolomite.
- at 593-596 - Light gray fossiliferous granular dolomite.
- at 597.5-598, 602-602.6, 607.8, 610, 616, 620, 627 - Wispy shale.
- at 598.6-599 - Stromatolitic.
- at 599-600 - Detrital zone.
- at 601.6 - Stylolite.
- at 602-602.6 - Weakly laminated.
- at 603.5-606 - Fine sucrosic dolomite, stromatolitic, with a 4-inch dark gray shale seam.
- at 609 - Celestite crystals.
- at 620-625 - Nodular and fossiliferous, fine sucrosic, shaly dolomite with gastropod and pelecypod casts and molds.
- at 620 - Nodular and burrowed.
- at 626 - Nodular and burrowed.
- at 630 - Stromatolitic.
- at 631 - 1/8-inch lignite seam.
- at 632 - Soft, black shale.
- at 633 - Intraformational conglomerate with poorly sorted, irregular dolomite clasts.

Table 11.--Description of thin sections of test-hole cores:  
San Marcos (LR-67-09-110)

Depth (feet)	
180	<u>Limestone</u> ; mudstone to wackestone; large mollusc fragments, rounded micrite lumps (200 to 400 microns) outlined by microsparite; porosity (isolated vugs 50 to 400 microns in size) is 5 to 10 percent; permeability is low.
190	<u>Dolomite</u> ; no original texture; very fine (10 to 20 microns) subhedral to euhedral rhombs in a chert matrix; porosity is low; permeability is low.
200	<u>Dolomite</u> ; no original texture; dense, very fine (20 to 40 microns) rhombs with hematite staining; porosity is less than 5 percent; permeability is low.
220	<u>Dolomite</u> ; wackestone; mollusc fragments with micrite infilling, well distributed, isolated rhombs (to 60 microns) replacing micrite; rhombs are concentrated along interlacing networks; porosity (intercrystal, vugs up to 300 microns) is 5 to 10 percent; permeability is medium.
230	<u>Dolomite</u> ; no original texture; very fine (10 microns) rhombs, chert inclusions, hematite stains, large irregular vugs, fracture; porosity is very low except for vugs; permeability is medium to high.
240	<u>Limestone</u> (slightly dolomitic); mudstone; few large mollusc fragments; patches of concentrated rhombs; porosity is very low; permeability is very low.
255	<u>Limestone</u> ; mudstone; mollusc fragments, echinoderms, hematite staining, small rhombs, ostracods; dense micrite; porosity is very low; permeability is very low.
280	<u>Limestone</u> ; mudstone or micritized grainstone; obscured original texture; miliolid ghosts; microsparite; vugs; porosity (intercrystal, vugs) is low; permeability is low.
300	<u>Dolomite</u> ; mudstone (dolomitized); micritized fossils of unaltered mudstone, inclusions; euhedral to subhedral replacement rhombs (20 to 50 microns); numerous wavy partings stained with limonite and organics.
320	<u>Limestone</u> (dolomitic); packstone; micritized miliolids and pellets; abundant microsparite in contact with very fine grained dolomite; porosity (intercrystal, vugs about 100 microns) is 10 percent; permeability is low.
335	<u>Dolomite</u> (gypsiferous); no original texture; sucrosic; euhedral rhombs (30 to 80 microns), gypsum inclusions replaced by dolomite rhombs; chert; porosity (intercrystal, vugs) is 10 to 15 percent; permeability is medium.

Depth  
(feet)

- 343 Dolomite; scattered patches of original micrite texture; euhedral rhombs (30 to 80 microns); porosity (intercrystal, vugs), is greater than 30 percent; permeability is high.
- 345 Limestone (dolomitic); mudstone; euhedral rhombs (30 to 80 microns), hematite-stained laminae and a calcite-filled fracture; porosity is less than 5 percent; permeability is low.
- 360 Limestone (dolomitic); packstone; highly micritized mollusc fragments, miliolids and dolomitized burrows; porosity (intercrystal, vugs) is 10 to 20 percent.
- 370 Dolomite; no original texture; euhedral rhombs (20 to 70 microns); porosity (intercrystal, scattered vugs) is 10 percent; permeability is low to medium.
- 371 Dolomite; isolated patches of original micrite texture; euhedral rhombs (20 to 70 microns); vugs up to 200 microns; porosity (intercrystal, vugs) is greater than 20 percent; permeability is medium to high.
- 385H Limestone (slightly dolomitic); mudstone; rare, small fossil fragments, isolated cubes; porosity is less than 5 percent; permeability is low.
- 385V Limestone (dolomitic); contact between a miliolid packstone and a dense mudstone; mudstone contains isolated cubes (100 microns on a side); packstone contains scattered mollusc fragments.
- 386 Limestone; packstone; miliolids, lumps, intraclasts and isotropic salt hoppers (halite).
- 395 Limestone (dolomitic); mudstone; small fossil fragments, scattered rhombs, micritized miliolids; porosity (intercrystal, vugs) is 5 to 8 percent; permeability is low to medium.
- 405 Limestone; contact between mudstone and wackestone; miliolids, mollusc fragments; mudstone has hematite stains; porosity (vugs) is poor; permeability is low.
- 407 Limestone; grainstone; miliolids, lumps, intraclasts, algae; microspar groundmass; porosity (intraparticle, intercrystal, vugs) is greater than 15 percent; permeability is medium.
- 410 Dolomite; original texture virtually obliterated; skeletal fragments, miliolids, foraminifera; hematite-stained laminae; porosity (intercrystal, vugs) is greater than 15 percent.
- 420 Limestone; wackestone; large (up to 500 microns) mollusc fragments with some chert replacement; moldic porosity after fossil fragments; porosity is 15 percent; permeability is medium.

Depth  
(feet)

- 424 Limestone; packstone; large mollusc fragments, lumps, intraclasts; micritized fragments are outlined with microsparite; porosity (interparticle, intercrystal, vugs) is 20 percent; permeability is medium.
- 494 Dolomite; no original texture; tightly interlocked rhombs (up to 50 microns); organic staining; porosity is low; permeability is low.
- 536 Dolomite; original texture obscured (some banding or layering); euhedral rhombs (20 to 40 microns); fractures; porosity (intercrystal, vugs) is 15 percent; permeability is medium.

Table 12.--Porosity characteristics of core samples as determined by laboratory tests: San Marcos (LR-67-09-110)

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury <sup>1</sup> )						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden <sup>2</sup> of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury-injection test	Air-injection test	Air-injection pressure atmosphere			500	1000	2000
180	--	10.8	0.0	4.8	11.1	18.2	40.6	63.8	0.21	--	--	2.70	--	--	--	--
200	--	29.8	0.0	1.5	32.5	72.3	94.7	97.2	40	--	--	2.80	12.1	--	--	--
220	--	15.4	6.6	11.8	17.0	26.4	78.9	97.8	3.7	--	--	2.70	--	--	--	--
230	32.7	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--
240	--	14.4	0.0	0.0	0.0	0.0	16.5	87.4	0.10	--	--	2.71	30.3	--	--	--
255	6.7	--	--	--	--	--	--	--	--	0.01	--	2.69	--	--	--	--
280	--	--	--	--	--	--	--	--	--	--	--	2.70	--	--	--	--
300	--	28.1	0.0	0.0	4.8	39.6	88	94.6	19	--	--	2.80	13.2	--	--	--
320	15.3	--	--	--	--	--	--	--	--	0.75	--	2.71	--	--	--	--
335	31.3	--	--	--	--	--	--	--	--	100	--	2.86	--	--	--	--
343	--	36.6	7.7	41.6	55.8	62.0	95.9	98.6	151	--	--	2.81	16.8	--	--	--
360	34.2	--	--	--	--	--	--	--	--	19	--	2.81	--	--	--	--
370	24.1	--	--	--	--	--	--	--	--	1	--	2.81	--	--	--	--
386	--	21.5	0.0	5.5	16.3	33.9	82.6	92.3	17	--	--	2.70	21.3	--	--	--
395	32.2	--	--	--	--	--	--	--	--	4.9	--	2.70	--	--	--	--
407	35.3	--	--	--	--	--	--	--	--	65	--	2.70	--	--	--	--
410	30.0	--	--	--	--	--	--	--	--	5.7	--	2.87	--	--	--	--
424	--	31.8	13.7	53	65.7	74.5	93.5	98.0	1320	--	--	2.69	14.6	--	--	--
494	--	23.1	0.0	30.0	50.3	71.2	93.9	98.1	58	--	--	2.82	15.3	--	--	--

<sup>1</sup>Percent of effective porosity intruded by mercury =  $\frac{\text{injection pressure}}{\text{(pounds per square inch)}} / \frac{\text{pore throat radius}}{\text{(microns)}}$

<sup>2</sup>Effective overburden in pounds per square inch.

Table 13.--Test-hole completion summary: Devine (TD-68-49-813)

Location: Medina County, Tex., near State Highway 173, 2 miles northwest of Devine.

Elevation of land surface: 664 feet above National Geodetic Vertical Datum of 1929.

Contractor: J. R. Johnson Drilling Co., San Antonio, Tex.

Spudded: January 26, 1973.

Completed: March 15, 1973.

Casing: 8-5/8-inch outer diameter x 0.264 inch wall thickness to 2570 feet. Cemented with 137 sacks of 4-percent gel and 100 sacks of class A neat cement, cement not circulated.

Total depth: 3194 feet.

Coring equipment: 6-1/4 diamond core bit.

Core-recovery summary: Total footage cored, 612 feet; total core recovered, 365.2 feet; and percentage of recovery, 59 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
2588-2598	10.0	8.2	8.2
2607	9.0	7.3	15.5
2634	27.0	9.7	25.2
2684	50.0	5.0	30.2
2706	22.0	0.5	30.7
2726	20.0	12.0	42.7
2746	20.0	6.6	49.3
2758	12.0	11.7	61.0
2790	32.0	23.0	84.0
2830	40.0	30.0	114.0
2860	30.0	26.0	140.0
2869	9.0	9.0	149.0
2871-2902	33.0	16.0	165.0
2940	38.0	9.0	174.0
2980	40.0	11.8	185.8
3000	20.0	14.2	200.0
3022	22.0	15.8	215.8
3042	20.0	18.7	234.5
3062	20.0	19.0	253.5
3082	20.0	16.3	269.8
3102	20.0	11.6	281.4
3134	32.0	23.7	305.1

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
3154	20.0	15.7	320.8
3174	20.0	18.4	339.2
3200	26.0	26.0	365.2

Notes: Core loss occurred throughout the drilling of this hole. The worst zone, from 2634 to 2684 feet, produced only 5 feet of recovered core. The long runs (20-40 feet) and the wide kerf core bit proved unsuitable in the fractured, heavily solutioned limestone.

The water was high in H<sub>2</sub>S but not in sulfate. The H<sub>2</sub>S smell dissipated quickly and the water was flat but drinkable. The water flowed at 250-300 gallons per minute above 2855 feet and at 300-350 gallons per minute below 2876 feet. The water temperature was 114°F.

The recovered core consisted of dolomite and dolomitic limestone slightly darker than the freshwater core.

Table 14.--Description of test-hole cores: Devine (TD-68-49-813)

Depth (feet)	Description
2588-2612	Limestone; color, 10YR 7/1,6/1; texture, mudstone to wackestone. Hard, dense, clayey biomicrite with stylolites; black shale seams, pyritized fossils, nodules, glauconite(?), and wispy shale. -- at 2588-2596 - Stylolites. -- at 2590 - Thin-section description (table 15). -- at 2590-2596 - Pyrite nodules. -- at 2600 - Thin-section description (table 15). -- at 2601-2605 - Wispy shale. -- at 2610 - Thin-section description (table 15). -- at 2610-2611.5 - Poorly sorted, angular limestone clasts; conglomerate(?). -- at 2611-2612 - Hard tar on face of vertical fracture.
2612-2634	Limestone; color, 10YR 6/1; texture, mudstone to wackestone. Hard, chalky micrite to biomicrite with oyster shells in the lower zone. -- at 2612 - Laminated shale and limestone. -- at 2613 - Wispy shale and conglomerate.
2634-2706	Limestone; color, 10YR 7/1; texture, mudstone to wackestone to packstone. Hard, dense, tan micrite to biomicrite with fractures. -- at 2635 - Thin-section description (table 15). -- at 2636 - Wispy shale. -- at 2637 - Rudist fragments. -- at 2637.3 - Gray biomicrite with dead oil on fracture. -- at 2638 - Very light gray biomicrite. -- at 2706 - Water with strong H <sub>2</sub> S odor flows through a rudist fragment biosparite with open vertical fractures.
2706-2734	Limestone and dolomite; color, 10YR 7/1,4/2; texture, mudstone to wackestone to crystalline carbonate. Light gray, hard, chalky mudstone to wackestone to burrowed and highly fractured sucrosic dolomite with stromatolitic zones and wispy shale streaks. -- at 2708 - Stylolite in stromatolitic zone. -- at 2709-2712 - Finely sucrosic, spongy dolomite with good moldic porosity. -- at 2710 - Thin-section description (table 15). -- at 2712-2714 - Chert and limestone clasts in sparry calcite. -- at 2714-2716 - Dark gray laminated limestone and shale with calcite and conglomerate zones. -- at 2716-2718 - Stromatolitic zone. -- at 2726.5, 2727.3, 2728.1 - Stylolites. -- at 2727 - 1-inch conglomerate. -- at 2727.6-2728, 2729.5 - Wispy shale. -- at 2730 - Asphalt; thin-section description (table 15). -- at 2730-2731 - Chalky to finely sucrosic stromatolitic dolomite with scattered limestone clasts.
2734-2767	Limestone to dolomite; color, 10YR 6/3,6/1,7/1; texture, mudstone to crystalline carbonate. Hard, light gray, dense, sucrosic mudstone and crystalline carbonate with porous limestone zones and intraclastic mudstone with chert, wispy shale and rudists. -- at 2747-2748, 2749-2749.5, 2755-2755.3, 2758-2758.3 - Open high-angle fractures. -- at 2750 - Tar and shale on stylolite; thin-section description (table 15). -- at 2750.1 - Laminated shale and limestone. -- at 2751, 2755, 2758.5, 2760, 2763.6-2764.4 - Chert. -- at 2753, 2756, 2758.4, 2767 - Wispy shale. -- at 2760 - Thin-section description (table 15).
2767-2795	Limestone and dolomite; color, 10YR 7/2,7/1,5/3,4/2; texture, mudstone to wackestone to packstone to grainstone to crystalline carbonate. Hard, dense rudist micrite to biomicrite and medium hard to hard finely sucrosic dolomite with stylolites and scattered shaly zones. -- at 2767-2768 - Miliolid grainstone (biosparite). -- at 2770 - Thin-section description (table 15). -- at 2770.5 - Shaly and stylolitic. -- at 2771-2777 - Rudist biomicrite. -- at 2772 - Stylolites and wispy shale. -- at 2777-2784.4 - Finely sucrosic dolomite. -- at 2778, 2781 - Wispy shale. -- at 2780 - Thin-section description (table 15). -- at 2790.4-2795 - Fractured miliolid and fossil fragment biosparite. -- at 2792 - Collapse zone (?)



Depth  
(feet)

- 2795-2830 Limestone and dolomite; color, 10YR 4/2,5/3,6/2,7/1; texture, mudstone to wackestone to crystalline carbonate. Light gray to gray, medium hard micrite, biomicrite and finely sucrosic shaly dolomite with rudists and miliolids. Burrowed with wispy shale streaks and open fractures filled with calcite.  
-- at 2795-2801 - Finely sucrosic shaly dolomite.  
-- at 2798.6, 2800-2801 - Wispy shale.  
-- at 2800 - Thin-section description (table 15).  
-- at 2802 - Detrital zone.  
-- at 2801-2809 - Slightly clayey miliolid biomicrite.  
-- at 2802, 2809.2 - Chert nodules.  
-- at 2807-2808, 2819-2820, 2821-2822 - Open vertical and high-angle fractures.  
-- at 2809-2809.5 - Shaly.  
-- at 2809.5-2812 - Partly open vertical fracture.  
-- at 2817, 2820 - Wispy shale.  
-- at 2819-2822 - Miliolid grainstone (biosparite).  
-- at 2820 - Thin-section description (table 15).
- 2830-2849 Limestone; color, 10YR 7/2; texture, grainstone to packstone to crystalline carbonate. Light gray, hard to medium hard miliolid and fossil fragment grainstone and mudstone with scattered stylolites and open fractures.  
-- at 2830-2833.5 - Very finely sucrosic and calcareous slightly clayey dolomite with scattered shale fragments.  
-- at 2833.5-2837.5 - Chalky fossiliferous packstone.  
-- at 2837-2849 - Partially open high-angle fracture.  
-- at 2837.5-2849 - Fossil fragment grainstone.  
-- at 2840 - Thin-section description (table 15).  
-- at 2845, 2848-2849, 2854 - Stylolites.  
-- at 2845-2849 - Miliolid grainstone with high moldic porosity.  
-- at 2837-2849 - Partially open high-angle and vertical fractures.  
-- at 2850 - Thin-section description (table 15).  
-- at 2851 - 1-inch shale seam.  
-- at 2854-2854.7 - Wispy shale.
- 2860-2876 Shaly limestone and shale; dark gray to black shaly mudstone and medium hard dark gray to black calcareous shale with few fossils. Mudstone is wispy, and angular limestone clasts occur in the shale.  
-- at 2860-2862 - Shaly mudstone.  
-- at 2860.5 - Stylolite.  
-- at 2861, 2868, 2868.5, 2869-2870, 2872 - Wispy shale.  
-- at 2862-2863 - Dark gray fissile calcareous shale.  
-- at 2863-2869 - Dense, chalky and variably shaly mudstone.  
-- at 2864 - Thin-section description (table 15).  
-- at 2869 - High-angle fracture.  
-- at 2870 - Thin-section description (table 15).  
-- at 2872-2874 - Black, fissile calcareous shale.  
-- at 2874 - Shale with small angular limestone clasts at base.  
-- at 2874-2876 - Chalky mudstone with scattered black shale fragments.  
-- at 2876 - Stylolite.
- 2876-2940 Limestone; color, 10YR 7/2; texture, grainstone; light gray medium hard to hard miliolid grainstone with fractures, wispy shale, breccia, boxwork porosity and rudist fragments.  
-- at 2877 - Miliolid and fossil fragment grainstone.  
-- at 2880 - Thin-section description (table 15).  
-- at 2882-2884 - Chalky to granular, spongy packstone.  
-- at 2882-2883 - Vertical fractures.  
-- at 2902-2926 - Granular limestone with collapsed or faulted zone and boxwork porosity.  
-- at 2903 - Vertical shale seam.  
-- at 2904, 2907 - Wispy shale.  
-- at 2905 - Miliolid grainstone; biosparite.  
-- at 2908 - Rudist molds.  
-- at 2909 - Celestite crystals.
- 2940-2985 Dolomite; color, 10YR 6/3,7/1; texture, crystalline carbonate to mudstone to wackestone to grainstone. Dark gray, finely sucrosic dolomite with molds and vugs after gypsum crystals. Mudstone and wackestone with algal structures interbedded with collapse breccia. Some miliolid grainstone.

Depth  
(feet)

- at 2940-2940.5 - Shaly micrite.
  - at 2940.5-2942 - Slightly clayey, finely sucrosic dolomite that is stromatolitic with wispy shale.
  - at 2942-2948 - Dolomitic miliolid grainstone to finely sucrosic, shaly dolomite.
  - at 2942-2943 - Miliolid grainstone with wispy shale.
  - at 2943-2944, 2944-2945, 2946-2947, 2950, 2952 - Wispy shale.
  - at 2948-2949 - Finely sucrosic dolomite with boxwork porosity.
  - at 2951 - Rudist.
- 2980-3001 Dolomite and limestone; color, 10YR 6/1,6/2,4/1,2.5/1; texture, crystalline carbonate to mudstone to wackestone. Finely sucrosic dolomite, clayey limestone and dolomitized rudist wackestone to mudstone with wispy shale and disturbed bedding.
- at 2980 - Thin-section description (table 15).
  - at 2980-2983 - Finely sucrosic dolomitic limestone with many molds.
  - at 2981 - Shaly.
  - at 2983-2989 - Finely sucrosic dolomite with small gypsum molds.
  - at 2984 - Gastropod and fossil fragment coquina.
  - at 2985-2987, 2990-2992 - Wispy shale.
  - at 2988 - Stromatolitic.
  - at 2989-2990 - Finely sucrosic, gypsiferous dolomite with a calcite stringer and abundant calcite crystals.
  - at 2990 - Thin-section description (table 15).
  - at 2992-2994 - Dark gray, very finely sucrosic shaly dolomite.
- 3001-3026 Limestone and dolomite; color, 10YR 4/2,5/2,7/2,7/3; texture, mudstone to grainstone to crystalline carbonate. Wispy, bedded mudstone and grainstone with scattered molds after gypsum crystals.
- at 3000 - Thin-section description (table 15).
  - at 3000-3003 - Finely sucrosic shaly dolomite.
  - at 3001.5-3002.2 - Open high-angle fracture.
  - at 3002.5, 3008.5-3008.9, 3024, 3025 - Wispy shale.
  - at 3003 - Elongate limestone clasts in calcareous shale.
  - at 3003.1 - Algal mat.
  - at 3003.2-3003.5, 3009.3, 3014 - Stylolites.
  - at 3004-3005 - Molds after gypsum crystals.
  - at 3005 - Open high-angle fracture and 1-1/2-inch opaque, blue chert bed.
  - at 3005-3007 - Fossil fragment coquina.
  - at 3007-3010 - Finely sucrosic shaly dolomite.
  - at 3008-3008.5 - Laminated shale and dolomite.
  - at 3009 - Algal mat.
  - at 3010-3014 - Dolomitized coquina.
  - at 3011-3012 - Molds after gypsum.
  - at 3012.5 - 2-inch gray chert bed.
  - at 3014-3015 - Hard, tightly cemented sucrosic dolomite.
  - at 3015 - Thin-section description (table 15).
  - at 3022-3026 - Poorly sorted, dolomitic fossil fragment grainstone.
  - at 3023-3024 - Molds after gypsum.
  - at 3024 - 1/2-inch blue-gray chert seam.
  - at 3025 - Large blue-gray chert nodule; thin-section description (table 15).
- 3026-3060 Dolomite and dolomitic limestone; color, 10YR 7/1,6/1,5/3; texture, mudstone to wackestone to packstone to crystalline carbonate. Sparse fossiliferous, wispy mudstone, wackestone and packstone that is variably laminated with fractures, scattered algal mats and chert.
- at 3026-3031 - Chalky, dense dolomitic biomicrite to biosparite with miliolids. Partially open vertical fracture mostly calcite healed.
  - at 3028 - Chalky mudstone with calcite-filled gypsum molds.
  - at 3030 - Thin-section description (table 15).
  - at 3031-3032 - Dolomitized calcareous miliolid grainstone with partly open vertical fracture.
  - at 3032-3034 - Medium sucrosic calcareous and shaly dolomite with wispy shale and an algal mat.
  - at 3034-3035.6 - Laminated finely sucrosic, calcareous dolomite with wispy shale and algal mats.
  - at 3035-3036 - Chalky, sucrosic limestone.
  - at 3035 - Shale seam.
  - at 3035.5 - Coquina.
  - at 3036 - Wispy shale.
  - at 3038-3042 - Rudist molds.
  - at 3039 - 4-inch wispy shale zone.

Depth  
(feet)

- at 3042-3045 - Fine to medium sucrosic dolomite.
  - at 3042.3-3042.8, 3043-3044 - Wispy shale.
  - at 3045.6-3046 - Rudist fragment identified in coquina.
  - at 3046.5-3048 - Burrowed chalky wackestone.
  - at 3048-3051 - Fossil fragment packstone.
  - at 3048, 3051 - Chert nodules.
  - at 3051-3062 - Weakly burrowed, finely sucrosic, fossiliferous limestone.
  - at 3052-3062 - Heavily burrowed, finely sucrosic grainstone.
  - at 3060 - Stylolite with black carbonaceous shale; thin-section description (table 15).
- 3060-3090 Limestone and dolomite; color, 10YR 7/2,6/2,5/2,4/3,3/3; texture, grainstone to packstone to mudstone to crystalline carbonate. Chalky grainstone and dark green, leached, clayey, sucrosic wackestone with disturbed bedding. Grainstone contains abundant intraclasts and there are rudists in the mudstone.
- at 3062-3066 - Well cemented fossil fragment packstone.
  - at 3062, 3062.5, 3067.2 - Chert nodules.
  - at 3063 - 1/4-inch black calcareous shale seam.
  - at 3067, 3067.5, 3068 - Dictyconid foraminifera.
  - at 3067.2 - Rudist fragments and highly burrowed.
  - at 3068.5-3072.4 - Chalky, variably brown mudstone, sucrosic in burrowed zones with calcite crystals scattered through matrix.
  - at 3069 - Brown, finely sucrosic dolomite.
  - at 3070.2 - 2 inches of opaque blue-gray chert.
  - at 3070.4 - Nodular and heavily burrowed.
  - at 3071 - Algal mat.
  - at 3072.2 - Laminated shale and dolomite.
  - at 3072.4-3076 - Rudist and fossil fragment packstone.
  - at 3076-3078 - Rudist and fossil fragment packstone.
  - at 3082.5 - Numerous long foraminifera.
  - at 3084, 3086 - Opaque blue-gray chert nodules.
  - at 3088-3089.5 - Hard, grainy, dolomitic and fossiliferous limestone with many brown dolomitic inclusions.
  - at 3089.5-3091.4 - Dark brown finely sucrosic dolomite.
- 3091-3120 Limestone and dolomite; color, 10YR 7/3,6/1; texture, mudstone to wackestone to crystalline carbonate. Brown, hard, very fossiliferous burrowed rudist mudstone to wackestone and finely sucrosic dolomite with some wispy shale and some clay.
- at 3091.4-3093 - Light gray, dolomitic fossiliferous, tightly cemented wackestone to packstone.
  - at 3092 - Microfossil grainstone.
  - at 3102-3106 - Miliolids common to abundant in packstone.
  - at 3105 - Thin-section description (table 15).
  - at 3106 - Finely sucrosic with many large rudist molds.
  - at 3111 - Wispy shale and 6-inch stromatolitic zone.
  - at 3111-3117 - Brown, finely sucrosic dolomite.
  - at 3117-3120 - Burrowed, fossiliferous, chalky packstone.
  - at 3117 - Algal mat.
- 3120-3138 Limestone and dolomite; color, 10YR 5/2; texture, wackestone to packstone to crystalline carbonate. Hard, dense, gray wackestone and packstone with dark, sucrosic burrowed dolomite; stromatolitic with disturbed bedding and stylolites.
- at 3120-3121.5 - Finely sucrosic dolomite.
  - at 3121.5-3123 - Chalky, fossiliferous wackestone and packstone.
  - at 3121.5 - Wispy shale.
  - at 3135, 3138 - Stylolites.
  - at 3137.5 - Gypsum crystals in a large vug.
- 3138-3149 Dolomitic limestone and dolomite; color, 10YR 6/2,4/2,7/1; texture, grainstone to crystalline carbonate. Medium hard to hard reefal coquina grainstone with large rudist molds and vugular dolomite.
- at 3138-3143.6 - Very fossiliferous and porous coquina with rudist, pecten and gastropod molds.
  - at 3144.8-3149 - Finely sucrosic, burrowed and nodular dolomite.
  - at 3144.8, 3145.4 - Chert nodules.
  - at 3148-3149 - Wispy shale.
- 3149-3163 Limestone; color, 10YR 7/1; texture, grainstone to packstone to mudstone. Nodular and cherty in upper zone and burrowed with some wispy shale in lower zone. Open vertical fractures and many black specks.

Depth  
(feet)

- at 3154 - Thin-section description (table 15).
  - at 3154-3155.5 - Miliolid and fossil fragment grainstone.
  - at 3155.5-3156.1 - Chalky and silty burrowed mudstone.
  - at 3156.1-3163 - Miliolid and fossil fragment grainstone with many black specks.
  - at 3158 - More chalky and silty than above with stylolites and calcite crystals in a chalky matrix.
  - at 3158.8-3159 - 2-inch stylolite zone.
  - at 3159-3159.3, 3162 - Wispy shale.
- 3163-3182 Dolomitic limestone; color, 10YR 5/3,7/1; texture, mudstone to wackestone. Medium hard, dense, nodular, finely sucrosic limestone which is stylolitic and wispy with low porosity.
- at 3164-3172 - Chalky, silty wackestone and mudstone with many small, scattered calcite crystals and stylolites.
  - at 3164.5, 3165.5, 3166.8 - Small clusters of pyrite crystals.
  - at 3164-3172, 3174-3178 - Stylolites.
  - at 3166, 3168, 3170 - Large gypsum crystals in vugs.
  - at 3171-3174.3 - Wispy shale.
- 3182-3200 Limestone and dolomite; color, 10YR 7/1; texture, mudstone to wackestone. Dense, burrowed and mottled stylolitic mudstone with fossil fragments scattered throughout.
- at 3182-3184 - Many stylolites.
  - at 3185 - Black rotund bodies.
  - at 3186 - Gypsum crystals in large vug.
  - at 3187-3200 - Black rotund bodies common to abundant.
  - at 3189-3200 - Weakly burrowed chalky, silty mudstone.
  - at 3189-3200 - Stylolites.
  - at 3190 - Thin-section description (table 15).

