PRELIMINARY SUMMARY

OF THE 1976 ATLANTIC MARGIN CORING PROJECT

OF THE

U. S. GEOLOGICAL SURVEY

By

John C. Hathaway, John S. Schlee, C. Wylie Poag,

Page C. Valentine, E. G. A. Weed, Michael H. Bothner,

Francis A. Kohout, Frank T. Manheim, Robert Schoen,

Robert E. Miller and David M. Schultz

NOVEMBER 1976

76-844

This report is preliminary and has not been edited or reviewed
for conformity with Geological Survey standards or nomenclature.

PREFACE

The Atlantic Margin Coring Project was planned in consultation with the State Geological Surveys of the Atlantic Coastal States and was carried out by a team of more than 40 scientists and technicians of the U.S. Geological Survey and State Geological Surveys who served alternating tours of duty aboard the D/V GLOMAR CONCEPTION.

The shipboard staff (affiliation, U.S. Geological Survey unless otherwise indicated) included Chief Scientists: John C. Hathaway and John S. Schlee; Paleontologists: C. Wylie Poag, Page C. Valentine, Charles C. Smith, and Raymond E. Hall; Sedimentologists: E.G.A. Weed, Penelope M. Hanshaw, William H. Abbott (South Carolina Division of Geology), Paul F. Huddlestun (Georgia Department of Natural Resources), John H. Talley (Delaware Geological Survey), Paul B. Dahlgren (New Jersey Bureau of Geology and Topography), William B. Rogers (New York Geological Survey), Bruce W. Nelson (Maine Geological Survey), Nancy S. Hardin, Mario J. Carnavalle, Harley J. Knebel, Peter A. Scholle, John C. Behrendt; Water Chemists: Frank T. Manheim, Francis A. Kohout, James M. Weigle, Robert Schoen, Michael H. Bothner; Organic Chemists: David M. Schultz, David D. Brandon, Robert E. Miller; Geotechnical Specialists: Adrian F. Richards (Lehigh University), Richard M. Coad (Lehigh University), Michael Perlow (Lehigh University); Chief Technician: Robert F. Commeau; Core Technicans: Lawrence J. Poppe, Patricia L. Forrestel, John M. Dunlavey, Anna C. Sundberg, Paul W. Cousins, Martha H. Winsor, Barbara Tausey, Randy J. Fabro, Susan J. Purdy; Secretaries: Katheryn M. Seitsinger, Janet L. Gelinas, Sandra C. Merchant.

Geophysicists, James M. Robb and Richard E. Sylwester, and Electronic Technicians, Kenneth F. Parolski, William L. Jaworski, and David W. Kinney worked aboard the supply boat M/V L'OLONNOIS, making geophysical surveys of each site prior to drilling and determining the navigational coordinates.

Hathaway, project chief, was chief scientist for the first four and the last three weeks of the cruise, and Schlee for the intervening three weeks.

Special acknowledgment for planning and organizing the shipboard laboratory work are due to Poag and Valentine for the paleontologic studies; Bothner, Manheim, and Kohout for the interstitial water analyses; Miller for the light hydrocarbon analyses; Hathaway and Weed for core description and sampling procedures; and Richards for analyses of geotechnical properties (to be reported separately).

The information in this report was collected by the shipboard scientific staff. The introduction was written by Hathaway and Weed, and the operations reports were assembled from reports of the tool pushers, from deck logs, and from the logs of the chief scientists. The site reports contain summaries and preliminary interpretations derived from notes and written statements of the scientific staff: lithologic columns were prepared by Valentine from graphic logs made by various members of the sedimentological group and by himself; statements on paleontology and paleoenvironment were written by Poag and Valentine from their data and those of Smith, Hall, and Abbott; discussions of interstitial water were assembled by Bothner from material written by Manheim, Kohout, Schoen, and himself; summaries of the light hydrocarbons were prepared by Miller and Schultz using information which they and Brandon collected. The organization and editing of this report were carried out by Hathaway and Weed.

Particular acknowledgment is made to those who reviewed geophysical data on each site for drilling safety: Kenneth O. Emery, John I. Ewing, James R. Heirtzler, and Elizabeth T. Bunce, all of the Woods Hole Oceanographic Institution; Hollis D. Hedberg of Princeton University; Louis E. Garrison, Newell T. Stiles, Marc E. Nelson of the U.S. Geological Survey.

Appreciation is due the supervisory staff of Global Marine Inc. who served at various times aboard the D/V GLOMAR CONCEPTION including: Superintendents: George Rowe and Charles Simons; Captains: David M. Coombs and Robert G. Dionisopoulos; Tool Pushers: Charles Hazlewood, Malcolm Clark, T.M. Taylor, L. Gideon and C. Watson; Drillers: Robert Brown, John Hensen, Patrick Flynn and Patrick Kelly. R.C. Johnson was Operations Manager for Global Marine Inc.

Special acknowledgment is due Judith A. Commeau who handled shore logistics for all laboratory supplies for the cruise.

CONTENTS

	Page
Preface	1
Contents	2
Abstract	4
Introduction	5
Program and purpose	5
Selection of sites	6
Anchoring	6
Drilling equipment	6
Coring methods	7
Hole numbering system	8
Shipboard analyses	9
Geophysical borehole logs	11
Plugging and abandonment of holes	11
Data presented in this report	11
Preliminary geologic ages	11
Data in preparation	12
Sample policy	15
Map showing location of sites	16
Summary of holes	17
Operations résumé	21
Site descriptions	24
Explanations	24
Site 6002	29
Site 6003	39
Site 6004	40
Site 6005	51
Site 6006	58

Site 6007. 63
Site 6008. 74
Site 6009. 81
Site 6010. 93
Site 6011. 103
Site 6012. 112
Site 6013. 126
Site 6014. 139
Site 6015. 146
Site 6016. 152
Site 6017. 157
Site 6018. 165
Site 6019. 169
Site 6020. 179
Site 6021. 184

Appendix A: Cross sections showing regional stratigraphic relationships by Page C. Valentine and C. Wylie Poag 198
Appendix B: Comparative geology of onshore and offshore South Carolina by Alan-Jon Zupan and William H. Abbott 206
Appendix C: Cross section showing zone of low salinity interstitial water extending seaward under the continental shelf off central New Jersey. Interpretive contours by Francis A. Kohout 215
Appendix D: Geophysical borehole logs 217

PRELIMINARY SUMMARY
OF THE 1976 ATLANTIC MARGIN CORING PROJECT
OF THE
U.S. GEOLOGICAL SURVEY

ABSTRACT

The U.S. Geological Survey Atlantic Margin Coring Project, 1976, a 60-day expedition to obtain core samples by drilling beneath the floor of the Continental Shelf and Slope of the eastern United States, was carried out in July, August, and September 1976 aboard D/V GLOMAR CONCEPTION.

The coring penetrated as much as 310 meters below the sea floor at 19 sites along the continental margin from Georgia to Georges Bank off New England in water depths ranging from 20 to 300 meters; 1,020 meters of material were recovered in 380 cores, ranging in age from Late Cretaceous to Holocene.

One of the major findings of the program was the discovery of relatively fresh water (salinities less than 3 parts per thousand) extending beneath the Continental Shelf as much as 60 nautical miles seaward from the New Jersey coast. Water of about 1 part per thousand salinity was found beneath the shelf more than 7 nautical miles off Ocean City, Maryland and Barnegat Inlet, New Jersey.

Analyses for light hydrocarbons in the cores show the highest concentrations (as much as 412,000 ppm) at sites in water depth greater than 200 meters (the shelf-slope break), principally in Pleistocene sediments, although methane concentrations greater than 400,000 ppm were also found in Miocene sediments at one site near the shelf edge.

INTRODUCTION

Program and purpose.--The U.S. Geological Survey Atlantic Margin Coring Project, 1976, a 60-day expedition to obtain core samples by drilling beneath the floor of the Continental Shelf and Slope of the eastern United States, was carried out in July, August, and September 1976.

The purpose of the program was to obtain reliable data for appraisals of environmental conditions and offshore resources. Objectives included measuring geotechnical and engineering properties of the shelf sediments, defining freshwater aquifers offshore, collecting information on possible resources such as phosphates, sand and gravel deposits, and calibrating existing geophysical data. Additional information was sought on the regional extent of geologic units, the stratigraphic column, characteristics and ages of the sediments, variance of the geochemical baseline, and zones of slope stability or potential instability.

The work was carried out aboard D/V GLOMAR CONCEPTION with the assistance of the M/V L'OLONNOIS in making seismic site surveys, anchoring the drilling vessel, and transporting supplies and equipment.

Holes were cored at 19 sites shown on the accompanying map (p. 16) in water depths ranging from 20 to 300 meters; 1,020 meters of material were recovered in 380 cores. A twentieth site (6003) was investigated but no cores were recovered owing to a resistant layer at the seafloor. An attempt was also made to investigate a site at latitude 32°00.99'N longitude 79°01.37'W at the inner edge of the Blake Plateau in 445 meters (1,460 feet) water depth. Anchoring was successful but the Gulf Stream prevented any attempt to drill. The current of 3 knots or greater shook the drill string to the extent that drilling could not be started.

Selection of sites.--Prior to the beginning of the cruise, potential sites were selected on the basis of existing reflection seismic profiles of areas where the objectives stated above might be reached within the limit of 305 meters (1,000 feet) of penetration. This limit was imposed to avoid the likelihood of hydrocarbon spills or blowouts since the program called for open-hole drilling without a riser system or blowout preventer. The sites also had to avoid possible hydrocarbon traps that might exist at penetration depths less than the 305 meter limit.

Prior to "spudding in" (initial penetration of the seafloor by the drill string), reflection seismic surveys were conducted by USGS geophysicists on the M/V L'OLONNOIS over the potential site to determine if the geologic structures at the location matched those shown by the previously run profiles and to make certain that no unforeseen dangerous structures existed at the actual drilling location.

At most of the sites a buoy was placed by the L'OLONNOIS to serve as a reference mark for the seismic survey and for anchoring the drilling vessel.

Anchoring.--The D/V GLOMAR CONCEPTION lacked a dynamic positioning system; it maintained position over the drilling sites by anchoring, which imposed a maximum water depth limit of 460 meters (1,500 feet). Depending upon site conditions, three or four anchors were deployed. Two anchors could be emplaced by the drilling vessel but the rest required the assistance of the L'OLONNOIS in carrying the anchors, each of which weighed 30,000 lbs., away from the drilling vessel. Tensions of about 110,000 lbs. were usually placed on each anchor chain to hold the ship in position. The average time for the anchoring operation was about six hours.

Drilling equipment.--Drilling was accomplished with bottom hole assemblies that usually consisted of a 9 5/8" (24.45 cm) O.D. (outside diameter) carbide-

button roller-cone bit with a core opening of 2 1/8" (5.40 cm), a bit sub containing a flapper (float) valve, an outer core barrel, a cross-over sub, three to six 8¼" O.D. drill collars, an 8¼" O.D. bumper sub, three 8¼" O.D. drill collars, and a cross-over sub to connect the bottom hole assembly to the 5" O.D. drill pipe. The 3 3/4" inside diameter of the tool joints (the threaded ends of the drill pipe) was the limiting factor in the size of core that could be taken, as the wire-line inner core barrel had to pass through the tool joints. The largest diameter core (in a liner) which could be taken with this system was 2 1/8" (5.40 cm).

Drilling fluid, either seawater or drilling mud made with seawater or freshwater, was pumped down the drill stem; the fluid passed between the inner and outer core barrels and was directed by jets in the drill bit against the material being drilled. The drill cuttings were carried to the sea floor through the annulus between the drill stem and the walls of the hole. Since no marine riser (conductor pipe) from the sea floor to the drilling vessel was used, no return circulation or reentry was possible; the drill cuttings were deposited on the sea floor and were not retrievable for study.

Coring methods.--The outer core barrel was equipped with bearings which allowed the inner core barrel to remain stationary with respect to the formation during rotation of the bit and the bottom hole assembly. The inner core barrel was fitted with a 29.5 ft (9.0 m) clear butyrate-plastic core liner. A core shoe containing a double set of spring-loaded hinged core-catcher fingers accomodated an additional 6 to 8 inches (0.2 m) of core allowing a maximum recovery of 30 ft (9.2 m) per core. The inner core barrel was dropped into the drill stem where the drilling fluid cushioned the descent of the inner barrel and prevented it from smashing into, and thereby demolishing, the

flapper valve. Intervals of 30 to 32 feet were usually cored and the inner core barrel retrieved by wire line. This was accomplished by using the sand line to lower a sinker bar equipped with an overshot (a latching device which engaged a pin on the top of inner core barrel) through the drill stem. When the inner core barrel was lifted from the outer core barrel, the flapper valve in the bit assembly closed to prevent drilling fluid from flowing up the drill stem. The inner core barrel, after retrieval, was placed on deck and the core catcher removed by the drilling crew. The core catcher with its sample, usually about 6 inches (15 cm) in length, was handed to the scientists for extraction of the sample. The drilling crew then withdrew the plastic core liner from the inner core barrel and handed the liner with its contained core material to the core technicians who cleaned, measured, and labeled the liner. Next the liner was cut into sections 150 cm in length. After torvane measurements of the shear strength at the cut ends of the sections and after cutting and removing special short sections (2 to 10 cm in length) for hydrologic, organic, and geotechnical analyses, the ends were capped and taped.

Hole numbering system.--The holes were numbered according to a system of sample numbering begun in 1962 by the Office of Marine Geology of the U.S. Geological Survey as part of a joint study with the Woods Hole Oceanographic Institution of surficial grab samples of the Atlantic continental margin. Approximately 3,000 samples were collected and were identified by a 4-digit number beginning with sample 1000[1]. Numbers beginning with 6000 were reserved for samples resulting from core drilling operations. Hole 6001 was drilled on the island of Nantucket, Massachusetts, November 1975 through February 1976.

[1]Hathaway, J. C., comp. and ed., 1971, Data file, continental margin program, Atlantic Coast of the United States, v. 2, Sample collection and analytical data: Woods Hole Oceanographic Institution, Technical report, no. 71-15, 496 p.

The system was continued with the numbering of Holes 6002 through 6021 of the project described here.

The initial hole drilled at a site was given the basic four-digit number, such as 6004. If a second hole was required at the same site, it was assigned the number 6004B. The initial hole was not renumbered with an A because this would require revising the labels on large numbers of samples already processed and stored. Additional holes at a site were labeled "C", "D", and so forth.

Shipboard Analyses.--The sealed sections of core were brought into the shipboard laboratory for further testing, describing, and sampling. Each unopened section was placed in a nuclear transmission densitometer for measurement of the bulk density of the core. Some sections were selected to be reserved for geotechnical tests to be made later at shore-based laboratories; these sections were sealed with wax and aluminum foil, taped to wooden splints to maintain rigidity and stored in a refrigerated van. Other sections were split in half and placed in rigid plastic "D tubes" (so-called because their cross section approximates the shape of the letter "D"). One-half of each section was labeled "working", and the other half "archive". The archive half was preserved in its original unsampled state to be available for future observation of the structure, color and condition of the sediments. Shear-vane and torvane tests were made in selected parts of the working halves. The working half was described and sampled for later shore-based laboratory analyses to include grain-size, mineralogy, geochemistry, paleontology, and geotechnical properties.

Shipboard laboratory analyses also included determination of the electrical resistivity of the sediment and the salinity, pH, alkalinity, and calcium content

of the interstitial water obtained by squeezing samples of the core in a hydraulic press.

Samples from gas pockets were taken by a syringe through the core liner and analysed for light hydrocarbon (methane, ethane, and propane) and H_2S content by gas chromatograph. Analyses were also made of gas liberated from samples of the core by ultrasonic treatment. Sections of the cores 10 cm in length were placed in cans; water and a bactericide were added, and the can and its contents were frozen to preserve the organic matter for future land-based laboratory analysis.