Table 15.--Description of thin sections of test-hole cores:  
Devine (TD-68-49-813)

Depth (feet)	Description
2590	<u>Limestone</u> ; wackestone; large mollusc fragments, pelagic foraminifera, black organic material, pyrite stylolites; fractures filled with coarse calcite; porosity (fracture voids) is less than 5 percent; permeability is very low.
2600	<u>Limestone</u> ; mudstone to wackestone; mollusc fragments, skeletal hash, pelagic foraminifera, numerous stylolites (some with black organic matter linings); porosity is less than 5 percent; permeability is low.
2610	<u>Limestone</u> ; mudstone; large mollusc fragments; uniform micrite groundmass; porosity is less than 5 percent; permeability is low.
2635	<u>Limestone</u> ; mudstone; scattered foraminifera; contact between a dense micrite and a grumous micrite; porosity is less than 5 percent; permeability is very low.
2710	<u>Limestone</u> (dolomitic); mudstone; moldic vugs after skeletal fragments; vugs lined with subhedral to euhedral dolomitic crystals (to 50 microns); matrix is grumous and fractured; porosity (vugs to more than 500 microns) is 10 percent; permeability is medium.
2730	<u>Dolomite</u> ; mudstone; dolomitic crystals; relict mudstone clasts; porosity (intercrystal, vugs) is 10 to 15 percent; permeability is medium.
2750	<u>Limestone</u> ; mudstone; mollusc fragment, foraminifera ghosts, organic staining; grumous groundmass; microsparite; porosity (vugs to 200 microns) is 5 to 10 percent; permeability is medium.
2760	<u>Limestone</u> ; mudstone; mollusc fragments, small skeletal fragments; groundmass is grumous with patches of mudstone clasts and microsparite; porosity is low.
2770	<u>Limestone</u> ; grainstone; miliolid ghosts, other foraminifera; microsparite cement; porosity (small vugs and intercrystal) is 15 percent; permeability is medium.
2780	<u>Dolomite</u> (limy); mudstone; skeletal fragments; euhedral rhombic crystals (20 to 60 microns) replace micrite; porosity is 5 percent; permeability is low.
2800	<u>Dolomite</u> (?); mudstone(?); fine (10 to 20 microns) subhedral to anhedral crystals; grumous matrix; porosity is less than 5 percent; permeability is less than 5 percent; permeability is very low.

Depth (feet)	
2820	<u>Limestone</u> ; grainstone (micritized) or packstone; abundant packed miliolids (variable preservation); large mollusc fragments replaced by chert; calcite-filled fracture; microsparite fills intraparticle voids; patches of mudstone intraclasts; porosity is 5 percent; permeability is low.
2840	<u>Limestone</u> ; wackestone to packstone; mollusc fragments with chert replacement, large star-shaped foraminifer; grumous matrix; porosity (vugs to 300 microns) is 10 percent; permeability is medium.
2850	<u>Limestone</u> ; mudstone; porosity is low; permeability is low.
2864	<u>Limestone</u> ; mudstone; scattered foraminifera, isolated mollusc fragments; dense, uniform groundmass; porosity is less than 5 percent; permeability is very low.
2870	<u>Limestone</u> ; mudstone to wackestone; as above.
2880	<u>Limestone</u> ; grainstone; miliolids, algal filaments, intraclasts, mollusc fragment; sparite cement; porosity is 5 percent; permeability is low.
2980	<u>Limestone</u> (dolomite); grainstone; dolomitized and highly leached resulting in large vugs and molds; mudstone intraclasts; grumous texture; porosity is 15 percent; permeability is medium to excellent.
2990	<u>Dolomite</u> ; no original texture; subhedral to euhedral rhombs (20 to 60 microns); stylolites; porosity (intercrystal and vugs) is 15 percent; permeability is medium.
3000	<u>Dolomite</u> ; no original texture; recrystallized fossil fragments in a groundmass of densely packed subhedral crystals (10 to 20 microns); porosity (vugs) is less than 5 percent; permeability is low.
3015	<u>Dolomite</u> ; altered wackestone; foraminifera ghosts, gypsum inclusion; organic matter; microsparite groundmass; porosity (intercrystal, small vugs) is 15 percent; permeability is medium.
3025	<u>Dolomite</u> ; no original texture; euhedral rhombs in vugs; subhedral crystals in groundmass; porosity (vugs less than 200 microns) is 20 percent; permeability is high.
3030	<u>Limestone</u> ; wackestone; miliolid ghosts; porosity (vugs to 500 microns) is greater than 30 percent; permeability is good.
3060	<u>Limestone</u> (dolomitic); no original texture; large mollusc fragments; vugs lined with fine crystals; porosity (vugs) is 10 percent; permeability is medium.
3105	<u>Dolomite</u> ; mudstone; large mollusc fragments, echinoderm; large rhombs (to 80 microns) replacing micrite; porosity is low; permeability is low.

Depth  
(feet)

- 3154 Limestone (dolomitic); packstone; numerous micritized miliolids and other fossil fragments; isolated large euhedral rhombs; porosity (interparticle) is 10 percent; permeability is medium.
- 3175 Limestone (dolomitic); wackestone; large mollusc fragments; stylolites; isolated rhombs; porosity is less than 5 percent; permeability is low.
- 3190 Limestone; mudstone; dolomitized burrows, stylolites, organic stains, mollusc fragments, gypsum flakes; porosity (vugs) is 10 percent; permeability is fair.

Table 16.--Test-hole completion summary: Lockhill (AY-68-28-404)

Location: Bexar County, Tex., 6043 Lockhill Road, about 0.75 mile off DeZavala Road.

Elevation of land surface: 910 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources (Failing 1500 core-drilling rig, modified).

Spudded: September 27, 1972.

Completed: November 7, 1972.

Casing: 6-1/4-inch inside diameter to 48 feet, cemented with 15 sacks of 4 percent gel, cement circulated.

Total depth: 564 feet (driller); 544 feet (log).

Coring equipment: Acker double-wall mining-type core barrel 5x4x10 inches. Diamond core heads, 5-1/2x4 inches, of 75-80 carats, 25 stones per carat. Bottom discharge.

Core-recovery summary: Total footage cored, 497 feet; total core recovered, 434.4 feet (including crushed core); and percentage of recovery, 87 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
46- 48	2.0	1.6	1.6
49	1.0	1.0	2.6
51	1.0	0.8	3.4
61	10.0	8.6	12.0
69	8.0	4.5	16.5
75	6.0	5.9	22.4
79	4.0	4.0	26.4
85	6.0	6.0	32.4
95	10.0	2.1	34.5
104	9.0	5.5	40.0
105	1.0	1.0	41.0
115	10.0	2.3	43.3
118	3.0	1.8	45.1
125	7.0	1.7	46.8
128	3.0	2.9	49.7
130	2.0	1.5	51.2
137	7.0	7.0	58.2
147	10.0	7.0	65.2
156	9.0	8.0	73.2
164	8.0	6.0	79.2



<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
173	9.0	5.4	84.6
182	9.0	5.0	89.6
190	8.0	7.0	96.6
200	10.0	9.6	106.2
210	10.0	9.9	116.1
220	10.0	10.0	126.1
230	10.0	10.0	136.1
238	8.0	8.0	144.1
248	10.0	9.5	153.6
258	10.0	10.0	163.6
264	6.0	4.8	168.4
268	4.0	3.6	172.0
275	7.0	6.8	178.8
285	10.0	8.0	186.8
294	9.0	8.8	195.6
304	10.0	8.4	204.0
314	10.0	10.0	214.0
324	10.0	10.0	224.0
333	9.0	8.2	232.2
343	10.0	9.6	241.8
353	10.0	9.5	251.3
363	10.0	9.5	260.8
373	10.0	10.0	270.8
382	9.0	9.0	279.8
392	10.0	9.7	289.5
400	8.0	7.0	296.5
409	9.0	6.3	302.8
418	9.0	8.1	310.9
427	9.0	8.1	319.0
436	9.0	9.0	328.0
446	10.0	9.9	337.9
456	10.0	10.0	347.9
466	10.0	10.0	357.9
476	10.0	10.0	367.9
486	10.0	9.9	377.8
496	10.0	10.0	387.8
506	10.0	9.5	397.3
516	10.0	9.1	406.4
524	8.0	8.0	414.4
534	10.0	10.0	424.4
544	10.0	10.0	434.4

Table 17.--Description of test-hole cores: Lockhill (AY-68-28-404)

Depth (feet)	
46-49	Limestone; color, 10YR 7/2; texture, mudstone. Dense, chalky, fractured and fossiliferous micrite to biomicrite with dissolution along fractures. -- at 47, 48.5 - Vug and moldic porosity.
49-85	Limestone; color, 10YR 7/2; texture, mudstone to wackestone to packstone. Dense, hard, mollusc, mollusc fragment and miliolid biomicrite with chert, abundant <u>Toucasia</u> , and other rudists. High moldic porosity after caprinids and clams. -- at 50.5, 53, 54, 55 - Open fractures lined with calcite. -- at 55.5 - Large fracture partially infilled with calcite and red clay. -- at 56.5, 57 - Large fracture partially filled with red clay. -- at 59-64 - Moldic porosity. -- at 61 - Thin-section description (table 18); laboratory test (table 20). -- at 75 - Thin-section description (table 18); laboratory test (table 20). -- at 76.5-82 - Brown to gray chert. -- at 78 - Large, open fracture lined with calcite. -- at 80-85 - Moldic porosity. -- at 83 - Thin-section description (table 18); laboratory test (table 20). -- at 84 - Brown chert nodule.
85-95	Limestone; color, 10YR 7/2; texture, mudstone to wackestone to crystalline carbonate. Dense, hard, clayey micrite to biomicrite with small open fractures and scattered chert. -- at 95 - Brown-black chert.
95-118	Limestone; color, 10YR 7/2; texture, mudstone to wackestone to crystalline carbonate. Chalky to hard biosparite and recrystallized limestone with molluscs and rudists. -- at 95-97 - Dolomitic. -- at 97-104 - Vugs and staining. -- at 104-104.5, 115 - Black chert nodules. -- at 104-117 - Moldic porosity. -- at 110 - Vugs filled with black sparite. -- at 115-117 - Travertine.
118-157	Limestone; color, 10YR 7/2; texture, mudstone to wackestone to packstone to crystalline carbonate. Miliolid and mollusc fragment biomicrite with scattered fractures, chert and red clay. -- at 119 - Small calcite-lined fracture with red clay. -- at 125-128.5, 134-138 - Small iron-stained and calcite-filled fractures. -- at 128 - 3-inch thick gray chert layer. -- at 129 - Thin-section description (table 18); laboratory test (table 20). -- at 132-133 - Thin shale break and chert nodule. -- at 133-138 - Scattered burrows filled with dolomitic limestone. -- at 137-138 - Moldic porosity. -- at 138-139.5 - Small fractures partially filled with calcite. -- at 139 - Chert nodule. -- at 143 - Vuggy porosity. -- at 143-144, 147-179 - Sparite and honeycomb. -- at 147.5 - Small chert nodule. -- at 151.5-155 - Complete mollusc shells and rudist molds. -- at 152-155 - Chert nodules.
157-166	Limestone; color, 10YR 7/2,6/4; texture, mudstone to crystalline carbonate. Dense and recrystallized with micrite, caprinid molds, fractures, red clay and chert. -- at 157 - Thin-section description (table 18); laboratory test (table 20). -- at 157-161 - Moldic porosity. -- at 158-159 - Chert nodules. -- at 161-166 - Small zone of intergranular porosity. -- at 164-166 - Honeycomb structure zone with molds after rudists.
166-190	Limestone; color, 10YR 7/2,7/3,7/4; texture, mudstone to wackestone to crystalline carbonate. Dense, hard, fossiliferous micrite to biomicrite with sparite, moldic porosity, chert, wispy zones and fractures with scattered clay. -- at 166-168 - Honeycomb structure and moldic after rudists. -- at 168 - 4- to 6-inch thick weathered shale seam. -- at 170 - Fractures and dissolution with yellow-brown clay. -- at 173-178 - Open vertical fractures with scattered orange-brown clay. -- at 178 - Chert nodule.

Depth  
(feet)

- at 182-183 - Rudist molds filled with sucrosic dolomitic limestone.
  - at 183 - Chert nodule.
  - at 183-184.5 - Moldic porosity.
  - at 184.5-187 - Honeycomb structures.
  - at 185 - Thin-section description (table 18); laboratory test (table 20).
  - at 187 - Miliolid grainstone.
  - at 187-188 - Rudists.
  - at 187-189 - Open and stained high-angle vertical fractures.
- 190-218 Limestone; color, 10YR 8/2,7/3; texture, mudstone. Chalky to hard clayey biomicrite with mollusc shells, fragments, wispy shale, clay-filled vugs and a few stylolites.
- at 190-192, 195, 199-203, 210-212, 216.5-218 - Wispy layers with a high clay content.
  - at 192 - a 1-inch thick brown weathered shale seam; thin-section description (table 18); laboratory test (table 20).
  - at 192-192.5 - Few stylolites.
  - at 195-198 - Small, calcite-healed, horizontal fracture.
  - at 196-197 - Clay-filled molds.
  - at 198.5, 200-203, 208-211, 213-214, 217.5 - High-angle, stained fractures.
  - at 199 - Thin-section description (table 18); laboratory test (table 20).
  - at 212-216.5 - Miliolid grainstone.
  - at 215 - Stylolite.
- 218-232 Limestone; color, 10YR 7/2,5/2; texture, grainstone to packstone to mudstone. Chalky miliolid and shell fragment biosparite (variably a coquina) with fractures and a few stylolites. Fossils preserved as molds.
- at 219 - Thin-section description (table 18); laboratory test (table 20).
  - at 220 - Thin-section description (table 18); laboratory test (table 20).
  - at 221, 222-223, 228-229, 234-236, 237-238 - Open vertical and high-angle fractures.
  - at 230 - Thin-section description (table 18); laboratory test (table 20).
  - at 232 - Chert nodule.
- 232-273 Limestone; color, 10YR 7/2,5/2; texture, grainstone to packstone to mudstone. Dense, hard, variably chalky miliolid and shell fragment biosparite with fractures and very few stylolites.
- at 234-236 - Soft and shaly.
  - at 234-236, 237-238, 241-241.5, 246.5-248, 250, 251-253, 254, 258-268, 270-271 - High-angle and vertical fractures.
  - at 236-239 - Miliolid and shell fragment grainstone.
  - at 238-241 - Honeycomb structure with a 1-foot diameter cavity at depth 240.
  - at 241, 244, 257-258, 268.6, 269.4, 270, 271.6 - Chert.
  - at 244-245 - Mottled and burrowed.
  - at 246 - Thin-section description (table 18).
  - at 246-248 - Well cemented miliolid grainstone.
  - at 250 - Thin-section description (table 18); laboratory test (table 20).
  - at 256-258 - Complex fractures.
  - at 258-261 - Dense, hard mudstone.
  - at 268-273 - Dense, well cemented miliolid grainstone.
  - at 270 - Thin-section description (table 18); X-ray diffraction analysis (table 19).
  - at 271 - X-ray diffraction analysis (table 19).
  - at 272 - Thin-section description (table 18); X-ray diffraction analysis (table 19); laboratory test (table 20).
- 273-314 Limestone and dolomite; color, 10YR; texture, mudstone to wackestone to packstone to grainstone to crystalline carbonate. Hard biosparite to biomicrite. Locally dolomitic with scattered open fractures in crystalline carbonate.
- at 273-313 - X-ray diffraction analysis (table 19).
  - at 273 - X-ray diffraction analysis (table 19).
  - at 273-282 - High moldic porosity.
  - at 275 - Possible collapse zone with chert breccia; laboratory test (table 20).
  - at 277 - Laboratory test (table 20).
  - at 280 - Laboratory test (table 20).
  - at 283 - Laboratory test (table 20).
  - at 285 - Laboratory test (table 20).
  - at 282-290 - High porosity; evaporite and dolomitic zones.
  - at 289 - Laboratory test (table 20).
  - at 290 - Laboratory test (table 20).
  - at 290-295, 298-303 - Miliolid and shell fragment biomicrite with dessication fractures.
  - at 300 - Thin-section description (table 18); laboratory test (table 20).
  - at 303-305 - Vuggy porosity.
  - at 305 - Thin-section description (table 18); laboratory test (table 20).

Depth  
(feet)

- at 305, 308, 312 - Stylolites.
  - at 305-308 - White, burrowed dolomitic limestone with high moldic porosity.
  - at 307 - Algal mat.
  - at 310 - Thin-section description (table 18); laboratory test (table 20).
  - at 312 - Thin-section description (table 18); laboratory test (table 20).
  - at 312-313 - Crystalline carbonate with vuggy and fracture porosity and red clay.
- 314-347 Limestone and dolomitic limestone; color, 10YR 7/1,8/2; texture, grainstone to packstone to crystalline carbonate. Hard to granular limestone and dolomitic shell fragment biomicrite; locally a biosparite with mollusc fragments and fractures. Dolomitic material fills burrows. Porosity is high; vugs and moldic after fossils.
- at 314-343 - X-ray diffraction analysis (table 19).
  - at 315 - Thin-section description (table 18).
  - at 316 - 3/4-inch thick chert layer.
  - at 317 - Thin-section description (table 18).
  - at 319 - Thin chert layer.
  - at 320 - Thin-section description (table 18); laboratory test (table 20).
  - at 320-321 - Burrows, open fractures and molluscs.
  - at 322 - Chert layer.
  - at 323-326 - Honeycomb structures.
  - at 325 - Thin-section description (table 18).
  - at 324-330 - Honeycomb structures with orange clay filling.
  - at 330 - Thin-section description (table 18).
  - at 330-331, 335, 336, 337, 339, 342 - Open and stained fractures.
  - at 331 - Chert nodules
  - at 334 - Thin-section description (table 18); laboratory test (table 20).
  - at 335 - High porosity in a fossiliferous unit containing rudists, clams and gastropods.
  - at 336 - Thin-section description (table 18).
  - at 337 - Chert nodule; thin-section description (table 18).
  - at 337.5 - Honeycomb structure.
  - at 339 - Thin-section description (table 18).
  - at 340 - Thin-section description (table 18).
  - at 341 - Thin-section description (table 18); laboratory test (table 20).
  - at 343 - Open rudist molds.
  - at 343-345 - Scattered chert nodules.
- 347-375 Limestone and dolomitic limestone; color, 10YR 7/1,8/2; texture, grainstone to packstone to crystalline carbonate. Hard to granular limestone, dolomitic biosparite and crystalline carbonate with fossil molds, shell fragments, burrows and fractures.
- at 344 - Chert nodules.
  - at 344-346 - Large calcite-lined vugs.
  - at 353 - Thin-section description (table 18); laboratory test (table 20).
  - at 353-357 - Thinly laminated, slightly dolomitic biosparite and very dolomitic carbonate.
  - at 353-354.4, 355-356, 358.5-360, 363.5 - Incipient and calcite-healed fractures.
  - at 355 - Thin-section description (table 18); laboratory test (table 20).
  - at 358-366 - Scattered chert nodules and chert replacement of fossils.
  - at 364-367 - Open vertical fracture.
  - at 369 - Miliolid biosparite with mudstone layers.
  - at 375 - Erosional surface(?).
- 375-420 Limestone and dolomitic limestone; color, 10YR 6/3,7/3,8/2; texture, mudstone to wackestone to grainstone. Hard and granular limestone; mottled, shell fragment, dolomitic biomicrite, which is nodular, fractured, burrowed and variably honeycomb structured and solutioned.
- at 376-381 - Stylolites with thin wisps of red clay.
  - at 379-396 - Fossiliferous and dolomitic material fills abundant burrows.
  - at 382 - Muddy sparite.
  - at 382-388, 393 - Scattered stylolites.
  - at 384 - Thin-section description (table 18).
  - at 388.5 - Muddy, *Turitella* biosparite.
  - at 392-393, 406-411 - Solution zone with honeycomb.
  - at 393-397.5 - Scattered chert nodules.
  - at 398 - Fossil fragment coquina.
  - at 400 - Chalky miliolid grainstone.
  - at 400.8-403, 404-406 - Incipient high-angle fractures.
  - at 401 - Thin-section description (table 18); laboratory test (table 20).
  - at 405-409 - Honeycomb structure with orange clay infilling.
  - at 411 - Mottled with small burrows filled with dolomitic material.
  - at 411-414 - Miliolid biomicrite.
  - at 412-415 - Open and partly calcite-healed fracture.

Depth  
(feet)

- at 418-420 - Patchy dolomitic limestone with moldic porosity.
- at 416-417 - Open fracture.
- at 419.5 - Stylolite.
  
- 420-451 Limestone and dolomitic limestone; color, 10YR 7/2,8/2,7/1; texture, mudstone to wackestone to grainstone. Hard to granular limestone. Fractured, mottled and burrowed dolomitic biomicrite with vugs and moldic porosity after molluscs.
  - at 420, 420.5, 421, 422, 424.5, 424.6, 437, 438, 439, 440, 441.5, 442, 443.6, 444.6, 445, 446.7, 448.5-451 - Stylolites.
  - at 424-429 - Vugs formed by leaching in burrows.
  - at 431 - Thin-section description (table 18); laboratory test (table 20).
  - at 431.7-435.5 - Miliolid and fossil fragment grainstone.
  - at 435 - Dolomitic patches that are partly leached to form vugs.
  - at 436 - Miliolid and fossil fragment coquina.
  - at 435.5-438 - Slightly dolomitic biomicrite with small open fractures displacing large micrite intraclasts.
  - at 438-451 - Leached dolomitic burrow fill forms open fractures.
  - at 442.5 - Well cemented miliolid grainstone.
  - at 443.6 - Burrows or fossil molds.
  - at 444 - Laboratory test (table 20).
  - at 446 - Miliolid and fossil fragment grainstone; thin-section description (table 18).
  
- 451-471 Limestone and dolomitic limestone; color, 10YR 8/2,7/2,6/1,5/1; texture, packstone to grainstone. Hard to granular clayey limestone. A dolomitic, clayey, shell fragment biomicrite with stylolites, wispy shale, large oyster fragments and shells.
  - at 451 - Tar(?) trace on stylolite.
  - at 451-457 - Variably limy dolomite with some moldic or vuggy porosity and locally burrowed with dolomitic fossil fragment fill and clay wisps.
  - at 451.5, 452, 452.5-453, 454-455 - Stylolites, many with shale or tar on partings.
  - at 457 - Distinct color change; tan, finely sucrosic dolomite with fractures that are partially calcite-healed.
  - at 457-471 - A few 1x2-centimeter, open and unconnected vugs and small fractures filled with calcite.
  - at 457-466, 470 - Abundant wisps of black calcareous shale and scattered black rotund bodies.
  - at 460 - Dark gray limy and sucrosic dolomite with stylolites.
  - at 465 - Thin-section description (table 18); laboratory test (table 20).
  - at 466-471 - Mottled burrows filled with fossils and dolomite.
  - at 468.5 - Dolomitic biomicrite with stylolites.
  - at 467-468 - Large fragments and complete oysters, gastropods and caprinids.
  - at 469-470 - Abundant caprinids.
  - at 470 - 1-inch wispy shale zone.
  
- 471-479 Limestone and dolomitic limestone; color, 10YR 6/1,5/1; texture, wackestone to packstone to grainstone. Hard, clayey limestone; clayey, dolomitic oyster and shell fragment biomicritic wackestone with stylolites. Wispy shale and black rotund bodies increase in abundance at bottom of interval.
  - at 471-473 - Mottled with infilled burrows.
  - at 473.5-476.5 - Wispy shale streaks.
  - at 473.5-479 - Abundant black rotund bodies.
  - at 474 - Laboratory test (table 20).
  - at 475 - Black rotund body biomicrite with limy dolomite in burrows.
  - at 476.5-479 - Wispy shale is rare.
  
- 479-496 Limestone and dolomitic limestone; color, 10YR 6/1,7/1; texture, wackestone to packstone. Locally burrowed, clayey, dolomitic, mollusc and mollusc fragment biomicrite. Burrows filled with dolomite and oysters, gastropods, clams and rudists.
  - at 479-482 - Black rotund bodies and scattered wispy shale.
  - at 481-486 - Abundant stylolites.
  - at 488-494 - Dolomitic biomicrite with little clay and few stylolites.
  - at 490-491 - Burrows filled with dolomitic material.
  - at 491 - Solution horizon with open vugs; thin-section description (table 18); laboratory test (table 20).
  - at 494 - Thin-section description (table 18).
  - at 494.5-496 - Very clayey with abundant wispy shale and stylolites.
  - at 496 - Stromatolite(?).

Table 18.--Description of thin sections of test-hole cores:  
Lockhill (AY-68-28-404)

Depth (feet)	
61	<u>Limestone</u> ; wackestone; miliolid ghosts, mollusc fragment replaced by chert; microsparite in a micrite groundmass; open fracture lined with large crystals, stained with hematite; porosity (intercrystal, intraparticle, vugs to 1,000 microns) is 5 to 7 percent; permeability is low.
75	<u>Limestone</u> ; wackestone; fine skeletal hash, micritized foraminifera, foraminifer filled with coarse sparite; fracture filled with coarse calcite, microsparite infills fine fractures; some iron staining; porosity is less than 5 percent; permeability is low.
83	<u>Limestone</u> ; mudstone; large mollusc (rudistid?) fragments; microsparite; porosity is less than 5 percent; permeability is very low.
129	<u>Limestone</u> (recrystallized); mosaic of irregular, tightly locked crystals; crystal shapes suggest original rock was a sucrosic dolomite; porosity (isolated vugs) is low; permeability is very low.
157	<u>Limestone</u> ; original texture may have been a wackestone or grainstone based on shape of vugs and large pieces; microsparite occupies original intraparticle space; porosity (intercrystal and vugs in microsparite) is 5 to 10 percent; permeability is low.
185	<u>Limestone</u> ; wackestone; large mollusc fragments with chert replacement; uniform micrite groundmass; porosity is very low; permeability is very low.
192	<u>Limestone</u> ; mudstone; scattered irregular voids filled by sparite; disseminated limonite; porosity is very low; permeability is very low.
199	<u>Limestone</u> ; mudstone; foraminifera ghosts; small needle-like fragments; iron staining; continuous fracture filled with coarse calcite; porosity is less than 5 percent; permeability is very low.
219	<u>Limestone</u> ; grainstone; original texture obscured by micritization; miliolid molds abundant, mollusc fragments; porosity (interparticle, intercrystal, vugs 200 to 300 microns connected by intercrystal porosity) is 15 to 20 percent; permeability is medium.
220	<u>Limestone</u> ; grainstone; original texture obscured by micritization; miliolid ghosts; microsparite; stylolite stained with limonite; porosity is low; permeability is low.
230	<u>Limestone</u> ; large mollusc fragments, miliolid ghosts; microsparite; fracture; porosity (intercrystal, vugs, moldic after miliolids) is 5 to 10 percent; permeability is low.

Depth  
(feet)

- 246 Limestone (partly micritized); grainstone; miliolids, mollusc fragments; porosity (interparticle, vugs less than 100 microns, intercrystal in microspar) is 5 percent; permeability is low.
- 250 Limestone (highly micritized); grainstone; microsparite in interparticle spaces; porosity (intercrystal, moldic, vugs) is 5 to 8 percent; permeability is low.
- 270 Limestone; wackestone to packstone; abundant small pellets or micritized very small foraminifera, algal filaments, microsparite; some laminae; porosity is less than 5 percent; permeability is low.
- 272 Limestone (recrystallized); no original texture; mosaic of large irregular crystals, tightly interlocked; porosity (irregular vugs larger than 1,000 microns) is greater than 25 percent; permeability is medium to high.
- 289 Limestone (recrystallized); no original texture; mosaic of large subhedral rhombs; patches suggest a sucrosic dolomite; porosity (intercrystal, vugs) is 15 to 20 percent; permeability is medium to high.
- 292 Limestone; mudstone; abundant limonite; highly micritized; porosity is less than 5 percent; permeability is very low.
- 297 Limestone (recrystallized); no original texture; mosaic of irregular ghost crystals replaced by subhedral rhombs (60 microns); porosity (intercrystal, small vugs) is 10 to 15 percent; permeability is medium to high.
- 300 Limestone (recrystallized); no original texture; porosity is 15 percent; permeability is medium to high.
- 305 Limestone (recrystallized); no original texture; porosity (vugs to 1,000 microns) is greater than 25 percent; permeability is high.
- 310 Limestone; wackestone; fossil fragments (molluscs, foraminifera) replaced by coarse spar and micrite; porosity (isolated vugs) is 5 percent; permeability is low.
- 312 Limestone; wackestone; indistinct particles; section of rock is very uniform; porosity (intercrystal in uniform section) is 5 to 8 percent; permeability is low.
- 315 Limestone (recrystallized); indistinct texture; rhombs in vugs; porosity (vugs to 1,000 microns, intercrystal) is greater than 20 percent; permeability is medium to high.
- 317 Limestone (micritized); grainstone; miliolids, foraminifera, mollusc fragments; porosity (interparticle, intraparticle, small vugs) is 5 to 10 percent; permeability is low.