The core catcher sample provided the first look at any sediment recovered in a core and represented the deepest penetration recovered at that point. It served as the principal material for paleontologic analysis aboard ship, and also provided a sample for interstitial water analysis. The core table presented under the individual hole descriptions later in this paper contain lithologic description of this material. Detailed lithology of the core itself was recorded on visual core description sheets which are not included in this report because of their bulk (more than 800 pages). These were used in preparing the generalized graphic lithologic sections accompanying the individual hole descriptions. Since lithologies varied within a given core, the table, which describes the lithology of the core-catcher sample, may not always match the generalized lithology shown in the graphic columnar section which represents the entire core.

After description and sampling of the working half and photography of the archive half were completed, the core halves were sealed in their D tubes (moisture content being maintained by a water-saturated block of porous material, "oasis", placed in one end of the D tube) and stored in a refrigerated van at about 3°C.

Geophysical Borehole Logs.--Geophysical borehole logs were run in several of the holes after completion of the coring operation. Caving, loss of downhole equipment, or sticking of the logging tools prevented complete logging of all of the holes. The types of logs run were: spontaneous-potential and resistivity, gamma ray and neutron porosity, compensated formation density (gamma-gamma) and caliper, sonic, and temperature logs (Appendix C).

Plugging and Abandonment of Holes.--The holes were plugged with cement or gel except where caving problems prevented keeping the bottom hole assembly in the hole to complete the cementing process, or in those cases where the bottom hole assembly or the drill string plugged, or was stuck and could not be retrieved.

Data presented in this report.--Data presented below include a tabular summary of the sites cored followed by a discussion of each site including the purpose of coring at the location, a résumé of operations, a lithologic graph and résumé, a brief discussion of the stratigraphy, paleontology and paleoenvironment, a résumé of the interstitial water chemistry, and of the gas (light hydrocarbon) content. A graph of the interstitial water salinity in parts per thousand (S o/oo versus depth of penetration below the sea floor) follows. A tabulation of the cores recovered at each site (CORE TABLE), and tables showing the results of shipboard interstitial-water and gas analyses complete the presentation for each site.

Preliminary geologic ages.--The geologic ages given in this report are preliminary; they are based on shipboard examinations and are subject to change following further detailed laboratory studies of the cores.

Data in preparation.--Data not presented in this preliminary summary but in preparation include:

1. Visual core section descriptions including core photographs
2. Geotechnical properties analyses
   - A. Index properties (classification tests)
     - (1) Grain size
     - (2) Plastic and liquid limits (Atterberg limits)
     - (3) Water content (laboratory bulk density determinations)
     - (4) Mineralogy (clay and heavy minerals)
     - (5) Grain density
     - (6) Carbon/carbonate content
   - B. Engineering properties
     - (1) Consolidation and triaxial tests
     - (2) Dynamic tests

   Shipboard determinations of bulk density and shear strength are in the process of data reduction and will be included in subsequent reports.
3. Geochemistry
   - A. Inorganic
     - (1) Sediments
       - a. Major elements
       - b. Pollution-indicating minor elements
       - c. Carbonate content
       - d. Stable carbon isotopes
       - e. Oxygen isotopes
     - (2) Interstitial water
       - a. Dissolved major elements
       - b. Pollution-indicating minor elements

B. Organic

(1) Solids

a. Hydrocarbons

b. Other organic species

c. Stable carbon isotopes

(2) Gasses

a. Light hydrocarbons

b. H_2S

c. Stable carbon isotopes

4. Mineralogy and Petrography

A. X-ray mineralogy

(1) Gross sediment

(2) Clay minerals

(3) Carbonate minerals

B. Optical mineralogy

(1) Smear slide analyses

(2) Heavy minerals

(3) Thin section mineralogy and petrography

C. Scanning Electron Microscopy

(1) Particle morphology

(2) Particle composition by energy dispersive X-ray fluorescence

5. Paleontology and Stratigraphy

A. Biostratigraphic zonation of cored sediments based on studies of calcareous nannofossils, foraminifers, diatoms, and ostracodes

B. Biostratigraphic correlation with other offshore and onshore bore holes

C. Interpretation of climatic and geologic history of the continental margin based on paleoecologic studies

6. Geophysical borehole log analyses

   A. Lithologic interpretation

   B. Regional correlation

7. Site survey data

   A. Plots of survey traverses

   B. Reflection seismic profiles

These data will be presented in a final published report upon completion of the shore-based laboratory analyses and their reduction.

Atlantic Margin Coring Project - Sample Policy

1. As soon as storage arrangements and cataloguing are completed, samples of cores recovered by the USGS Atlantic Margin Coring Project will be available to qualified investigators for the purpose of conducting research. Written requests are required that should include a statement on the nature of the study, number and size of samples, and if special sampling or handling techniques are required. Requests for exceptionally large samples or large number of samples may be subject to modification at the discretion of the USGS curator upon discussion with the investigator.

2. All core samples remain the property of the USGS.

3. All cores will be split; one-half will be preserved as an archive and used only for visual examination, the other will be used for research. At such time that the working half has been sufficiently consumed at certain intervals to inhibit research, the archive half may be sampled with the approval of the curator.

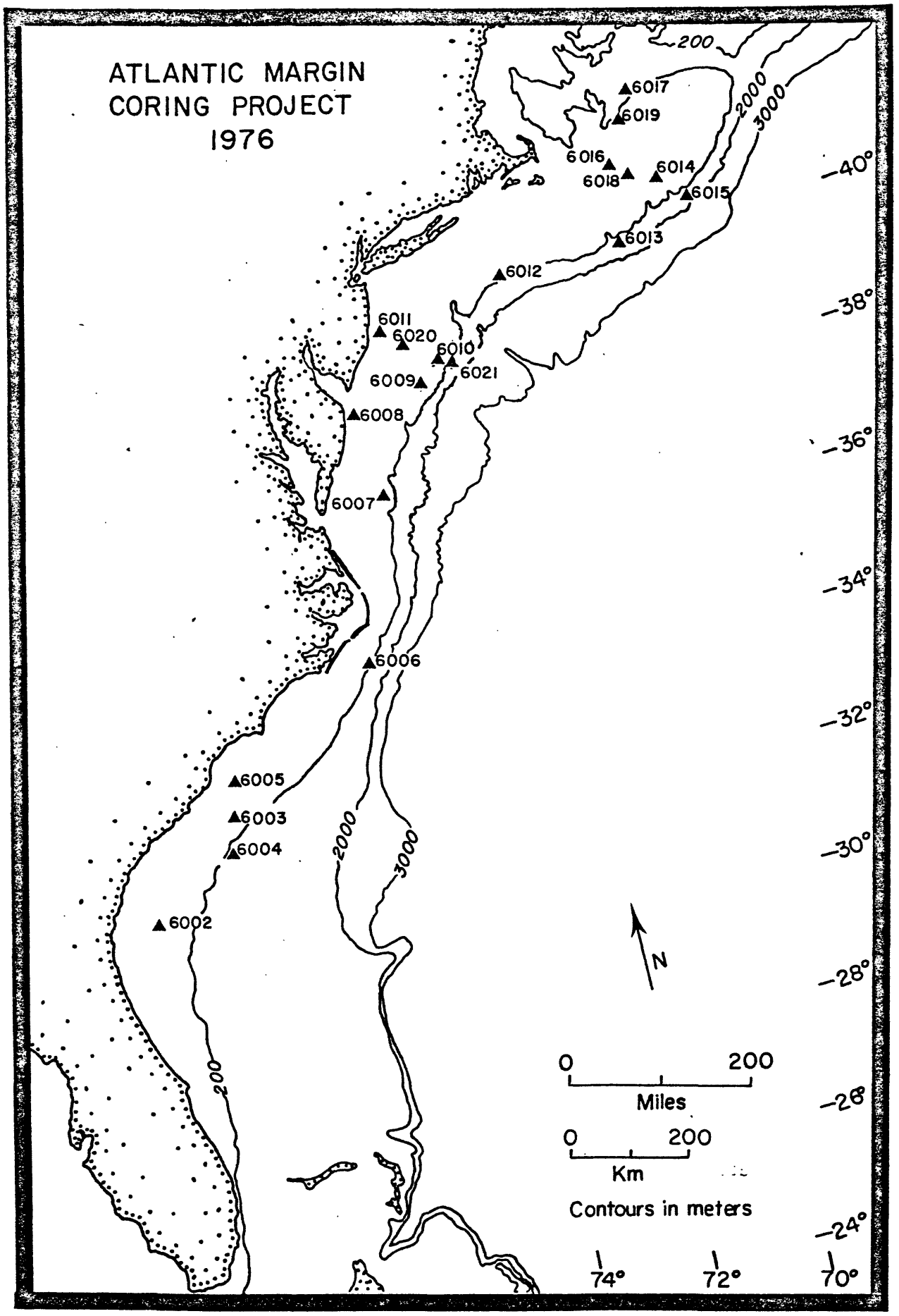
4. Samples may be provided for thin section or other slide preparation providing the slides and other recoverable material from the samples are returned to the USGS curator on completion of the study along with a record of the data derived from the samples.

5. Samples that will be destroyed during the proposed investigation will be provided only with the approval of the USGS curator. Data derived from the samples will be provided to the curator.

6. Three copies of publications resulting from research on the cores will be submitted to the USGS curator. Where it is evident that a publication will not be forthcoming or in the event there is a substantial delay, the USGS reserves the right to make the data available to the public in an appropriate form.

Requests should be directed to:

Curator
U. S. Geological Survey
Woods Hole, Massachusetts 02543



LOCATION OF SITES

SUMMARY OF HOLES

DATE	HOLE (SITE)	LATITUDE LONGITUDE	WATER DEPTH FT.(m)	STRING DEPTH Feet (RKB[1]) Mudline	T.D.	MAXIMUM PENETRATION Feet (Meters)	NO. OF CORES	RECOVERY PERCENT	MAXIMUM AGE REACHED	LOGS[2]
7/22-23/76	6002	31°08.57'N 80°31.05'W	106 (32.3)	138	1138	1000 (304.8)	33	27	Eocene	C, E, FD, G, N, S, T.
7/25/76	6003	32°37.66'N 78°48.80'W	134.5 (41.0)	Unable to spud in because of hard layer at sea floor. No recovery.						
7/26/76	6004	32°03.98'N 79°05.86'W	570 (173.7)	602	1056	454 (138.4)	15	67	Miocene	See 6004B.
7/26-7/27/76	6004B	"	"	602	1612	1010 (307.9)	20	45	Cretaceous	E.
7/30/76	6005	33°15.10'N 78°44.08'W	61 (18.6)	93	249	156 (47.6)	6	6	Paleocene	None.
7/30/76	6005B	"	"	93	249	156 (47.6)	3	13	Paleocene	None.
8/2/76	6006	34°41.4'N 75°43.0'W	184 (56.1)	216	509	293 (89.3)	9	22	Pleistocene	None.
8/4-5/76	6007	37°17.99'N 74°39.16'W	279 (85.0)	311	707	396 (120.7)	13	26	Pliocene	See 6007B.

SUMMARY OF HOLES (CONTINUED)

DATE	HOLE (SITE)	LATITUDE LONGITUDE	WATER DEPTH FT.(m)	STRING DEPTH Feet (RKB[1]) Mudline	T.D.	MAXIMUM PENETRATION Feet (Meters)	NO. OF CORES	RECOVERY PERCENT	MAXIMUM AGE REACHED	LOGS[2]
8/5-6/76	6007B	"	"	311	1330	1019 (310.6)	20	26	Miocene	C, E, FD, G, N, S.
8/8/76	6008	38°24.21'N 74°53.83'W	68 (20.7)	100	492	392 (119.5)	13	23	Pleistocene	None.
8/12/76	6009	38°51.27'N 73°35.47'W	183 (55.7)	215	523	308 (93.9)	10	9	Pleistocene	None.
8/12-13/76	6009B	"	192 (58.5)	224	1207	983 (299.6)	32	24	Miocene	C, E, FD, G, N, S.
8/14-15/76	6010	39°03.29'N 73°06.8'W	249 (75.9)	281	1300	1019 (310.6)	33	31	Miocene	C, E, FD, G, N, S, V.
8/17-18/76	6011	39°43.5'N 73°58.6'W	73 (22.3)	105	958	853 (260.0)	28	23	Early to mid-Eocene	C, E, FD, G, N, S, T.
8/20-22/76	6012	39°59.57'N 71°20.09'W	862 (262.7)	894	1891	997 (303.9)	33	56	Pleistocene	None.
8/23-24/76	6013	40°05.04'N 68°52.13'W	799 (243.5)	831	1173	342 (104.2)	11	31	Pleistocene	See 6013B.

SUMMARY OF HOLES (CONTINUED)

DATE	HOLE (SITE)	LATITUDE LONGITUDE	WATER DEPTH FT.(m)	STRING DEPTH Feet (RKB[1]) Mudline	T.D.	MAXIMUM PENETRATION Feet (Meters)	NO. OF CORES	RECOVERY PERCENT	MAXIMUM AGE REACHED	LOGS[2]
8/24-25/76	6013B	"	783 (238.7)	815	1815	1000 (304.8)	23	18	Early Pleistocene	C, E, FD, G, N, S, T.
8/26-27/76	6014	40°48.33'N 67°53.64'W	229 (69.8m)	261	597	336 (102.4)	10	27	Pleistocene	None.
8/28-29/76	6015	40°23.11'N 67°35.85'W	686 (209.1)	718	924	206 (62.8)	6	10	Pleistocene	None.
9/1/76	6016	41°09.50'N 68°41.83'W	218 (66.4)	250	272	22 (6.7)	1	2	Pleistocene	None.
9/1-2/76	6016B	"	"	250	476	226 (68.9)	6	5	Miocene	None.
9/5/76	6017	42°10.45'N 67°57.51'W	783 (238.7)	815	1112	297 (90.5)	10	20	Pleistocene with reworked Eocene	E, G, N, S.
9/6-7/76	6018	40°55.90'N 68°18.14'W	152 (46.3)	183	342	159 (48.5)	6	5	Plio-Pleistocene	None.

SUMMARY OF HOLES (CONTINUED)

DATE	HOLE (SITE)	LATITUDE LONGITUDE	WATER DEPTH FT.(m)	STRING DEPTH Feet (RKB[1]) Mudline	T.D.	MAXIMUM PENETRATION Feet (Meters)	NO. OF CORES	RECOVERY PERCENT	MAXIMUM AGE REACHED	LOGS[2]
9/9-10/76	6019	41°49.27'N 68°16.39'W	570 (173.7)	602	837	235 (71.6)	9	21	Middle Eocene	E, to 50 ft.
9/10/76	6019B	"	"	602	607	5 (1.5)	1	100	Quaternary	None.
9/13/76	6020	39°25.41'N 73°35.63'W	128 (39)	160	304	144 (43.9)	6	23	Pleistocene	None.
9/16/76	6021	38°57.92'N 72°49.20'W	987 (298.1)	1010	1060	50 (15.2)	3	57	Pleistocene	See 6021B.
9/16-17/76	6021B	"	"	1010	2010	1000 (304.8)	2		No Samples	C, E, FD, G, N, S, T.
9/18/76	6021C	"	988 (301.2)	1020	2020	1000 (304.8)	33	23	Pleistocene	See 6021B.