Depth  
(feet)

- 320 Limestone; wackestone; mollusc fragment, scattered molds after fossils, echinoderm(?) replaced by chert; microsparite within molds; porosity (intercrystal, moldic, vugs) is 15 percent; permeability is medium to high.
- 325 Limestone; grainstone (highly micritized); miliolids, algal lumps (elongated and oriented); microsparite cement; porosity (intraparticle, vugs less than 100 microns) is 8 to 10 percent; permeability is medium.
- 330 Limestone; grainstone (micritized); miliolid, mollusc fragments, large lumps, interlacing microsparite network; porosity (intraparticle, intercrystal, vugs) is 10 to 15 percent and connected by intercrystal; permeability is medium.
- 334 Limestone; grainstone; large miliolids, mollusc fragments, lumps; microsparite cement; porosity (intercrystal, intraparticle, vugs) is 10 percent; permeability is low to medium.
- 336 Limestone; mudstone to wackestone; few mollusc fragments; some microsparite; porosity is 5 percent; permeability is low.
- 337 Limestone; no original texture; mosaic of tightly interlocking anhedral and subhedral rhombs (20 to 40 microns); porosity is 5 percent; permeability is low.
- 339 Limestone; grainstone/packstone; large (more than 1,000 microns) rounded lumps containing miliolids, algal fragments, mollusc fragments in a microsparite matrix; porosity (intercrystal, intracrystal, interparticle, intraparticle, vugs) is greater than 15 percent; permeability is medium to high.
- 340 Limestone; grainstone/packstone (highly micritized); mollusc (*Gryphaea*) fragments, algal fragments, lumps; microsparite groundmass; porosity (intercrystal, intraparticle, moldic, vugs 50 to 200 microns) is 10 percent; permeability is low.
- 341 Limestone; grainstone; foraminifera, algal filaments, *Gryphaea* and other pelecypod fragments, intraclasts; microsparite groundmass; porosity (interparticle, intraparticle, intercrystal, moldic) is 5 to 20 percent; porosity is well interconnected; permeability is medium to high.
- 353 Limestone; no original texture; ghost mosaic of large, irregular calcite and disseminated anhedral to subhedral rhombic pseudomorphs after dolomite; porosity (intercrystal, vugs) is 15 to 20 percent and well interconnected; permeability is high.
- 355 Limestone (highly micritized); packstone; ovoid to spherical particles (200 microns) in a microsparite groundmass; porosity (intercrystal, scattered vugs) is 10 percent; permeability is medium.



Depth  
(feet)

- 369 Limestone (highly micritized); grainstone to packstone; miliolid, algal filaments, pelecypods; rhombic molds; microsparite ground-mass; porosity (intercrystal, intraparticle, vugs) is 10 to 15 percent; permeability is low to medium.
- 384 Limestone; wackestone; foraminifera, mollusc fragments; open fractures; contact between a less porous wackestone and a highly porous, leached grainstone containing completely micritized grains; porosity (fractures, moldic, vugs) is 10 to 15 percent; permeability is medium to high.
- 401 Limestone; mudstone; spherical ghosts, mollusc fragments, echinoderm fragments; microsparite fills interparticle space; porosity (intercrystal, small vugs) is 5 to 10 percent; permeability is medium.
- 431 Limestone; mudstone; Gryphaea fragments, miliolid ghosts, small skeletal fragments; micrite particles outlined microsparite; porosity (intercrystal, vugs less than 50 microns) is 5 percent; permeability is low.
- 446 Limestone (highly micritized); grainstone; large (500 to 1,000 microns) rounded ovoid to elongate micrite particles outlined by microsparite; eroded pelecypod fragments; porosity (intraparticle, intercrystal, moldic) is 10 to 15 percent; permeability is medium to high.
- 465 Limestone (dolomitic); wackestone; mollusc fragments, numerous euhedral rhombs (to 80 microns), oil stained stylolites, dolomitized burrows, chert flakes; porosity is less than 5 percent; permeability is low.
- 491 Limestone (dolomitic); wackestone; miliolid ghosts, mollusc fragments, quartz or gypsum flakes; fracture filled with microsparite; organic staining; porosity is low; permeability is low.
- 494 Limestone (dolomitic); mudstone; laminated with layers of sucrosic dolomite and micrite; gypsum flakes; open fracture; porosity is developed in the rhombic layers; porosity (intercrystal, vugs) is 10 percent; permeability is low.
- 501 Limestone (dolomitic); mudstone; numerous miliolid ghosts; euhedral rhombs (40 microns); stylolites stained with limonite and organics; gypsum or quartz flakes; contact between dolomitized and non-dolomitized rock; micritized pellets in dolomitized rock; porosity is low; permeability is low.
- 513 Dolomite; uniform, very fine grained dolomite with subhedral grains (20 microns); contact between miliolid grainstone and dolomite; gypsum flakes in both types; porosity is low; permeability is low.

Depth  
(feet)

- 515 Dolomite; no original texture except for molds; interparticle space is a network of euhedral rhombs (30 to 60 microns), gypsum flakes, organic stain; porosity (intercrystal, moldic) is greater than 30 percent and well connected; permeability is high.
- 517 Dolomite; as above; porosity is high.

Table 19.--Mineralogy of core samples as determined by X-ray diffraction analysis: Lockhill (AY-68-28-404)

Depth (feet)	Mineral composition (percent)			Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz		Calcite	Dolomite	Quartz
270-271	100	0	0	294-295	100	0	0
271-272	92	0	8	295-296	100	0	0
272-273	100	0	0	296-297	100	0	0
273-274	98	2	0	297-298	99	<1	0
274-275	98	2	0	298-299	99	<1	0
275-276	98	2	0	299-300	100	0	0
276-277	97	3	0	300-301	100	0	0
277-278	96	4	0	301-302	100	0	0
278-279	90	10	0	302-303	100	0	0
279-280	88	12	0	303-304	99	1	0
280-281	86	14	0	304-305	100	0	0
281-282	94	6	0	305-306	100	0	0
282-283	97	0	3	306-307	99	<1	0
283-284	100	0	0	307-308	99	<1	0
284-285	100	0	0	308-309	100	0	0
285-286	99	<1	0	309-310	99	<1	0
286-287	100	0	0	310-311	99	<1	0
287-288	100	0	0	311-312	100	0	0
288-289	100	0	0	312-313	99	<1	0
289-290	100	0	0	313-314	100	0	0
290-291	100	0	0	314-315	99	<1	0
291-292	100	0	0	315-316	94	<1	5
292-293	100	0	0	316-317	100	0	0
293-294	100	0	0	317-318	100	0	0

Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz
318-319	100	0	0
319-320	99	0	1
320-321	100	0	0
321-322	98	0	2
322-323	98	2	0
323-324	98	2	0
324-325	100	0	0
325-326	100	0	0
326-327	99	1	0
327-328	100	0	0
328-329	100	0	0
329-330	100	0	0
330-331	99	1	0

Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz
331-332	96	0	4
332-333	100	0	0
333-334	100	0	0
334-335	100	0	0
335-336	98	2	0
336-337	100	0	0
337-338	94	2	4
338-339	94	2	4
339-340	99	<1	0
340-341	100	0	0
341-342	100	0	0
342-343	100	0	0

Table 20.--Porosity characteristics of core samples as determined by laboratory tests: Lockhill (AY-68-28-404)

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury <sup>1</sup> )						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden <sup>2</sup> of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury-injection test	Air-injection test	Air-injection pressure atmosphere			500	1000	2000
61	--	--	--	--	--	--	--	--	--	--	--	2.70	--	--	--	--
75	--	--	--	--	--	--	--	--	--	--	--	2.72	--	--	--	--
83	--	--	--	--	--	--	--	--	--	--	--	2.70	--	--	--	--
129	--	--	--	--	--	--	--	--	--	--	--	2.73	--	--	--	--
157	--	--	--	--	--	--	--	--	--	--	2.0	2.77	--	--	--	--
185	--	--	--	--	--	--	--	--	--	--	2.0	2.68	--	--	--	--
192	--	--	--	--	--	--	--	--	--	--	--	2.71	--	--	--	--
199	--	--	--	--	--	--	--	--	--	--	--	2.71	--	--	--	--
219	--	--	--	--	--	--	--	--	--	1.4	1	2.68	--	--	--	--
220	25.2	--	--	--	--	--	--	--	--	5.0	0.2	2.66	2.6	--	--	--
230	--	--	--	--	--	--	--	--	--	4.3	1	2.64	--	--	--	--
250	11.7	12.2	0.0	0.0	0.0	0.0	61.7	90.4	0.19	--	0.12	2.70	61.2	--	--	--
272	5.3	5.3	2	4	5	5	30	90	--	--	--	2.69	--	--	--	--
275	2.0	--	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	2.72	--	--	--	--
277	5.1	5.0	0.0	2	2	2	6	90	--	--	--	2.71	--	--	--	--
280	18.6	3.5	7	8	10	10	16	20	--	--	--	2.71	--	--	--	--
283	--	--	--	--	--	--	--	--	--	--	--	2.70	--	--	--	--
285	5.7	4.5	1	4	19	42	72	78	--	3.2	1.0	2.71	--	--	--	--
289	--	15.4	11.7	41.3	56.8	70.9	91.5	96.1	19	--	--	2.70	24.2	--	--	--
290	26.9	24.8	20	66	84	88	92	92	--	350	0.1	2.74	--	--	--	--
297	21.1	20.0	9	70	93	94	94	94	--	390	0.1	2.68	--	--	--	--
305	8.9	8.4	46	66	82	90	94	94	--	1700	0.1	2.69	--	--	--	--
310	11.3	10.9	22	64	80	88	95	96	--	--	--	2.65	--	--	--	--
320	4.7	0.4	0.0	0.0	0.0	3	8	9	--	--	--	2.72	--	--	--	--

<sup>1</sup>Percent of effective porosity intruded by mercury =  $\frac{\text{injection pressure}}{\text{pore throat radius}}$  /  $\frac{\text{pore throat radius}}{\text{microns}}$   
 (pounds per square inch)

<sup>2</sup>Effective overburden in pounds per square inch.

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury)						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury- injection test	Air- injection test	Air-injection pressure atmosphere			500	1000	2000
334	0.8	0.6	0.0	0.0	0.0	10	30	44	--	0	--	2.65	--	--	--	--
341	--	21.4	5.3	20.5	42.4	60.1	85.9	93.4	21.4	--	--	2.70	55.7	--	--	--
353	19.8	19.2	67	88	94	96	96	96	--	720	--	2.69	--	--	--	--
355	16.7	15.5	0.0	0.0	6	29	91	91	--	--	--	2.69	80.4	--	--	--
369	--	18.1	0.0	0.0	0.0	9.6	85.9	92.6	1.6	--	--	2.70	52.9	--	--	--
401	--	--	--	--	--	--	--	--	--	9.4	0.75	2.74	77.3	--	--	--
431	--	--	--	--	--	--	--	--	--	--	--	2.66	--	--	--	--
446	--	--	--	--	--	--	--	--	--	100	0.3	2.69	--	--	--	--
465	--	--	--	--	--	--	--	--	--	0.44	1.0	2.71	--	--	--	--
474	--	--	--	--	--	--	--	--	--	--	--	2.73	--	--	--	--
491	--	--	--	--	--	--	--	--	--	5.0	1.0	2.71	--	--	--	--
501	--	--	--	--	--	--	--	--	--	--	--	2.70	--	--	--	--
513	--	--	--	--	--	--	--	--	--	--	--	2.82	--	--	--	--
517	--	--	--	--	--	--	--	--	--	2.80	1.1	2.75	--	--	--	--

Table 21.--Test-hole completion summary: Castle Hills (AY-68-28-910)

Location: Bexar County, San Antonio, Tex., on city property between Southern Pacific Railroad right-of-way and west end of Cedar Elm Road (Castle Hills quadrangle).

Elevation of land surface: 815 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources (Failing 1500 core-drilling rig, modified).

Spudded: February 5, 1974.

Completed: April 9, 1974.

Casing: 6-1/4-inch inside diameter to 216 feet.

Total depth: 804 feet (driller); 802 feet (log).

Coring equipment: Christensen 10-foot double-wall mining core barrel 5-3/4x4 inches to 579 feet. Acker 10-foot double-wall core barrel 5-1/2x4 inches, 579 to 784 feet. Christensen 10-foot double-wall mining core barrel 5-3/4x4 inches (modified, inner barrel stabilized), 784 to 804 feet. Four diamond-core heads of 71 to 81 carats, 20 stones per carat. Bottom discharge with 16 waterways. One tungsten carbide insert core head.

Core-recovery summary: Total footage cored, 596 feet; total core recovered, 488.6 feet; and percentage of recovery, 82 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
216-224	8.0	6.8	6.8
234	10.0	9.6	16.4
244	10.0	10.0	17.4
254	10.0	10.0	18.4
264	10.0	9.7	28.1
274	10.0	10.0	38.1
284	10.0	10.0	48.1
294	10.0	9.0	57.1
300	6.0	3.8	60.9
306	6.0	6.0	66.9
316	10.0	8.0	74.9
323	7.0	5.0	79.9
330	7.0	4.3	84.2
340	10.0	7.0	91.2
342	2.0	1.6	92.8
346	4.0	3.0	95.8
354	8.0	7.2	103.0

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
362	8.0	6.4	109.4
369	7.0	6.0	115.4
378	7.0	5.4	120.8
385	7.0	4.0	124.8
390	5.0	3.0	127.8
396	6.0	5.2	133.0
406	10.0	10.0	143.0
416	10.0	10.0	153.0
426	10.0	7.5	160.5
433	7.0	6.5	167.0
439	6.0	5.6	172.6
449	10.0	6.5	179.1
455	6.0	6.0	185.1
460	5.0	4.0	189.1
465	5.0	4.5	193.5
475	10.0	3.3	196.8
480	5.0	4.0	200.8
485	5.0	3.5	204.3
490	5.0	1.2	205.5
494	4.0	2.8	208.3
496	2.0	1.0	209.3
496-504	8.0	7.5	216.8
505	1.0	1.0	217.8
509	4.0	3.0	220.8
515	6.0	4.5	225.3
520	5.0	4.0	229.3
526	6.0	5.6	234.9
532	6.0	6.0	240.9
538	6.0	1.8	242.7
544	6.0	4.8	247.5
549	5.0	3.4	250.9
557	8.0	4.0	254.9
562	5.0	4.0	258.9
566	4.0	4.0	262.9
572	6.0	6.0	268.9
574	2.0	0.5	269.4
579	5.0	5.0	274.4
587	8.0	3.8	278.2
592	5.0	5.0	283.2
600	8.0	8.0	291.2
608	8.0	8.0	299.2
616	8.0	7.2	306.4
626	10.0	10.0	316.4
636	10.0	7.0	323.4
644	8.0	8.0	331.4
654	10.0	10.0	341.4
664	10.0	9.6	351.0
674	10.0	9.2	360.2
684	10.0	10.0	370.2
694	10.0	9.5	379.7
704	10.0	9.8	389.5



<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
714	10.0	10.0	399.5
724	10.0	10.0	409.5
734	10.0	9.7	419.2
744	10.0	10.0	429.2
754	10.0	10.0	439.2
764	10.0	10.0	449.2
774	10.0	9.7	459.0
784	10.0	10.0	469.0
794	10.0	9.9	478.9
804	10.0	9.8	488.6

Notes: Core recovery was 82 percent but 10 to 15 percent of the recovered core was shattered. This shattered core was suitable gross lithology and core recovery estimates.

The use of a double-wall core barrel with a poorly stabilized inner barrel probably caused the excessive shattering. The different rotation rates between the inner and outer barrels caused the core to shatter whenever a fracture or irregularity was encountered.

A further cause of shattered core may have been the slow and erratic penetration rate that varied from 4 to 30 minutes per foot.

The introduction, at a depth of 579 feet, of an Acker core barrel with a stabilized inner barrel resulted in an increase in core recovery to 96 percent.

The inner barrel of the original tool was stabilized and used to core the last 20 feet. The recovery rate increased to 98-99 percent on 10-foot runs. The increased penetration rate of 2-3 minutes per foot produced no shattered core.

Table 22.-- Description of test-hole cores: Castle Hills (AY-68-28-910)

Depth (feet)	Description
216-221	Limestone; color, 10YR 8/3; texture, mudstone and wackestone. Dense, chalky biomicrite with <u>Gryphaea</u> , <u>Kingena</u> and clams abundant in the upper 1.5 feet. The lower 2 feet are marly and thinly bedded with many small pyrite crystals. Limonite staining and solution along bedding planes and fractures. -- at 220 - X-ray diffraction analysis (table 24); laboratory test (table 25).
221-234	Limestone; color, 10YR 7/2; texture, wackestone and mudstone. Dense, chalky rudists, clams and <u>Gryphaea</u> biomicrite with numerous scattered pyrite crystals. Solution along bedding planes. Some vugs after rudists. -- at 221 - Caprinid mold lined with drusy calcite. -- at 230 - X-ray diffraction analysis (table 24); laboratory test (table 25). -- at 232-234 - Dense, porcelaneous mudstone with an open (0.5-inch) vertical fracture which is partially calcite-healed.
234-240	Limestone; color, 10YR 8/1,8/2; texture, mudstone. Dense, porcelaneous micrite with high-angle and vertical fractures and some fracture-associated breccia. A partially calcite-healed fracture opens below the 237-foot level to reveal black specks and stains (manganese?). -- at 239.4 - Brown clay (2-3 inches). -- at 240 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).
240-258	Limestone; color, 10YR 7/2,8/2; texture, grainstone. Biosparite--a recrystallized rudist and fossil fragment coquina with large vugs after caprinids and slightly argillaceous zones. Few fractures. -- at 242.5-243 - Large rudist molds. -- at 250 - Thin-section description (table 23); laboratory test (table 25).
258-268	Limestone; color, 10YR 8/1,8/2; texture, grainstone. Rudist biosparite and fossil fragment coquina becoming more chalky with more oxidized chert below the 260-foot level. Few high-angle or vertical fractures. -- at 260 - X-ray diffraction analysis (table 24); laboratory test (table 25).
268-278	Limestone; color, 10YR 8/1,8/2; texture, mudstone and grainstone. Micrite and biosparite with chalky fossil fragment coquina that is sucrosic towards the base. Few high-angle fractures. -- at 267.2 - 1-inch chert bed composed of dirty white, dull and opaque chert. -- at 268 - 1-1/2-inch chert bed composed of dark brown, greasy, subtranslucent chert. -- at 270 - Thin-section description (table 23); laboratory test (table 25).
278-287	Limestone; color, 10YR 7/2; texture, mudstone and wackestone. Burrowed and mottled micrite with dessication fractures, high-angle and vertical fractures and breccia towards the base. -- at 278 - Possible trace of dead oil. -- at 280 - X-ray diffraction analysis (table 24); laboratory test (table 25). -- at 282.5-283 - Black irregular chert vein. -- at 285-287 - Possible collapse zone with pink sparry calcite crystals in breccia.
287-298	Limestone; color, 10YR 8/2; texture, mudstone and crystalline carbonate. Dense, recrystallized carbonate. Dense, recrystallized, burrowed and brecciated mudstone and crystalline carbonate. -- at 287.7 - 1/4-inch tan clay seam overlain by 1-inch bed of sparite in a dense micrite. -- at 288.5 - Algal mat. -- at 290 - Thin-section description (table 23); laboratory test (table 25). -- at 292-292.5 - Wispy shale stringers. -- at 294-295 - Reddish-purple clay seam and algal mat, terra rosa in solution zones. -- at 295.8-296 - Dull, opaque gray-brown chert nodule.
298-309	Limestone; color, 10YR 6/1,7/2; texture, mudstone-wackestone. Dense micrite with breccia and wispy laminations. -- at 300 - X-ray diffraction analysis (table 24); laboratory test (table 25). -- at 300.8 - Chert nodules. -- at 301 - Thin-section description (table 23). -- at 302 - X-ray diffraction analysis (table 24). -- at 303 - Thin-section description (table 23). -- at 304 - Thin-section description (table 23); X-ray diffraction analysis (table 24). -- at 304-306 - Mudstone breccia with chert. -- at 305 - Thin-section description (table 23).

Depth  
(feet)

- 440 Limestone; grainstone; fragments have micritic rims, micrite or microsparite interiors; less altered mollusc fragments; fragments are 200 to 1,000 microns; porosity (intercrystal, interparticle, intraparticle, vugs) is 5 to 10 percent; permeability is low to medium.
- 461 Limestone; grainstone; coarse sparite grains outlined by micrite; mollusc fragments (larger than 1,000 microns); dolomite rhombs; chert; porosity is low.
- 483 Limestone (recrystallized); mosaic of large calcite crystals; ghost inclusions; relict stylolite; porosity (large irregular, angular vugs) is high; permeability is medium.
- 501 Limestone (recrystallized); stylolite; porosity is greater than 30 percent; permeability is high.
- 517 Limestone (recrystallized); porosity is high; permeability is high.
- 542 Limestone (recrystallized); porosity is high; permeability is high.
- 559 Limestone; wackestone; highly micritized miliolids, mollusc fragments, foraminifera, skeletal fragments; organic staining; isolated, angular chert fragment in matrix; stylolites; porosity (isolated vugs) is less than 5 percent; permeability is low.
- 560 Limestone; wackestone; micritized foraminifera, mollusc fragments; porosity (isolated vugs to 100 microns) is 5 to 8 percent; permeability is medium.
- 582 Limestone (recrystallized); no original texture; mosaic of anhedral crystals (30 to 60 microns); porosity (intercrystal, vugs) is 5 to 8 percent; permeability is low.
- 598 Limestone; wackestone; highly micritized miliolids, skeletal fragments; porosity (vugs) is low; permeability is low.
- 621 Limestone; grainstone; highly micritized miliolids, algal fragments; microsparite cement; porosity (interparticle, intraparticle, vugs 50 to 150 microns) is 10 to 15 percent; permeability is low.
- 640 Dolomite (limy); wackestone; mosaic of euhedral to subhedral rhombs (20 to 40 microns) replacing micrite; random skeletal fragments; porosity is very low; permeability is very low.
- 649 Limestone; mudstone; miliolids, mollusc fragment; foraminifera, organic material; porosity is very low; permeability is low.
- 669 Limestone; mudstone to wackestone; mollusc fragment, miliolids, skeletal debris, scattered angular chert, organic stains; porosity (vugs less than 100 microns) is 5 percent; permeability is low.

Depth  
(feet)

- 679 Limestone (dolomitic); wackestone; micritized skeletal debris, foraminifera; flakes of angular chert; stylolites; abundant dolomite rhombs (20 to 40 microns); porosity is low; permeability is low.
- 687 Limestone; wackestone to packstone; micritized mollusc fragments, black organically stained particles; scattered small rhombs; scattered angular chert flakes; numerous stylolites lined with organic material; porosity is very low; permeability is low.

Table 35.--Porosity characteristics of core samples as determined by laboratory tests: Sabinal (YP-69-37-402)

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury <sup>1</sup> )						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot with effective overburden <sup>2</sup> of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury-injection test	Air-injection test	Air-injection pressure atmosphere			500	1000	2000
301	--	20.6	14.3	28.9	44.4	70.0	92.8	98.5	28	--	--	2.70	2.53	--	--	--
325	6.6	--	--	--	--	--	--	--	--	0.04	--	2.70	--	--	--	--
340	5.4	--	--	--	--	--	--	--	--	0.09	--	2.69	--	--	--	--
380	--	15.1	7.5	10.7	15.4	28.7	90.7	98	1.3	--	--	2.70	88.8	--	--	--
405	3.1	--	--	--	--	--	--	--	--	0.01	--	2.68	--	--	--	--
421	12.3	--	--	--	--	--	--	--	--	0.57	--	2.70	--	--	--	--
440	1	10.2	5.6	6.6	7.2	8.0	54	96.2	0.03	--	--	2.70	247	--	--	--
461	4.6	--	--	--	--	--	--	--	--	0.1	--	2.71	--	--	--	--
483	--	17.5	60.4	67.5	70.9	74.5	81.1	83.6	4930	--	--	2.69	38.3	--	--	--
501	--	14.5	63.5	68.1	70.8	72.2	77.9	81.8	2060	--	--	2.67	58.7	--	--	--
517	13.3	--	--	--	--	--	--	--	--	0.02	--	2.69	268	--	--	--
542	7.9	--	--	--	--	--	--	--	--	2430	--	2.70	--	--	--	--
560	--	5.2	--	--	--	--	--	--	0.02	--	--	--	253	--	--	--
582	3.8	--	--	--	--	--	--	--	--	7.8	--	2.69	--	--	--	--
598	13.3	--	--	--	--	--	--	--	--	0.27	--	2.69	--	--	--	--
621	--	6.0	0.0	0.0	0.0	8.2	27.8	36.8	0.02	--	--	2.70	126	--	--	--
640	7.5	--	--	--	--	--	--	--	--	0.04	--	2.73	--	--	--	--

-147-

<sup>1</sup>Percent of effective porosity intruded by mercury =  $\frac{\text{injection pressure (pounds per square inch)}}{\text{pore throat radius (microns)}}$

<sup>2</sup>Effective overburden in pounds per square inch.

Table 36.--Description of cores from Texas Department of Water Resources test hole  
DX-68-23-202, Comal County

Depth (feet)	Description
275-289	Limestone; white to light yellow--buff, very hard except for short sections of porous rock; dense, recrystallized with scattered megafossil molds; intraclasts and a suggestion of brecciation. Mudstone or recrystallized wackestone with fenestral type pores; fractures, some with calcite, and large iron-stained vugs; porosity of matrix is less than 5 percent and secondary porosity is low.
289-298	Limestone; white to yellow, tan, gray-pink and mottled. Very hard except for friable, grainy material in burrows; isolated megafossils (rudists?); matrix porosity is less than 5 percent.
298-309	Limestone; white to light gray; hard with soft zones; recrystallized; zones of fossil hash. Mudstone and grainstone that is recrystallized with iron staining, rudists and gastropods; matrix porosity is 10 to 15 percent.
310-327	Limestone; white to gray; very hard, dense with few fossils except in lenses; porosity is 5 to 10 percent.
327-344	Limestone; white to light gray; mottled; fossil hash with large fossils; chalky grainstone that is leached; vertical fractures; no bedding; porosity is 10 to 15 percent.
345-365	Limestone; white; very hard to hard; fossil grainstone to 348 feet; below 348, fewer fossils and more mudstone; burrowed with honeycomb vugs; 351-363, possibly moldic after gypsum; 362-365, very dense recrystallized mudstone; porosity less than 10 percent.
365-376	Limestone; tannish-white to gray-white; very hard; fossil hash sparite forms grainstone; 365-370, mudstone with large vugs; 370-376, porous grainstone (more than 10 percent).
376-389	Limestone; whitish-gray; very hard, burrowed mudstone with some grainstone; open vugs in burrows; at 389 feet, cave nodules; vugular porosity.
390-396	Limestone; white to tan dolomite; hard, fossiliferous mudstone with very fine sucrosic dolomite; burrowed, bioturbated with grainstone lens; iron-stained fracture; porosity is greater than 10 percent.
396-411	Limestone and dolomite; light gray to dark gray; wavy with thin shale laminae at 410-411 feet; low porosity.
411-421	Dolomite and limestone; medium gray to mottled, dark gray; bioturbated with wavy shale laminae; stylolites; small black rotund bodies.

Table 37.--Description of cores from Texas Department of Water Resources test hole TD-69-39-504, Medina County

Depth (feet)	Description
90-96	Limestone; whitish, light tan with blotches of orange tan, hard caprinid grainstone with many fossil fragments; caprinids are in growth position; sparite cement, some of the rock is recrystallized. Porosity is about 10 percent; vugs or molds after caprinids, permeability is good; iron stains indicate circulation of freshwater; matrix is cemented with sparite or filled with recrystallized micrite.
97-105	Limestone; whitish tan with orange staining along fractures and vugs; zones of softer chalky rock; porosity about 10 to 15 percent; large vugs and molds, open fractures up to 2 millimeters in width.
105-115	Limestone; grayish white, with caprinids, sparite, some chert and recrystallized, burrowed wackestone and mudcracks in places; porosity about 10 percent.
115-126	Limestone; grayish tan to white, mottled with blotches of dark gray in tan matrix. Hard to crumbly rock, burrowed mudstone (much core loss); dessication cracks filled with calcite, chert; low matrix porosity.
126-136	Limestone; grayish tan, hard to chalky along seams with fossil fragments and occasional whole <i>Toucasia</i> ; wackestone and grainstones; porosity is 5 to 10 percent, vugs, open fractures, and fenestral porosity.
136-152	Limestone; grayish tan to light tan, mottled, isolated oysters; hard with softer zones; bioturbated with mudstone, chert; low matrix porosity.
152-176	Limestone; whitish gray, hard to chalky, softer and less dense than above, leached, burrowed mudstone; higher porosity than above unit with openings and large vugs.
176-216	Limestone; tannish gray to tannish white, hard to medium hard; very few fossil grains but with many small, tightly cemented, mudstone lithoclasts; burrowed and leached; isolated large vugs with zones of highly leached chalky rock; at 216, zone of fossil fragment grainstone.
217-248	Limestone; light gray to whitish tan, hard to chalky, with a few large fossils, caprinids and <i>Toucasia</i> , wackestone with some grainstone; vugular with open fractures; porosity is greater than 20 percent.
248-285 much core loss	Limestone; whitish gray to tan, hard to medium hard, with a few isolated fossil grains; wackestone and some chalkified grainstone; some chert; scattered vugs; porosity is 5 to 10 percent.
261-285	Limestone; medium gray with orange-stained vugs, hard mudstone and wackestone; vugular (honeycomb rock) formed in leached burrows; porosity is more than 25 percent.
285-292	Limestone; gray, dense burrowed mudstone; honeycombed rock has rounded calcite deposits suggesting a vadose origin; excellent permeability in burrows. (Note: Much natural water movement in this zone.)
292-303	Dolomitic limestone; gray, very finely crystalline, dolomitized mudstone with finely sucrosic zones, dessication cracks and some wispy partings; porosity is about 10 percent; at 300, large vugs filled with calcite.
303-323	Limestone; gray to tannish gray, hard to medium hard, mudstone, packstone and some grainstone; somewhat leached and chalky with micritized foraminifera. -- at 305 - Miliolid grainstones. -- at 306 - Dolomitic mudstone. -- at 308 - Porous grainstone. -- at 311-314 - Foraminifera grainstone. -- at 314-323 - Dolomitized shaly mudstone with isolated organic blebs; thin fractures filled with calcite; low porosity.
323-330	Shaly dolomite; gray, hard to medium hard mudstone with wispy shale partings, very thin undisturbed laminations; few inclined, calcite-filled fractures; very low porosity.

Depth (feet)	
330-355	Limestone; whitish tan to gray, medium hard miliolid and fossil fragment grainstone and packstone with micritized foraminifera; bedding planes indistinct; porosity is 5 to 10 percent; low permeability in matrix.
356-373	Limestone; light gray, medium hard to hard, fine grained packstone and wackestone changing to mudstone toward bottom; lithoclasts of mudstone at 370-371; more porous and bioturbated in upper part; some thin beds of laminated rock and few fossils in lower part; mostly chalky porosity.
373-419	Limestone; gray with whitish gray blotches, hard, dense, with no grains; mudstone and possibly recrystallized evaporites; no fossils, some chert; variable porosity and permeability; very large vugs lined with dogtooth spar in upper part.
419-439	Limestone; mottled medium gray to light gray; no grains; some collapse zones of mudstone breccia cemented with recrystallized calcite and chert. -- at 434 - Mottled limestone appears to be burrowed, but with no fossils; high vugular porosity interspersed in zones of dense rock.
439-457	Limestone; medium gray to light gray, somewhat mottled to shades of gray; recrystallized rock and mudstone toward base with scattered zones of laminated bedding; very few fossils; vugular porosity in dense recrystallized matrix; some inclined fractures partially filled with calcite; porosity is 5 to 15 percent.
457-473	Limestone; medium gray to tannish white, recrystallized mudstone with fossil grainstone toward bottom; well developed open and vertical fractures up to 1/2-inch wide; vuggy zone with variable porosity up to 25 percent; interparticle porosity in grainstone; good permeability in upper part, in vuggy zones and along fractures.
473-487	Limestone; medium gray to tannish gray, hard, recrystallized fossil fragment grainstone in the upper part grading to dolomitic mudstone in the lower part; very few fossils to unfossiliferous with no evidence of bioturbation toward bottom; uniform, dense sucrosic mudstone; porosity is low to moderate, with some large isolated vugs and chalky porosity in grainstone.
487-501	Dolomitic limestone; medium gray, hard, nonfossiliferous with mudstone lithoclasts in breccia zone; very fine crystalline, sucrosic mudstone with 1-inch beds of fossils bounded by sucrosic mudstone. -- at 488-495 - Low porosity, no large vugs, some sucrosic porosity and low permeability. -- at 495-501 - Interparticle porosity to 15 percent. -- at 500 - Narrow zones of porous honeycomb structures with rounded calcite deposits.
502-515	Limestone and dolomitic limestone; medium gray to light gray with some buff tan; hard, very finely crystalline mudstone and dolomitic limestone; <u>Toucasia</u> wackestone and grainstone in upper part; thin beds of miliolid grainstone toward top; mudstones are uniform and do not show evidence of bioturbation. -- at 505 - Stylolites. -- at 507 - Low porosity, vuggy zone with few fractures and some sucrosic porosity toward bottom.
515-537	Dolomitic limestone; medium gray, hard, nonfossiliferous mudstone with isolated <u>Toucasia</u> , and a few 1- to 2-inch beds of broken fossils; burrowed and laminated at places; porosity is less than 10 percent.
537-557	Dolomite; light brown to tan, mottled, medium hard, very finely sucrosic dolomite; nonfossiliferous with mudstone lithoclasts up to 1-inch, small dessication cracks filled with calcite and a few large, isolated vugs lined with dogtooth calcite. Vugs related to burrows; sucrosic porosity is more than 20 percent. -- at 543 - Breccia. -- at 545 - Stylolites. -- at 553 - Open fracture. -- at 556 - Algal mat, shaly mudstone.
557-575	Dolomitic limestone and dolomite; whitish tan, medium hard, leached grainstone and mudstone; variable porosity (sucrosic and moldic) from less than 5 to greater than 20 percent. -- at 558 - Well-leached grainstone. -- at 571 - Vugular porosity.
575-602	Dolomite; light tan with darker mottling; medium hard to hard, very finely sucrosic mudstone; bioturbated and burrowed; chert; isolated vugs in dessicated zones; porosity is 10 to 20 percent.



Depth  
(feet)

602-617

Dolomite; light to medium brown, mottled with dark brown, very finely sucrosic, bioturbated mudstone and wackestone with some miliolid grainstone; sucrosic porosity is about 20 percent with small dessication cracks and isolated vugs.  
-- at 604 - Leached miliolid grainstone.  
-- at 617 - Stylolite.

617-650

Dolomite, limy, shaly; dark gray green with mottled black blotches; bioturbated mudstone and wackestone with many stylolites, black rotund bodies, shaly partings and isolated large fossils; low porosity overall but has isolated porous zones.

Table 38.-- Description of cores from Texas Department of Water Resources test hole  
YP-69-42-709, Uvalde County

Depth (feet)	Description
70-146	Limestone; whitish, light buff with orange oxidized zones along bedding planes; hard to medium hard, chalky mudstone with beds of leached, fine grained grainstone; zone appears homogeneous and uniform overall with few macrofossils; matrix porosity is low but contains porous zones; matrix permeability is low to very low and results from openings along fractures and scattered bedding planes. -- at 71 - Stylolites. -- at 71-74 - A dense, uniform mudstone, shaly with very low porosity. -- at 74 - Speckled orange. -- at 91-110 - Limestone; light buff, leached, fine grained with fossiliferous hash and foraminifera grainstone; very porous with good matrix porosity but moderate permeability; few fractures. -- at 110-146 - Limestone; light buff, very fine grained, miliolid-fossil hash grainstone; homogeneous with very few fractures; porosity is more than 20 percent, absorbs water quickly but drains slowly. Leached, with very small rounded molds after miliolids. Much core loss in this zone.
146-200	Limestone; light buff, medium hard to chalky, very fine grained miliolid grainstone and mudstone; homogeneous with small iron-stained open fractures; porous, leached rock with matrix porosity more than 20 percent; low permeability in matrix. -- at 160 - Chert.
200-400	Limetone; light tan to whitish buff, medium hard, chalky mudstone with very fine grained grainstone; narrow, inclined fractures with orange stains; chert; low to medium porosity. -- at 200 - Gray marl. -- at 212 - Gray chert. -- at 214-234 - Limestone; whitish light buff, medium hard. Homogeneous nonfossiliferous mudstone with no bedding planes and chalky, instant porosity. -- at 235-248 - Limestone; whitish light buff, chalky, homogeneous with chert at 237. -- at 248-250 - Limetone; whitish, chalky, leached fossil hash grainstone with chert; porosity is 25 percent. -- at 250-280 - Limestone; whitish, chalky, homogeneous mudstone; porosity is 10 to 20 percent; few fractures. -- at 280-400 - Limestone; whitish, chalky, homogeneous mudstone; low matrix permeability and few open fractures.
400-433	Limestone; gray to grayish brown, mottled to grayish white, hard, nonfossiliferous, brecciated with mudstone lithoclasts, algal structures, dessication cracks, and laminated and thinly bedded mudstone; vuggy porosity zones formed from evaporites; porosity is more than 25 percent in evaporites and less than 5 percent in dense mudstone.
433-452	Dolomitic limestone; gray to dark gray with tannish and mottled zones; hard and recrystallized in part; nonfossiliferous, algal mat mudstone with evaporite zones and breccia-filled dessication cracks, evaporites are recrystallized to coarse, dark gray mosaic spar; evidence of dessication; laminated; porous, vugular zones after evaporites; secondary porosity to 20 percent; iron stain on vugs in evaporites; dogtooth spar lines some vugs.
452-478	Limestone, shaly; light buff, medium hard, dense mudstone, with few laminated zones; fractures iron stained and filled with calcite; porosity is less than 5 percent.
478-512	Limestone, shaly with organic matrix; dark gray to dark greenish gray, nonfossiliferous uniform mudstone with some laminae. -- at 510-512 - Well developed laminae.
512-560	Limestone; tan to medium gray, dense, hard nonfossiliferous mudstone without noticeable bedding planes; very low porosity. -- at 527 - Chert after gypsum nodule. -- at 528 - Banded chert.
560-588	Limestone; tannish to light gray, dense, hard, oyster wackestone with packstone; low porosity.
588-642	Limestone; light gray to medium gray, hard, dense, wackestone, mudstone, and packstone; mostly oysters, with gastropods, stylolites and vertical fractures filled with calcite; porosity is less than 10 percent with very few vugs and fractures.

Depth  
(feet)

642-660

Limestone, shaly; dark gray, dense, nonporous mudstone, with organic seams, oysters and stylolites; mudstone has been "homogenized" by burrowing organisms, oysters. Porosity is less than 5 percent.

660-684

Limestone; light tan, dense, earthy wackestone and mudstone, with a few oysters and a vertical fracture filled with calcite; no large grains or well developed bedding planes; low porosity and permeability.

684-707

Limestone; dark gray, dense, bioturbated wackestone and mudstone with a few oysters; low porosity and permeability.

Depth  
(feet)

- at 306 - Thin-section description (table 23).
  - at 306-307 - Small, banded chert nodules.
  - at 307 - Thin-section description (table 23).
  - at 308 - Thin-section description (table 23).
  - at 308.3 - Reddish-purple and yellowish-brown shale stringers.
- 309-320 Limestone; color, 10YR 7/2,7/1; texture, mudstone. Micrite, brecciated and solutioned in the upper part. Highly fractured.
- at 309 - X-ray diffraction analysis (table 24).
  - at 310 - Thin-section description (table 23); laboratory test (table 25).
  - at 310-312 - Large calcite-lined vugs with clay infilling.
  - at 311 - X-ray diffraction analysis (table 24).
  - at 312 - Thin-section description (table 23).
  - at 312.4 - Stylolite.
  - at 313 - X-ray diffraction analysis (table 24).
  - at 316 - Thin-section description (table 23).
  - at 317 - X-ray diffraction analysis (table 24); thin-section description (table 23).
  - at 318 - Highly fractured with an opaque light purple chert nodule; X-ray diffraction analysis (table 24); thin-section description (table 23).
  - at 320 - Opaque, black and brown chert nodules; thin-section (table 23); laboratory test (table 25).
- 320-335 Limestone; color, 10YR 7/2,7/1; texture, mudstone. Dense, recrystallized and mottled micrite. Highly fractured and variably honeycombed with evidence of water flow along fractures.
- at 321 - X-ray diffraction analysis (table 24).
  - at 323 - Thin-section description (table 23).
  - at 323-323.2 - Dull tan chert nodules.
  - at 324 - Thin-section description (table 23).
  - at 324-324.6 - Honeycombed siliceous limestone with chert nodules and wispy shale filaments.
  - at 325 - Thin-section description (table 23); laboratory test (table 25).
  - at 326 - Thin-section description (table 23).
  - at 327 - X-ray diffraction analysis (table 24).
  - at 328 - Thin-section description (table 23).
  - at 329 - Dull black to tan opaque chert nodule; thin-section description (table 23).
  - at 330 - X-ray diffraction analysis (table 24).
  - at 331 - Thin-section description (table 23); laboratory test (table 25).
  - at 332.5 - Honeycomb structures.
  - at 333.2 - Fractured zone with light purple clay seam on bedding plane.
  - at 334 - X-ray diffraction analysis (table 24).
  - at 334.4-334.8 - Honeycomb structures.
- 335-348 Limestone; color, 10YR 7/2; texture, mudstone. Dense, recrystallized micrite with scattered Toucasia fragments, yellow mottling and random fractures.
- at 335 - X-ray diffraction analysis (table 24).
  - at 335.8 - Small nodule of clear quartz crystals.
  - at 336 - X-ray diffraction analysis (table 24).
  - at 337 - Thin-section description (table 23).
  - at 340 - Small chert nodule; thin-section description (table 23); laboratory test (table 25).
  - at 342 - 4-inch gray-white, mostly opaque and glassy chert bed.
  - at 345 - Thin-section description (table 23); laboratory test (table 25).
  - at 346 - Thin-section description (table 23).
  - at 346-347 - Toucasia and elongate vugs lined with milk-white quartz.
  - at 347 - Thin-section description (table 23).
- 348-354 Limestone; color, 10YR 7/2; texture, mudstone. Micrite with few fractures and rudists. Vuggy in the upper part and recrystallized in the lower.
- at 348 - X-ray diffraction analysis (table 24).
  - at 348.4-350 - Honeycombed.
  - at 349 - High-angle fractures with orange-brown clay stain.
  - at 350 - Thin-section description (table 23); laboratory test (table 25).
  - at 350.2 - Opaque to subtranslucent gray-tan chert nodule.
  - at 352 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
  - at 353 - X-ray diffraction analysis (table 24).
- 354-372 Limestone; color, 10YR 7/2,8/2; texture, mudstone to grainstone. Dense, micrite to biomicrite with Toucasia and some clay. Cavernous in the middle part with abundant terra rosa. Rock is oxidized to orange in this zone. Numerous fractures with honeycomb structure zones.

Depth  
(feet)

- at 354 - High-angle open fracture with orange-brown stain; thin-section description (table 23).
- at 355 - X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 356 - Small, tan chert nodules; thin-section description (table 23).
- at 357 - Thin-section description (table 23).
- at 358 - Thin-section description (table 23).
- at 358.3 - Large, light purple banded chert nodule.
- at 359 - Thin-section description (table 23); laboratory test (table 25).
- at 360 - Thin-section description (table 23).
- at 362.5-363 - Pale brown gummy clay which changes to a tough waxy light yellow-brown clay at 362.7
- at 364 - Thin-section description (table 23).
- at 365 - X-ray diffraction analysis (table 24).
- at 365.5-367.5 - Broken and nodular with internodular hard light yellow-brown clay.
- at 366 - Thin-section description (table 23).
- at 367 - Thin-section description (table 23); laboratory test (table 25).
- at 367.5-368 - Siliceous limestone with a 1-inch tan chert bed on top; upper surface of the limestone is bored and irregular and the overlying chert fills the borings.
- at 368 - X-ray diffraction analysis (table 24).
- at 371 - Thin-section description (table 23).
- at 371-372 - High-angle fracture with orange-brown stain.

372-390

Limestone; color, 10YR 7/2; texture, mudstone to wackestone. Dense, recrystallized micrite to biomicrite with scattered Toucasia fragments. High-angle fractures and a cave zone at the bottom.

- at 372 - Thin-section description (table 23).
- at 372-372.4 - Siliceous limestone; dull, opaque chert and translucent brown chert nodules.
- at 373 - Thin-section description (table 23).
- at 374 - Thin-section description (table 23).
- at 375 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
- at 376 - Thin-section description (table 23); laboratory test (table 25).
- at 376.4 - Glassy chert nodule.
- at 378 - X-ray diffraction analysis (table 24).
- at 379 - X-ray diffraction analysis (table 24).
- at 380 - Red-brown clay in nodular honeycomb zone; X-ray diffraction analysis (table 24).
- at 381 - Thin-section description (table 23); laboratory test (table 25).
- at 382 - X-ray diffraction analysis (table 24).
- at 384 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
- at 385 - X-ray diffraction analysis (table 24).
- at 385-387.8 - High-angle fracture with brown clay stain.
- at 386 - X-ray diffraction analysis (table 24).
- at 387 - Thin-section description (table 23).
- at 388 - Recrystallized (sparite), vugular, fractured and solutioned; thin-section description (table 23); laboratory test (table 25).

390-412

Limestone; color, 10YR 8/5, 7/1; texture, mudstone to wackestone. Dense, clayey micrite and biosparite with many wispy shale filaments, a few shale seams, megafossil fragments and calcite-healed vertical fractures.

- at 390 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
- at 390.5 - Soft, yellow-brown clay.
- at 392.2 - 1/4-inch clay bed and vertical fracture.
- at 392.5 - Soft clayey shale zone, dark gray to black.
- at 393.5 - 1/2-inch brown, gummy clay seam beside 1-inch wispy shale zone.
- at 394 - Vertical calcite-healed fracture.
- at 396.5-397.3 - Wispy shale filaments.
- at 397.3-397.7 - Laminated shale and limestone.
- at 398-398.2 - Weakly mottled and variably wispy shale.
- at 399.4-399.6 - Wispy, soft, brown shale.
- at 400 - Thin-section description (table 23).
- at 403.3 - Abrupt color change from gray above to tan-yellow below.
- at 404.8-405 - Shaly.
- at 406-406.3 - Stylolite.
- at 408-408.8 - Open vertical fracture with orange-brown clay stain.
- at 412.3-412.5 - Soft, marly zone.

415-462

Limestone; color, 10YR 8/2-8/3; texture, grainstone to packstone to mudstone. Variably chalky miliolid and fossil fragment biosparite with spar cemented miliolid biomicrite; wispy shale and stylolites. Variably fractured with some intraparticle porosity in miliolid zones. Porosity is seldom connected.

Depth  
(feet)

- at 417.5 - Stylolite and thin shale stringer.
- at 417.7-417.8, 418.5-419 - Wispy shale.
- at 420 - High-angle and vertical fractures; thin-section description (table 23); laboratory test (table 25).
- at 422 - High-angle and vertical fractures.
- at 428 - Stylolite and pale orange stained fracture.
- at 430 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 432.5 - Caprinid mold.
- at 434-435 - Dense micrite with chert, high-angle fractures, stylolites and a few rudist molds. Chert is purple-white and opaque.
- at 438 - Purple-white, dull, opaque chert.
- at 440 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 440-442 - Fractured with sparry calcite nodules and cave popcorn; porosity is high.
- at 442.4-442.6 - Small angular pieces of blue chert.
- at 443.5-444.8 - Friable and sponge-like.
- at 444.8-446.8 - Possible collapse zone with subangular limestone clasts and Toucasia fragments.
- at 450 - X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 451.5 - Chalky limestone with micrite clasts.
- at 455-456 - Highly burrowed micrite.
- at 460 - X-ray diffraction analysis (table 24).
- at 460-461.9 - Miliolid and fossil fragment grainstone cemented by sparry calcite; open high-angle fracture lined with calcite.
- at 461 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).

462-478

Limestone; color, 10YR 7/1; texture, mudstone to wackestone to crystalline carbonate. Highly fractured, chalky miliolid biomicrite with algal mats and chert.

- at 462 - Thin-section description (table 23).
- at 463 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
- at 464 - Thin-section description (table 23).
- at 465 - Thin-section description (table 23); laboratory test (table 25).
- at 465.2 - Tan-gray opaque chert.
- at 466 - Thin-section description (table 23).
- at 466.3 - Tan-gray opaque chert.
- at 467.8 - Pink chert nodule.
- at 468 - Bedding planes inclined about 10-15° from horizontal; thin-section description (table 23).
- at 469 - Thin-section description (table 23).
- at 470 - X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 471 - Thin-section description (table 23).
- at 472 - Thin-section description (table 23).
- at 473 - Thin-section description (table 23).
- at 474 - X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 475 - Vuggy and recrystallized; X-ray diffraction analysis (table 24).
- at 476 - Thin-section description (table 23).
- at 476.7-478 - Granular limestone fills burrows in sparry calcite.
- at 477 - Thin-section description (table 23); X-ray diffraction analysis (table 24).
- at 478 - Thin-section description (table 23).

478-492

Limestone; color, 10YR 8/2; texture, grainstone. Burrowed, mottled and recrystallized grainstone with grumous zones. Vuggy.

- at 479 - X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 480 - X-ray diffraction analysis (table 24).
- at 481 - X-ray diffraction analysis (table 24).
- at 482 - Thin-section description (table 23).
- at 483 - X-ray diffraction analysis (table 24).
- at 484 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).
- at 485 - 2-inch seam of hard, red-brown calcareous clay; thin-section description (table 23).
- at 485.5 - Sparry calcite with cave popcorn in vugs.
- at 486 - Thin-section description (table 23).
- at 490 - X-ray diffraction analysis (table 24).
- at 490-491 - Open high-angle and vertical fractures calcite-lined and stained yellow.
- at 491 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).

- Depth  
(feet)
- 492-503 Limestone; color, 10YR 8/2; texture, grainstone to mudstone. Recrystallized vugular limestone, burrowed and solutioned with boxwork vugs.  
 -- at 494 - Thin-section description (table 23).  
 -- at 496 - Thin-section description (table 23); X-ray diffraction analysis (table 24); laboratory test (table 25).  
 -- at 497 - Thin-section description (table 23).  
 -- at 498 - Thin-section description (table 23).  
 -- at 499 - X-ray diffraction analysis (table 24).  
 -- at 500 - Thin-section description (table 23); laboratory test (table 25).  
 -- at 502 - Thin-section description (table 23).
- 503-517 Limestone; color, 10YR 8/2; texture, grainstone to mudstone. Recrystallized and vugular with boxwork vugs.  
 -- at 503 - X-ray diffraction analysis (table 24).  
 -- at 504 - Open, high-angle fracture; thin-section description (table 23); laboratory test (table 25).  
 -- at 505 - X-ray diffraction analysis (table 24).  
 -- at 506 - X-ray diffraction analysis (table 24).  
 -- at 507 - X-ray diffraction analysis (table 24).  
 -- at 509 - Laboratory test (table 25).  
 -- at 510 - X-ray diffraction analysis (table 24).  
 -- at 511 - X-ray diffraction analysis (table 24).  
 -- at 512 - X-ray diffraction analysis (table 24); laboratory test (table 25).  
 -- at 514 - Thin yellow-brown shale beds; X-ray diffraction analysis (table 24).  
 -- at 516 - Stromatolite; X-ray diffraction analysis.
- 517-528 Limestone; color, 10YR 7/2; texture, wackestone to packstone. Dense, recrystallized limestone after laminated dolomite.  
 -- at 517 - X-ray diffraction analysis (table 24).  
 -- at 518 - Thin-section description (table 23).  
 -- at 519 - Miliolid biomicrite; X-ray diffraction analysis (table 24).  
 -- at 520-522 - Coquina.  
 -- at 521 - Thin-section description (table 23); laboratory test (table 25).  
 -- at 522 - X-ray diffraction analysis (table 24).  
 -- at 523 - X-ray diffraction analysis (table 24).  
 -- at 524 - Orange-brown clay in high-angle fracture; thin-section description (table 23); X-ray diffraction analysis (table 24).  
 -- at 524.6-525.6 - Laminated mudstone.  
 -- at 525 - Thin-section description (table 23).  
 -- at 526 - Thin-section description (table 23).  
 -- at 527 - Thin-section description (table 23).  
 -- at 527.5-528 - Fossil fragment coquina with good moldic porosity.  
 -- at 528 - Thin-section description (table 23); laboratory test (table 25).
- 528-541 Limestone; color, 10YR 7/2-8/2; texture, mudstone to grainstone. Dense to chalky, recrystallized with rudist molds and oxidized chert. Burrowed near the top and miliolid biosparite towards bottom. Zones of solution rounded and orange stained vugs.  
 -- at 529 - Thin-section description (table 23).  
 -- at 530 - Thin-section description (table 23).  
 -- at 531 - Chert nodules.  
 -- at 538.7-541 - Open, high-angle and vertical fractures stained orange-brown.  
 -- at 540 - Thin-section description.
- 541-553 Limestone; color, 10YR 8/2,6/6; texture, mudstone to grainstone. Dense, recrystallized miliolid biomicrite to biosparite with some chert.  
 -- at 544-545 - Open high-angle fractures with orange-brown stain.  
 -- at 545 - Blue-gray glassy chert layer.  
 -- at 546 - Laminated.  
 -- at 547 - Gray, glassy opaque chert nodules and hard brown clay with black dendrites.  
 -- at 549 - Hard yellowish-brown clay and a chert geode lined with drusy quartz.  
 -- at 550 - Thin-section description (table 23).  
 -- at 552 - Wispy shale.
- 553-567 Limestone; color, 10YR 7/2,6/3,8/2; texture, mudstone to grainstone. Dense recrystallized micrite which is burrowed and fractured with zones of honeycomb.  
 -- at 558 - Stylolite, gastropod and clam fragments.  
 -- at 558.9 - Vugs after rudists, stained orange-brown.  
 -- at 560 - Thin-section description (table 23).  
 -- at 563.5 - Highly burrowed.  
 -- at 564.5-566 - Biosparite; miliod and fossil fragment coquina.  
 -- at 565-566 - High-angle fractures.

Depth  
(feet)

- 567-577 Limestone; color, 10YR 7/2; texture, wackestone to grainstone. Fractured and recrystallized miliolid biosparite with some chalky zones.  
-- at 568.5-569 - High-angle fractures with orange stain and clay.  
-- at 570 - Thin-section description (table 23).  
-- at 571.5 - Fossil fragment coquina.  
-- at 572.5 - Orange-brown stained high-angle fractures with clay fill.  
-- at 574 - Fossil fragment coquina.  
-- at 575.5 - Mudstone clasts and small blue-gray chert nodules.  
Interval of 577-579 missing; no core recovery.
- 579-591 Limestone; color, 10YR 7/1,8/2; texture, mudstone to grainstone. Dense limestone with chalky, sucrosic, recrystallized and dolomitic zones.  
-- at 580.8-581.2 - Dolomitic and finely sucrosic with high intercrystalline porosity.  
-- at 581.2-582.4 - Hard and soft clays with a single opaque, gray chert nodule.  
-- at 582.4-582.8 - Well cemented miliolid biosparite.  
-- at 587 - Miliolid and fossil fragment biosparite with moldic porosity after rudist fragments and algal or sponge remnants.  
-- at 589 - Chalky limestone.  
-- at 590-590.8 - Argillaceous limestone; thin-section description (table 23).
- 591-600 Limestone and dolomite; color, 10YR 8/1.5-6/3; texture, mudstone to wackestone to grainstone to sucrosic dolomite. Burrowed, fractured micrite to biosparite with Toucasia(?) and other rudists altering to vuggy sucrosic dolomite.  
-- at 592.6 - Biomicrite with high-spined gastropods.  
-- at 594 - Blue-gray opaque chert nodule.  
-- at 594.5 - Limonite-stained stylolite.  
-- at 595.6 - 1-inch wispy shale bed on top of a vertical fracture which reaches to depth 597.  
-- at 597-599 - Burrowed sucrosic dolomite and dolomitic limestone with high moldic and intercrystalline porosity.  
-- at 600 - Thin-section description (table 23).
- 600-608 Limestone and dolomite; color 10YR 7/1,6/1.5,8/2; texture, mudstone to wackestone to packstone to crystalline dolomite. Micrite to muddy biosparite altering to burrowed and slightly fractured sucrosic dolomite.  
-- at 602.3 - Finely sucrosic dolomite or dolomitic limestone with yellow-stained vertical fractures. Intercrystalline and moldic porosity.  
-- at 604 - Chalky, burrowed and fossiliferous micrite to biomicrite.  
-- at 605.6-607 - Stained and solutioned high-angle fracture.  
-- at 607 - Burrowed and fossiliferous containing clams, gastropods and rudists.
- 608-619 Limestone to dolomite; color, 10YR 8/2,7/2,6/1.5; texture, mudstone to wackestone to grainstone to crystalline dolomite. Micrite to biosparite to finely sucrosic burrowed dolomite.  
-- at 608 - Fossil fragment coquina.  
-- at 610 - Sucrosic limestone, spongelike, with moldic porosity; thin-section description (table 23).  
-- at 610.5 - Burrowed micrite.  
-- at 610.6 - Stylolite.  
-- at 611.5 - Stylolite with heavy brown stain on partings.  
-- at 613.8 - Finely sucrosic and nodular dolomite (or dolomitic limestone) with large calcite-lined vugs.  
-- at 616 - Burrowed and nodular with large calcite-lined vugs.  
-- at 617.5-619 - Heavily burrowed with large calcite-lined vugs.
- 619-626 Limestone and dolomite; color, 10YR 7/1.5,8/2; texture, mudstone to grainstone to crystalline carbonate. Micrite and biosparite. Nodular sucrosic dolomite with wispy shale and few fractures.  
-- at 619 - Burrowed zones with large gastropods and fossil fragments.  
-- at 620 - Thin-section description (table 23).  
-- at 620.2-620.5 - Orange-stained open vertical fracture with small clay flakes.  
-- at 620.5 - Chalky micrite.  
-- at 621.5 - Biosparite with small vugs and open vertical fractures with orange-brown stain.  
-- at 622.4 - Stylolite in sucrosic dolomite or dolomitic limestone.  
-- at 624.4 - Fine calcite crystals in a micrite matrix with gastropods.  
-- at 625.5 - Low-angle stylolite.
- 626-640 Limestone and dolomite; color, 10YR 7/2,7/1,6/1; texture, mudstone. Burrowed, stylolitic, nodular micrite.