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

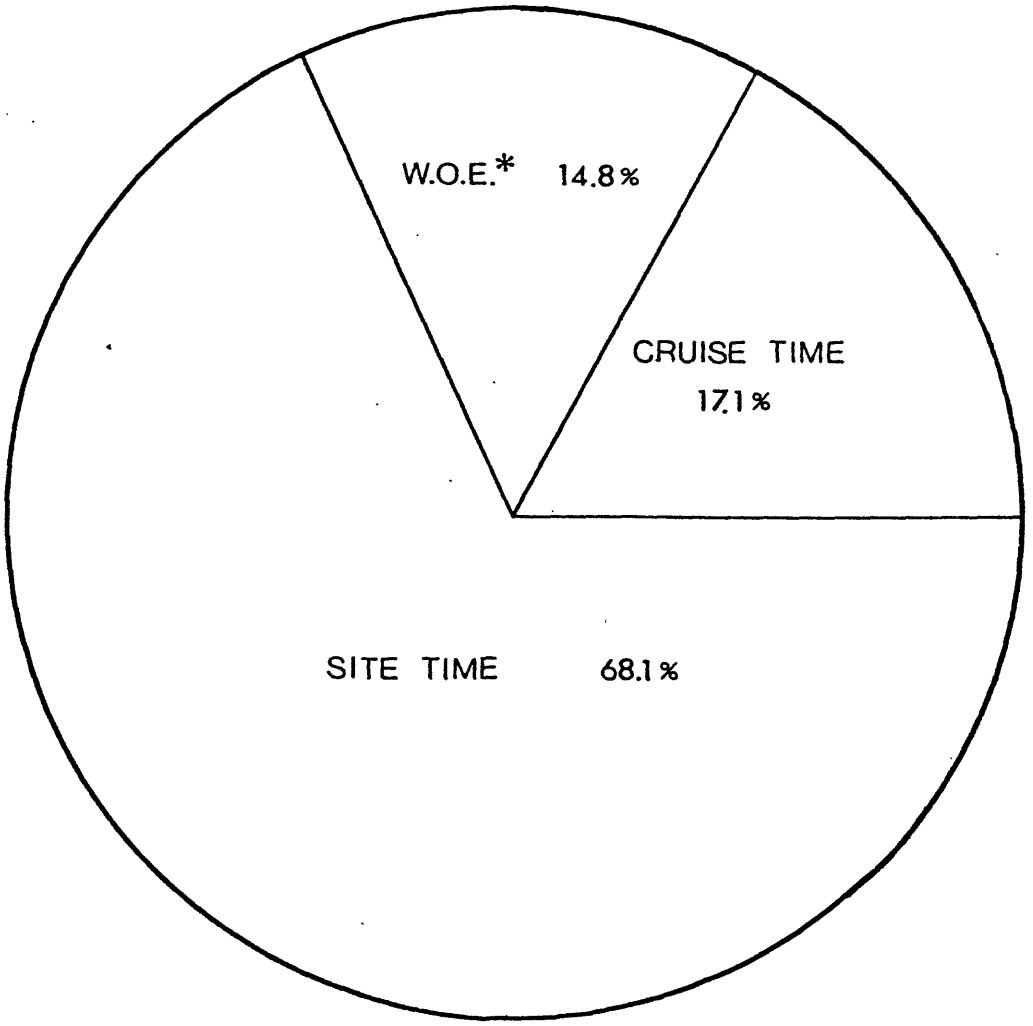
[2]LOG CODE: C=Caliper; E-Electrical (Spontaneous Potential and Resistivity); FD=Formation Density; G=Gamma Ray; N=Neutron; S=Sonic; T=Temperature; V=Sonic Variable Density

OPERATIONS RÉSUMÉ

Total days:	
Mobilization, July 15, 1976 - July 21, 1976	6.5
Operations, July 21, 1976 - September 19, 1976	60.0
Transport of USGS equipment ashore by work boat, Sept. 19-20	1.0
Operations:	
Total days in port	0
Total days underway	10.3
Total days on site	49.7
Trip time, Drilling time, Coring time (days)	19.0
Logging time (days)	5.0
Mechanical downtime (days)	1.3
Anchoring (position ship) (days)	9.8
Other:	
Waiting on weather (days)	1.3
Waiting on site survey (days)	1.5
Waiting on delivery of downhole equipment (days)	8.9
Working stuck pipe (days)	2.8
Total distance traveled (nautical miles) (est.)	3,176
Mobilization (est.)	1,248
Operations (est.)	1,928
Average speed (knots)	7.9
Sites investigated	20
Holes drilled	29
Number of cores attempted	395
Number of cores with recovery	380
Percent of cores with recovery	96.1%
Total meters cored	3,590.8
Total meters recovered	1,020.9
Percent recovery	28.4%
Total meters drilled	703.4
Total meters of penetration	4,294.2
Percent of penetration cored	83.6%
Maximum penetration (meters)	310.6
Minimum penetration (meters)	0.0
Maximum water depth (meters)	301.2
Minimum water depth (meters)	18.6

ATLANTIC MARGIN CORING PROJECT

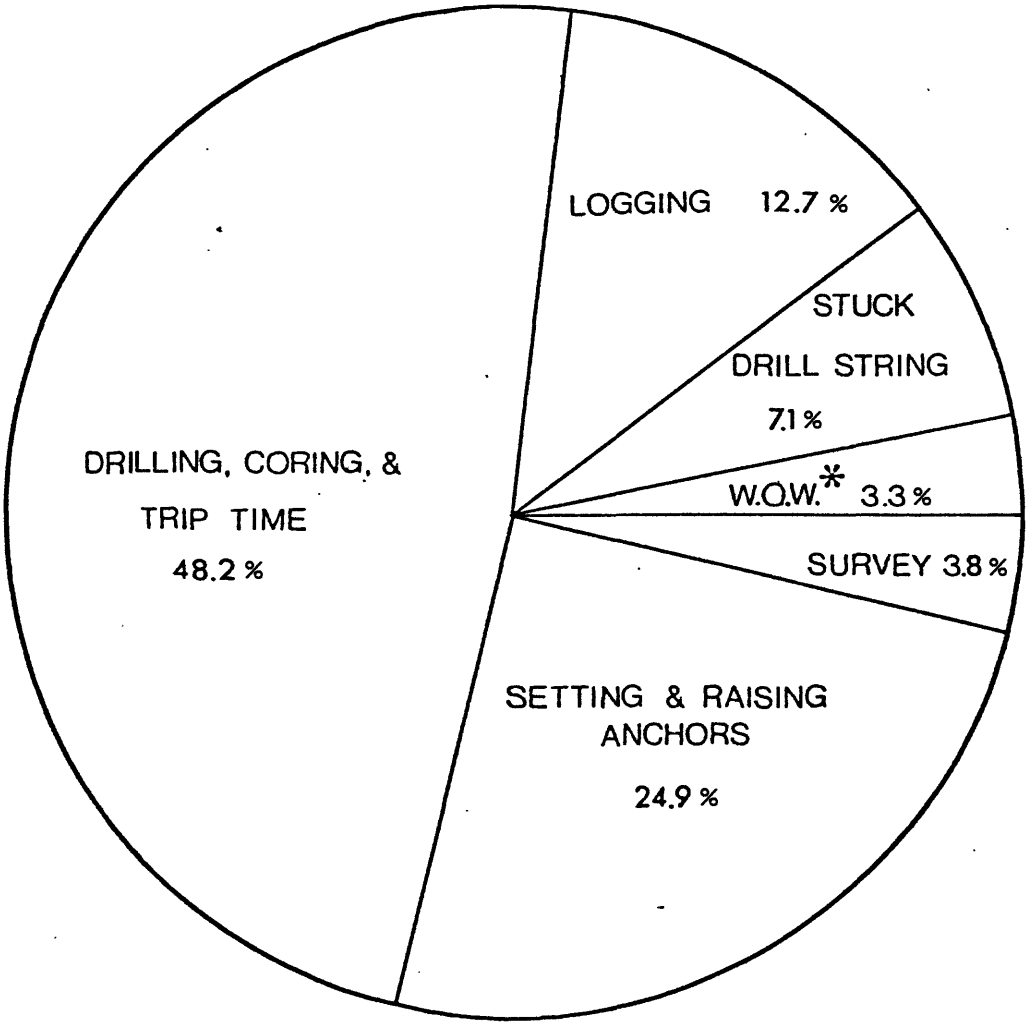
TOTAL TIME DISTRIBUTION



START OPERATIONS	JULY, 21, 1976
FINISH OPERATIONS	SEPT., 19, 1976
TOTAL TIME	60 DAYS

* W.O.E. = Waiting on equipment delivery

ATLANTIC MARGIN CORING PROJECT
SITE TIME DISTRIBUTION



TOTAL TIME ON SITE	40.8 DAYS
TOTAL SITES	20
TOTAL HOLES	29

*W.O.W. = Waiting on weather

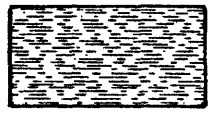
SITE DESCRIPTIONS

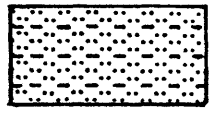
Explanations

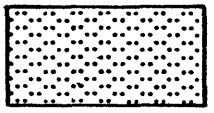
The diagrams that follow explain the terms used in the figures and tables in the descriptions of each site. The string depths, in feet relative to the Kelly bushing (RKB), are retained in the tables because these depths are used in the geophysical borehole logs and in the original drillers records.

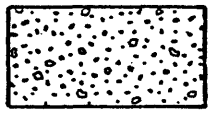
Explanation of Symbols Used in Stratigraphic Sections

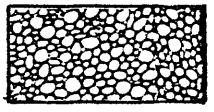
Clay

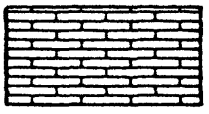

Silty Clay


Silty and Clayey Sand


Sand


Gravel


Carbonate Sand (unconsolidated calcareous sediment)


Limestone (indurated)

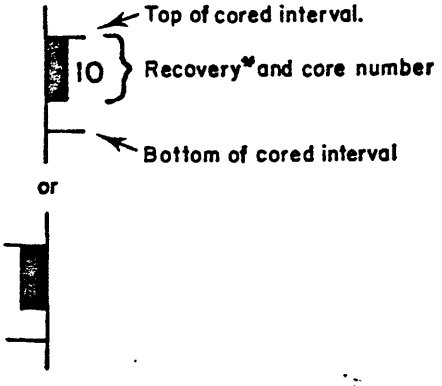
G Glauconite

P Phosphate

S Shells (and Fragments)

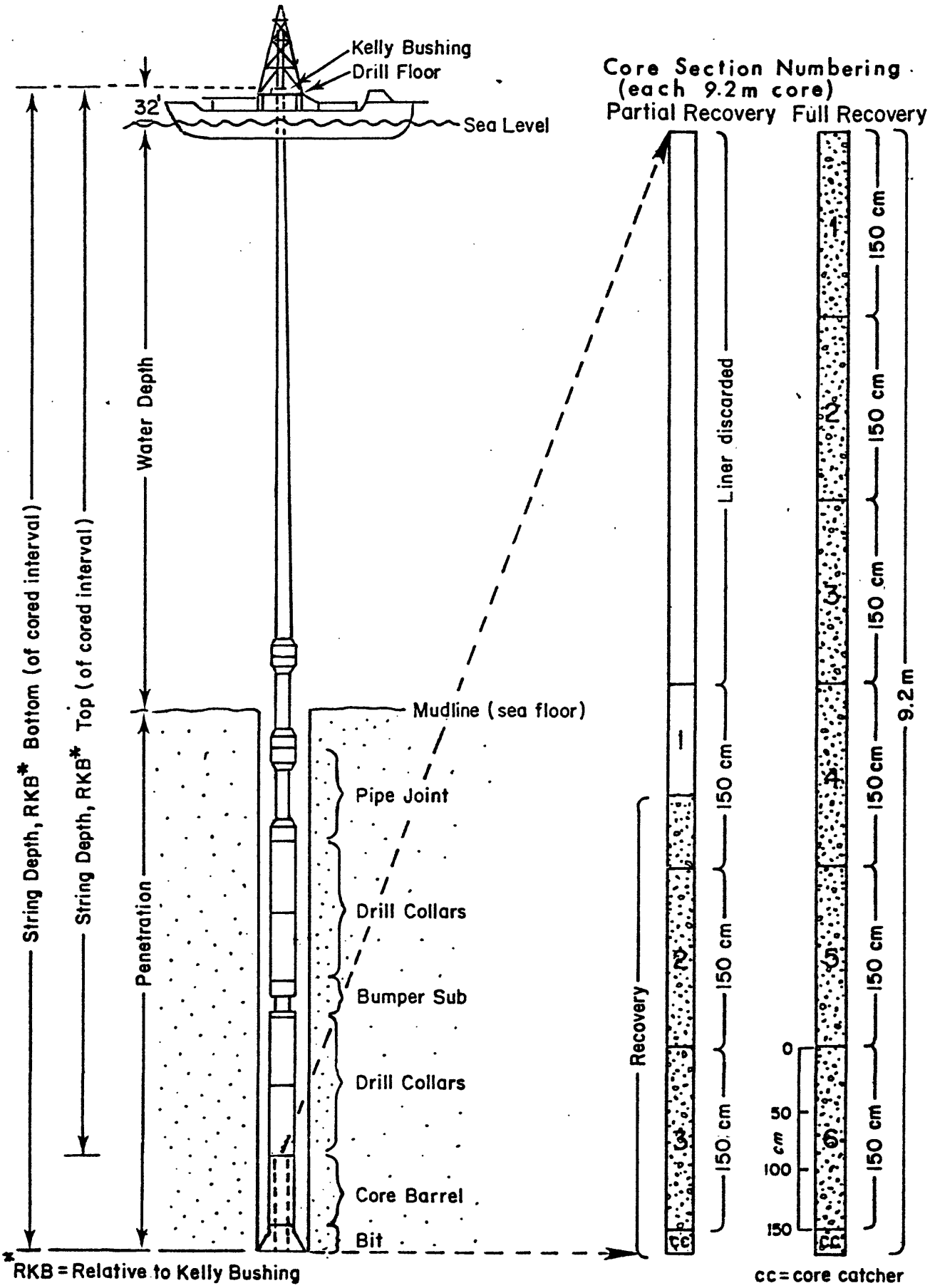
SD Siderite

D. I. Drilled Interval



*Recovery arbitrarily shown at upper end of interval cored

Explanation of Measurements and Core Numbering



Not to Scale

Explanation of Water Chemistry Table

All measurements were made aboard ship as soon as possible after the sediment was recovered, usually within one-half hour.

Depth - owing to the uncertainty of the position of the recovery within a given cored interval, the maximum depth of that interval is given.

Punch in pH - determined by inserting pH electrode directly into bulk sediment

pH - measured on the filtered interstitial water prior to alkalinity titration

Alkalinity - reported in milliequivalents per liter. Determined by titration with Na_2CO_3

Calcium - determined by complexometric titration after the method of Tsunogai et al (1968 Tantala 15: 385-390)

Salinity - determined on filtered interstitial water with an ENDECO refractometer.

Rs - bulk electrical resistivity of the sediment in ohm-m

F - ratio of bulk electrical resistivity of the sediment to the resistivity of the pore fluid alone. F is referred to as the formation factor.

Explanation of Light Hydrocarbon Table

The concentrations of gasses shown in the table are relative to the sample of gas taken. The absolute amount of gas per volume of original solid material can only be determined if a pressure core barrel is used to trap the original gas content at ambient pressure. A pressure core barrel was not used in this program.

CH_4 - methane

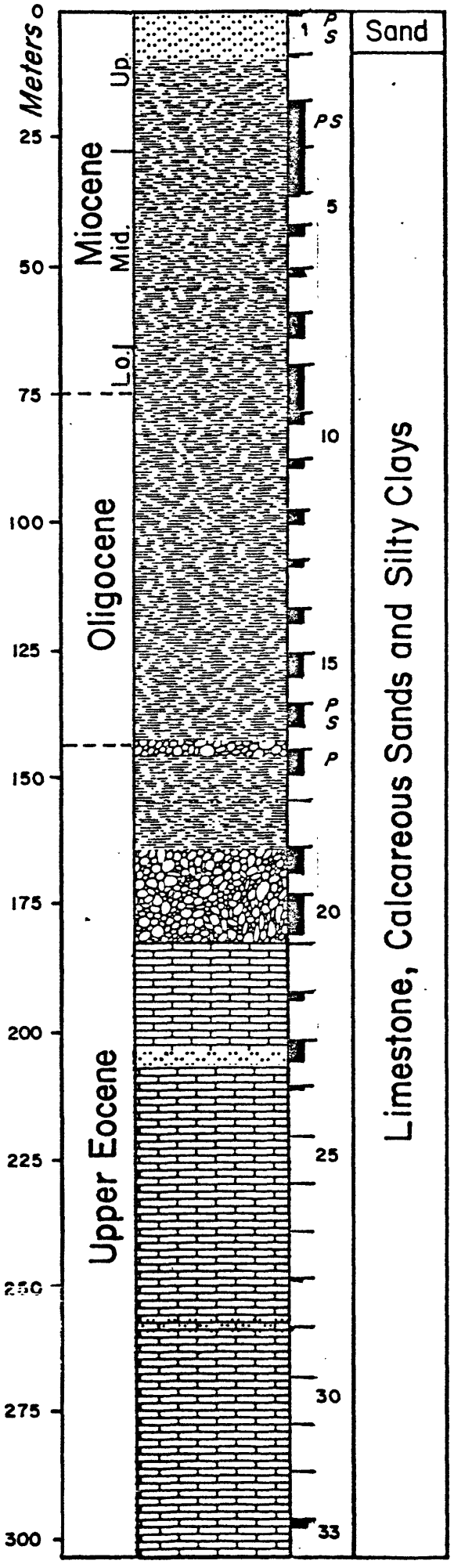
C_2H_6 - ethane

C_3H_8 - propane

SITE 6002

Location and purpose.--The location of this site about 40 nautical miles (74 km) east of Brunswick, Georgia was selected in the mid-shelf area of the Southeast Georgia Embayment to provide information on geotechnical properties of the sediments, the extent of possible offshore freshwater aquifers, the extent of any phosphate occurrences, and the stratigraphy of this embayment.