Depth  
(feet)

- at 626 - Low-angle stylolites with orange-brown stained partings.
- at 626.3 - Wispy shale zone.
- at 628 - Stylolite.
- at 628.3 - Stylolites and wispy shale.
- at 629.8 - Nodular with wispy shale.
- at 630 - Thin-section description (table 23).
- at 630.8-633 - Dolomitic, argillaceous and nodular with burrows and fractures.
- at 632 - Medium porosity in dolomite zone.
- at 636.2 - Dead oil on stylolite partings.
- at 637.5-637.8, 638.4-639 - Numerous wispy shale beds.
- at 639-642 - More sucrosic and highly burrowed.
- at 640 - Thin-section description (table 23).
- at 640.1, 640.6, 641.2 - Caprinid fragments.
- at 642-644 - Increasingly nodular.

644-676

- Limestone and dolomite; color, 10YR 7/1,7/3,8/2; texture, mudstone to wackestone to packstone. Chalky, argillaceous, nodular micrite with dolomite patches. Burrows, stylolites, wispy shale, black rotund bodies, oyster fragments and dogtooth spar in fractures. First occurrence of black rotund bodies is in this interval.
- at 646.6-646.7, 647.1-648; 649.5-649.8 - Numerous beds of wispy shale.
  - at 650 - Thin-section description (table 23).
  - at 650.3 - Abundant black rotund bodies.
  - at 651 - Miliolid packstone with stylolites and black rotund bodies.
  - at 654-655 - Abundant stylolites.
  - at 656.2 - Large vug.
  - at 656.5-656.8 - Stylolites.
  - at 657 - Gastropod and rudist fragment packstone.
  - at 658.1-660 - Abundant stylolites.
  - at 660 - Thin-section description (table 23).
  - at 660.9 - Finely sucrosic limestone; color changes to 10YR 7/3; black rotund bodies are oxidized to orange.
  - at 663.2 - Orange-stained and solutioned bedding plane marked by soft yellow-brown clay.
  - at 664 - Finely sucrosic dolomite.
  - at 664.2 - Chalky packstone with 5-inch possible breccia zone of poorly sorted, subangular to subrounded clasts containing black rotund bodies and orange-stained stylolites.
  - at 666.2 - Burrowed and nodular with black rotund bodies, stylolites and shell fragments.
  - at 669.4 - 1-inch zone of small fossil fragments.
  - at 670 - Heavily burrowed, with stylolites and black rotund bodies common; thin-section description (table 23).
  - at 671, 672 - Abundant stylolites.
  - at 674.6 - Chalky miliolid biomicrite with a few large high-spined gastropods.
  - at 676.4-676.8 - Calcite-lined vertical fractures.
  - at 677-677.4 - Shale inclusions in laminated zone (possible algal mat).
  - at 680 - Thin-section description (table 23).

Table 23.--Description of thin sections of test-hole cores:  
Castle Hills (AY-68-28-910)

Depth (feet)	
240	<u>Limestone</u> ; packstone; mollusc and skeletal fragments of variable size (50 to more than 1,000 microns); many recrystallized fragments filled with medium to coarse spar; particles not aligned; some leaching is evident; porosity is low to moderate; scattered large vugs (up to 1,000 microns) are isolated or poorly connected; permeability is low.
250	<u>Limestone</u> ; recrystallized wackestone; mollusc fragments (up to 1,000 microns in length); many show leaching; micrite contains abundant microspar; porosity greater than 20 percent (vugular and intercrystal porosity); vugs are well connected and range widely in size (40 to 500 microns); permeability is medium to high.
270	<u>Limestone</u> ; packstone/wackestone; highly micritized mollusc, oyster fragments, skeletal hash and algal materials; most mollusc fragments contain calcite mosaic, micrite and some grumous microspar, porosity is less than 5 percent; isolated vugs commonly less than 100 microns; permeability is low.
290	<u>Limestone</u> ; obliterated texture; rock may be a dedolomite; recrystallized mosaic of large crystals that contain anhedral to subhedral rhombs smaller than 20 microns; porosity is low (10 percent) with large isolated vugs; groundmass permeability is low; overall permeability may be high because of leaching.
301	<u>Limestone</u> ; highly altered mudstone to wackestone; pellets, lumps, intraclastic micritized skeletal fragments; micrite and some microspar with calcite infilling of fractures; porosity is low (less than 10 percent) with a few unconnected vugs; permeability is very low.
303	<u>Limestone</u> ; packstone; oyster fragments, foraminifera, algal fragments and pellets of variable size (most less than 100 microns); porosity (intercrystal) is low; permeability is low.
304	<u>Limestone</u> ; highly altered packstone/wackestone; mollusc fragments, foraminifera and some fine to moderate size (up to 200 microns) pellets; micrite contains some microspar; porosity is less than 5 percent; permeability is low.
305	<u>Limestone</u> ; highly altered wackestone; molluscs, pellets, broken skeletal fragments, lumps, broken particles; most grains are micritized; radial chert; small fractures filled with calcite; porosity (vug and channel) is less than 5 percent; permeability is low.
306	<u>Limestone</u> ; highly altered wackestone; mollusc fragments, lumps, intraclasts, skeletal fragments and variable size pellets; some bedding of lag deposits separated by mudstone; radial chert; porosity (some intercrystal) less than 5 percent; permeability is low.

Depth  
(feet)

- 307 Limestone (partially dolomitized); mudstone; intraclasts containing a few fine skeletal fragments; much of the mud matrix is recrystallized to psuedo spar; radial chert replacement; porosity is low; permeability is low.
- 308 Limestone; mudstone; few mollusc fragments, rare forams in a structureless uniform micrite groundmass; porosity (some intercrystal) is low; permeability is low.
- 310 Limestone; mudstone; non-fossiliferous; micrite is recrystallized in patches to a coarser, tight calcite mosaic; porosity (some intercrystal porosity in recrystallized mosaic) is low; permeability is low.
- 312 Limestone; mudstone; replacement by very large calcite mosaics; fractures contain some rhombs; porosity (isolated vugs) is low; permeability is low.
- 314 Limestone; mudstone; containing an isolated mollusc fragment about 500 microns long; matrix is partially recrystallized to microspar; porosity (vugs generally less than 100 microns) is low to medium; some intercrystalline porosity (less than 10 microns); permeability is low to medium.
- 316 Limestone; mudstone; non-fossiliferous uniform micrite with coarser crystals in vugs; porosity is low (vugs are mostly less than 100 microns and are partially filled with microspar); permeability is low.
- 317 Limestone; wackestone; fine hash of fossil fragments, pellets, intraclasts, foraminifera and abundant microspar; porosity (some vugs) is low; permeability is low.
- 318 Limestone; mudstone; layered pellets; transition from pelletal zone to micrite; porosity (isolated fenestrae) is low; some open fractures vertically aligned; permeability is low.
- 320 Limestone; wackestone to mudstone; micritized skeletal hash, few foraminifera; calcite-filled fractures; porosity is low; permeability is low.
- 323 Limestone; mudstone; grumous texture, clots are very fine crystals with diffuse boundaries; abundant black pyrite cubes (10 to 20 microns on a side); chert; closely spaced fractures containing sparite; porosity is low; permeability is low.
- 324 Limestone (recrystallized); possible dedolomite; replacement of coarse spar by anhedral rhombs (20 to 40 microns); porosity is much less than 5 percent; permeability is very low.

Depth  
(feet)

- 325 Limestone (recrystallized); originally a nonfossiliferous mudstone with a few isolated large rhombs; pyrite; no matrix porosity; isolated large vugs, solution enlarged; permeability high because of fractures.
- 326 Limestone; mudstone; elongated microspar indicates relictual bedding; porosity is much less than 5 percent; permeability is very low.
- 328 Limestone; wackestone to packstone; micritized ghosts of pellets, skeletal fragments (molluscs), foraminifera (miliolids); rock appears as mudstone with hand lens; micrite is partially converted to microspar; porosity (isolated vugs up to 50 microns) is less than 5 percent; permeability is low.
- 329 Limestone; wackestone to mudstone; highly micritized skeletal fragments, molluscs, foraminifera, and algal mat with organic staining.
- 331 Limestone (recrystallized); mudstone replaced by mosaic of sparite ghosts; patches of rhombs (up to 40 microns); no clear fossil evidence; porosity (large isolated vugs) is medium; permeability may be high because of dissolution.
- 337 Limestone (recrystallized); mudstone; large mollusc fragments, scattered vugs (50 to 200 microns) and open fractures suggest original rock was a wackestone; porosity is 20 percent; permeability is medium.
- 340 Limestone; mudstone to wackestone; large molluscs (Toucasia?), miliolids, skeletal fragments; most particles are 100 microns or less and highly micritized; some micrite is recrystallized to microspar; porosity (isolated vugs) is low; permeability is low.
- 345 Limestone; mudstone; mollusc fragments (sparse), pellets and chert; all particles are less than 100 microns; partial conversion of micrite to microspar; isolated vugs (mostly less than 100 microns); porosity is less than 5 percent; permeability is low.
- 346 Limestone; mudstone; mollusc fragments replaced by chert, few relict foraminifera; isolated vugs up to 300 microns; porosity is medium; permeability is low to medium.
- 347 Limestone; mudstone; algal fragment, mollusc fragment (chert replaces some fragments); micrite is partially converted to microspar; isolated vugs (30 to 100 microns in size) connected by intercrystal openings in microspar. Porosity is 10 percent; permeability is low to medium.
- 350 Limestone (dolomitic); dense mosaic of completely recrystallized anhedral crystals (10 to 50 microns); porosity (vugs to 300 microns and intercrystal) is medium; permeability is medium.

Depth  
(feet)

- 352 Limestone; mudstone; recrystallized skeletal fragments (all about 100 microns or less); porosity is very low; permeability is low.
- 354 Limestone; mudstone (possibly a highly micritized fine grained packstone); few mollusc fragments, some chert, some grumous micrite converted to microspar; porosity is 10 percent (poorly connected vugs 40 to 200 microns and intercrystal in the microspar); permeability is low to medium.
- 356 Limestone; mudstone; few mollusc fragments, chert, grumous micrite and some microspar; porosity (small vugs less than 100 microns) is 5 to 10 percent; permeability is low.
- 357 Limestone; mudstone; highly micritized mollusc fragments (Gryphaea?), algal filaments and some chert; porosity (poorly connected vugs less than 100 microns) is 5 to 8 percent; permeability is low.
- 358 Limestone; wackestone; skeletal fragments, rare foraminifera, micrite with microspar, chert replacement of some fragments; porosity (vugs less than 100 microns) is low; permeability is low.
- 359 Limestone; mudstone; echinoderm plate, fine skeletal hash, isolated chert and uniform micrite; porosity (scattered vugs up to 200 microns) is 5 percent; permeability is low.
- 360 Limestone; mudstone; isolated skeletal and mollusc fragments, ostracod(?) and foraminifera; grumous micrite.
- 364 Limestone (recrystallized); a dense matrix of anhedral crystals with disseminated pyrite and chert; rare, large (greater than 1,000 microns) isolated voids; porosity is very low; permeability may be high because of dissolution.
- 366 Limestone; coarsely recrystallized; isolated patches of former rock with sparite, chert and some breccia zones; porosity (isolated vugs) is secondary only; no permeability.
- 367 Limestone; mudstone (very uniform); dense anhedral crystals (less than 10 microns) stained orange; no porosity; no permeability.
- 371 Limestone; wackestone to mudstone; few mollusc fragments, skeletal hash, pellets and zones of dolomitization; micrite is grumous and microspar is present in clotted areas; porosity is low and best developed in former dolomite areas. No permeability.
- 372 Limestone; mudstone; relict rhombs--altered dolomite; grumous texture; abundant disseminated black particles (about 10 microns in size); chert; porosity is very low; permeability is very low.
- 373 Limestone; mudstone; mollusc fragments and micritized foraminifera (micrite contains microspar); porosity (isolated small vugs less than 2,000 microns) is low; permeability is low.

Depth  
(feet)

- 374 Limestone; mudstone; few skeletal fragments, patches of dolomite (very fine rhombs), micrite contains microspar; porosity (vugs and intercrystal in microspar channels) is 5 to 10 percent; permeability is low.
- 375 Limestone; mudstone; mollusc fragments, grumous micrite with microspar ghosts of dolomite rhombs; porosity (vugs less than 100 microns) is low.
- 376 Limestone; mudstone; isolated chert replaced mollusc fragments, micrite contains abundant microspar; isolated vugs are about 30 to 80 microns; porosity is about 5 percent; permeability is low.
- 381 Limestone (densely recrystallized); mudstone; dense, anhedral mosaic of very fine crystals; isolated, large (up to more than 1,000 microns) solution vugs; dolomite rhombs (up to 40 microns) in burrows; porosity follows burrows.
- 384 Limestone (densely recrystallized); mudstone; micrite is very dense and blade-shaped along vugs; porosity (vugs) is very low; no permeability.
- 387 Limestone; wackestone; large mollusc (Toucasia?) fragments with some chert replacement; micrite contains some fine hash; porosity is very low; no permeability.
- 388 Limestone (recrystallized); coarse mosaic of grumous spar; porosity is very low; permeability is low.
- 390 Limestone (recrystallized); a mosaic of coarse calcite with vugs (solution-enlarged burrows) outlined by large calcite crystals; porosity only in burrows; permeability is high because of burrows.
- 400 Limestone (dolomitized); mudstone; scarce small skeletal fragments (some chert replacement) and foraminifera; replacement of mudstone matrix by disseminated dolomite rhombs (up to 40 microns); disseminated weathered pyrite cubes; porosity is much less than 5 percent; no permeability.
- 420 Limestone; grainstone; miliolids and algal fragments (most particles are partially micritized); partially recrystallized sparite cement; porosity (vugs, intraparticle) is about 10 percent and not well connected; permeability is low.
- 430 Limestone; grainstone; intense micritization of particles and some cement; miliolid ghosts, foraminifera (biserial tests); porosity (vugs and intraparticle) is low; permeability is low.
- 440 Limestone (highly recrystallized); grainstone; miliolid ghosts; original texture obliterated; fine partings lined with darker materials cut across grains; coarse calcite mosaic with ghosts of former rock.

Depth  
(feet)

- 461 Limestone; grainstone; miliolids, algal fragment, gastropods and intraclasts of former rock; all particles are moderately to highly micritized; cement is granular to blocky sparite (10 to 20 microns in size); porosity (vugs and intraparticle) is low to medium and poorly connected; permeability is low to medium.
- 462 Limestone; grainstone; miliolids and intensely micritized fragments; granular sparite cement; moldic, intraparticle and intercrystal porosity (connected with openings of less than 10 to 400 microns) is low to medium; permeability is low to medium.
- 463 Limestone; grainstone; rock is strongly micritized; miliolid molds; granular sparite cement; porosity (moldic, intercrystal and vugs) is more than 20 percent; permeability is medium.
- 464 Limestone; grainstone; numerous miliolids, intraclasts and a few molluscs; granular sparite cement; porosity (isolated vugs and intraparticle) is 5 to 8 percent; permeability is low.
- 465 Limestone; grainstone; micritized miliolids and some mollusc fragments (all particles less than 200 microns); porosity (vugs and intraparticle) is less than 10 percent; permeability is low.
- 466 Limestone; grainstone; micritized miliolids (small and abundant) and pellets; granular sparite cement; porosity (vugs less than 100 microns and some intraparticle) is low; permeability is low.
- 468 Limestone; slide represents contact between a grainstone (algal and fossil fragments) and a recrystallized mudstone; the mudstone has low porosity (intercrystal) and the grainstone low porosity; the grainstone particles are oriented along bedding planes.
- 469 Limestone (recrystallized); a calcite mosaic of large anhedral grains and rare miliolid; vugs up to 400 microns; porosity is 15 to 20 percent; permeability is high.
- 471 Limestone (recrystallized); a mosaic of coarse sparite, irregular crystals and fractures filled with calcite; porosity (large irregular vugs) is medium to low; permeability may be high if pores are connected.
- 472 Limestone (recrystallized); a mosaic of coarse sparite, irregular crystals and fractures filled with calcite; porosity is medium to low; permeability may be high if pores are connected.
- 473 Limestone; contact between mudstone and grainstone; grainstone (upper unit) contains miliolids and mudstone intraclasts (from lower unit); grainstone porosity (intercrystal and intraparticle) is medium; permeability is low to medium; mudstone contains rare fossil ghosts and isolated small vugs; mudstone has low permeability.

Depth  
(feet)

Depth  
(feet)

- 476 Limestone (recrystallized); no original texture; a mosaic of coarse spar with subhedral rhombs (up to 70 microns); angular vugs; porosity (vugs and intercrystal) is high; permeability is medium.
- 477 Limestone (recrystallized); large subhedral rhombs (70 to 80 microns), mosaic of large crystals, relict rounded particles and a mollusc fragment; porosity (vugs and intercrystal) is about 15 percent; permeability is medium to high.
- 478 Limestone (recrystallized); mosaic of coarse sparite with numerous inclusions of subhedral rhombs (up to 80 microns); porosity (vugs and intercrystal from 40 to more than 500 microns) is 20 percent; permeability is medium to high.
- 482 Limestone (recrystallized); mosaic of coarse sparite with many inclusions of small anhedral crystals; porosity (vugs) is low; permeability is low.
- 484 Limestone (recrystallized); mudstone to wackestone; moldic preservation of foraminifera and mollusc fragments; isolated large openings (up to 500 microns) with intercrystal connection; porosity (moldic, vugs and intercrystal) is 10 percent; permeability is medium.
- 485 Limestone (recrystallized); mudstone; grumous texture with rhombs (80 to 100 microns); porosity (isolated small vugs less than 50 microns) is low; permeability is low.
- 486 Limestone; wackestone; highly micritized mollusc fragment, Gryphaea fragments and foraminifera; abundant microspar in micrite; porosity (small isolated vugs) is low; permeability is low.
- 491 Limestone; wackestone; miliolids and algal fragments (parallel orientation of elongate particles); geopetal structure within a Gryphaea; porosity is low; permeability is low.
- 494 Limestone (recrystallized); no original texture; grumous; mosaic of larger crystals and disseminated, weathered pyrite; porosity is low; permeability is very low.
- 496 Limestone (recrystallized); mosaic of very coarse crystals and weathered pyrite; porosity is very low; permeability is very low.
- 497 Limestone (recrystallized); small disseminated inclusions (clear rhombs with dark borders); some large vugs.
- 498 Limestone (recrystallized); mosaic of sparite with inclusions, chert and numerous vugs; permeability is probably high.
- 500 Limestone (recrystallized); mosaic of coarse sparite with numerous rhombs (20 to 60 microns); porosity (intercrystal and vugs) is greater than 25 percent; permeability is medium to high.



Depth  
(feet)

- 501 Limestone; same as for 500 feet.
- 502 Limestone (recrystallized); dense mudstone; burrows, small recrystallized fractures and vugs along former burrows.
- 504 Limestone; dense mudstone; few fossils, isolated vugs and an isolated foraminifer; porosity is very low; permeability is very low.
- 509 Limestone (recrystallized); mosaic of coarse sparite with inclusions; rhombs outlined with opaques and vugs; porosity (vugs) is low.
- 513 Limestone (recrystallized); no original texture; calcite with inclusions; porosity is low; permeability is low.
- 518 Limestone; fine grained wackestone; Gryphaea, algal fragments (filaments show bedding); porosity is very low; permeability is very low.
- 521 Limestone; mudstone (highly micritized); micrite contains microspar; porosity is low; permeability is low.
- 524 Limestone; mudstone; few miliolids, vugs (40 to more than 100 microns); micrite contains microspar; porosity (vugs) is 5 to 10 percent; permeability is low.
- 525 Limestone; wackestone; miliolids and micritized particles; porosity (intraparticle, moldic and vugs) is 5 to 10 percent; permeability is low.
- 526 Limestone; wackestone; some bedding.
- 527 Limestone; grainstone; miliolid, intraclasts, algal filaments and granular sparite cement. Porosity (intraparticle, moldic and vugs) is 5 to 10 percent; permeability is low.
- 528 Limestone; grainstone; micritized particles of miliolids, lumps, intraclasts, an algal fragment and granular sparite cement. Porosity (intraparticle, moldic and vugs) is 10 to 15 percent; permeability is low.
- 529 Limestone; mudstone (or highly micritized grainstone); large mollusc fragment (partial chert replacement), micritized foraminifera and microsparite cement; porosity (vugs) is medium to high; permeability is medium.
- 530 Limestone; wackestone; mollusc fragment, chert replaced mollusc lumps and foraminifera; porosity (vugs smaller than 100 microns) is 5 to 10 percent; permeability is low.
- 540 Limestone; grainstone (highly micritized); miliolids, algal filaments and mollusc fragments; groundmass is a fine granular microsparite with numerous miliolid molds; porosity (moldic, interparticle and 200-micron sized vugs) is 20 percent; permeability is low to medium.

Depth  
(feet)

- 550 Limestone; wackestone (highly micritized); miliolids, fossil fragment and lumps; groundmass is microsparite and some micrite; small (less than 100 microns) and poorly connected vugs and pores; porosity (intraparticle and vugs) is 5 percent; permeability is low.
- 560 Limestone; mudstone; skeletal fragments, foraminifera, chert and parallel striations marked by opaques; porosity is low; permeability is very low.
- 570 Limestone; packstone (highly micritized); miliolids, algal filaments and Gryphaea fragments (some infilled with granular sparite); microsparite in groundmass; isolated vugs smaller than 80 microns; porosity (vugs) is less than 5 percent; permeability is low.
- 580 Limestone; wackestone; mollusc fragments, foraminifera (micritized); microsparite in groundmass; porosity is much less than 5 percent; permeability is low.
- 590 Limestone; mudstone; isolated, small skeletal fragments and a fracture; porosity is much less than 5 percent; permeability is low.
- 600 Limestone; mudstone; micrite replaced by clear, euhedral rhombs (up to 100 microns); porosity (intercrystal and fracture) is low.
- 610 Limestone; wackestone to packstone; micritized particles (molluscs, foraminifera and algal filaments); sparite in groundmass; porosity (poorly restricted vugs and molds) is 20 percent; permeability is low to medium.
- 620 Limestone; wackestone to packstone; highly micritized; miliolids, fractures; microsparite groundmass; vugs usually less than 100 microns; porosity is 5 percent and poorly connected by intercrystal in microsparite; permeability is low.
- 630 Limestone (dolomitized); mudstone; miliolids, Gryphaea (some chert replacement) and micrite replaced by abundant euhedral rhombs (up to 100 microns); porosity (intercrystal) is 5 percent; permeability is low.
- 640 Dolomite; mudstone; miliolids, algal fragments and burrows with sharp dolomitization; micrite contains rhombs up to 100 microns; porosity (intercrystal and vugs) is 5 percent; permeability is low.
- 650 Limestone; mudstone; foraminifera and a mollusc fragment; black micritized particles; stylolites; chert; porosity is very low; permeability is very low.
- 660 Limestone (dolomitic); wackestone; micritized miliolids, a mollusc fragment, dolomite rhombs (about 20 microns) and stylolites; porosity (isolated vugs up to 100 microns) is 5 percent; permeability is low.

Depth  
(feet)

- 670 Limestone; packstone; micritized foraminifera, lumps and a mollusc fragment; localized zones of dolomitization with rhombs (30 to 100 microns); dolomitization occurs along burrowed channel; microspar in groundmass; porosity (intercrystal, vugs) is low; permeability is low.
- 680 Limestone (dolomitized); wackestone; micritized miliolids and mollusc fragment; micrite groundmass is selectively dolomitized; porosity (intercrystal, channel and vugs) is medium; permeability is low.
- 690 Limestone (dolomitic); mudstone and dolomitized grainstone in contact; mudstone is completely recrystallized; grainstone is dolomitized and highly porous; porosity (vugs, moldic, intercrystal channel, intraparticle) is greater than 30 percent; permeability is high.
- 700 Dolomite; recrystallized (no original texture); subhedral rhombs (20 to 40 microns), numerous disseminated, angular chert fragments (40 to 60 microns); porosity (vugs, intercrystal, moldic) is greater than 30 percent; permeability is high.
- 720 Dolomite; recrystallized; mosaic of densely packed, very fine subhedral rhombs with a layer of coarser rhombs with intercrystal porosity; relict mudstone fragments; porosity (intercrystal with small pore openings) is 10 to 20 percent; permeability is low.
- 740 Limestone (dolomitic); mudstone; dolomitized Gryphaea fragments, micritized miliolids, rhombs (40 to 80 microns); porosity (intercrystal) is low; permeability is low.

Table 24.--Mineralogy of core samples as determined by X-ray diffraction analysis: Castle Hills (AY-68-28-910)

Depth (feet)	Mineral composition (percent)			Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz		Calcite	Dolomite	Quartz
220	100	0	0	368*	87	0	3
230	100	0	0	369	98	0	2
240	100	0	0	375	100	0	0
260	100	0	0	378	67	1	32
280	100	0	0	379	100	0	0
300	100	0	0	380	99	<1	0
302	100	0	0	382	99	1	0
304	100	0	0	384	92	8	0
309	99	1	0	385	99	1	0
311	93	6	1	386	100	0	0
313	100	0	0	390	99	1	0
317	100	0	0	430	100	0	0
318	100	0	0	440	98	2	0
321	100	0	0	450	100	0	0
327	100	0	0	460	100	0	0
330	100	0	0	461	100	0	0
334	99	1	0	463	100	0	0
335	98	2	0	466	100	0	0
336	100	0	0	470	100	0	0
348	99	1	0	474	100	0	0
352	100	0	0	475	99	1	0
353	100	0	0	477	99	1	0
355	100	0	0	479	98	2	0
365	98	1	1	480	98	2	0

\*Contains 10 percent clay minerals.

Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz
481	99	1	0
483	100	0	0
484	99	1	0
490	100	0	0
491	100	0	0
496	98	2	0
499	100	0	0
503	100	0	0
505	100	0	0
506	98	2	0
507	96	4	0

Depth (feet)	Mineral composition (percent)		
	Calcite	Dolomite	Quartz
510	98	2	0
511	98	2	0
512	100	0	0
514	98	2	0
515	100	0	0
516	100	0	0
517	100	0	0
519	100	0	0
522	100	0	0
523	100	0	0
524	100	0	0

Table 25.--Porosity characteristics of core samples as determined by laboratory tests: Castle Hills (AY-68-28-910)

Depth (feet)	Porosity (percent)		Pore-size distribution (percent of effective porosity intruded by mercury <sup>1</sup> )						Permeability (millidarcies)			Grain density (grams per cubic centimeter)	Formation factor	Acoustic velocity (microseconds per foot) with effective overburden <sup>2</sup> of:		
	Total	Effective	9/11.8	21/5.07	40/2.66	80/1.33	500/0.21	1500/0.071	Mercury-injection test	Air-injection test	Air-injection pressure atmosphere			500	1000	2000
220	11.2	10.0	0.0	0.0	0.0	0.0	24	84	--	--	--	2.73	--	--	--	--
230	--	--	--	--	--	--	--	--	--	0.16	2	2.71	--	--	--	--
240	17.8	17.7	12	18	28	50	94	99	--	--	--	2.71	46.1	--	--	--
250	--	--	--	--	--	--	--	--	--	16	0.10	2.71	--	--	--	--
260	--	--	--	--	--	--	--	--	--	97	0.10	2.70	--	--	--	--
270	--	--	--	--	--	--	--	--	--	30	0.10	2.71	--	--	--	--
280	15.2	14.2	0.0	1	26	74	90	93	--	--	--	2.71	20.2	--	--	--
290	--	--	--	--	--	--	--	--	--	0.01	2.0	2.72	--	--	--	--
300	13.2	11.9	4	9	12	24	73	88	--	--	--	2.70	--	--	--	--
310	--	--	--	--	--	--	--	--	--	--	--	2.75	--	--	--	--
320	4.5	3.0	2	2	4	4	6	66	--	--	--	2.69	81.3	--	--	--
325	--	--	--	--	--	--	--	--	--	0.06	2.0	2.70	--	--	--	--
331	--	--	--	--	--	--	--	--	--	18	0.10	2.80	--	--	--	--
340	1.4	0.5	10	--	--	--	--	40	--	0	2.0	2.68	--	--	--	--
345	7.8	2.3	4	6	9	9	18	28	--	0	2.0	2.73	--	--	--	--
350	--	--	--	--	--	--	--	--	--	1.84	0.5	2.74	118.5	--	--	--
355	14.6	14.4	0.0	2	3	5	90	98	--	--	--	2.70	--	--	--	--
359	15.3	13.6	0.0	1	3	6	80	88	--	--	--	2.76	--	--	--	--
367	--	--	--	--	--	--	--	--	--	0	2.0	2.81	6.2	--	--	--
376	--	--	--	--	--	--	--	--	--	--	--	2.72	--	--	--	--
381	2.1	0.07	0.0	0.0	0.0	0.0	0.0	0.0	--	1.18	0.10	2.73	--	--	--	--
388	--	--	--	--	--	--	--	--	--	39	0.20	2.68	156.5	--	--	--
420	11.0	10.5	0.0	0.0	0.0	1	82	96	--	0.48	0.50	2.71	--	--	--	--
430	--	--	--	--	--	--	--	--	--	0	2	2.72	70.1	--	--	--
440	9.1	3.9	16	24	30	34	40	42	--	38	--	2.78	--	--	--	--
450	2.6	0.5	0.0	1	2	5	12	18	--	--	--	2.71	--	--	--	--

-113-

<sup>1</sup>Percent of effective porosity intruded by mercury =  $\frac{\text{injection pressure}}{\text{pore throat radius}}$  /  $\frac{\text{pore throat radius}}{\text{microns}}$   
 (pounds per square inch) (microns)

<sup>2</sup>Effective overburden in pounds per square inch.