Operations.--The drilling vessel arrived at the site on July 21, 1976. A reflection seismic survey revealed no structures that might be traps for hydrocarbons; the chief scientist approved the site for drilling and the hole was spudded in at 0250, July 22. Thirty-three cores were recovered by 0950, July 23, for a total penetration depth of 305 meters (1000 ft), the limit for the project. No equipment difficulties or detrimental hole conditions were encountered. Average time for cutting each 30 ft (9.2 m) core was 14 minutes.



HOLE 6002

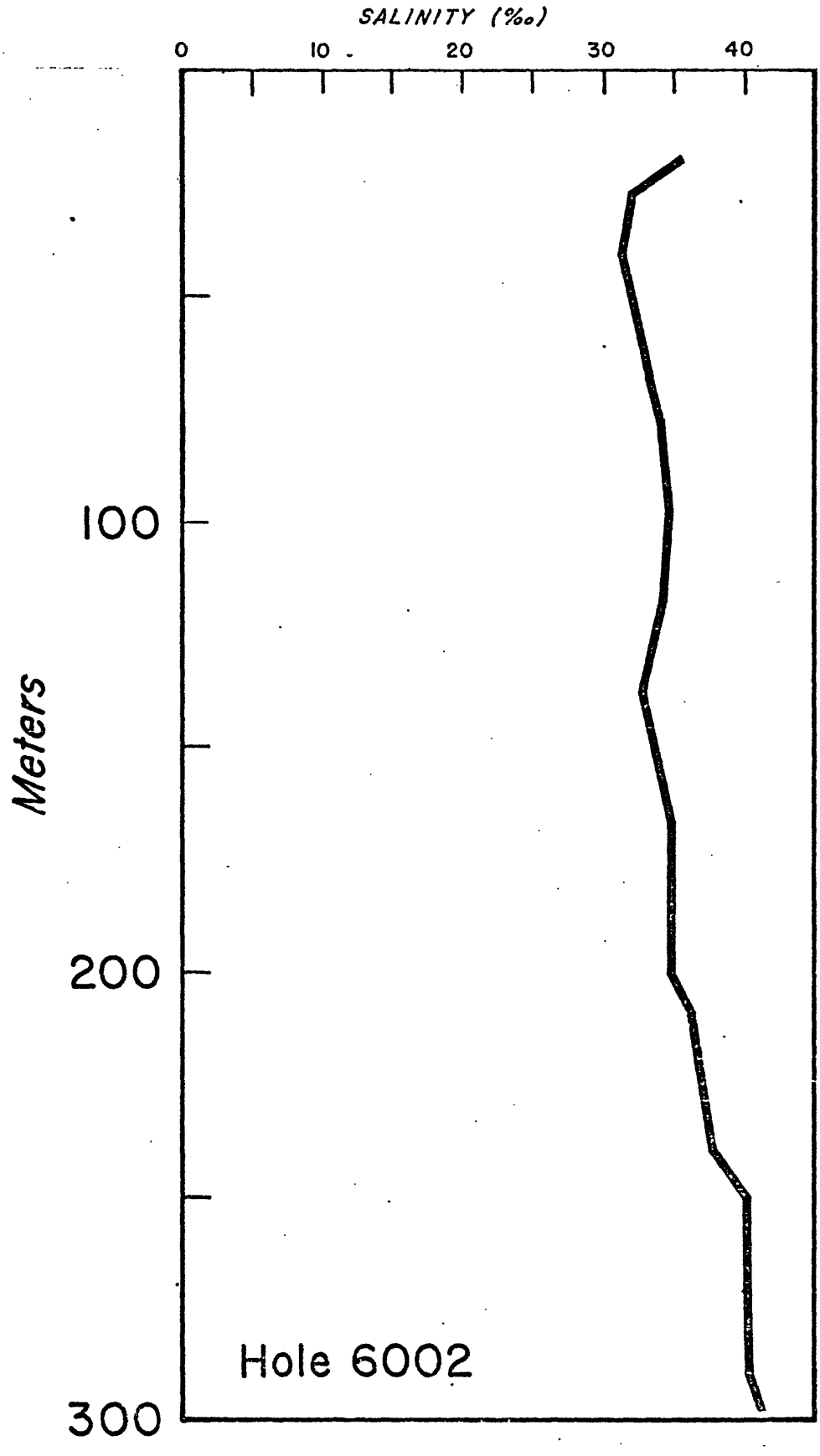
Lithology.--The oldest sediments encountered were hard, white, fine-grained limestones of early late Eocene age. Above this, Eocene limestones extended for approximately 120 meters. These were overlain by late Eocene carbonate sands and calcareous silty clays about 40 meters thick which in turn were overlain by a nearly complete sequence of middle Tertiary strata consisting of about 70 meters of Oligocene calcilutites and calcareous silty clays, and about 75 meters of Miocene sandy or silty clays and clay beds. The section is capped by a thin veneer of Quaternary sand.

Paleontology.--Most fossil assemblages appear to be of outer shelf origin, containing abundant planktic specimens (Foraminifers, nannofossils, diatoms, and radiolarians) and benthic forms (foraminifers, ostracods). Some shallower water assemblages are present,

however, in the middle Miocene and upper Eocene, where benthic foraminifers and cheilostome bryozoans predominate. Larger foraminifers are the predominant forms in most of the upper Eocene strata. Radiolarians and diatoms are moderately abundant in some of the middle Miocene beds where calcarous fossils are rare.

Interstitial water.--A salinity is present at 30.50 meters which may reflect the influence of freshwater. With increasing depth, salinity values increase to greater than 40 o/00, possibly owing to diffusion of salts from hypersaline brines from greater depth.

Light hydrocarbons.--Methane was detected in concentrations ranging from $1\text{-}2 \times 10^2$ ppm, in middle Miocene calcareous sands and silty clays at a depth range from 70 to 101 meters. H_2S was detected in sediments above the methane zone. No ethane or propane was present.


SALINITY (‰)
0
10
20
30
40
100
200
300
Meters
Hole 6002

DATE: 7/22-23/76

CORE TABLE -- HOLE 6002

LATITUDE: 31°08.57'N
LONGITUDE: 80°31.05'W

WATER DEPTH: 106 ft (32 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
1	138	165	27	27	8.2	1	1	.3	3	Brown phosphate sand Age: Late Miocene	
2	165	195	30	57	17.4	1	1	.3	3	Green silty clay Age: Late Miocene	
3	195	225	30	87	26.5	6	30	9.1	100	Green silty clay Age: Middle (?) Miocene	35.5
4	225	256	31	118	36.0	6	30	9.1	100	Green silty clay Age: Middle Miocene	32.0
5	256	273	17	135	41.1	1	1.5	.5	9	Green silty clay Age: Middle (?) Miocene	
6	273	302	29	164	50.0	2	6.7	2.0	23	Green Clayey-silty sand Age: Miocene	31.6
7	302	332	30	194	59.1	2	5.6	1.7	19	Olive green clay	
8	332	365	33	227	69.2	3	13.4	4.1	45	Olive green silty clay Age: Early (?) Miocene	33.4
9	365	396	31	258	78.6	6	29.1	8.9	97	Olive green sandy silty clay Age: Late Oligocene	
10	396	427	31	289	88.1	2	6.0	1.8	20	Olive green sandy silty clay Age: Late Oligocene	34.3
11	427	459	32	321	97.8	2	5.25	1.6	18	Light olive clay-olive green silty clay - Core liner collapsed Age: Late Oligocene	

CORE TABLE -- HOLE 6002 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
12	459	490	31	352	107.3	3	10.7	3.3	36	Light gray clay - Core liner collapsed Age: Late Oligocene	34.8
13	490	521	31	383	116.7	1	3.6	1.1	12	Light gray clay, calcareous microfossils Age: Early Oligocene	
14	521	552	31	414	126.2	6*	11.8	3.6	39	Light gray clay, fossiliferous Sec. 2, 3, 4 empty except for drilling fluid, discarded Age: Early Oligocene	34.3
15	552	583	31	445	135.6	4	16.4	5.0	55	Light olive gray clay Age: Early Oligocene	
16	583	614	31	476	145.1	3	14.7	4.5	49	Light yellow-gray silty clay	32.8
17	614	646	32	508	154.8	4	18.6	5.7	62	Light gray clayey sand, fossiliferous, glauconite (?) Age: Late Eocene	
18	646	677	31	539	164.3	CC only	TR	TR	1	Core washed out Fine white sand & shells Age: Late Eocene	
19	677	708	31	570	173.7	4	15.2	4.6	51	White calcareous clay	34.8
20	708	739	31	601	183.2	5	24.3	7.4	81	Light yellow-green calcareous fossiliferous limestone	
21	739	770	31	632	192.6	CC only	TR	TR	1	Light yellow-white fossiliferous limestone	

CORE TABLE -- HOLE 6002 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
22	770	801	31	663	202.1	1	4.4	1.3	15	White limestone Age: Eocene	36.0
23	801	832	31	694	211.5	3	14.9	4.5	50	White calcareous sand and limestone fragments	36.5
24	832	864	32	726	221.3	1	2.0	.6	7	Hard white sandy limestone	
25	864	895	31	757	230.7	CC only	TR	TR	1	Hard white sandy limestone	
26	895	926	31	788	240.2	CC only	TR	TR	1	Hard white sandy limestone	37.9
27	926	957	31	819	249.6	CC only	TR	TR	1	Hard white sandy limestone	
28	957	988	31	850	259.1	1	1.5	.5	5	White sandy limestone	40.3
29	988	1020	32	882	268.8	CC only	TR	TR	1	Fossiliferous clayey sand	
30	1020	1051	31	913	278.3	CC only	TR	TR	1	Hard limestone and fine sand	
31	1051	1082	31	944	287.7	CC only	TR	TR	1	Hard limestone fragments and fine sand	
32	1082	1113	31	975	297.2	CC only	TR	TR	1	Hard fine grains, limestone, white	40.5
33	1113	1138	25	1000	304.8	1	5.0	1.5	25	Age: Late Eocene	41.0

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6002

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
3	1.	140-50	27	Green shelly sand				.460	35.5	.771	4.33
4	1	140-50	36	Green silty, white flecks, H_2S		7.08	4.20	.534	32.0		
6	1	141-54	50	Green sandy silt, white layers		7.42	4.1	.587	31.6	.605	3.15
8	1	138-49	70	Fissile green clay, shale, H_2S		7.40	2.6	.594	33.4	.374	2.00
10	1	123-33	89	Light green clayey mud(?)				.653	34.3	.444	2.47
12	1	107-117	108	Light green clayey mud(?) H_2S			3.6	.635	34.9	.635	3.88
14	1	107-117	127	Light gray clay H_2S		7.13	3.7	.669	34.3		
16	2	129-139	146	Coarse green sand (yellow silty clay rest b/core??)		7.01	4.3	.598	32.8	1.225	6.48
18				(White sand and shell)							
19	2	140-150	174	White calcareous clay L. Olig.		7.13	3.7	.656	34.8	2.019	11.3

Chemistry of Water Samples from Hole 6002 (continued)

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
22	CC		203	Partly cemented coarse limestone					36.0		
23	CC		212	Lithified white creamy limestone easily crushable				.757	36.5		
26	CC		241	Hard white sandy limestone				.788	37.9		
27	CC		250	Drilled holes into lith. lime-stone .8 cm penetration					39.0	1.419	8.55
28	28	1	260	White sandy limestone				.897	40.3		
31			288	Hard limestone and fine sand				.883			
32	CC		298						40.5		
33	1	0-10	305	Olive green lithi-fied silty-clayey limestone senshed before squeezing		7.13	2.3		41.0		

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6002

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6002-8-3 core catcher max pene 227' 69.2m	olive green silty clay sonicated	137.7	ND	ND
6002-9-6 core catcher max pene 258' 78.6m	olive green sandy silty clay sonicated	211.4	ND	ND
6002-12-2 140-150 cm max pene 352' 107.3m	light gray clay sonicated	238.7	ND	ND
6002-16-2 140-150 cm max pene 476' 145m	lt. yellow gray silty clay sonicated	ND	ND	ND
6002-33-1 135-150 cm max pene 1000' 304.8m	hard fine sand	ND	ND	ND

SITE 6003

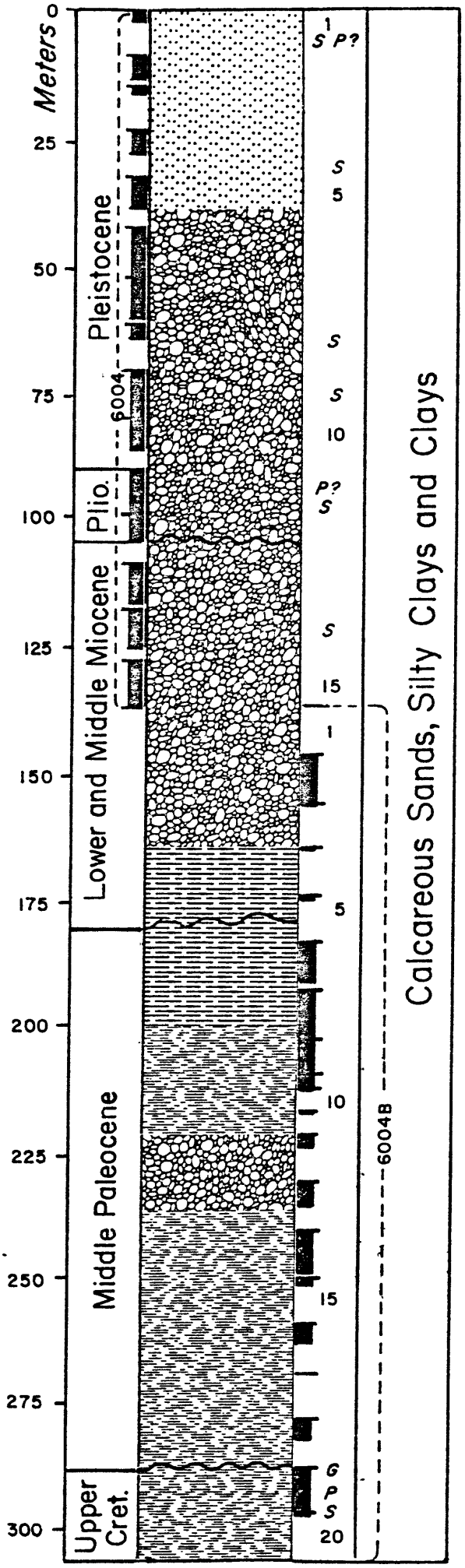
Location and purpose.--The location of site 6003 in the middle continental shelf area about 35 nautical miles (65 km) southeast of Cape Romain, South Carolina, was selected to provide information on geotechnical properties of the shelf sediments, to determine the extent of possible freshwater aquifers, to investigate the possible existence of phosphate or other mineral occurrences, and to determine the stratigraphy in this area.

Operations.--The drilling vessel arrived on location at 2215, July 24, 1976, to await delivery of the on-site reflection seismic survey. The site was approved by the chief scientists at 0400 July 25 and the first anchor was dropped at 0500. Poor holding ground was noted; the anchors tended to "skate" on the bottom, which suggested a hard surface with little sediment deposited on it. The drilling assembly was lowered and the bit touched bottom at a water depth of 41 meters. Attempts to cut a core failed. After one hour and 40 minutes of rotation, no penetration had been made and an attempt to retrieve the inner core barrel failed. The drill string was pulled and the core shoe was found smashed; no sediment or rock material was trapped in, or was clinging to the bit. The conclusion was reached that the sea floor was composed of material too hard for the bit to "spud in", perhaps a siliceous zone of the Santee Limestone or Duplin Marl. The decision was made to cease efforts to drill and to move to the next site.

SITE 6004

Location and purpose.--The location of this site on the Florida-Hatteras slope 55 nautical miles (102 km) southeast of Charleston, South Carolina, was selected to provide data on geotechnical properties of the slope sediments, to determine if freshwater aquifers in the Southeast Georgia Embayment extend beneath the continental shelf to the shelf edge, to identify reflectors in seismic profiles crossing the site, and to determine the stratigraphy in the Florida-Hatteras slope area.

Operations.--The drilling vessel arrived at the location at 2045 on July 25, 1976. The site was approved for drilling after receipt of the reflection seismic survey which showed no hazardous structures. Anchoring was completed and coring begun at 0200 on July 27. By 0941, fourteen cores had been retrieved; at this point the pin sheared on the pull-bar fishing-neck of the core barrel which prevented Core 15 from being retrieved. The drill string and bottom hole assembly were pulled out of the hole, the core was recovered and a new hole, 6004B, begun. The site was redrilled to the previous depth reached in 6004, and coring was resumed. Twenty more cores were recovered by 1657 on July 27 for a total penetration of 308 meters. The hole was then conditioned for logging. Electric logs were run to 130 meters penetration before the logging tool was stopped by bridging or caving. A second attempt to log was unsuccessful. The hole bridged over and five drill collars, one outer core barrel, one inner core barrel, and the bit were lost.



HOLES 6004 AND 6004B

Lithology.--The oldest sediments found were 17 meters of Upper Cretaceous firm gray silty clay. These were overlain unconformably by about 100 meters of hard gray silty calcareous clay of middle Eocene age. A major unconformity separates the gray clay from 85 meters of overlying lower and middle Miocene olive gray clay and carbonate sands or foraminiferal ooze. This in turn is overlain unconformably by a continuous section of upper Pliocene and Pleistocene carbonate sands, calcareous clays, and calcareous clayey sands.

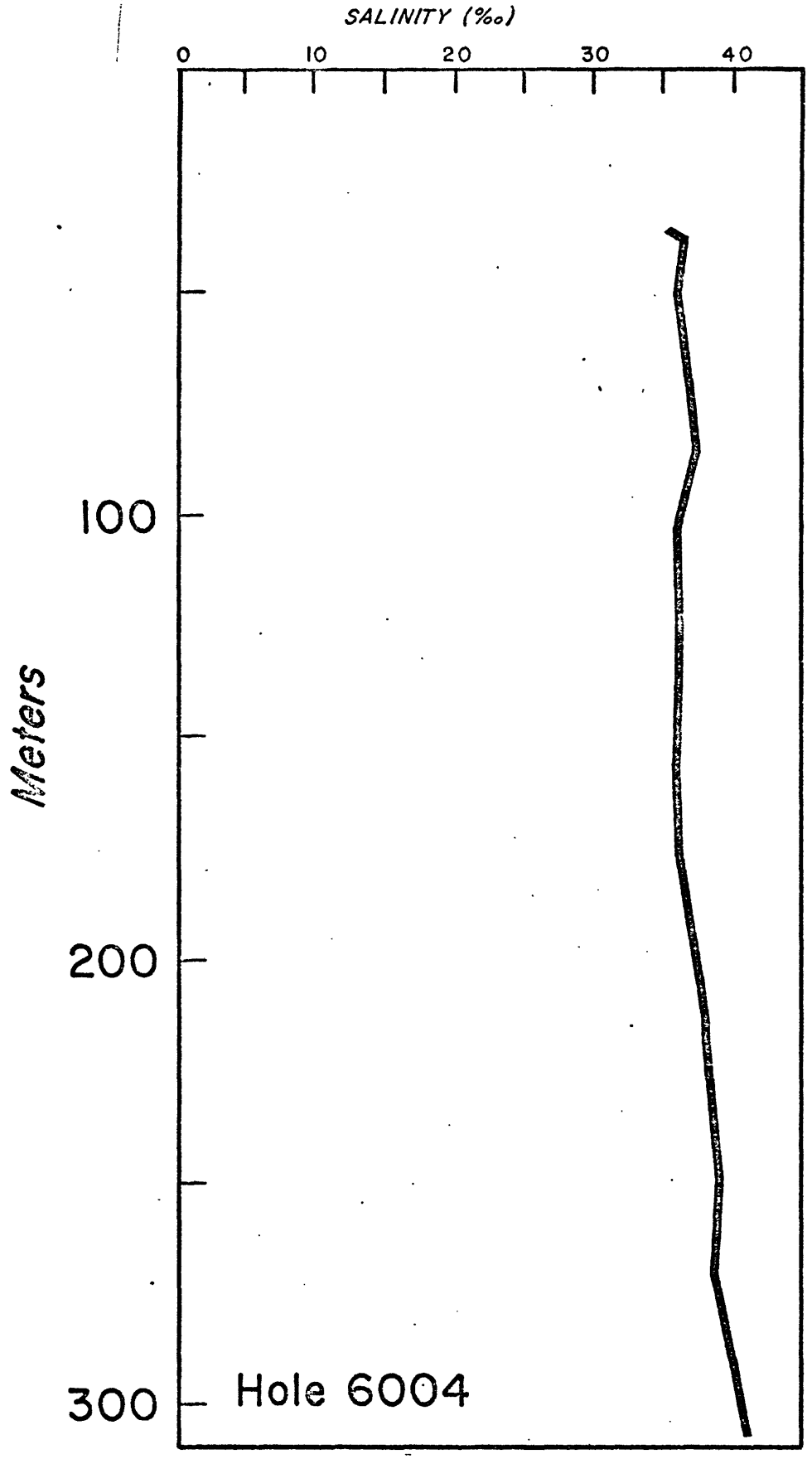
Paleontology.--The section is rich in planktic foraminifers and calcareous nannofossils, and the environments of deposition were generally outer shelf and upper slope.

Interstitial water.--The salinites measured in the samples from this hole showed a gradual increase

with depth from about 35 o/oo near the top to more than 40 o/oo at the bottom possibly caused by diffusion of salts from hypersaline brines in Early Cretaceous-Jurassic strata presumed to lie below.

The section at this site is characterized by a biochemically active Miocene section rich in organic matter which gave high alkalinity values. These permit estimation of more than 200 mg/l H_2S and attest to the extraordinary productivity of the water column during deposition of these sediments.

Light Hydrocarbons.--Significant amounts of H_2S were detected in the sediments above the methane zone located at a depth of penetration of about 220 meters. The methane occurred at a concentration of $1x10^3$ ppm in a hard gray calcareous clay of Paleocene age. Ethane and propane were not detected.


SALINITY (‰)
0
10
20
30
40
Meters
100
200
300
Hole 6004

DATE: 7/26/76

CORE TABLE -- HOLE 6004

LATITUDE: 32°03.98'N
LONGITUDE: 79°05.86'W

WATER DEPTH: 570 ft (173.7 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	602	632	30	30	9.1	2	6.7	2.3	22	Sand, argill., calcareous, olive Age: Holocene/Pleistocene	36.3
2	632	652	20	50	15.2	2	14.8	4.5	74	Sand, argill., calcareous, olive, microfossils, some shells Age: Holocene/Pleistocene	
3	652	683	31	81	24.7	1	5.0	1.5	17	Sand, calcareous, micaceous, olive Age: Pleistocene	
4	683	713	30	111	33.6	4	16.0	4.9	53	Sand, clayey, calcareous (fine sand), olive	35.8
5	713	745	32	143	43.3	4	19.75	6.0	66	Unconsolidated Carbonate sand, clayey, microfossils, olive	
6	745	776	31	174	52.7	6	29.6	9.0	100	Unconsolidated Carbonate sand, clayey, microfossils, olive Age: Middle Pleistocene	35.9
7	776	807	31	205	62.1	6	28.6	8.7	95	Clay, calcareous, microfossils, olive	
8	807	838	31	236	71.5	2	8.0	2.4	27	Sand, shelly, argill., olive	36.7
9	838	870	32	268	81.2	6	29.6	8.9	100	Sand, shelly, argill., olive Age: Early Pleistocene	
10	870	901	31	299	90.6	4	17.3	5.3	58	Clay, sandy, olive shells Age: Late Pliocene	36.2
11	901	932	31	330	100.0	6	29.7	9.0	100	Clay, sandy, olive Age: Late Pliocene	

CORE TABLE -- HOLE 6004 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
12	932	963	31	361	109.4	4	17.3	5.3	57	Clay, sandy, olive, glauc. (?) Age: Middle Miocene	36.0
13	963	994	31	392	118.8	6	27.3	8.3	91	Sand, clayey, olive (Forams)	
14	994	1025	31	423	128.2	6	25.3	7.7	84	Foram sand, clayey, olive Age: Middle Miocene	35.9
15	1025	1056	31	454	138.4	6	29.8	9.1	100	Foram sand, clayey, light olive (color change) Age: Middle Miocene	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 7/26-27/76

CORE TABLE -- HOLE 6004B

LATITUDE: 32°03.98'N
LONGITUDE: 79°05.86'W

WATER DEPTH: 570 ft (173.7 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
D.I.	602	1056		454	138.1					Drilled interval	
1	1056	1087	31	485	147.8	0	0	0	0	No recovery	
2	1087	1118	31	516	157.3	6	29.6	8.7	100	Foram sand, light olive, light gray Age: Middle Miocene	36.4
3	1118	1149	31	547	166.7	1	1.0	.3	3	Shell hash and silty foram ooze, light olive	
4	1149	1179	30	577	175.8	1	2.2	.67	7	Stiff olive clay and foram ooze, black chert	35.9
5	1179	1210	31	608	185.3	1	2.75	.84	9	Stiff olive gray clay, stiff gray clay, lithology contact in core catcher Age: Early Miocene/Paleocene	
6	1210	1241	31	639	194.8	6	24.75	7.5	82	Stiff gray clay, calcareous Age: Paleocene	
7	1241	1272	31	670	204.8	6	30.0	9.1	100	Hard gray clay, calcareous	37.5
8	1272	1295	23	693	211.2	6	24.8	7.6	100	Hard gray clay, calcareous	
9	1295	1304	9	702	214.0	4	17.9	5.5	100	Hard gray silty clay Age: Middle Paleocene	37.9
10	1304	1320	16	718	218.9	1	1.5	.46	9	Hard gray silty clay	38.1
11	1320	1335	15	733	223.4	1	4.6	1.4	31	Hard gray silty clay, calcareous	
12	1335	1366	31	764	232.9	2	8.0	2.4	27	Hard gray silty clay, calcareous	

CORE TABLE -- HOLE 6004B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
13	1366	1397	31	795	242.3	3	16.0	4.9	53	Hard gray silty clay, calcareous	
14	1397	1429	32	827	252.1	6	29.2	8.9	97	Hard gray silty clay, calcareous	39.0
15	1429	1459	30	857	261.2	1	4.5	1.4	15	Hard gray silty clay, calcareous	
16	1459	1490	31	888	270.7	3	10.75	3.3	36	Hard gray silty clay, calcareous	38.6
17	1490	1521	31	919	280.1	CC only	.5	.15	2	Hard gray silty clay, calcareous	
18	1521	1552	31	950	289.6	3	11.75	3.6	39	Hard gray silty clay, calcareous Age: Middle Paleocene	
19	1552	1582	30	980	298.7	6	30.0	9.1	100	Hard gray silty clay, calcareous Age: Late Cretaceous	39.8
20	1582	1612	30	1010	307.9	1	2.5	.76	8	Firm gray silty clay Age: Late Cretaceous	40.7

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6004

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	2	Bottom	10	Green med. sand, coarse, clean	7.68	7.71	2.00	.395	36.3	.568	3.32
4	4	140-150	34	Green-yellow, coarse, unconsol. H_2S smell	7.67	7.54	3.20	.408	35.8	.690	3.81
6	6	140-150	53	Green sandy silt	7.40	7.63	4.80	.398	35.9	.577	3.22
8		Bottom	72	Disturbed green sand, shelly to silty		7.68	2.82*	.437	36.7*		
10	3	0-10	91	Green silty sand, strong H_2S	7.20	7.28	8.88		36.2	.743	4.22
12	5	140-50	110	Green carbonate sand, strong H_2S		7.44	9.00	.538	36.0	.153	0.85(?)
14	6	0-10	129	Green sand with white streaks, strong H_2S		7.0	17.1	.547	35.9	.516	2.79

*Probably contaminated

Chemistry of Water Samples from Hole 6004B

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
2	6	Bottom	158	Green, calcareous, sandy, partly lithified nodules, strong H_2S		7.20 drift to 7.1	10.08	.597	35.9	.404	2.2
4	1	140-150	176	Dark green, silty, diatomaceous and cherty mudstone, H_2S		7.44 drift to 7.47	4.88	.638	35.9	.588	3.27
7	CC		205	Gray-green fissile clay shale, sandy in part, no odor		7.26	4.40	.743	37.5		
9	3	141-150	215	Gray clay with brittle chunks in consolidated plastic mass					37.9	1.01	6.08
10	CC		219	Gray, fissile, sl. plastic shale		7.72	3.72	.788	38.1		
14	6	140-150	253	Gray, fissile, shale, excellent sample		7.40	2.38	.834	39.0	1.64	10.00
16	3	140-150	271	Hard gray shale				.889	38.6		
19	1	140-150	298	Gray hard shale, sl. silty in part		7.35	4.44	.916	39.8		
20	1	140-150	308	Gray siltstone, shaly		7.60	1.57	.994	40.7	.939	5.31

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLES 6004 AND 6004B

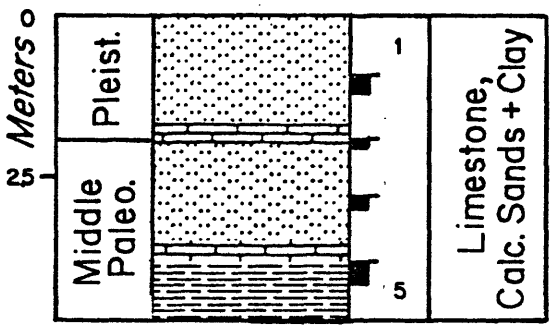
SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6004-2-2 140-150 cm max pene 50' 15.2m	olive sand, argill, calcar. sonicated	ND	ND	ND
6004-10-3 10-20 cm max pene 299' 69.8m	olive clay, sandy, shell sonicated	ND	ND	ND
6004B-2-6 130-140 cm max pene 516' 157.3m	lt. olive foram sand sonicated	ND	ND	ND
6004B-4-1 130-140 cm max pene 577' 169.8m	stiff olive clay, foram ooze black chert sonicated	ND	ND	ND
6004B-7-6 140-150 cm max pene 670' 204.2m	hard gray calc. clay sonicated	421.4	ND	ND
6004B-7-6 140-150 cm max pene 670' 204.2m	hard gray calc. clay core liner gas space	967.3	ND	ND
6004B-8 middle max pene 693' 211.2m	hard gray calc. clay core liner gas space	692.1	ND	ND
6004B-9 bottom max pene 702' 214.0m	hard gray silty clay core liner gas space	ND	ND	ND
6004B-9 1.5 m from bottom 212.5m	hard gray silty clay core liner gas space	ND	ND	ND
6004B-14 bottom max pene 827' 252.1m	hard gray silty calc. clay core liner gas space	1101	ND	ND
6004B-19 core catcher max pene 980' 298.7m	hard gray silty calc. clay pore squeezing	ND	ND	ND

SITE 6005

Location and purpose.--The location of this site on the continental shelf 22 nautical miles (41 km) off Georgetown, South Carolina, was selected to determine the extent of possible offshore aquifers and to identify reflectors in seismic profiles, and to determine the stratigraphy of the region near the Cape Fear Arch. The site was selected as close to shore as the minimum water depth for drilling, 18 meters (60 feet), would allow.