Table 26.--Test-hole completion summary: Feathercrest (AY-68-29-506)

Location: Bexar County, Tex., on Feathercrest Road 0.3 mile east of the intersection of Feathercrest and Jones-Maltsberger Road.

Elevation of land surface: 788 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources.

Spudded: August 2, 1972.

Completed: September 26, 1972.

Casing: 6-1/4-inch inside diameter to 204 feet. Cemented with 50 sacks of 4-percent gel, cement circulated. 5-1/2-inch liner dropped from 60 to 240 feet, lodged on ledge at 240 feet.

Total depth: 701 feet.

Coring equipment: Acker double-wall mining-type core barrel 5x4x10 inches. Diamond core heads, 5-1/2x4 inches, of 75-80 carats, 25 stones per carat. Bottom discharge.

Core-recovery summary: Total footage cored, 469 feet; total core recovered, 385.6 feet; and percentage of recovery, 82 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
226-236	10.0	9.4	9.4
245	9.0	9.0	18.4
254	9.0	7.0	25.4
264	10.0	9.5	34.9
274	10.0	10.0	44.9
284	10.0	10.0	54.9
299	15.0	13.5	68.4
314	15.0	13.0	81.4
316	2.0	1.5	82.9
318	2.0	1.5	84.4
327	9.0	6.0	90.4
336	9.0	9.0	99.4
348	12.0	10.0	109.4
354	6.0	5.0	114.4
360	6.0	6.0	120.4
370	10.0	9.0	129.4
378	8.0	8.0	137.4
388	10.0	9.0	146.4
398	10.0	9.0	155.4
408	10.0	10.0	165.4

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
417	9.0	9.0	174.4
428	11.0	10.0	184.4
438	10.0	10.0	194.4
446	8.0	8.0	202.4
455	9.0	8.5	210.9
464	9.0	9.0	219.9
474	10.0	10.0	229.9
484	10.0	7.0	236.9
494	10.0	3.5	240.4
500	6.0	6.0	246.4
500-507	7.0	1.0	247.4
518	11.0	8.0	255.4
528	10.0	2.0	257.4
537	9.0	2.0	259.4
540	3.0	2.9	262.3
550	10.0	6.0	268.3
556	6.0	6.0	274.3
565	9.0	4.5	278.8
570	5.0	5.0	283.8
574	4.0	3.5	287.3
582	8.0	1.5	288.8
587	5.0	2.0	290.8
594	7.0	3.2	294.0
604	10.0	10.0	304.0
614	10.0	6.5	310.5
624	10.0	8.0	318.5
640	10.0	8.0	326.5
641	1.0	0.7	327.2
651	10.0	8.8	336.0
661	10.0	10.0	346.0
671	10.0	10.0	356.0
681	10.0	10.0	366.0
691	10.0	10.0	376.0
701	10.0	9.6	385.6



Table 27.--Description of test-hole cores: Feathercrest (AY-68-29-506)

Depth (feet)	Description
226-236	Limestone; color, 10YR 7/1,7/2; texture, wackestone. Hard, dense, pyritic, weathered biomicrite that is fractured with black dendrites common in the upper foot. -- at 227-229, 229-233 - High-angle and vertical fractures with associated vugs. -- at 232 - Vugs associated with open fractures.
236-245	Limestone; color, 10YR 5/1,6/2,7/2; texture, mudstone. Hard, dense, fractured and stained micrite with some chert. -- at 237-238 - Calcite-filled fracture. -- at 238-241, 241-242, 244, 245 - Open fractures with staining. -- at 237, 238, 241, 244, 245 - Chert nodules. -- at 240 - Thin-section description (table 28).
245-296	Limestone; color, 10YR 7/2,7/1,4/1; texture, mudstone to wackestone to packstone. Hard, dense micrite to mollusc shell biomicrite. Hard, dense micrite to mollusc shell biomicrite. Variably clayey and vuggy with erratic fractures. -- at 246-247 - Vuggy with evidence of solutioning along bedding plane. -- at 246, 252, 254 - Chert. -- at 250 - Thin-section description (table 28). -- at 252 - Fossil fragment packstone. -- at 254-255.5 - Mollusc molds. -- at 254-263, 266, 283-284 - Open and stained fractures with very little calcite. -- at 260 - Thin-section description (table 28). -- at 270 - Thin-section description (table 28). -- at 270-271 - Calcite-healed vertical fractures. -- at 271-272 - Honeycomb structures along vertical fractures. -- at 274-275 - Wispy shale. -- at 277 - Vuggy with some honeycomb structure. -- at 280 - Thin-section description (table 28). -- at 286 - Very fossiliferous with complete and fragmented mollusc shells. -- at 290 - Thin-section description (table 28). -- at 294-296 - Vugs and abundant small fossil fragments.
296-300	No core recovery.
300-334	Limestone; color, 10YR 7/2,6/1; texture, wackestone to packstone to grainstone. Hard, dense biomicrite to muddy biosparite with microfossils and fractures. -- at 300 - Thin-section description (table 28). -- at 300-301 - Small vugs. -- at 300-302 - Microfossil grainstone. -- at 310 - Thin-section description (table 28). -- at 312 - Vuggy porosity. -- at 312-314 - Crystalline carbonate. -- at 316 - Fine sucrosic material fills burrows. -- at 317.5 - Rudist. -- at 319-320 - Microfossil and fossil fragment grainstone. -- at 320 - Thin-section description (table 28). -- at 321-324 - Burrowed micrite, clayey biomicrite and open, stained fractures. -- at 327, 327.5, 329, 333 - Chert. -- at 328 - 6-inch vuggy zone. -- at 329-330 - Moldic porosity. -- at 330 - Thin-section description (table 28). -- at 333-334 - Fossil fragment grainstone.
336-360	Limestone; color, 10YR 7/2,7/6; texture, mudstone to wackestone. Hard, dense micrite, biomicrite and rarely a biosparite. Fossiliferous with burrows and honeycomb structures. -- at 336, 337, 346 - Chert. -- at 337-340 - Boxwork and moldic porosity. -- at 339 - Rudists. -- at 340-342 - Siliceous miliolid grainstone. -- at 341 - Thin-section description (table 28). -- at 341, 344-346, 348-353, 355-360 - Fractures. -- at 342-343 - Honeycomb structure zone with cave deposits(?). -- at 343-344 - Laminated limestone and shale. -- at 350 - Thin-section description (table 28). -- at 353 - Vuggy-cavernous zone. -- at 354-357 - Abundant rudists.

Depth  
(feet)

360-394

Limestone; color, 10YR 8/2,7/2; texture, wackestone. Hard, dense, variably clayey micro-fossil biomicrite with fractures. Lower zones contain stylolites.  
-- at 360 - Chert nodule; thin-section description (table 28).  
-- at 368, 369, 371-373, 374-375, 377-378, 386, 388, 384-385 - Fractures.  
-- at 369 - Soft clay zone.  
-- at 370 - Thin-section description (table 28).  
-- at 370, 374, 376 - Stylolites.  
-- at 370 - Abundant microfossils.  
-- at 370, 374, 376 - Stylolites.  
-- at 380 - Thin-section description (table 28).  
-- at 380-381 - Burrowed.  
-- at 381-382 - Laminated shale and limestone.  
-- at 384 - Large calcite crystals line fossil mold.  
-- at 383-387 - Abundant microfossils.  
-- at 388 - Wispy shale; 6-inch honeycomb structure zone.  
-- at 390 - Thin-section description (table 28).  
-- at 391 - Burrowed.  
-- at 392-394 - Abundant microfossils.  
-- at 393 - Rudists.

394-425

Limestone; color, 10YR 7/2,7/1,8/2; texture, mudstone to wackestone. Medium hard, dense, clayey micrite and biomicrite with stylolites and wispy shale.  
-- at 394-396 - Closed fractures.  
-- at 395.5 - 3-inch wispy shale zone with 1/2-inch shale seam.  
-- at 398 - 1-inch wispy shale zone.  
-- at 399 - 2-inch wispy shale zone.  
-- at 400 - 2-inch shale seam; thin-section description (table 28).  
-- at 403-415 - Wispy shale streaks.  
-- at 405, 406-408, 409-415 - Stylolites.  
-- at 410 - Thin-section description (table 28).  
-- at 414-415 - Abundant mollusc fragments.  
-- at 415-416 - Fossil molds.  
-- at 415-417 - Microfossils and mollusc fragments.  
-- at 419 - 1-inch weathered yellow shale streak.  
-- at 420 - Thin-section description (table 28).  
-- at 424 - 1-inch yellow-brown, weathered, wispy shale zone with 1/4-inch shale streak at the bottom of the zone.  
-- at 417.8, 419.5, 420, 421, 421.4, 421.7 - Stylolites with weathered yellow shale partings.  
-- at 423.6-424 - Brown shale on fractures.

425-472

Limestone; color, 10YR 8/2,6/3; texture, grainstone to crystalline carbonate. Hard, dense miliolid biosparite to biomicrite; well cemented miliolid grainstone.  
-- at 427-430 - Open fractures.  
-- at 430 - Thin-section description (table 28).  
-- at 438.4 - Erosional surface contact.  
-- at 440 - Thin-section description (table 28).  
-- at 441.5 - Thin shale seams.  
-- at 442-444, 446-448, 455-457, 460-464, 466-468 - Open fractures.  
-- at 446 - Rudist molds.  
-- at 448-454 - Vuggy porosity in sparite.  
-- at 450 - Thin-section description (table 28).  
-- at 455 - Chert.  
-- at 457-459 - Burrowed.  
-- at 459 - 1-inch, soft, white shale seam.  
-- at 460 - Thin-section description (table 28).  
-- at 470 - Thin-section description (table 28).  
-- at 472 - Rudist mold.

472-530

Limestone; color, 10YR 8/2,6/3; texture, grainstone to crystalline carbonate. Dense, hard micrite, biomicrite and crystalline carbonate.  
-- at 478 - Honeycomb structure zone in crystalline carbonate.  
-- at 478, 479 - Chert nodules.  
-- at 479-484 - Coarse granular, crystalline carbonate.  
-- at 484 - Thin-section description (table 28).  
-- at 485-486.5 - Hard, dense crystalline carbonate.  
-- at 492 - Thin-section description (table 28).  
-- at 494-500 - Calcite in molds.  
-- at 498-501, 507 - Open fractures, some partly calcite-healed.  
-- at 500 - Thin-section description (table 28).

Depth  
(feet)

- at 508-509 - Calcite druse and clay in solution cavities.
  - at 510 - Thin-section description (table 28).
  - at 510-511 - Honeycomb structures.
  - at 513 - Sucrosic dolomitic limestone.
  - at 518-519 - Hard, dense biosparite.
  - at 519-520 - Fine grained siliceous limestone.
  - at 520 - Thin-section description (table 28).
  - at 529 - Solutioned sucrosic, dolomitic limestone.
  - at 530 - Thin-section description (table 28).
- 537-582 Limestone; color, 10YR 7/3,6/2; texture, packstone to grainstone to crystalline carbonate. Hard, dense, miliolid biosparite and sucrosic dolomitic limestone with abundant microfossils and few megafossils. Variably burrowed and fractured.
- at 540 - Sparse biomicrite; thin-section description (table 28).
  - at 546 - Moldic porosity in gastropod zone.
  - at 550 - Thin-section description (table 28).
  - at 552-552.5, 553-554 - Solutioned and honeycomb structures.
  - at 552, 553.5, 555, 556.5, 565 - Chert.
  - at 552-552.5, 555-556, 565-570 - Open fractures.
  - at 556-558 - Rudists common.
  - at 558-563 - 5-foot-long cavity.
  - at 563 - Thin-section description (table 28).
  - at 563-564 - Cave deposits(?); travertine, flowstone and orange-brown clay.
  - at 567 - Miliolid biosparite.
  - at 568 - Clayey biomicrite.
  - at 570 - Stromatolites; thin-section description (table 28).
  - at 574 - Miliolid grainstone.
- 582-630 Limestone; color, 10YR 7/2; texture, grainstone to mudstone to wackestone. Hard, dense, sparse miliolid biomicrite with burrows, fractures and stylolites.
- at 580 - Thin-section description (table 28).
  - at 582 - Fractured with stylolites and pyrite traces.
  - at 588 - Mollusc zone.
  - at 590 - Thin-section description (table 28).
  - at 596-599 - Well cemented miliolid and fossil fragment biosparite.
  - at 596-598, 600-601, 602, 604-610 - Fractures.
  - at 600 - Thin-section description (table 28).
  - at 601.5, 602, 603.5 - Chert.
  - at 604 - Caverock(?) and a 6-inch zone of high vuggy porosity.
  - at 608-608.5 - Miliolid biosparite.
  - at 610 - Thin-section description (table 28).
  - at 614-616 - Very hard, dense honeycomb structure micrite.
  - at 616.5 - Honeycomb structures on bedding plane.
  - at 620 - Chert; thin-section description (table 28).
  - at 621-622 - Open fractures.
- 630-654 Limestone; color, 10YR 8/1,7/2; texture, wackestone to packstone to grainstone to crystalline carbonate. Hard, dense, burrowed, fractured and variably clayey biomicrite with scattered vuggy zones.
- at 631 - Thin-section description (table 28).
  - at 632 - Coquina.
  - at 634 - Stylolites.
  - at 634-640 - Burrowed.
  - at 635-637 - Vuggy with 1-inch vugs filled with calcite.
  - at 640 - Thin-section description (table 28).
  - at 640-641 - Well cemented miliolid grainstone.
  - at 642-646 - 1-inch vugs lined with calcite.
  - at 650 - Thin-section description (table 28).
  - at 652-654 - Fossil fragment grainstone.
- 654-700 Limestone to dolomitic limestone to dolomite; color, 10YR 7/1,6/1,5/1; texture, mudstone to wackestone to packstone. Hard, dense, silty and clayey micrite to biomicrite. Dolomitized and burrowed with fossils, black rotund bodies and wispy shale. Nodular and stylolitic with scattered large vugs lined with calcite.
- at 654 - Clayey, heavily burrowed wackestone.
  - at 655, 658-659.5, 660, 661.2-661.4, 662.8-663.5, 688.5, 669, 671-672, 672-675, 675-675.5, 695 - Stylolites.
  - at 656.2 - Erosional contact(?).

Depth  
(feet)

- at 657 - 1-inch detrital zone.
- at 659-659.5, 663.2-663.4, 671.5-672, 672-675 - Wispy shale.
- at 660 - Thin-section description (table 28).
- at 660-663.5 - Burrowed microfossil and fossil fragment packstone.
- at 663.5 - Burrowed and nodular dolomitic limestone.
- at 666 - Dead oil or tar.
- at 670 - Thin-section description (table 28).
- at 671 - Rudist.
- at 675.5 - Contact(?).
- at 675.5-685, 696-698 - Black rotund bodies.
- at 680 - Thin-section description (table 28).
- at 684 - Darker.
- at 685 - Increasingly nodular with fewer fossils and black rotund bodies.
- at 685, 686, 687.5-688.3, 688.7, 689-691, 699.1-699.4 - Abundant stylolites.
- at 690 - Thin-section description (table 28).
- at 691-694 - Hard, dense, silty burrowed and nodular limestone.
- at 694 - Detrital zone.
- at 695 - 8-inch zone of sucrosic dolomite.
- at 696 - 1-inch zone of siliceous limestone.
- at 696-698 - Hard, dense, clayey and fossiliferous, black rotund body packstone.
- at 699.1-699.4 - Prominent stylolites with black shale partings.
- at 700 - Thin-section description (table 28).

Table 28.--Description of thin sections of test-hole cores:  
Feathercrest (AY-68-29-506)

Depth (feet)	
240	<u>Limestone</u> ; mudstone; highly micritized skeletal hash and pyrite; porosity is less than 5 percent; permeability is very low.
250	<u>Limestone</u> ; wackestone; partially recrystallized large mollusc fragments and skeletal hash; porosity is less than 5 percent; permeability is low.
260	<u>Limestone</u> ; grumous matrix with numerous and well dispersed rounded to angular inclusions of coarse calcite; foraminifera; porosity is less than 5 percent; permeability is low.
270	<u>Limestone</u> ; mudstone; mollusc fragment and small foraminifera; porosity is less than 5 percent; permeability is low.
280	<u>Limestone</u> ; wackestone; mollusc fragment, gastropod, skeletal debris; porosity is less than 5 percent; permeability is very low.
290	<u>Limestone</u> ; wackestone; highly micritized mollusc fragments, lumps, foraminifera; porosity is less than 5 percent; permeability is very low.
300	<u>Limestone</u> ; grainstone; highly micritized miliolids, lumps and some mollusc fragments; groundmass is microspar and micrite; porosity is 5 to 10 percent; permeability is low to medium.
310	<u>Limestone</u> ; no original texture; mosaic of anhedral calcite (crystals about 100 microns) with radial chert inclusions; porosity (intercrystal, channel, vugs) is 10 percent; permeability is medium.
320	<u>Limestone</u> ; disrupted texture; all particles leached or micritized; vugs up to more than 200 microns; porosity (intercrystal, moldic, vugs) is 15 percent and connected; permeability is low.
330	<u>Limestone</u> ; mudstone; mollusc fragments; micrite with interlaced microspar; porosity (small vugs less than 100 microns, intercrystal) is 5 to 10 percent; permeability is low.
341	<u>Limestone</u> ; mudstone to wackestone; particles highly micritized; miliolid ghosts; some evidence of bedding; microsparite groundmass; porosity (intercrystal, vugs) is 10 percent; permeability is low.
350	<u>Limestone</u> (completely recrystallized); no original texture; mosaic of very large subhedral crystal ghosts filled with subhedral rhombs (about 10 microns); porosity is much less than 5 percent; permeability is very low.
360	<u>Limestone</u> ; mudstone; mollusc fragments, foraminifera; porosity (isolated vugs) is 5 percent; permeability is low.

Depth  
(feet)

- 370 Limestone; wackestone; micritized particles, skeletal fragments, mollusc and rare chert; porosity (small vugs) is 5 percent; permeability is low.
- 380 Limestone; mudstone; mollusc fragments (recrystallized to microspar); porosity (isolated vugs less than 50 microns) is less than 5 percent; permeability is low.
- 390 Limestone; mudstone (very uniform); mollusc fragments, foraminifera; porosity is much less than 5 percent; permeability is very low.
- 400 Limestone; mudstone; stylolite, few particles, lumps; porosity is less than 5 percent; permeability is low.
- 410 Limestone; mudstone; uniform mudstone with zone of ostracods, foraminifera, chert; porosity is less than 5 percent; permeability is very low.
- 420 Limestone; grainstone; highly micritized miliolids, lumps and algal fragments; porosity is 5 percent; permeability is low.
- 430 Limestone; miliolid ghosts, grumous texture; leached microspar; porosity (isolated vugs, molds) is 10 percent; permeability is low.
- 440 Limestone; mudstone; grumous texture; microsparite cemented; small rounded cavities; porosity is less than 5 percent; permeability is very low.
- 450 Limestone; ghost mosaic of large anhedral crystals; zones of anhedral to subhedral rhombs up to 40 microns; porosity (intercrystal, large vugs) is 10 to 20 percent; permeability is high.
- 460 Limestone; grainstone; miliolid ghosts, mollusc fragments, microspar cement; porosity (intercrystal, moldic, vugs to 200 microns); permeability is medium.
- 470 Limestone; grainstone; miliolid molds and ghosts; abundant micrite; microspar; highly leached; porosity (intercrystal, moldic, vugs) is 20 percent and well connected; permeability is medium to high.
- 484 Limestone; grainstone; mosaic of anhedral crystals with miliolid ghosts; porosity is less than 5 percent; permeability is low.
- 492 Limestone; obliterated texture; mosaic of large irregular sparite and subhedral rhombs; porosity (intercrystal, very large vugs) is 10 to 20 percent; permeability is high.
- 500 Limestone; grainstone; miliolids, algal bits, lumps; grains are micritized and longitudinal grains are aligned; microsparite cement; fracture; porosity (intercrystal and isolated vugs) is low; permeability is low.

Depth  
(feet)

- 510 Limestone; wackestone; mollusc fragments, foraminifer with microsparite center and micrite rims; grumous texture; porosity is very low; permeability is low.
- 520 Limestone (recrystallized); no original texture; mosaic of large, irregular crystals and ghosts of rhombs; porosity (large vugs) is 15 percent; permeability is medium to high.
- 530 Limestone; micrite(?) with rare corroded mollusc fragments; microsparite in a grumous matrix; porosity (few small vugs) is less than 5 percent; permeability is low.
- 540 Limestone; grainstone; miliolid, large lumps, mollusc fragments; microsparite cement; porosity (scattered small vugs) is less than 5 percent; permeability is low.
- 550 Limestone; grainstone; foraminifera, mollusc fragments, oriented particles, intraclasts (to 100 microns); microsparite cement; porosity (vugs within the cement) is 5 percent; permeability is low.
- 563 Limestone (recrystallized); very fine texture of orange-stained anhedral grains (10 microns) containing patches of unstained anhedral grains (up to 40 microns); porosity is much less than 5 percent; permeability is very low.
- 570 Limestone; grainstone; large mollusc fragments, foraminifera, intraclasts; microsparite cement; porosity (intercrystal, openings less than 10 microns) is less than 5 percent; permeability is low.
- 580 Limestone; mudstone; fine skeletal fragments, foraminifer, large, extensively bored mollusc fragment; porosity is less than 5 percent; permeability is low.
- 590 Limestone; wackestone; skeletal fragments, miliolids; micrite patches; porosity is less than 5 percent; permeability is very low.
- 600 Limestone; packstone or micritized grainstone; foraminifera, scattered mollusc fragments; network of interlaced microsparite; porosity (intercrystal, vugs, fracture channels less than 100 microns) is 5 to 10 percent; permeability is medium.
- 610 Limestone; mudstone; miliolid ghosts, mollusc fragment; microsparite network; porosity (irregular vugs up to 400 microns, intercrystal in microsparite) is 15 to 20 percent.
- 620 Limestone; wackestone; highly micritized mollusc fragments; groundmass partially altered to microsparite; porosity (moldic, vugs, intercrystal) is 5 to 10 percent; permeability is low to medium.

Depth  
(feet)

- 631 Limestone; grainstone; highly micritized with grains outlined by microsparite; miliolids, mollusc fragments; interparticle space filled with microsparite; porosity (intercrystal, intraparticle, vugs) is 15 percent; permeability is medium to high.
- 640 Limestone; grainstone (micritized); foraminifera, intraclasts, mollusc fragment; microsparite cement; porosity (interparticle, intercrystal, vugs less than 200 microns) is 5 to 10 percent; permeability is low to medium.
- 650 Dolomite (limy); mudstone (dolomitized); scattered miliolid ghosts, euhedral replacement rhombs (to 80 microns); porosity is less than 5 percent; permeability is low.
- 660 Limestone (slightly dolomitic); packstone (micritized); abundant miliolids, skeletal fragments, isolated large dolomite rhombs; porosity is less than 5 percent; permeability is very low.
- 670 Dolomite (limy); mudstone; euhedral rhombs (40 to 90 microns) replace micrite, burrows containing smaller euhedral rhombs, relict organic materials; porosity is less than 5 percent; permeability is very low.
- 680 Limestone (dolomitic); mudstone; foraminifera ghosts, oil stains; euhedral replacement rhombs (to 80 microns); porosity is less than 5 percent; permeability is very low.
- 690 Limestone (slightly dolomitic); mudstone (highly micritized); very faint miliolid ghosts (some oil stained), numerous stylolites, chert; porosity (small vugs) is 5 to 8 percent; permeability is low.
- 700 Dolomite (limy); packstone (micritized); foraminifera (oil stained), mollusc fragment; groundmass of euhedral dolomite rhombs (to 70 microns); porosity is less than 5 percent; permeability is low.



Table 29.--Test-hole completion summary: Rio Medina (TD-68-34-506)

Location: Medina County, Tex., at the northwest corner of the intersection of FM 1957 (Potronco Road) and Wurzbach Road, and 0.5 mile west of the county line.

Elevation of land surface: 1042 feet above National Geodetic Vertical Datum of 1929.

Contractor: J. R. Johnson (Ideal T-8 R16, 80HP) Franks Draw Works.

Spudded: August 21, 1973.

Completed: October 10, 1973.

Casing: 8-5/8-inch to 420 feet; 7-inch liner 418-448 feet. Cemented with 70 sacks of 4-percent gel.

Total depth: 941 feet (driller); 935 feet (log).

Coring equipment: Stoutco 30-foot double-wall core barrel, 5-1/2x3-1/2 inches, 436-941 feet. Seven diamond core heads, 6x3-1/2 inches, of 200-230 carats, 4-6 stones per carat.

Core-recovery summary: Total footage cored, 494 feet; total core recovered, 297.7 feet; and percentage of recovery, 60 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
436-445.5	9.5	5.8	5.8
455	9.0	2.7	8.5
464	9.0	4.3	12.8
467	3.0	0.4	13.2
482	15.0	11.3	24.5
489	7.0	0	24.5
494	5.0	0	24.5
499	5.0	0	24.5
503	3.0	2.2	26.7
516	13.0	6.0	32.7
523	7.0	0.7	33.4
524	1.0	0.9	34.3
527-537	10.0	7.0	41.3
547	10.0	6.0	47.3
554	7.0	3.0	50.3
564	10.0	5.8	56.1
582	18.0	3.0	59.1
590	8.0	5.0	64.1
593	3.0	0	64.1
594-605	11.0	4.7	68.8
616	11.0	5.9	74.7

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
626	10.0	6.8	81.5
636	10.0	8.0	89.5
649	13.0	11.3	100.8
659	10.0	6.1	106.9
674	15.0	10.0	116.9
679	5.0	4.5	121.4
686	7.0	6.7	128.1
701	15.0	11.1	139.2
710	9.0	7.9	147.1
720	10.0	7.5	154.6
730	10.0	6.4	161.0
740	10.0	6.8	167.8
750	10.0	2.1	169.9
751-761	10.0	8.6	178.5
771	10.0	8.4	186.9
779	8.5	7.4	194.3
789	10.0	7.8	202.1
790-794.5	4.5	0.5	202.6
801	6.5	2.8	205.4
808.5	7.5	6.0	211.4
811-821	10.0	2.5	213.9
826	5.5	0	213.9
837	10.5	5.0	218.9
839	2.0	1.0	219.9
840.5-851	10.5	8.5	228.4
864	13.0	5.1	233.5
874	10.0	8.9	242.4
879	5.0	1.4	243.8
889	10.0	8.6	252.4
899	10.0	9.3	261.7
909	10.0	8.5	270.2
926	17.0	13.8	284.0
941	15.0	13.7	297.7

Notes: It was suggested to the contractor that small diamonds (about 20 stones per carat) be used for coring the test hole. The Corps of Engineers recommends the smaller stone size and four previous wells had been cored successfully with diamond core heads of 22-24 stones per carat. However, the contractor preferred large stones (4-6 stones per carat). The large exposed faces quickly chipped off whenever chert was encountered. Broken core in the hole also damaged the large stone bits.

The broken core in the hole was ground up with a 4-cone rock bit and the hole bottom flattened before re-entry with the core barrel.

Core runs were reduced from 15-10 feet or less in an effort to retard shattering.

Continued use of dull or worn bits, poor core catchers, and slow cutting further complicated core recovery.

Table 30.--Description of test-hole cores: Rio Medina (TD-68-34-506)

Depth (feet)	
436-441	Limestone; color, 10YR 8/3,7/8; texture, mudstone. Soft, marly, chalky and fossiliferous tan limestone with <u>Gryphaea</u> and pecten fragments common. High-angle fracture, stylolite and rare limonite. -- at 436 - Thin-section description (table 31). -- at 440 - Thin-section description (table 31).
441-455	Limestone; color, 10YR 7/2; texture, mudstone to wackestone. Fine crystalline fossiliferous mudstone. Fractures and rudist molds are common. -- at 440-446 - Burrows. -- at 445 - Thin-section description (table 31).
455-471	Limestone; color, 10YR 5/2,8/1; texture, wackestone. Dense to chalky, marly wackestone with molluscs, burrows, fractures and vugs. -- at 455 - Black oil stain. -- at 455, 459 - High-angle fractures. -- at 456 - Vuggy. -- at 462 - Thin-section description (table 31). -- at 470 - Thin-section description (table 31).
471-482	Limestone and dolomite; color, 10YR 7/2; texture, mudstone to wackestone. Dense, hard, marly mudstone and wackestone with rudists and chert.
482-499	Core lost.
499-523	Limestone (poor core recovery); color, 10YR 7/2; texture, mudstone to wackestone to grainstone. Hard, chalky to fine sucrosic mudstone and wackestone with fractures, burrows, vugs and some chert. -- at 500 - Thin-section description (table 31). -- at 501 - Chert. -- at 500-502 - Large, partially calcite-filled veins. -- at 502, 503-503.5, 506-506.5, 506.8-507.5, 508-509 - Fractures. -- at 507.5-508 - Vug zone. -- at 508 - Thin-section description (table 31). -- at 520 - Thin-section description (table 31).
523-538	Limestone and dolomite; color, 10YR 7/1,6/3; texture, mudstone to wackestone to grainstone to crystalline carbonate. Dense to chalky mudstone and wackestone (some recrystallization) and some miliolid and fossil fragment grainstone. -- at 528, 530.4 - Chert. -- at 528.5 - Red, brown and black laminated shale with a trace of dead oil. -- at 529-530 - Fossil fragment grainstone. -- at 530.6-534 - Fossiliferous mudstone. -- at 531 - Thin-section description (table 31).
538-555	Limestone; color, 10YR 8/3; texture, mudstone to wackestone to grainstone (some recrystallization) with chert and fractures. -- at 538 - Calcite veins and calcite-lined vugs. -- at 538.5 - Chert. -- at 540-545.5 - Vugs, recrystallized breccia composed of calcite with mudstone clasts. -- at 541 - Thin-section description. -- at 547 - Miliolid mudstone. -- at 548 - Well cemented miliolid grainstone. -- at 549 - Sucrosic rudist fragment grainstone. -- at 554-555 - Mudstone with large caprinid molds.
555-582	Limestone and dolomite (poor core recovery); color, 10YR 7/3,5/3; texture, mudstone to wackestone to grainstone. Dense, hard wackestone, mudstone and grainstone. Rudists are common in the upper layers; sucrosic and shalier in the lower part. -- at 555, 557.9, 564, 565.5 - Chert. -- at 556 - Quartz. -- at 557 - Soft, fine sucrosic dolomitic limestone with much calcite. -- at 565 - Collapse zone. -- at 565.3-565.5, 566.2-566.5 - Fracture. -- at 565.5-566 - Limestone with dolomite clasts. -- at 580 - Thin-section description (table 31).