Operations.--The drilling vessel arrived on location 0100, July 30, 1976; the reflection seismic survey revealed suitable conditions, the site was approved, and coring began at 1105. Five cores were retrieved by 1635 but Core 6 could not be retrieved by the wire line; the inner barrel had sanded-up and was stuck. The drill string was pulled out of the hole and Core 6 was recovered at 1840. Because of caving of the hole, it had cored the same interval as Core 5.

The vessel was repositioned about 3 meters and Hole 6005B was begun at 1940. The string was washed in until resistance was encountered at about 20 meters penetration. Three cores were recovered by 0200 for a total penetration of 47.6 meters. The hole was caving steadily, and in order to keep the string from sticking, the hole had to be continually reamed and washed. The caving almost literally chased the bit out of the hole. At 0430 the decision was made to abandon the hole.



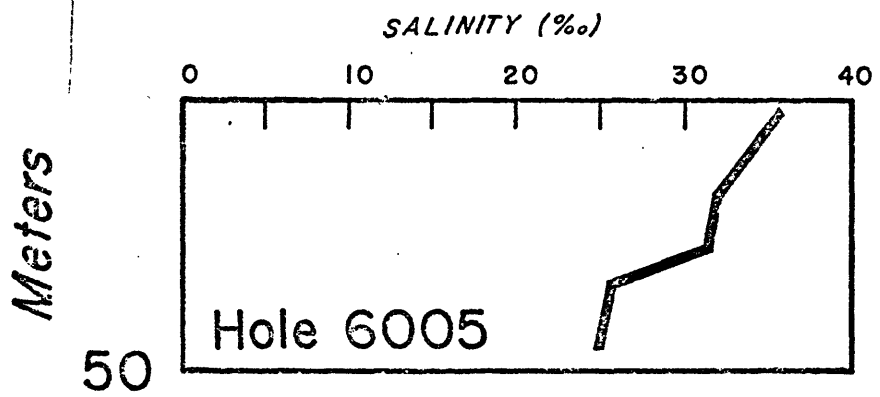
HOLES 6005 AND 6005B

Lithology.--The section consists of 48 meters of limestone and calcareous sands and clay. Dark gray calcareous clay and limestone of Paleocene age was encountered below approximately 20 meters of Holocene/Pleistocene micaceous sand.

Paleontology.--The foraminiferal faunas are of low diversity, mainly benthic in composition, indicating shallow shelf conditions. The Paleocene fauna is typical of the Vicentown and Black Mingo Formations of the Atlantic Coastal Plain. No Pleistocene fauna is present; however, diatoms occur in the upper part of the core.

Interstitial Water.--Operations at site 6005 were terminated at 47.6 meters due to severe drilling difficulties. The salinity to this depth steadily decreased suggesting considerable fresh water influence. Possible fresh water reservoirs at greater depth unfortunately cannot be assessed.

Light hydrocarbons.--No samples suitable for gas analyses were recovered.


SALINITY (‰)
0
10
20
30
40
Meters
50
Hole 6005

DATE: 7/30/76

CORE TABLE -- HOLE 6005

WATER DEPTH: 61 ft (18.6 m)

LATITUDE: 33°15.10'N
LONGITUDE: 78°44.08'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	34.9
1	93	124	31	31	9.5	CC only	.5	1.5	2	Black clayey micaceous sand Age: Holocene	35.7
2	124	157	33	64	19.5	2	8.7	2.7	26	Badly disturbed, drilling fluid contamination Coarse sand, gray limestone Dark gray sand, silt Age: Pleistocene with Paleocene lithoclasts	32.0
3	157	186	29	93	28.3	1	5.5	1.7	19	Section 1 spilled on deck when cap came off; disturbed sand, dark gray silty sand in core catcher Age: Paleocene	31.6
4	186	218	32	125	38.1	2	6.5	2.0	21	Coarse sand and shells, Probable caving Hard dense sandy limestone Age: Paleocene	
5	218	249	31	156	47.6	1	.5	.15	2	Dark gray dense clay	23.8
6	218	249	31	156	47.6	3	10	3.0	32	Cavings in same interval as Core 5 Hard, dense, gray limestone in bit Age: Paleocene	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 7/30-31/76

CORE TABLE -- HOLE 6005B

WATER DEPTH: 61 ft (18.6 m)

LATITUDE: 33°15.10'N
LONGITUDE: 78°44.08'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
D.I.	93	157	64	64	19.5	-	-	-	-	Hard layer encountered at 40'12.2" in penetrated drilled interval	
1	157	189	32	96	29.3	3	13.5	4.1	42	Sand cavings and 1-4" plug of hard sandy limestone	
2	189	218	29	125	38.1	2	6.2	1.9	21	Hard gray limestone and sand cavings	25.6
3	218	249	31	156	47.6	CC only	.5	.15	2	Sand cavings	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6005

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		10	Gray, silty sand with shells unconsolidated		7.42	3.25	.420	35.7	1.56	8.39
2	CC		20	Gray, coarse sand with shell, micaceous, limestone cobbles, contaminated		7.64	8.83	.444	32.0*	1.90	9.84
3	CC		29	Gray, coarse, micaceous sand with lighter limey streaks, unconsolidated		7.35	4.49	.480	31.4		
5	CC		48	Black clayey-silty sand, micaceous	7.71	7.86	5.10	.458	25.0	2.16-2.44	8.78-9.92

*Core catcher sample may be contaminated with fresh water drilling mud

Chemistry of Water Samples from Hole 6005B

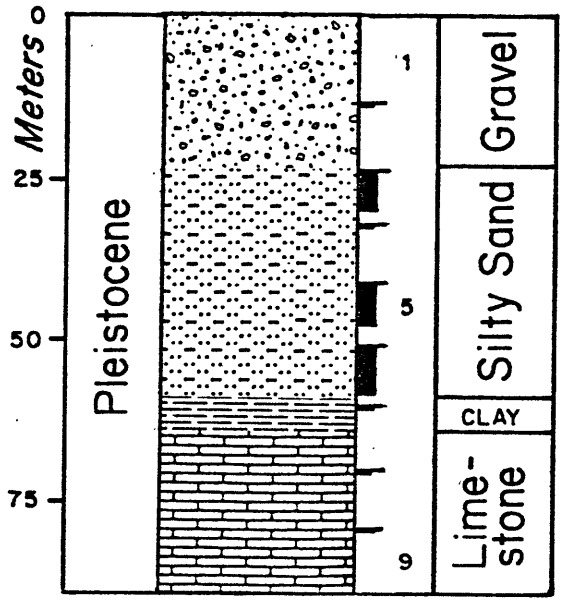
CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
2		140-50	39	Hard gray,silty, limestone recovered .40 ml #14 water		7.20*	6.48		25.6	64.3	273.6

*pH after diluting 10 times with distilled H_2O

SITE 6006

Location and purpose.--The location of this site near the continental shelf edge, 26 nautical miles (48 km) offshore in Raleigh Bay, was selected to determine the geotechnical properties of the sediments, identify upper reflectors in seismic profiles such as the IPOD-CDP line which crosses the site, and calibrate the depths to those reflectors. The site was selected also to provide stratigraphic data at the shelf just south of Cape Hatteras.

Operations.--The drilling vessel arrived at the location at 1100, August 2, 1976; the seismic records were received from the survey vessel and the site was approved for drilling at 1700. By 0040 on August 3, nine cores had been recovered for a total penetration of 89.3 meters. The bit "sanded-up" and became stuck during the cutting of Cores 6 and 8 but was freed in both cases. During the cutting of the tenth core, the pipe became stuck again. The string was worked for more than 5 hours in attempts to free it. At 0602 the pipe parted with the loss of the bit, the outer core barrel, the inner core barrel, five drill collars and one bumper sub. Because of the poor hole conditions and high risk to the drilling equipment, no further drilling was attempted on the site. The anchors were raised and the ship was underway to the next site at 1515, August 3, 1976.



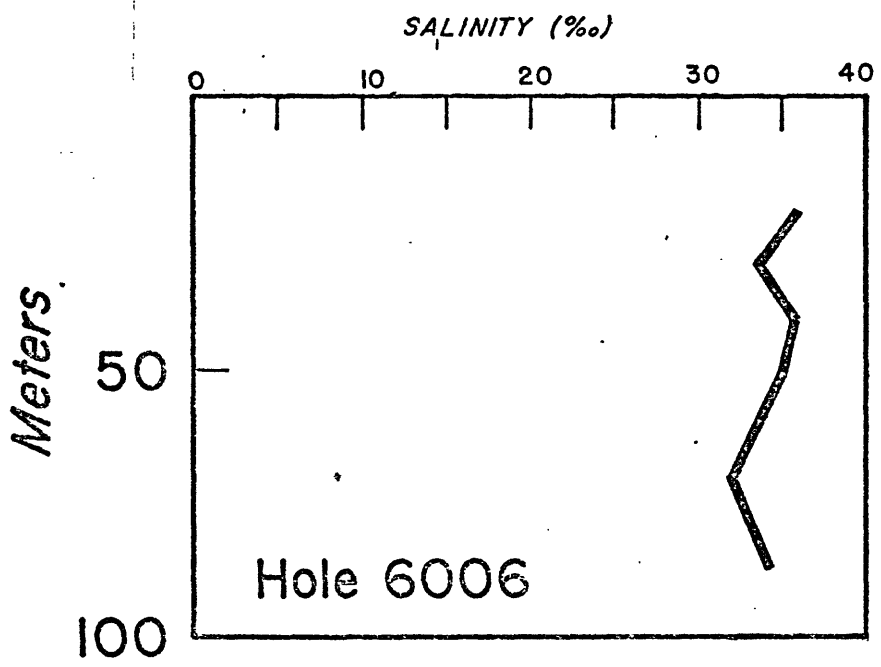
HOLE 6006

Lithology.--The section that was cored consists of limestone at the base overlain by some clay, much loose sand and gravel about 57 meters thick, all of Pleistocene age.

Paleontology.-- Calcareous nannofossils are common, and middle to outer shelf foraminiferal faunas are present in most cores.

Interstitial water.--No distinct gradients in salinity were observed at this location. A strong zone of H_2S was observed at 70 meters decreasing above and below this level.

Light hydrocarbons.--No samples suitable for gas analyses were recovered.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6006

DATE: 8/2/76

CORE TABLE -- HOLE 6006

WATER DEPTH: 184 ft (56.1 m)

LATITUDE: 34°41.4'N
LONGITUDE: 75°43.0'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	216	262	46	46	14.0	0	0	0	0	No recovery	0
2	262	294	32	78	23.8	CC only	.5	.15	2	Gray silty sand with gravel and cobble size sediments Age: Pleistocene	35.9
3	294	322	28	106	32.3	4	20	6.1	19	Gray silty, sand & shells Age: Pleistocene	33.2
4	322	353	31	137	41.8	1	.3	.08	1	Gray fine silty sand with shell fragments. Age: Pleistocene	35.7
5	353	384	31	168	51.2	4	20	6.1	65	Gray clayey silty sand, shell fragments Age: Late Pleistocene	34.9
6	384	415	31	199	60.7	6	23	7.0	74	Sandy, probably cavings, gray sandy clay Age: Late Pleistocene	
7	415	447	32	231	70.4	CC only	.5	.15	2	Gray clay with chunks of limestone and claystone Age: Late Pleistocene	31.9
8	447	478	31	262	79.9	CC only	.3	.08	1	Sandy limestone Age: Pleistocene	
9	478	509	31	293	89.3	CC only	.3	.08	1	Hard porous limestone Age: Pleistocene	34.3

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6006

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
2	CC		24	Green-gray sand and gravel fossiliferous			2.44	.454	35.9		
3	CC		33	As above	7.85	7.57	4.10	.511	33.2*	1.12	6.02
4	CC		42	Green-gray silt, clayey to sandy	7.53	7.45	4.45	.568	35.7	.66	3.71
5	CC		52	Dark green sandy silt, clayey, with fossils, H_2S	7.55	7.35	6.62	.541	34.9	1.015	5.64
6	CC		61	Green sandy silt, strong H_2S							
7	CC		71	Green-yellow silts, sand, very strong H_2S, dry texture	7.45	7.43	17.34	.313	31.9		
8	CC		80	Dense sandy lime-stone, very hard						34.5	184.5
9	CC		90	Porous gray, highly lithified lime-stone, moderate H_2S		7.67	6.46	.450	34.25	5.6	30.6
5 BBL drilling mud								.222	31.1		

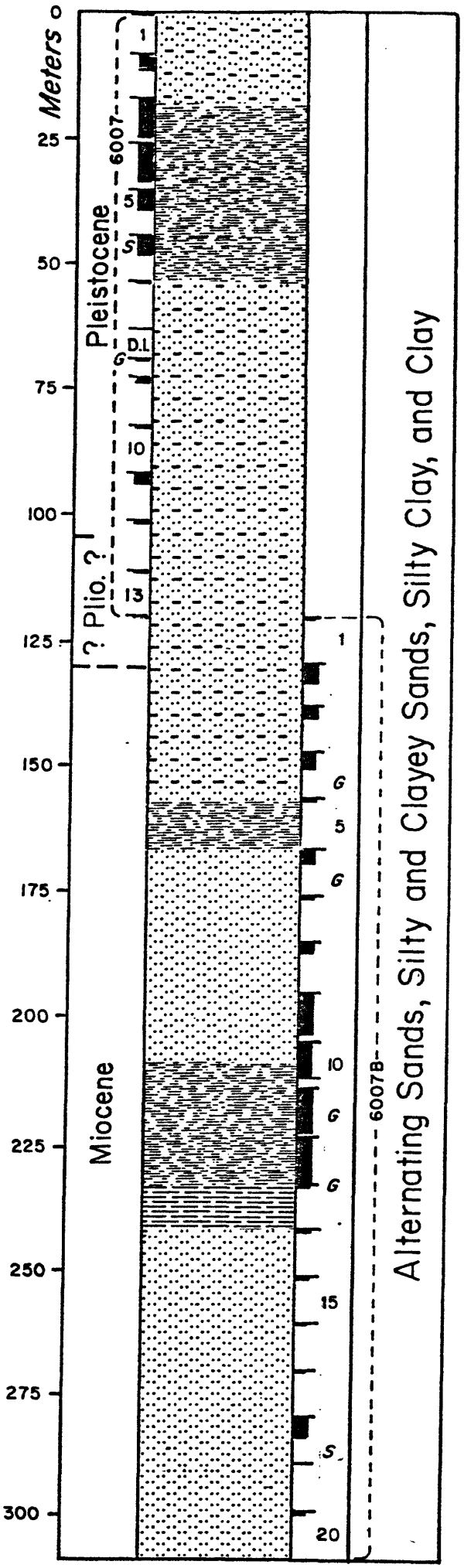
*Possible contamination

SITE 6007

Location and purpose.--The location of this site on the outer edge of the continental shelf 47 nautical miles (87 km) offshore from the southern end of the Delmarva Peninsula, was selected to determine geotechnical properties of the sediments, explore the possibility of extent of offshore freshwater aquifers to the shelf edge, identify reflectors in high-resolution geophysical profiles through the site and determine stratigraphy in the continental shelf at the southern part of the Baltimore Canyon Trough region.