Depth (feet)	
582-605	<p>Limestone and dolomitic limestone (poor core recovery); color, 10YR 6/1,5/3; texture, mudstone to wackestone to packstone to crystalline carbonate. Dense, hard, shaly mudstone with fractures, disturbed bedding and intraclasts. The upper portion of this zone is sucrosic with vugs and fractured chert.</p> <ul style="list-style-type: none"> <li>-- at 583 - Very fossiliferous packstone.</li> <li>-- at 584 - Fine sucrosic dolomite and dolomitic limestone.</li> <li>-- at 585 - Scattered, irregular limestone clasts, wispy shale and erratic fractures; collapse zone(?).</li> <li>-- at 594 - Sucrosic and slightly chalky limestone.</li> <li>-- at 595.2, 595.5 - Chert.</li> <li>-- at 595.5, 596.6-597.4 - Fracture.</li> <li>-- at 596.2-597.3 - Brecciated and shaly.</li> <li>-- at 598.6 - Wispy shale.</li> <li>-- at 600 - Thin-section description (table 31).</li> </ul>
605-620	<p>Limestone and dolomite; color, 10YR 7/1,6/3,5/3; texture, wackestone to mudstone. Partly dolomitic mudstone to wackestone with sucrosic layers common. The upper part contains chert, fractures and hard shaly layers. Porosity is variable, mostly thin layers of intercrystalline porosity in a dense matrix.</p> <ul style="list-style-type: none"> <li>-- at 605.8-607.4 - Sucrosic limestone with many rudist molds.</li> <li>-- at 606 - Chert.</li> <li>-- at 607.3 - Wispy shale.</li> <li>-- at 610 - Dolomitic and shaly limestone.</li> <li>-- at 610.1-610.4 - Many discontinuous and irregular shale zones.</li> <li>-- at 610.5-610.7 - Asphalt on high-angle fracture.</li> <li>-- at 610.6-611 - Good moldic porosity.</li> <li>-- at 616.2-616.4 - Discontinuous wispy shale.</li> <li>-- at 616.4 - Soft black shale or asphalt in rudistid mold.</li> <li>-- at 619 - Fractures.</li> </ul>
620-646	<p>Limestone and dolomite; color, 10YR 7/1,7/2,6/3; texture, mudstone to wackestone. Hard, dense mudstone to wackestone with wispy, shaly rudist zones in the upper part; wispiest and shalier in the lower part.</p> <ul style="list-style-type: none"> <li>-- at 620 - Very fine sucrosic, shaly dolomitic limestone with discontinuous irregular shale zones.</li> <li>-- at 621 - Large calcite crystals; thin-section description (table 31).</li> <li>-- at 621-622 - Fracture lined with small calcite crystals.</li> <li>-- at 626 - Dense, fossiliferous rudist wackestone.</li> <li>-- at 627-629 - Dense fossiliferous mudstone.</li> <li>-- at 629-630 - Miliolid wackestone to packstone.</li> <li>-- at 630-630.5 - Shaly and chalky limestone with disturbed bedding.</li> <li>-- at 631 - Small black angular clasts and small pyrite inclusions.</li> <li>-- at 631.4-634 - Medium soft shaly to very shaly limestone with irregular shale beds.</li> <li>-- at 636-638, 641-642, 645-647 - Fractures.</li> <li>-- at 637.5-643 - Gray calcareous shale and interbedded chalky limestone with wispy shale streaks and discontinuous shale fragments. Fragments may be shale-filled rhizoconcretion or rip-up clasts.</li> <li>-- at 639 - Thin-section description (table 31).</li> <li>-- at 643-646 - Dark gray calcareous shale grading into shaly limestone by 646.</li> <li>-- at 645 - Thin-section description (table 31).</li> </ul>
646-676	<p>Limestone; color, 10YR 8/2,8/3,8/1,7/2; texture, wackestone to packstone to grainstone. White, oxidized medium hard chalky miliolid grainstone with mudstone in the lower part and large rudist molds in the upper part. The grainstone is tightly cemented, but the remainder is fractured with low matrix porosity and permeability along fractures.</p> <ul style="list-style-type: none"> <li>-- at 649-650 - Hard, dense slightly fossiliferous mudstone with a few stylolites and wispy shale stringers.</li> <li>-- at 650-653 - Packstone with abundant microfossils and rudists.</li> <li>-- at 653-655 - Very well cemented miliolid grainstone with rudist molds.</li> <li>-- at 653, 654, 655 - Stylolites.</li> <li>-- at 655 - Thin-section description (table 31).</li> <li>-- at 659-660, 663.4, 665-665.5 - Wispy shale.</li> <li>-- at 660-666.5 - Miliolid packstone with scattered thin layers of miliolid grainstone.</li> <li>-- at 665.5-667 - Very well cemented miliolid and fossil fragment grainstone.</li> <li>-- at 667-669 - Chalky wackestone with fractures and a few rudist molds.</li> <li>-- at 670 - Thin-section description (table 31).</li> </ul>
676-701	<p>Limestone; color, 10YR 8/1,7/2,6/2; texture, grainstone to mudstone to crystalline carbonate. Hard, dense, variably chalky mudstone and miliolid grainstone with mollusc fragments. Many fractures are calcite-healed.</p>

Depth  
(feet)

- at 674-675 - Chalky mudstone.
  - at 675-676.5 - Well cemented fossil fragment grainstone.
  - at 676.5-678.5 - Wackestone.
  - at 679-680.5 - Dense to slightly chalky mudstone.
  - at 680 - Thin-section description (table 31).
  - at 680.5-683 - Miliolid packstone and grainstone.
  - at 682-683, 683-684.5, 694-694.5 - Open fractures.
  - at 683-684.5 - Dense hard mudstone.
  - at 684 - Thin honeycomb structure zone.
  - at 684.5-685.7 - Very well cemented miliolid grainstone.
  - at 686-689 - Miliolid grainstone.
  - at 689-692.5 - Sparry calcite and recrystallized limestone.
  - at 689 - Thin-section description (table 31).
  - at 689-689.5 - Honeycomb zone.
  - at 692.5 - Chert.
  - at 692.5-694 - Shaly wackestone with few fossil fragments.
  - at 694-695 - Sparry calcite and recrystallized limestone.
  - at 695-696 - Shaly wackestone and miliolid grainstone.
  - at 699-701 - Microfossil and fossil fragment packstone with dictyonids.
  - at 700 - Thin-section description (table 31).
- 701-720 Limestone; color, 10YR 8/1,7/2; texture, mudstone to wackestone. Very hard, dense mudstone and some interbedded grainstone with fractures (both open and healed).
- at 701-707 - Well cemented miliolid grainstone.
  - at 703-703.5, 707.5-708.5, 710-713.5 - Fractures.
  - at 707-707.9 - Hard, dense mudstone.
  - at 710 - Thin-section description (table 31).
  - at 710-713.5 - Hard, dense mudstone.
  - at 713 - Thin-section description (table 31).
  - at 713.5-714.5 - Well cemented miliolid grainstone, -variably a coquina.
  - at 714.5-716 - Dense, hard mudstone.
  - at 715-715.3 - High moldic porosity.
  - at 716 - Chert.
  - at 716-717 - Well cemented, variably argillaceous miliolid grainstone.
- 720-740 Limestone; color, 10YR 7/2,7/3; texture, mudstone to crystalline carbonate. Hard, dense mudstone and recrystallized limestone, sparry calcite and boxwork porosity. Evaporitic above grading to a grainstone below.
- at 720-722 - Fine sucrosic limestone with irregular clasts of chalky and harder limestone.
  - at 721-733.5, 733.7 - Chert.
  - at 721.5-722 - Honeycomb structure zone in calcite.
  - at 722-726.4 - Moderately honeycombed sparite with fossil molds--mostly rudistids.
  - at 730 - Thin-section description (table 31).
  - at 733.1-734 - Dolomite and fossil fragment grainstone.
  - at 734-736.8 - Variably honeycombed sparite.
- 740-761 Limestone and dolomite; color, 10YR 8/2,6/2,7/2,5/3; texture, crystalline carbonate. Hard, sucrosic mudstone and wackestone, well cemented, burrowed and brecciated. Wispy shale zones and algal mats with dessication cracks. Large dolomite clasts occur in black mudstone. Some gypsum converted to calcite. A vugular rock showing no evidence of recent leaching.
- at 740-740.2 - Vugs in sparite nearly filled with calcite crystals.
  - at 740.2-740.5 - Burrowed sucrosic limestone with calcite veins.
  - at 740.5-741.2 - Sucrosic dolomite with smooth solution channels.
  - at 741.2 - Asphalt in burrowed zones.
  - at 741.6 - Stylolites.
  - at 742, 751.2-752, 753.7, 755.4 - Wispy shale.
  - at 750 - Thin-section description (table 31).
  - at 752-753 - Dogtooth spar lines vugs in limestone-calcite hash.
  - at 753-753.7 - Well cemented fossil fragment grainstone with algal mats.
  - at 755.7 - Chert.
  - at 755.9 - Algal mat.
- 761-770 Dolomite and limestone; color, 10YR 5/3,5/1,6/3; texture, crystalline carbonate to mudstone to wackestone. Dark greenish-gray, fine sucrosic dolomite, mudstone to wackestone with laminated zones, disturbed bedding zones, algal mats and wispy shale. Porosity is high. Dark color suggests restricted water movement and low permeability.
- at 761 - Thin-section description (table 31).
  - at 761-762.4 - Burrowed and vuggy sucrosic limestone with abundant calcite.
  - at 762.3 - Chert.

Depth  
(feet)

- at 762.4-765 - Fine sucrosic dolomite with algal mats.
- at 762.4-762.8, 764.7-765, 766.8, 767.5, 767.8, 768, 768.8 - Wispy shale.
- at 767.5 - Algal mat.

770-780

- Dolomite and limestone; color, 10YR 6/3,7/2; texture, crystalline carbonate to mudstone to wackestone. Dark to medium gray with zones of greenish gray sucrosic dolomite and abundant calcite. Shaly mudstone and wackestone also present. Chert, algal mats and rudists in upper part and nodular beds with dense wackestone layers in middle part. Lower part contains silty dolomite with fossil molds and a laminated zone.
- at 771 - Thin-section description (table 31).
  - at 771-774 - Fine sucrosic limestone.
  - at 771.8-772.1, 772.4, 772.8, 773.1-774 - Zones of calcite layers.
  - at 771.8, 772.4, 773.1, 773.8 - Algal mat.
  - at 772.7, 773.1, 773.8 - Wispy shale.
  - at 774-776 - Well cemented miliolid and fossil fragment grainstone.
  - at 775.6, 775.8-776.1 - Chert.
  - at 776.1-779.8 - Fine sucrosic dolomitic limestone with fossil molds, many calcite filled. Identified molds are clam, rudist and gastropod.
  - at 777-779.8 - Laminated limestone and shale.
  - at 779 - Thin-section description (table 31); very thin shale bed.

780-801

- Limestone and dolomite; color, 10YR 7/2,8/1; texture, mudstone to packstone to grainstone. Medium hard to chalky mudstone with packstone or grainstone with chert and calcite. The middle zone is dolomite and the lower zone is dense, earthy rock.
- at 780-781.6 - Medium hard, fine, sucrosic limestone.
  - at 781 - Dull, fissile dolomitic shale.
  - at 781.4-781.6 - Calcite.
  - at 781.6-785.8 - Miliolid grainstone.
  - at 785.2-785.8, 786.4, 786.8 - Fractured.
  - at 785.8-786.8 - Slightly silty, fine, sucrosic dolomite.
  - at 790 - Thin-section description (table 31).
  - at 790-790.5 - Very fine sucrosic limestone with low to high vuggy porosity.
  - at 794.2 - Boxwork porosity.
  - at 794.2-794.3, 795 - Chert.
  - at 794.3-795 - Chalky, slightly sucrosic dolomite with mollusc fragments and a 3-inch thick zone of fossiliferous rock.

801-827

- Limestone and dolomite; texture, wackestone to grainstone to crystalline carbonate. Medium hard sucrosic wackestone to grainstone with shaly partings and chert. Dense to porous grainstone in the upper part and dolomitic with intercrystalline porosity in the lower part.
- at 801 - Miliolid grainstone and some mudstone with fossil molds; thin-section description (table 31).
  - at 803 - Subcoquina of recrystallized boundstone.
  - at 804 - Open fracture.
  - at 805 - Laminated mudstone and shale.
  - at 805-807 - Brown sucrosic dolomite with thin laminated beds.
  - at 807.5 - Dark gray to black laminated algal mats.
  - at 808.5 - Chert.
  - at 811-812.5 - Fine sucrosic dolomite with many vugs.
  - at 812.5-813.5 - Thinly laminated, well cemented grainstone.
  - at 821 - Thin-section description (table 31).

827-844

- Limestone and dolomite; color, 10YR 7/2; texture, wackestone to packstone. Dense, silty dolomite, wackestone and packstone with fractures, wispy shale and disturbed bedding. Stylolites in the upper part. Porosity and permeability is low.
- at 827, 828.1, 837 - Chert.
  - at 827-831.3 - Hard fossiliferous laminated wackestone with fossil molds.
  - at 831.3 - Vertical fracture.
  - at 837.5-838 - Hard, earthy wackestone with a few fossil molds and laminations.
  - at 838 - Vertical fracture.
  - at 840 - Thin-section description (table 31).
  - at 840.5-843.5 - Dense to chalky, fossiliferous mudstone with many burrows filled with fossil fragments.

844-864

- Limestone and dolomite; color, 10YR 7/2; texture, wackestone to packstone. Dense dolomite, wackestone and packstone with burrows, fractures, wispy shale and disturbed bedding.
- at 844-847 - Medium hard, chalky wackestone.
  - at 847 - Grainstone coquina.
  - at 849 - Chert.

Depth  
(feet)

- at 851-852.2 - Medium hard, slightly chalky, variably burrowed fossiliferous wackestone with many mollusc fragments.
  - at 852-854.6 - Coquina composed of microfossil and fossil fragment grainstone.
  - at 854.6 - Chert.
  - at 854.6-856.1 - Silty microfossil wackestone with about 10 percent moldic porosity.
  - at 855.9 - Algal mat.
- 864-874 Limestone and dolomite; color, 10YR 7/1,7/2,6/2; texture, grainstone to packstone. Leached fossil fragment packstone to grainstone in the upper half and mottled, dolomitized mudstone with chert and wispy shale common in the lower half. Matrix porosity is greater than 15 percent. The upper half is leached and the lower half is sucrosic. Permeability is low.
- at 864 - Thin-section description (table 31).
  - at 864-866.5 - Microfossil and fossil fragment grainstone with dictyonids and high interparticle porosity.
  - at 866.5-871 - Variably argillaceous fossil fragment packstone to grainstone.
  - at 868-871 - Wispy shale.
  - at 868, 868.1, 869 - Dull gray opaque chert and glassy, black, subtranslucent chert.
  - at 868.4, 868.5 - Stylolites.
  - at 867, 867.5-868.5, 868.9-869.1 - Fractures.
  - at 871-871.8, 872.5-872.7 - Wispy shale.
- 874-889 Limestone and dolomite; color, 10YR 7/2,5/3; texture, mudstone to packstone to crystalline carbonate. Chalky to dense mudstone and packstone. Porous rudist packstone capped with a 1-foot thick dolomite layer in the upper part. Dense burrowed mudstone and wackestone with lenses of well cemented grainstone comprises the middle to lower part. The lowest part is dense and nonpermeable.
- at 874-875 - Very fine sucrosic dolomite with medium moldic porosity.
  - at 874.8-875.1 - Vertical fracture.
  - at 875 - Thin-section description (table 31).
  - at 875.1 - Gray chert.
  - at 879 - Very fossiliferous wackestone to packstone with rudists, gastropods, foraminifera and fossil molds.
  - at 881.7-883 - Very hard, fine sucrosic dolomite with few fossil molds.
  - at 883-884 - Rudist, gastropod and miliolid packstone.
  - at 883.2 - Sparite-lined rudist mold.
  - at 884 - Chalky, burrowed, variably argillaceous wackestone.
  - at 885.8, 885.9 - Stylolites.
- 889-898 Limestone and dolomite; color, 10YR 6/2,7/2; texture, mudstone to wackestone to packstone. Mottled and burrowed dense, silty wackestone with disturbed bedding, tight fractures and a few small vugs in the lower part. Porosity and permeability is low.
- at 889-893.7 - Miliolid packstone lens in chalky burrowed wackestone.
  - at 890 - Thin-section description (table 31).
  - at 891.5 - Shaly and stylolitic.
  - at 892.3 - Wispy shale.
  - at 893.6-893.7 - Stylolites.
  - at 893.7-895.3 - Miliolid wackestone to packstone.
  - at 893.7-894.1 - Laminated.
  - at 895.3-898.3 - Variably burrowed, chalky and shaly wackestone to packstone with abundant gastropod molds.
  - at 898 - Stylolite.
- 898-909 Limestone and dolomite; color, 10YR 6/2,7/2; texture, mudstone to wackestone to packstone. Dense to chalky burrowed mudstone with disturbed bedding. Low matrix porosity and permeability.
- at 899-900 - Chalky, slightly fossiliferous wackestone.
  - at 900-901 - Chalky mudstone with abundant microfossils.
  - at 900 - Stylolite; thin-section description (table 31).
  - at 901 - Shaly mollusc fragment packstone with disturbed bedding.
  - at 902.2 - Miliolid and fossil fragment grainstone.
  - at 902.9, 903.1-903.5 - Stylolite.
  - at 903-907.5 - Burrowed mudstone with abundant microfossils.
  - at 904.5, 905.4, 906.5 - Vertical fractures.
- 909-920 Limestone and dolomite; color, 10YR 7/2,4/2; texture, mudstone to packstone to crystalline carbonate. Dense, clayey, mottled and nodular mudstone to packstone with wispy shale and fossils. The upper foot is dark gray-green dolomite with low porosity and permeability.
- at 909.6-911 - Limy, sucrosic dolomite with rudists and oysters.
  - at 909.8, 910.5, 917.2-917.5 - Discontinuous filaments of wispy shale.

Depth  
(feet)

- at 910 - Thin-section description (table 31).
- at 911-917 - Lenses of miliolid grainstone in hard, burrowed mudstone to wackestone.
- at 915 - Wispy shale.
- at 917-920 - Medium hard, chalky, burrowed mudstone to wackestone.
- at 920 - Thin-section description (table 31).

920-941

Clayey limestone; color, 10YR 6/1; texture, mudstone to wackestone. Dense, burrowed fossiliferous mudstone and wackestone with wispy shale, stylolites and abundant oyster shell fragments.

- at 921.5-922 - Wispy shale and stylolites.
- at 926-933 - Silty, burrowed mudstone with many oyster fragments.
- at 926, 928.5, 932.5-933.6, 936.6-936.9 - Stylolites.
- at 929-930 - Abundant oysters.
- at 930 - Thin-section description (table 31).
- at 933-936.5 - Very stylolitic shaly wackestone with oyster fragments.
- at 936.5 - Wispy shale.
- at 936.5-938.5 - Rare black rotund bodies.
- at 938.4-938.5 - Wispy shale, stylolites and abundant black rotund bodies.



Table 31.--Description of thin sections of test-hole cores:  
Rio Medina (TD-68-34-506)

Depth (feet)	
436	<u>Limestone</u> ; wackestone to packstone; fossil hash (fragments 50 to 80 microns), foraminifera, disseminated weathered pyrite and an isolated oyster; brown oxidation stain; porosity is less than 5 percent; permeability is very low.
440	<u>Limestone</u> ; wackestone; skeletal fragments, foraminifera, micritized grains (40 to 60 microns), some micrite altered to psuedosparite, chert replacement in groundmass, oxidation stains; porosity (isolated intercrystalline, vugs) is 5 to 10 percent; permeability is low.
445	<u>Limestone</u> ; wackestone; foraminifera, intraclasts, skeletal fragments (30 to 100 microns); some larger fragments recrystallized to coarse sparite, an isolated fragment (up to several millimeters); micrite is partially converted to psuedospar; brecciated fractures with calcite infilling; leaching along fractures; hematite staining; porosity (vugs, intraparticle, moldic, fracture, channel) is 10 percent and poorly connected; permeability is low to medium.
462	<u>Limestone</u> ; wackestone; miliolids (400 microns), highly micritized grains, micrite and psuedosparite; fine sparite fills intraparticle voids; porosity (intraparticle, vugs, channel) is 5 to 10 percent and poorly connected; permeability is low.
470	<u>Limestone</u> ; wackestone; miliolids, foraminifera and a skeletal fragment; micrite, psuedosparite and some chert replacement; porosity (poorly connected vugs) is 10 to 15 percent; permeability is low to medium.
500	<u>Dolomite</u> (limy); obliterated original texture; euhedral to subhedral crystals (50 to 60 microns) in a tight mosaic; porosity (connected vugs up to 200 microns) is 10 to 15 percent; permeability is low to medium.
508	<u>Limestone</u> (recrystallized); wackestone; molluscs, angular skeletal fragments, vugs up to 1000 microns; porosity (isolated vugs) is 10 percent; permeability is low to medium.
520	<u>Limestone</u> (dolomitized); subhedral to anhedral dolomite rhombs (40 to 50 microns); porosity (intercrystal, vugs) is less than 10 percent; permeability is low.
531	<u>Limestone</u> ; mudstone; highly micritized miliolids, pellets, foraminifera ghosts in a dismicrite matrix; porosity (interparticle, vugs less than 40 microns) is less than 5 percent; permeability is low.
541	<u>Limestone</u> (recrystallized); coarse mosaic of sparite (crystals up to 500 microns); smaller crystals replace larger ones; isolated chert replacement; porosity (isolated vugs) is less than 5 percent.

Depth  
(feet)

- 550 Limestone; original texture obscured; subhedral rhombs (20 to 40 microns); porosity (intercrystalline, vugs) is 5 to 10 percent; permeability is low to medium.
- 560 Limestone; mudstone; foraminifera, mollusc fragment, echinoderm spine, micritized fragments; psuedosparite; vugs from 30 to 100 microns; porosity (poorly connected intercrystal, vugs) is 5 percent; permeability is low.
- 580 Limestone (dolomitic); wackestone; large mollusc fragments and fossil debris; euhedral rhombs (up to 80 microns) replacing micrite; some stylolites; an irregular fracture; porosity (isolated vugs 50 to 100 microns) is 5 percent; permeability is low.
- 600 Limestone; mudstone; nonfossiliferous micrite and psuedosparite; vugs (200 to 300 microns) are lined by psuedosparite; porosity (intercrystal, connected vugs) is 15 to 20 percent; permeability is medium.
- 621 Limestone; wackestone; miliolids, foraminifera, skeletal fragments (to 200 microns); holes are filled with calcite; mollusc fragments replaced by chert; stylolites; micrite slightly dolomitized; porosity is less than 5 percent; permeability is low.
- 639 Limestone; mudstone; spine-like skeletal fragments, foraminifera (smaller than 60 microns); stylolite; micrite with psuedosparite; porosity is less than 5 percent; permeability is very low.
- 645 Limestone; mudstone; isolated forams; homogenous micrite; sealed fracture; porosity is less than 5 percent; permeability is very low.
- 655 Limestone; grainstone (micritized); miliolids, mollusc fragments (some chert replaced) up to 500 microns; micritized sparite cement; porosity is 5 percent; permeability is low.
- 670 Limestone; mudstone/grainstone; micrite; zones of pellets; porosity (vugs) is 5 to 10 percent; permeability is low.
- 680 Limestone; mudstone; relict miliolids; groundmass is grumous to homogenous; fracture partially filled; porosity is less than 5 percent; permeability is low.
- 689 Limestone; grainstone; miliolids, pelletal intraclasts, algal bits, molluscs (200 to 1,000 microns), foraminifer, rounded lumps, micritized particles, granular calcite cement; porosity (isolated vugs less than 100 microns) is less than 5 percent; permeability is low.
- 700 Limestone; grainstone (highly micritized); miliolids, molluscs, lumps; porosity (intraparticle, isolated vugs) is 5 to 10 percent; permeability is low.

Depth (feet)	
710	<u>Limestone</u> ; grainstone (pelsparite); pellets (80 to 100 microns), miliolids, foraminifera; all particles highly micritized; ground-mass is psuedosparite; porosity (isolated vugs less than 100 microns) is less than 5 percent; permeability is low.
718	<u>Limestone</u> ; wackestone (pelsparite); pellets and small (less than 50 microns) microspar; weakly laminated micrite and microspar; porosity (isolated vugs) is less than 5 percent; permeability is low.
730	<u>Limestone</u> ; grainstone; miliolids, mollusc fragments, lumps, algal fragments (up to 1,000 microns); psuedosparite cement; porosity (isolated vugs) is less than 5 percent; permeability is low.
750	<u>Limestone</u> (dolomitic); wackestone; ghosts of miliolids, subhedral to anhedral rhombs replace sparite cement; porosity (fractures, vugs to 100 microns) is 10 percent; permeability is medium to low.
761	<u>Limestone</u> (dolomitic); euhedral to subhedral rhombs (40 to 60 microns) are replacing sparite; porosity (intercrystal, vugs to 500 microns) is 10 percent; permeability is medium.
771	<u>Limestone</u> (dolomitic); relict grains suggest rock was a mudstone or wackestone; euhedral to subhedral rhombs replace sparite; hematite staining; porosity (intercrystal, vugs) is 20 percent; permeability is medium.
779	<u>Limestone</u> (dolomitic); relict mudstone intraclasts; subhedral crystals (10 to 30 microns); porosity (vugs to 500 microns) is 10 to 20 percent; permeability is medium.
790	<u>Dolomite</u> ; no original texture; rhombs (20 to 40 microns); larger crystals in vugs; porosity (intercrystal, vugs that are 100 to 300 microns) is 15 to 20 percent; permeability is medium.
801	<u>Limestone</u> ; packstone; highly micritized foraminifera, molluscs; cement is micrite recrystallized to microsparite; porosity (intercrystal, intraparticle, vugs) is 10 percent; permeability is low to medium.
821	<u>Dolomite</u> ; no original texture; euhedral to subhedral rhombs (10 to 30 microns); porosity (well connected intercrystal, vugs 50 to 200 microns) is greater than 30 percent; permeability is high.
840	<u>Limestone</u> ; mudstone; foraminifera ghosts, miliolids, dismicrite and micrite matrix; porosity (isolated vugs) is less than 5 percent; permeability is low.
864	<u>Limestone</u> ; wackestone; highly micritized foraminifera, algal bits, skeletal fragments; matrix is grumous micrite and psuedosparite; porosity (isolated vugs to 100 microns) is less than 5 percent; permeability is low.

Depth  
(feet)

- 875 Dolomite; no original texture; mosaic of euhedral to subhedral rhombs (40 to 60 microns); porosity is low to medium.
- 890 Limestone (dolomitic); mudstone; foraminifera, euhedral rhombs (to 60 microns) form a mosaic; matrix is micrite; porosity is less than 5 percent; permeability is low.
- 900 Limestone; mudstone; isolated dolomite rhombs; grumous micrite; porosity is less than 5 percent; permeability is low.
- 910 Dolomite (limy); mudstone; rhombs have bimodal size distribution (60 to 100 micron rhombs fill cavities, 30 to 50 micron rhombs replace groundmass); hand specimen is a dense mudstone with abundant organics and dolomitized burrows; porosity (intercrystal, vugs to 100 microns) is greater than 20 percent; permeability is high in burrows.
- 920 Dolomite; mudstone to packstone; highly micritized with zones of dolomitization; micrite contains microsparite; foraminifera, skeletal grains, stylolites; porosity (isolated vugs less than 50 microns) is less than 5 percent; permeability is very low.
- 930 Dolomite; mudstone; replacement by mosaic of dolomite rhombs (to 50 microns); isolated mollusc fragment and skeletal fragments in micrite groundmass; porosity is less than 5 percent; permeability is low.