Operations.--The drilling vessel arrived on location at 1630, August 4, 1976. The site was approved for drilling after receipt of the reflection seismic records from the survey vessel. The string was spudded-in and the first core recovered at 2145. Twelve cores had been recovered by 0255 on August 5. After Core 13 had been cut at a penetration of 120.7 meters, the inner core barrel became stuck in the outer core barrel and the overshot broke in attempts to retrieve it. The sand line parted on the second attempt to retrieve the inner core barrel after repair of the overshot. It was necessary to pull the drill string to recover the barrel and at this point the pipe became stuck in the hole. Working the pipe freed it at 0700, the string pulled out of the hole and, at 0800, Core 13 was recovered from the outer core barrel.

At 1400, August 5, Hole 6007B was spudded-in and by 0630 on August 6, twenty more cores had been recovered for a total penetration of 310.6 meters. At 0735 about 100 meters of pipe were pulled for about one hour to make sure that the hole was not caving. The string was run back the total depth and the hole was conditioned for logging. By 0200, August 7, all logs except temperature had been run. At that time the sonic logging tool caught in the bit opening during retrieval, snapped off and was lost down the hole. No temperature log was run. The drill string was pulled, the anchors raised, and the ship was underway to the next site at 0630 on August 7, 1976/



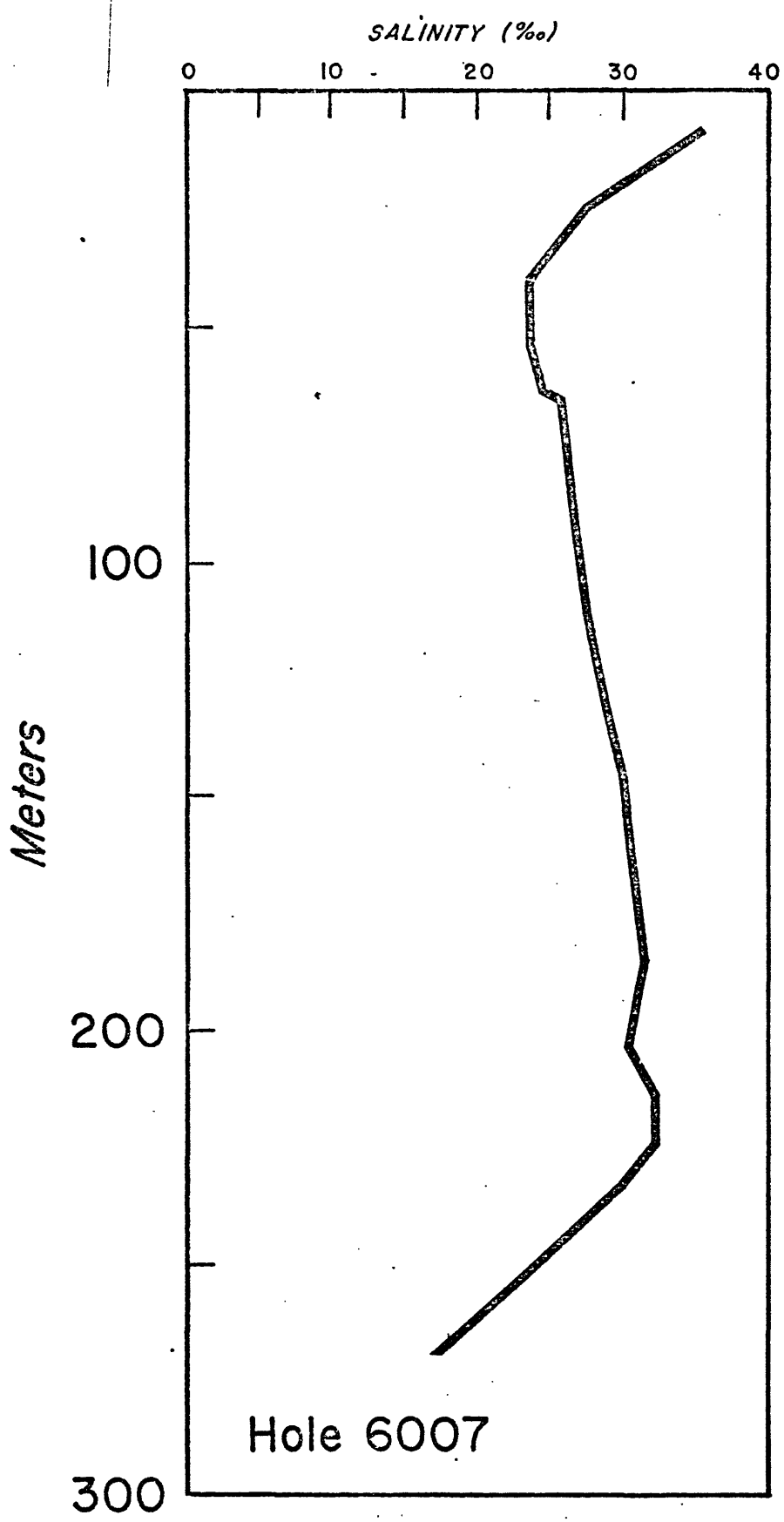
HOLES 6007 AND 6007B

Lithology.--The sediments consist of alternating silty and clayey sands, and clays of late Tertiary age (Miocene through Holocene).

Paleontology.--Much of the section contains few or no diagnostic foraminifers or calcareous nannofossils. Diatom-rich intervals are present, however. Environments of deposition were chiefly nearshore marine and deltaic, although middle and outer shelf environments are also represented.

Interstitial water.--The salinity profile at this location shows a minimum of 23.5 o/oo at 50 meters depth followed by a uniform increase in salinity toward normal seawater values at the bottom of the hole. Calcium values show the same trends as salinity over the top 90 meters, suggesting that water of low salinity and low calcium has influenced the higher salinity water at this depth.

Light hydrocarbons.--In this hole, the methane concentrations rose steadily from a concentration of 1215 ppm at a depth of 58 meters, in lower Pleistocene gray, sticky clays, to a concentration of 417×10^3 ppm in olive gray silt and clays of mid-Miocene age at a core depth of 247 meters. A greenish gray, silty clay, with a strong fetid odor of H_2S, formed a clay seal immediately above the methane-rich sediments with abundant diatoms, and served as a barrier to trap the light hydrocarbons. Ethane was detected in only one sample from the methane-rich zone, and had a concentration of 4.2×10^3 ppm. In the unconsolidated sands that lie immediately under the methane-rich zone, the light hydrocarbon concentration feel to zero. Propane was not detected.


SALINITY (‰)
0
10
20
30
40
100
200
300
Meters
Hole 6007

DATE: 8/4-5/76

CORE TABLE -- HOLE 6007

LATITUDE: 37°17.99'N
LONGITUDE: 74°39.16'W

WATER DEPTH: 279 ft (85 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
1	311	340	29	29	8.8	1	1.5	0.5	5	Dark olive gray silty sand, shells, live starfish. Age: Pleistocene	35.3
2	340	368	28	57	17.4	3	10	3.0	36	Clay, olive gray. 1,2 missing Age: Pleistocene	
3	368	396	28	85	25.9	6	26	7.9	93	Gray clay & dark olive sand Sec. 1,2,3,4 empty except for drilling fluid, discarded. Age: Pleistocene	27.8
4	396	427	31	116	35.4	5	23	7.0	72	Gray clay and drilling mud 1,2,3,4 discarded Age: Early Pleistocene	
5	427	458	31	147	44.8	3	14.5	4.4	47	Dark olive gray clay, silty shells. Age: Early Pleistocene	23.6
6	458	489	31	178	54.3	3	11.2	3.4	36	Sticky gray clay Age: Early Pleistocene	23.5
7	489	520	31	209	63.7	1	1.3	0.4	4	Sticky gray clay and sand Age: Early Pleistocene	24.6
D.I.	520	529	9	218	66.4	-	-	-	-	Drilled interval	
8	529	551	22	240	73.2	1	2.92	.89	9	Blue-black clayey sand	26.1
9	551	583	32	272	82.9	1	3.5	1.1	11	Gray clayey sand plus hard sandstone chunks Age: Pleistocene	

CORE TABLE -- HOLE 6007 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
10	583	614	31	303	92.4	1	1.83	.56	6	Gray clayey sand with shells	26.6
11	614	645	31	334	101.8	2	7	2.1	23	Gray clayey sand with sandstone chunks	
12	645	677	32	366	111.6	CC only	.5	.15	2	Gray clayey sand Age: Pleistocene (?)	27.1
13	677	707	30	396	120.7	CC only	.3	.09	1	Fine clayey sand plus gravel, shells Age: Pliocene	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 8/5-6/76

CORE TABLE -- HOLE 6007B

LATITUDE: 37°17.99'N
LONGITUDE: 74°39.16'W

WATER DEPTH: 279 ft (85 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
DI	311	707	396	396	120.7	-	-	-	-	Drilled interval	
1	707	739	32	428	130.5	1	2	0.6	6	Olive gray, silty clay with shells Age: Early Pliocene Late Miocene	28.8
2	739	768	29	457	139.3	3	13.8	4.2	48	Olive gray silty clay Age: Late Miocene	
3	768	798	30	487	148.4	2	6.67	2.0	22	Olive gray, silty, sandy clay Age: Late Miocene	29.9
4	798	828	30	517	157.6	3	10.6	3.2	35	Olive gray, silty,sandy clay	
5	828	861	33	550	167.6	1	1.4	.4	4	Olive gray, silty,sandy clay	31.2
6	861	892	31	581	177.1	2	10	3.0	32	Dark olive gray sandstone	
7	892	923	31	612	186.5	1	1.6	4.9	5	Olive gray sandy clay	31.6
8	923	955	32	644	196.3	2	6.1	1.9	19	Olive gray sand, shells	
9	955	987	32	676	206.0	CC only	.5	.15	2	Olive gray sand, fossiliferous	
10	987	1018	31	707	215.5	5	25.75	7.8	83	Olive gray silt	30.7
11	1018	1050	32	739	225.3	6	28.75	8.8	90	Greenish gray silt and clay Age: Mid-Miocene	32.1
12	1050	1081	31	770	234.7	6	30.2	9.2	100	Gray silty clay, methane Age: Mid-Miocene	29.9

CORE TABLE -- HOLE 6007B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
13	1081	1112	31	801	244.2	CC only	.5	.15	2	Gray clay	
14	1112	1142	30	831	253.3	1	1.75	.53	6	Gray sand	
15	1142	1172	30	861	262.4	1	2.5	.76	8	Light gray, loose sand	
16	1172	1204	32	893	272.2	1	1	.3	3	Light gray, loose sand with limestone chunk	
17	1204	1235	31	924	281.6	1	.67	.2	2	Light gray shelly, loose sand	
18	1235	1266	31	955	291.1	3	13.25	4.0	43	Light gray shelly, loose sand	
19	1266	1297	31	986	300.5	0	0	0	0	No recovery	
20	1297	1330	33	1019	310.6	1	2.3	.7	7	Gray clayey sand	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6007

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		9	Green sand with shells	7.51	7.29	5.01	.458	35.3	.913	5.31
3	6	140-150	26	Olive clay (good sample)	7.52	7.61	10.1	.189	27.75	.92	4.3
5	2	140-150	45	Olive clay, silty	7.88	7.95	11.6	.151	23.6	1.32	5.5
		Drilling fluid							4.35		
6	3	140-150	55	Gray, very fine sticky clay	7.95	7.94	11.1	.138	23.5	1.30	5.3
7	CC		64	Gray clay		7.87	10.7	.145	24.6		
8		140-150	74	Olive gritty sand with shell and sandy limestone	8.31	8.06	9.34	.182	26.1	1.64	7.3
10	1	145-150	93	Green-olive fine sand. Mud contamination (?)	?	7.81	9.91	.221	26.6	1.07	4.8
12	CC		112	Green-olive sand				(.167)	27.6	14.1	66.0
				Limestone Layer							* .205

*at 22°C

Chemistry of Water Samples from Hole 6007B

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		131	Olive clayey silt, firm					28.75		
3	3	147-150	149	Olive medium sand		8.26	12.42		29.9	1.41	7.0
5	CC		168	Olive green-gray clay, silty in part					30.6	1.52	7.7
6	2	140-150	178	Olive coarse glauconite sand, non-calcareous						7.04	3:6
7	CC		187	Olive green, coarse with hard gravel		8.27	11.6		31.6		
9	CC		206	Olive fossiliferous, fine sand		8.30	11.3		30.2		
10	5	140-150	216	Olive fissile siltstone, clayey		7.87	13.46		32.2	1.51	7.95
11	5	140-150	226			7.96	12.9		32.1	2.28	12.0
12	4	140-150	235	Olive brittle clay-shale, strong Methane generation, fish scales					29.9	1.10	5.5
17	1	145-150	282	Coarse, badly contaminated sand					16.9*	3.25	9.6
Surface water						8.17	2.50				

*Probably contaminated

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLES 6007 AND 6007B

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6007-6-3 130-140 cm max pene 178' 54.3m	sticky gray clay sonicated	1215.5	ND	ND
6007-10-1 140-150 cm max pene 303' 92.4m	gray clayey sand with shells pore squeezing	1402.5	ND	ND
6007-11-2 140-150 cm max pene 334' 101.8m	gray clayey sand sonicated	761.4	ND	ND
6007B-1 core catcher max pene 428' 130.5m	olive gray silty clay with shells pore squeezing	ND	ND	ND
6007B-2-3 140-150 cm max pene 457' 139.3m	olive gray silty clay sonicated	ND	ND	ND
6007B-10-5 130-140 cm max pene 707' 215.5m	olive gray silt pore squeezing	2835.8	ND	ND
6007B-11-6 max pene 739' 225.3m	greenish gray silt and clay core liner gas space	7441	ND	ND
6007B-12-3 max pene 770' 234.7m	gray silty clay core liner gas space	43,195	ND	ND
6007B-12-4 135-145 cm 231.6m	gray silty clay sonicated	3055.5	ND	ND
6007B-12-6 .8 m from bottom 233.9m	gray silty clay core liner gas space	407,500	ND	ND
6007B-12-6 bottom 234.7m	gray silty clay core liner gas space	417,500	4210	ND

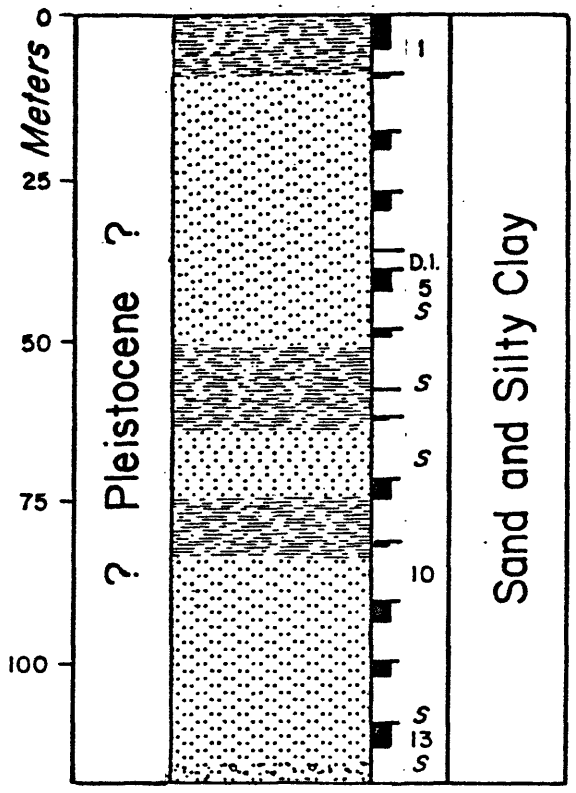
SITE 6008

Location and purpose.--The location of this site on the continental shelf 7.6 nautical miles (14 km) off Ocean City, Maryland was selected to determine if freshwater aquifers such as the Ocean City-Manokin aquifer system extend offshore to this distance, or if the freshwater/saltwater interface in the system lies shoreward of the site. Further purposes of the site were to determine geotechnical properties of the sediments and identify reflectors in reflection seismic profiles of the area.