Table 32.--Test-hole completion summary: Sabinal (YP-69-37-402)

Location: Uvalde County, Tex., on the east side of State Highway 187, 8.2 miles north of Sabinal and 1 mile south of the intersection with Ranch Road 1796 (Comanche Waterhole quadrangle).

Elevation of land surface: 1158 feet above National Geodetic Vertical Datum of 1929.

Contractor: Texas Department of Water Resources (Failing 1500 core-drilling rig, modified).

Spudded: November 19, 1973.

Completed: January 30, 1974.

Casing: 6-1/4-inch inside diameter to 233 feet. Cemented with 62 sacks neat cement, cement circulated.

Total depth: 694 feet (driller); 694 feet (log).

Coring equipment: Christensen double-wall mining core barrel, 5-3/4x4 inches x 10 feet long. Diamond core heads of 67-81 carats, 20 stones per carat. Bottom discharge, 16 waterways.

Core-recovery summary: Total footage cored, 455 feet; total core recovered, 339.8 feet; and percentage of recovery, 75 percent.

CORING AND RECOVERY DETAIL

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
234-243	9.0	5.5	5.5
253	10.0	0.3	5.8
255-262	7.0	7.0	12.8
265	3.0	0.6	13.4
278	13.0	2.3	15.7
282	4.0	0	15.7
285	3.0	0	15.7
289	4.0	1.6	17.3
290	1.0	1.2	18.5
300	10.0	9.5	28.0
305	5.0	4.6	32.6
315	10.0	7.3	39.9
323	8.0	5.8	45.7
328	5.0	3.3	49.0
333	5.0	3.2	52.2
339	6.0	3.5	55.7
343	4.0	3.6	59.3
351	8.0	7.0	66.3
360	9.0	3.6	69.9

<u>Cored interval (feet)</u>	<u>Cored footage</u>	<u>Recovered footage</u>	<u>Cumulative footage recovered</u>
363	3.0	3.0	72.9
367	4.0	4.0	76.9
377	10.0	10.0	86.9
384	7.0	7.0	93.9
388	4.0	3.2	97.1
398	10.0	2.0	99.1
400	2.0	1.0	100.1
406	6.0	3.0	103.1
416	10.0	3.7	106.8
418	2.0	1.0	107.8
426	8.0	5.8	113.6
433	7.0	3.2	116.8
435	2.0	1.0	117.8
444	9.0	9.0	126.8
453	9.0	9.0	135.8
467	10.0	10.0	145.8
473	10.0	10.0	155.8
482	9.0	9.0	164.8
490	8.0	5.4	170.2
497	7.0	6.0	176.2
507	10.0	7.5	183.7
515	8.0	8.0	191.7
525	10.0	4.0	195.7
527	2.0	0.8	196.5
534	7.0	3.0	199.5
541	7.0	2.5	202.0
550	9.0	9.0	211.0
552-559	7.0	6.0	217.0
569	10.0	10.0	227.0
570-579	9.0	1.6	228.6
584	5.0	5.0	233.6
596	12.0	10.0	243.6
606	10.0	10.0	253.6
615	9.0	8.6	262.2
625	10.0	8.8	271.0
635	10.0	10.0	281.0
645	10.0	10.0	291.0
654	9.0	9.0	300.0
664	10.0	10.0	310.0
674	10.0	10.0	320.0
684	10.0	9.8	329.8
694	10.0	10.0	339.8

Notes: Much of the recovered core was shattered and suitable only for determination of lithology. Discontinuous core runs increased the shattering problem. Shorter runs produced a better recovery percentage.

Table 33.--Description of test-hole cores: Sabinal (YP-69-37-402)

Depth (feet)	Description
234-257	Limestone; color, 10YR 7/2,8/2; texture, wackestone to packstone. Hard, recrystallized, fossiliferous wackestone to packstone, leached in the upper zone, with caprinids and other molluscs common. Matrix porosity is low and moldic and fracture porosity is low to medium. -- at 233-234 - Burrowed sparite. -- at 234 - Thin-section description (table 34). -- at 236 - Brown, glassy, translucent chert. -- at 236-239 - Hard, burrowed, chalky packstone. -- at 254-257 - Abundant rudists in grainstone.
257-284	Limestone; color, 10YR 8/2,7/2; texture, wackestone to packstone to crystalline carbonate. Hard, fossil hash to dense, aphanitic, recrystallized rock. Tightly cemented with molds, fractures and vugs forming secondary porosity. -- at 257 - High-angle fracture. -- at 261 - Travertine lines fracture. -- at 262 - Siliceous mudstone; thin-section description (table 34). -- at 265-267.3 - Very hard siliceous mudstone with many subangular to angular chert fragments; fragments appear oriented along plane of old high-angle fracture. -- at 278 - Thin-section description (table 34). -- at 279 - Glassy, translucent chert. -- at 282 - Limestone to crystalline carbonate.
285-295	Limestone; color, 10YR 8/4; texture, crystalline carbonate. Recrystallized mudstone to wackestone with caprinid, <u>Toucasia</u> and chert; very low matrix porosity; fractures and moldic vugs form secondary porosity. -- at 285-286.6 - Orange-stained, recrystallized limestone. -- at 286 - Thin-section description (table 34). -- at 286-286.6 - Abundant caprinids. -- at 289, 295 - Glassy brown chert. -- at 290-293 - Stylolites and caprinid molds. -- at 291 - Thin-section description (table 34). -- at 293-295 - Fossil fragment grainstone with molds.
295-323	Limestone; color, 10YR 8/1,7/2; texture, mudstone to grainstone to recrystalline carbonate. Recrystallized mudstone to laminated, coarse, fossil fragment grainstone with caprinids, <u>Toucasia</u> and stylolites. -- at 295.3, 295.6 - Stylolites. -- at 295-299.5, 300, 305, 311.5-312, 320.6-320.8 - High-angle and vertical fractures. -- at 300-301.7 - Medium to coarse grained, fossil fragment grainstone. -- at 300.5, 308, 309.5, 309.6 - Chert. -- at 301 - Thin-section description (table 34); laboratory test (table 35). -- at 303, 304.5, 307.1 - Stylolite. -- at 303.5-304.6 - Laminated chert in upper zone. -- at 305-305.4 - Granular brown opaque chert. -- at 305.4-306.2 - Siliceous mudstone with caprinids. -- at 306.2-308.4 - Recrystallized biosparite with caprinid fragments and abundant molds. -- at 308, 308.1 - Silica replaced rudists. -- at 315-315.8 - Recrystallized caprinid grainstone. -- at 315.8-316.1 - Glassy, subtranslucent chert. -- at 316.1-320.8 - Recrystallized fossiliferous limestone.
323-333	Limestone; color, 10YR 7/2; texture, crystalline carbonate. Very hard, dense, chalky to sucrosic recrystallized wackestone, mudstone and grainstone with chert. Interparticle porosity is low; vuggy and cavernous porosity is 15 percent. -- at 323-324 - Chalky, recrystallized mudstone. -- at 324 - Cavernous or honeycomb fracture. -- at 324-325.5 - Sucrosic crystalline carbonate. -- at 325 - Thin-section description (table 34); laboratory test (table 35). -- at 325-327 - Recrystallized packstone. -- at 329-331.4 - Caprinid grainstone. -- at 329.2-329.4, 329.8-331.1 - High-angle and vertical fractures.
333-346	Limestone; color, 10YR 7/2; texture, crystalline carbonates. Hard to very hard dense mega-fossil wackestone with grainstone zones and caprinids, <u>Toucasia</u> , chert and leaching. -- at 333-334 - Sucrosic. -- at 333, 333.6 - Glassy, translucent brown chert. -- at 334-336.5 - Grainstone with miliolids and high-spined gastropods.

Depth  
(feet)

- at 335.3, 339 - High-angle fractures.
  - at 339-339.9 - Wackestone.
  - at 340 - Thin-section description (table 34); laboratory test (table 35).
  - at 340.3 - Chert.
  - at 340.5-346 - Wackestone with many caprinid molds.
  - at 341.6-342 - Agatized fossils, chalcedony, and glassy, translucent chert.
  - at 345 - Stylolite with pale orange stain.
- 346-367 Limestone; color, 10YR 8/2,7/1; texture, crystalline carbonate to grainstone. Very hard, dense, recrystallized wackestone, mudstone and grainstone; fractured and stylolitic with caprinids and caprinid molds.
- at 346-350 - Variably leached miliolid and fossil fragment grainstone.
  - at 346-347.5, 348-351, 361, 362.4, 363-366, 366-367 - High-angle and vertical fractures.
  - at 352 - Sucrosic crystalline carbonate.
  - at 354, 360.4, 361.6, 363-363.2 - Glassy, translucent brown chert.
  - at 360-361.6 - Chalky recrystallized mudstone.
  - at 363 - Siliceous mudstone.
  - at 363-366 - Finely sucrosic, slightly chalky mudstone.
  - at 366-367 - Miliolid grainstone.
  - at 367 - Black chert and siliceous mudstone.
- 367-379.4 Limestone; color, 10YR 8/2; texture, grainstone to mudstone. Hard microfossil grainstone tightly cemented with sparite. Fractured and iron stained with microvugs in the grainstone and with chert.
- at 367-377 - Miliolid grainstone with algal mat.
  - at 368.4 - Thin mudstone layer.
  - at 368, 372, 375.5 - Stylolites.
  - at 371 - Chalcedony nodules.
  - at 367-372, 373-377 - High-angle and vertical fractures.
  - at 377-379.4 - Gastropod and miliolid grainstone.
  - at 379.4 - Red clay on stylolite.
- 379.4-388 Limestone; color, 10YR 8/1; texture, mudstone and wackestone. Hard, dense wackestone and very fine grained grainstone with Toucasia, iron-stained fractures and isolated voids and fractures forming secondary porosity.
- at 379.8 - Red clay and fossil molds on stylolite.
  - at 380 - Thin-section description (table 34); laboratory test (table 35).
  - at 380.2 - Stained high-angle fracture.
  - at 383-384 - Rudist mudstone and wackestone.
  - at 384-387 - Fossil fragment grainstone.
  - at 387 - Packstone.
  - at 388 - Dull and opaque, brown chert fragments.
  - at 384.5, 386, 387 - Orange-stained stylolites.
- 388-416 Limestone; color, 10YR 7/2, texture, grainstone to mudstone. Hard, dense mudstone and miliolid grainstone with stylolites, fractures and chert.
- at 388-390 - Fossil fragment to miliolid grainstone with casts and molds of high-spired gastropods.
  - at 400-402 - Fine sucrosic and fossiliferous.
  - at 400, 406, 408.5 - High-angle fracture.
  - at 402-403 - Sucrosic crystalline carbonate.
  - at 405 - Thin-section description (table 35); laboratory test (table 36).
  - at 406 - Fractured granular crystalline carbonate with calcite crystals on orange-stained fracture faces.
  - at 407 - Red-brown chert.
  - at 407.2 - Glassy brown chert.
  - at 408.2 - Large mold or channel filled with calcite.
- 416-433 Limestone; color, 10YR 7/2; texture, crystalline carbonate to mudstone to wackestone. Very hard mudstone to wackestone, variably laminated and fractured with chert, Toucasia, and some large vugs after fossils. Fractures are stained orange and contain clay.
- at 416 - Granular recrystallized limestone with red clay on fracture faces.
  - at 418-419.5 - Mudstone.
  - at 418.5 - Stylolite.
  - at 418.5-420.5, 421.9-422.5, 428-429 - High-angle and vertical fractures.
  - at 419.5-421.4 - Wackestone.
  - at 421 - Thin-section description (table 35); laboratory test (table 36).
  - at 421, 428.5 - Chert.
  - at 421.4-423.8 - Rudist wackestone and fossil fragment grainstone.
  - at 426-429 - Wackestone.



Depth (feet)	
433-447	<p>Limestone; color, 10YR 7/2; texture, grainstone to wackestone. Very hard, dense grainstone and wackestone with stylolites, high-angle open fractures with terra rosa and calcite fill, low interparticle porosity, isolated vugs and fracture porosity.</p> <p>-- at 433-434 - Stylolitic wackestone to packstone.</p> <p>-- at 435-441 - Fossil fragment packstone.</p> <p>-- at 440 - Thin-section description (table 35); laboratory test (table 36); fracture faces lined with clay.</p> <p>-- at 440-444 - Rudists.</p> <p>-- at 441-444 - Fossil fragment grainstone.</p>
447-464	<p>Limestone; color, 10YR 7/2; texture, grainstone to crystalline carbonate. Hard microfossil hash with terra rosa on high-angle and vertical fractures.</p> <p>-- at 447-461 - Poorly sorted grainstone.</p> <p>-- at 447.5-448.5 - Fractured zone with stylolites and orange-brown clay.</p> <p>-- at 452.5 - Orange-stained stylolites.</p> <p>-- at 458.5-460 - Stylolites.</p> <p>-- at 458 - Vuggy.</p> <p>-- at 461 - Thin-section description (table 35); laboratory test (table 36).</p> <p>-- at 461.5-463.5 - Variably shaly, dense mudstone with 12-inch arenaceous zone.</p>
464-474	<p>Limestone; color, 10YR 6/2,7/1,8/2; texture, grainstone to crystalline carbonate. Hard, fossil fragment grainstone and dense recrystallized limestone with shaly streaks. Upper zone is recrystallized mudstone with sedimentary features.</p> <p>-- at 464-467.5 - Shaly arenaceous mudstone.</p> <p>-- at 467.5-468.5 - Granular sparry calcite.</p> <p>-- at 468.5-472 - Fossil fragment grainstone.</p> <p>-- at 472.1-472.5 - Large calcite crystals on face of vertical fracture.</p> <p>-- at 472.5-474 - Shaly arenaceous mudstone.</p>
474-482	<p>Limestone; color, 10YR 7/1,8/2,7/2,6/2; texture, mudstone. Hard, dense, partially recrystallized mudstone with slickensides and fractures with calcite, terra rosa and iron staining.</p> <p>-- at 474-474.5 - Fractured, shaly and sucrosic limestone.</p> <p>-- at 474.5-479.5 - Very dense porcelaneous mudstone with calcite-healed fractures.</p> <p>-- at 476.5 - Mottled.</p> <p>-- at 477.5 - Low-angle fractures, stained and lined with calcite.</p> <p>-- at 479.5 - Stylolite.</p> <p>-- at 479.5-480.5 - Silty mudstone.</p> <p>-- at 480.5-481.5 - Fractured porcelaneous mudstone.</p> <p>-- at 481.5-482 - Silty mudstone.</p> <p>-- at 483 - Thin-section description (table 35); laboratory test (table 36).</p>
482-497	<p>Limestone; color, 10YR 6/1,8/1,7/2; texture, mudstone to crystalline carbonate. Variably dolomitic, vugular, recrystallized mudstone with fractured cave rock, chert and vugular porosity.</p> <p>-- at 482 - Chalky, sucrosic mudstone and stained fracture.</p> <p>-- at 482.2, 486 - Chert.</p> <p>-- at 482.5-486 - Medium sucrosic, vuggy, crystalline carbonate; loosely cemented and brittle.</p> <p>-- at 486-487 - Finely sucrosic, crystalline carbonate.</p> <p>-- at 490 - Tan siliceous mudstone.</p> <p>-- at 490.3-496 - Sucrosic, crystalline carbonate with stained and loosely cemented, high-angle fractures.</p> <p>-- at 494.2 - Vug zone; most vugs calcite lined.</p>
497-515	<p>Limestone; color, 10YR 6/3; texture, mudstone to crystalline carbonate. Dense, recrystallized mudstone in the upper zone and coarse, vugular nondescript rock in lower zone; extensive fracturing and recrystallization.</p> <p>-- at 497-499.6 - Moderately and erratically burrowed, fine grained crystalline carbonate.</p> <p>-- at 497.4, 497.6, 498, 499 - Orange-stained, high-angle fractures.</p> <p>-- at 499.6-501 - Burrowed granular and sucrosic crystalline carbonate.</p> <p>-- at 499.8-500, 500.5-500.6 - Brown, glassy, subtranslucent chert.</p> <p>-- at 500.5-501 - Coarsely sucrosic crystalline carbonate.</p> <p>-- at 501 - Thin-section description (table 35); laboratory test (table 36).</p> <p>-- at 501-511 - Medium to coarsely sucrosic crystalline carbonate.</p> <p>-- at 507-511 - Extensively fractured.</p> <p>-- at 511-515 - Fine, granular, slightly shaly crystalline carbonate with red-brown clay in fractures.</p> <p>-- at 511-513 - Fractures.</p> <p>-- at 513.2-513.4 - Calcite-lined vugs.</p> <p>-- at 513.4-515 - High-angle and vertical fractures with red-brown clay on fracture faces.</p>

Depth  
(feet)

- 515-534 Limestone; color, 10YR 6/2,6/3,8/2; texture, mudstone to crystalline carbonate. Vuggy, recrystallized, partly sucrosic mudstone with breccia, chert, terra rosa in voids and large vugs filled with white calcite. Fractures allow high permeability.  
-- at 515-515.7 - Hard, dense, recrystallized mudstone.  
-- at 515.4 - Stylolite.  
-- at 515, 515.4-515.7 - Vertical and high-angle fractures with orange-brown stain.  
-- at 515.7-517 - Variably vuggy, fine to medium sucrosic crystalline carbonate.  
-- at 515.8, 527 - Chert.  
-- at 517 - Thin-section description (table 35); laboratory test (table 36).  
-- at 517-519 - Medium to coarse, sucrosic crystalline carbonate.  
-- at 525-527 - Fine to medium, sucrosic crystalline carbonate.  
-- at 527-527.5 - Vuggy with recemented breccia.  
-- at 527-534 - Fine, sucrosic crystalline carbonate.
- 534-550 Limestone; color, 10YR 5/3,6/3; texture, mudstone to crystalline carbonate. Dense, mottled and fractured mudstone with laminated chert and terra rosa at bottom.  
-- at 534-536.5 - Hard recrystallized mudstone.  
-- at 535 - Chert.  
-- at 541-542.4 - Fractures and stylolites common; orange-brown clay on fractures.  
-- at 541-544.7 - Fine, sucrosic, muddy crystalline carbonate.  
-- at 542 - Thin-section description (table 35); laboratory test (table 36).  
-- at 542.4 - Chert.  
-- at 542.4-544 - High-angle fractures.  
-- at 544.7-546 - Fine sucrosic crystalline carbonate with brecciated white sparite.  
-- at 546-546.4 - Chert.  
-- at 546-550 - Granular and sucrosic crystalline carbonate; vertical and high-angle faults.
- 550-558 Limestone; color, 10YR 6/2,7/4; texture, mudstone to crystalline carbonate. Dense, burrowed, fractured and recrystallized mudstone with chert, orange stain and slickensides on fractures; zones of coarse, vugular porosity and fracture permeability.  
-- at 550-551.7 - Burrowed, fine, granular crystalline carbonate with veins and patches of white sparite.  
-- at 550-551.7 - Calcite-lined vugs.  
-- at 551.7-552.3 - Fine, sucrosic and spongy.  
-- at 552.3-556 - Fine, granular, crystalline carbonate with stylolites and fractures.  
-- at 555.5 - Clear and white calcite.  
-- at 555.5-556 - Abundant vugs.  
-- at 557-558 - Granular, recrystallized limestone.  
-- at 557-558 - Fractures, stylolites and orange-brown clay.  
-- at 557.2 - Chert.
- 558-573 Limestone; color, 10YR 8/3,6/3,7/2; texture, grainstone. Hard, dense miliolid grainstone, tightly cemented with thin leached zones; large brecciated clasts in upper zone; low inter-particle and fracture porosity.  
-- at 558-566 - Miliolid and fossil fragment grainstone.  
-- at 559 - Thin-section description (table 35).  
-- at 560 - Thin-section description (table 35); laboratory test (table 36).  
-- at 563.5-565 - Fossil fragment packstone.  
-- at 566.6-568 - Medium sucrosic crystalline carbonate.  
-- at 568-573 - Highly fractured and brecciated hard, dense mudstone.  
-- at 568.4, 569.4, 572.5 - Large calcite-lined vugs.  
-- at 568.2, 568.3, 569.2, 569.9, 573 - Chert.  
-- at 571.5 - Chert and siliceous limestone.  
-- at 570-571, 571-572.5 - Fractures.
- 573-584 Limestone; color, 10YR 8/3,6/3,7/2; texture, grainstone. Hard, dense recrystallized wackestone to packstone in the upper part with laminated and disturbed mudstone in the lower part; tightly cemented with fracture porosity and isolated vugs.  
-- at 573.3-574.6 - Dense recrystallized mudstone.  
-- at 574.2 - Packstone.  
-- at 576.1-578.1 - Fossil fragment grainstone.  
-- at 578 - Chert.  
-- at 576-578 - High-angle fracture with solution channels.  
-- at 578.1-581 - Fine, sucrosic crystalline carbonate.  
-- at 579.6, 580.6, 579.4-579.6, 579.7-580 - Vuggy zones.  
-- at 581-583.6 - Sucrosic crystalline carbonate.  
-- at 582 - Thin-section description (table 35); laboratory test (table 36).

Depth (feet)	
584-601	<p>Limestone; color, 10YR; hard, dense, variably laminated mudstone in the upper part and variably leached, recrystallized miliolid grainstone in the lower part; fracture porosity.</p> <ul style="list-style-type: none"> <li>-- at 583.6-591 - Miliolid grainstone.</li> <li>-- at 584 - Spongy appearance.</li> <li>-- at 585-586 - Miliolid grainstone.</li> <li>-- at 586-589 - Spongy appearance.</li> <li>-- at 589-591.5 - Fossil fragment grainstone.</li> <li>-- at 591.5-597 - Miliolid and fossil fragment grainstone.</li> <li>-- at 593.2 - Chert.</li> <li>-- at 595.5-596.4 - Rudist molds.</li> <li>-- at 597-598 - Laminated, mottled mudstone.</li> <li>-- at 598 - Thin-section description (table 35); laboratory test (table 36).</li> <li>-- at 598-601 - Silty burrowed wackestone.</li> </ul>
601-620	<p>Limestone; color, 10YR 7/2,6/2; texture, mudstone to wackestone to crystalline carbonate. Heavily burrowed, recrystallized mudstone with intercrystalline porosity and very large isolated vugs; grainstone fills burrows.</p> <ul style="list-style-type: none"> <li>-- at 601-602.4 - Chalky stylolitic wackestone.</li> <li>-- at 602.4, 607.2-607.6, 611.8 - Wispy shale.</li> <li>-- at 602.6-604 - Granular burrowed mudstone.</li> <li>-- at 604-606.2 - Granular and sucrosic burrowed mudstone.</li> <li>-- at 608-609.6 - Spongy crystalline carbonate.</li> <li>-- at 610-611.6 - Heavily burrowed, fine, granular mudstone with small vugs.</li> <li>-- at 611.7-615.4 - Chalky mudstone with few burrows.</li> <li>-- at 612.7-613 - Solution channels.</li> <li>-- at 613-615.4 - Fractures and stylolites.</li> <li>-- at 615.4-618.8 - Caprinid packstone with few burrows.</li> <li>-- at 617-618.8 - Vertical fractures.</li> </ul>
620-645	<p>Limestone; color, 10YR 8/3,8/2,7/2; texture, grainstone to mudstone to wackestone. Recrystallized miliolid grainstone in the upper part and hard, dense recrystallized mudstone with disturbed bedding in the lower part.</p> <ul style="list-style-type: none"> <li>-- at 620-621 - Fine sucrosic crystalline carbonate.</li> <li>-- at 621 - Thin-section description (table 35); laboratory test (table 36).</li> <li>-- at 621-625.5 - Wackestone, packstone and miliolid grainstone.</li> <li>-- at 622.4, 622.9, 623, 623.3, 623.8 - Stylolites.</li> <li>-- at 622.4-624 - Argillaceous and burrowed.</li> <li>-- at 625.5-630 - Burrowed wackestone with Turitellid gastropods and a spongy appearance.</li> <li>-- at 630-632.2 - Burrowed, stylolitic wackestone with calcite veins.</li> <li>-- at 632.4-633.4 - Sucrosic crystalline carbonate.</li> <li>-- at 633.4-635.4 - Chalky, burrowed wackestone.</li> <li>-- at 635.1, 635.3-635.5, 640-641, 642-644, 646.5-649 - Stylolites.</li> <li>-- at 635.4-644 - Chalky, burrowed wackestone.</li> <li>-- at 635.1, 635.3-635.5, 640-641, 642-644, 646.5-649 - Stylolites.</li> <li>-- at 635.4-644 - Chalky, burrowed mudstone with few fossil fragments.</li> <li>-- at 640 - Thin-section description (table 35); laboratory test (table 36).</li> <li>-- at 642-643.6, 646.6-648 - Wispy shale.</li> <li>-- at 642 - High-angle fracture with calcite-lined cavity.</li> </ul>
645-649	<p>Limestone; color, 10YR 7/1; texture, mudstone to wackestone to packstone. Hard, dense, mottled and partly recrystallized mudstone to packstone with wispy shale, stylolites, oysters and black rotund bodies.</p> <ul style="list-style-type: none"> <li>-- at 644, 648-649 - Few black rotund bodies.</li> </ul>
649-689	<p>Limestone; color, 10YR 7/1,8/1; texture, wackestone. Shaly, chalky wackestone with stylolites, black rotund bodies and oysters; many black rotund bodies have pyrite centers; wispy shale common below 650 feet.</p> <ul style="list-style-type: none"> <li>-- at 649 - Thin-section description (table 35).</li> <li>-- at 651.9-655.5 - Chalky wackestone with many black rotund bodies.</li> <li>-- at 651.9-652, 656.2-657, 659.5-660, 662.6-663.4 - Wispy shale.</li> <li>-- at 653-657 - Burrowed with black rotund bodies and grainstone fill.</li> <li>-- at 651.9-652.5, 654.2, 655, 656.1-657 - Stylolites.</li> <li>-- at 657.1-669 - Burrowed chalky wackestone with black rotund bodies, stylolites and fossils.</li> <li>-- at 659-661 - Stylolites.</li> <li>-- at 659-663 - Abundant black rotund bodies.</li> <li>-- at 663-669 - Black rotund bodies.</li> <li>-- at 669 - Thin-section description (table 35).</li> <li>-- at 669-674 - Burrowed, chalky and stylolitic wackestone with black rotund bodies and large calcite-lined vugs.</li> </ul>

Depth  
(feet)

- at 674-679 - Miliolid wackestone with black rotund bodies and few gastropods.
- at 679 - Thin-section description (table 35).
- at 679-683.5 - Miliolid wackestone with wispy shale, stylolites, gastropods, small clams and a few black rotund bodies.
- at 683.5-686 - Silty miliolid wackestone with black rotund bodies, wispy shale, clams, oysters and gastropods.
- at 686-689 - Shaly wackestone with stylolites, oysters, clam fragments and a few miliolids; black rotund bodies are common to 688; moderately burrowed with black rotund bodies and shale making up fill.
- at 687 - Thin-section description (table 35).

Table 34.--Description of thin sections of test-hole cores:  
Sabinal (YP-69-37-402)

Depth (feet)	
234	<u>Limestone</u> (recrystallized); ghost mosaic of outlined large crystals replaced by subhedral rhombs (30 to 40 microns); porosity (scattered vugs to 300 microns) is low; permeability is low.
262	<u>Limestone</u> (recrystallized); mollusc fragments; chert inclusions; microsparite groundmass with sparite mosaic; porosity (intercrystal, vugs to 300 microns); is greater than 20 percent; permeability is medium to high.
278	<u>Limestone</u> ; mudstone; extremely fine particle hash, rare mollusc fragment; open fractures with rhombs (30 to 40 microns); porosity is very low; permeability is low except in open fractures.
286	<u>Limestone</u> ; mudstone; mollusc fragments; clotted micrite and microsparite groundmass with anhedral crystals (50 microns); porosity (vugs to 200 microns, intercrystal in microsparite) is 10 percent; permeability is low.
291	<u>Limestone</u> ; wackestone (recrystallized); highly micritized; microsparite groundmass; porosity (intercrystal, fracture, vugs to 200 microns) is 20 percent; permeability is medium.
301	<u>Limestone</u> (recrystallized); mollusc fragments (some chert replacement); large angular moldic voids; porosity (molds, vugs 100 to more than 200 microns) is more than 30 percent; permeability is high.
325	<u>Limestone</u> (slightly dolomitic); wackestone (recrystallized); mollusc fragments (to more than 1,000 microns) replaced by chert; recrystallized angular skeletal fragments; porosity (poorly connected vugs 80 to 120 microns) is 15 to 20 percent; permeability is medium.
340	<u>Limestone</u> (recrystallized); wackestone; little original texture; miliolid ghosts, recrystallized mollusc fragments with a sparite mosaic; fractures; porosity (poorly connected intraparticle, intercrystal, vugs) is 5 percent; permeability is low.
380	<u>Limestone</u> ; grainstone (micritized); algal filaments, foraminifera, lumps (particles are 100 to 300 microns); porosity (intercrystal, interparticle, vugs) is 5 to 8 percent; permeability is low.
405	<u>Limestone</u> ; no original texture; recrystallized mosaic of tightly interlocking anhedral crystals (40 to 70 microns); no porosity; no permeability.
421	<u>Limestone</u> (slightly dolomitic); wackestone (recrystallized); highly micritized mollusc fragments, skeletal debris; isolated dolomite rhombs; porosity (intercrystal, vugs less than 100 microns) is 5 to 10 percent; permeability is low.