Operations.--The drilling vessel arrived on location at 1600, August 7, 1976. The reflection seismic records were received from the survey vessel L'OLONNOIS and the site was approved for drilling at 1700. Hole 6008 was spudded-in and the first core recovered at 2015. By 0610 on August 8, thirteen cores had been retrieved for a total penetration of 119.5 meters. At this point the pipe stuck in the hole. From 0615 to 2400 on August 8, the pipe withstood all attempts to free it, including pulls of as much as 450,000 lbs. During this time, hurricane "Belle" was making its relentless and ever accelerating approach from the south, straight toward the location of Site 6008. "String shot", explosives to loosen the pipe and permit backing-off the pipe at a joint below the mudline, was ordered from Houston and was scheduled to arrive in the morning. At 0200, August 9, hurricane "Belle" was reported 190 miles south of Cape Hatteras, and on a northerly course at about 25 miles per hour. The shipboard laboratory and storage area were secured for the approaching hurricane. At 0930 the helicopter arrived with the string shot and the explosives specialist, and at 1130 the shot was fired successfully, the string backed-off 16 feet (4.9 meters) below the mudline.

Lost were the bit, the outer core barrel, seven drill collars and a bumper sub. At 1330 the scientific party was evacuated to Lewes, Delaware, aboard the M/V L'OLONNOIS. The transfer in the Lewes Harbor of Refuge to the crew launch BIG STONE II took place in 60-knot or higher winds. The D/V GLOMAR CONCEPTION weighed anchor and headed for deeper water to ride out the hurricane. The eye of hurricane "Belle" later passed within eight miles of the drilling vessel which experienced winds of about 120 miles per hour but received negligible damage.

The next day the scientific party returned to the drilling vessel via the M/V L'OLONNOIS and reboarded at about 2200 August 10 at the next site.



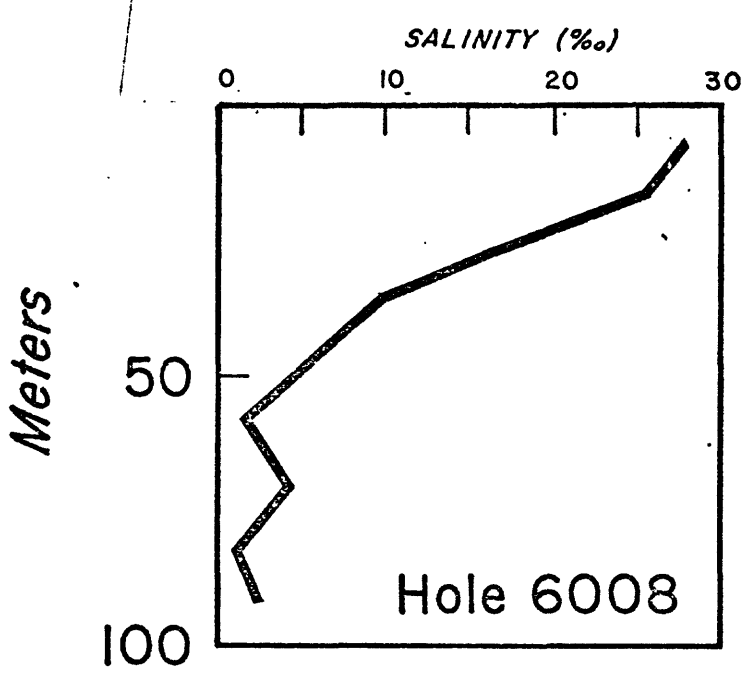
HOLE 6008

Lithology.--The section penetrated consisted of 120 meters of sands and silty clays. A gravel zone was encountered near the bottom of the hole.

Paleontology. Most of the samples examined were barren of calcareous nannofossils and foraminifers. The few scattered speciments are of shallow water marine and lagoonal origin and appear to be of Pleistocene age.

Interstitial water. At this site a steep gradient in the salinity was measured to a minimum value of 1.3 o/oo at 81 meters. The finding of freshwater at this distance from shore suggests that the freshwater-seawater transition zone in a major aquifer at 113 meters is more than 8 miles seaward of the shoreline.

Light hydrocarbons.--No samples suitable for gas analyses were recovered.


SALINITY (‰)
0
10
20
30
Meters
50
100
Hole 6008

DATE: 8/8/76

CORE TABLE -- HOLE 6008

WATER DEPTH: 68 ft (20.7 m)

LATITUDE: 38°24.21'N
LONGITUDE: 74°53.83'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
1	100	130	30	30	9.1	4	17.2	5.2	57	Dark gray sandy clay Age: Holocene or Late Pleistocene	27.6
2	130	160	30	60	18.2	1	3	1	1	Dark gray silty clay, siderite Age: Pleistocene (?)	25.5
3	160	190	30	90	27.4	2	8.7	2.7	29	Dark gray silty clay Age: Pleistocene (?)	15.9
4	190	220	30	120	36.6	2	8.6	2.6	28	Blue-green clay, shelly Age: Pleistocene (?)	9.7
D.I.	220	229	9	129	39.3	-	-	-	-	Drilled interval	
5	229	260	31	160	48.8	2	10.5	3.2	34	Sticky gray shelly clay and loose sand.	
6	260	291	31	191	58.2	1	4	1.2	13	Blue-gray clayey shelly sand Mixed/drill mud Age: Pleistocene	1.6
7	291	305	14	205	62.5	0	0	0	0	No recovery	
8	305	336	31	236	71.9	1	0.7	.2	2	Sticky gray clay plus loose shelly sand. Age: Pleistocene	4.7
9	336	367	31	267	81.4	2	8	2.4	26	Gray-green silty clay with loose sand above	1.3
10	367	398	31	298	90.8	1	3	.9	10	Gray clayey shelly sand Age: Pleistocene (?)	2.3

CORE TABLE -- HOLE 6008 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
11	398	429	31	329	100.3	2	10	3.0	32	Gray clayey coarse shell hash	
12	429	460	31	360	109.7	2	6	1.8	19	Gray-brown clayey coarse sand	
13	460	492	32	392	119.5	2	11	3.4	35	Coarse sand (starts at 79 cm in sec. 1) and pebble gravel (Probable Ocean City-Manokin aquifer system)	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6008

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		10	Dark gray clay	7.0	7.09	4.1	.639	27.6	1.00	4.65
2	CC		19	Brownish gray sandy clay	7.1	7.48	4.8	.425	25.5	3.07	13.35
3	1	140-150	28	Dark gray clay	7.1	7.46	4.2	.551	15.9	2.29	6.11
4	CC		37	Dark gray sandy clay	7.4	7.77	2.9	.439	9.7	4.19	7.04
6	CC		59	Blue-gray clayey sand	8.4	8.35	3.6	.121	1.6	35.5	7.89
8	CC		72	Gray sticky clay	7.5			.263	4.7	1.10	.88
9	CC		82	Gray sticky clay	7.9	8.04	3.0	.162	1.3	14.0	2.55
10	CC		91	Shelly sand clay	8.1				2.3		

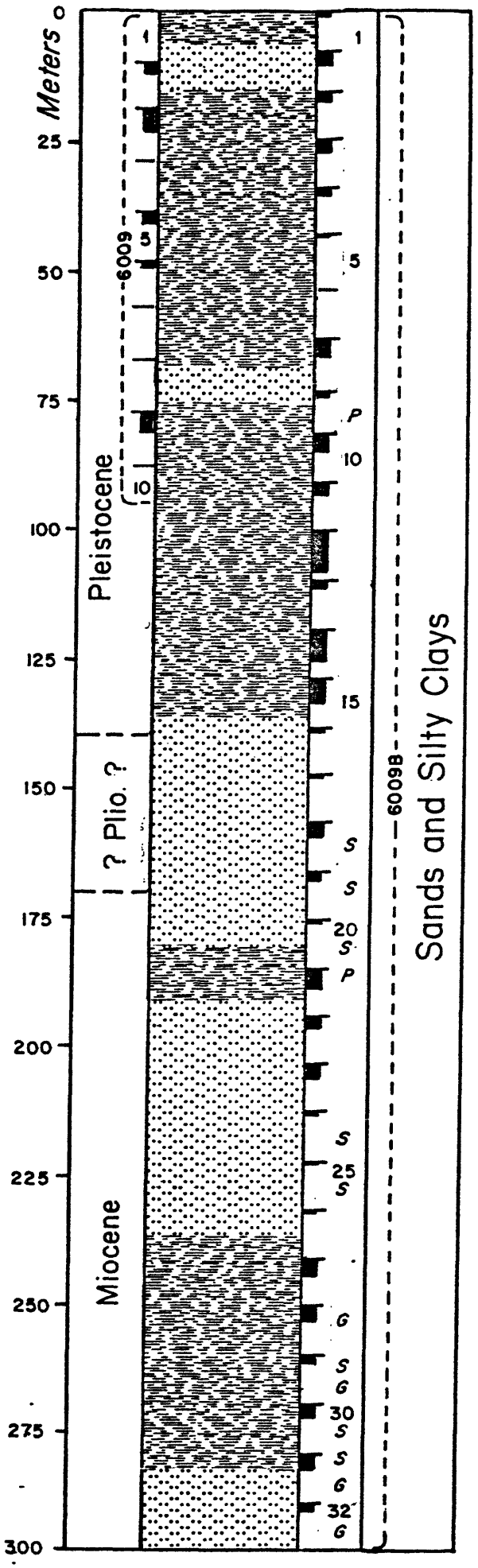
Cores below this depth were loose washed sand invaded by drilling fluid.

SITE 6009

Location and purpose.--The location of this site on the outer continental shelf 50 nautical miles (93 km) off Atlantic City, New Jersey was selected to determine the geotechnical properties of sediments in the Baltimore Canyon Trough area, and to determine if any freshwater aquifers extend offshore to this part of the continental shelf. A further purpose was to determine the stratigraphy of the younger formations in the Baltimore Canyon Trough region, to identify reflectors and calibrate geophysical profiles run through the site.

Operations.--Owing to the loss of equipment at Site 6008, the start of drilling at Site 6009 was delayed until the arrival of new outer core barrels at 0340 August 12, 1976. The site was approved and the hole spudded in at 0700. In the first three cores recovered, the core liners were collapsed and twisted. The drillers found that the spacing in the new inner core barrels was not set properly and corrected the trouble. By 1500 ten cores had been recovered for a total penetration of 93.9 meters. A cumulative core recovery of only 9% for this interval prompted pulling the string out of the hole to check the reason for poor recovery. The drillers found nothing wrong with the core barrel; the ship was moved slightly and Hole 6009B was spudded-in. Because recovery had been poor on the first attempt, the upper 94 meters was to be cored again. Core recovery improved on the second attempt to 20%. Hole 6009 had been drilled with freshwater drilling mud. So as to check the possible effects of invasion of drilling mud into the cores, Hole 6009B was drilled instead with salt water drilling mud (see discussion of interstitial water below). By 1400 on August 13, 32 cores had been recovered for a total penetration of 300 meters. The hole was displaced with gel mud and logging

began at 1900. The ES (electric logging) tool stuck at 71 meters after completion of the electric log, and at 2015 the logging cable parted and the ES tool was lost down the hole. The remaining logs, except temperature, were run successfully; however, the sonic tool stuck in the bit on retrieval. It was recovered along with the string but a temperature log therefore could not be run. The anchors were pulled and the ship was underway to the next site at 1100 on August 14, 1976.



HOLES 6009 AND 6009B

Lithology.--The section consists of 300 meters of Miocene through Pleistocene sands and silty clays, usually dark gray or dark olive gray in color. Shell fragments and probable glauconite grains are common in the lower part of the section.

Paleontology.--The youngest Pleistocene beds are of middle and outer shelf origin, but inner shelf and lagoonal sediments are present in the older Pleistocene beds. Pliocene and the upper part of the Miocene strata contain largely shallow marine benthic foraminifers indicative of the inner and middle shelf. The oldest Miocene strata are of inner shelf and lagoonal origin.

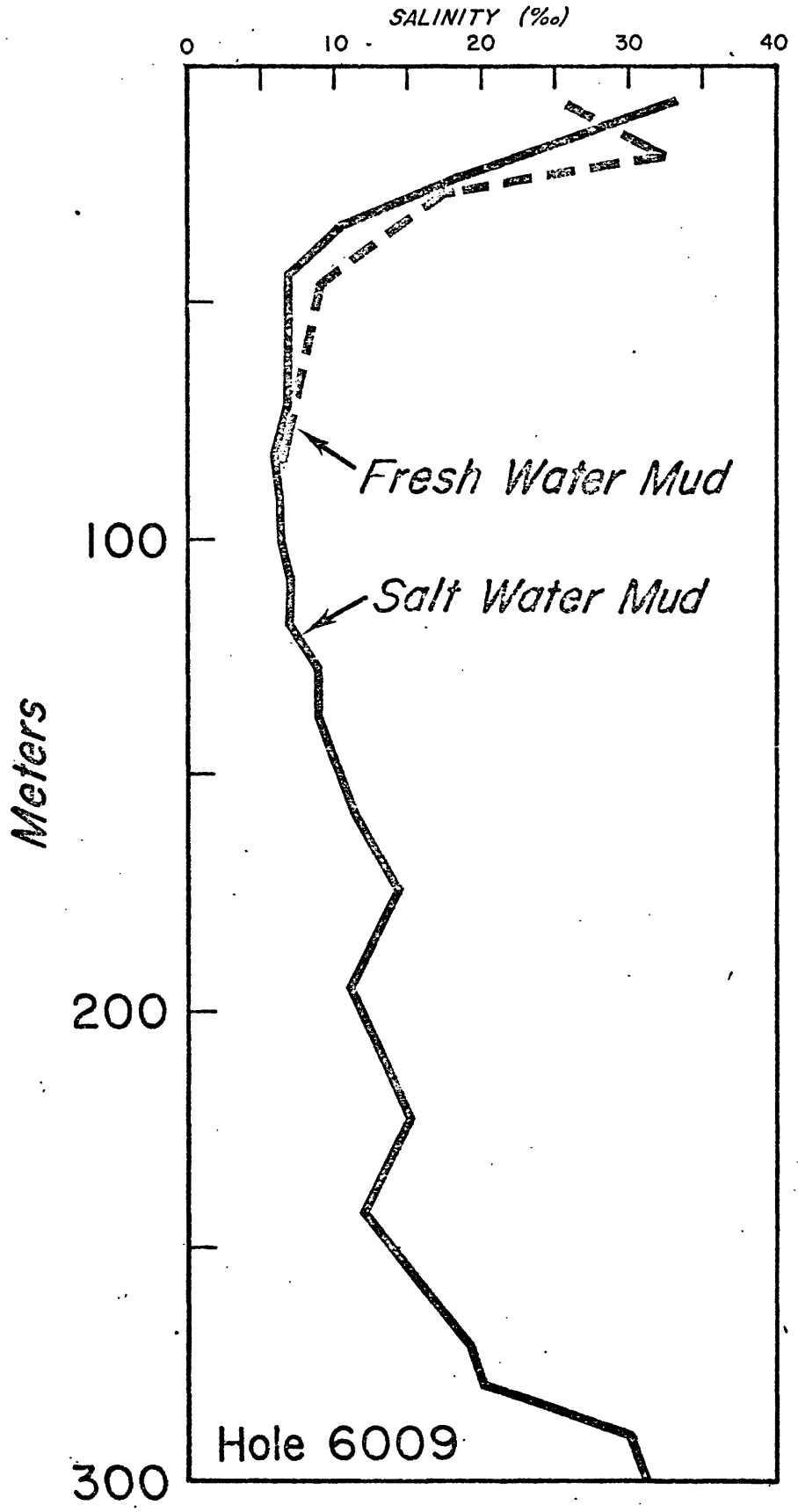
Interstitial water.--Salinity values at this site decrease sharply with depth to about 6 o/oo at 82 meters and remained less than 10 o/oo between 34 - 139 meters. Aquifer

continuity from nearshore (as indicated by mainland wells at Ocean City, New Jersey, and Hole 6008) cannot be presumed since the aquifers utilized on land dip eastward and would occur deeper than the zone of low salinity measured at this location. The zone of low salinity water may be relict water emplaced during a period of lower sea level during the Pleistocene[1].

Because of the equipment difficulties discussed under Operations above, two holes were dilled within 15 feet at this station. The first was drilled with freshwater mud, the second, 6009B, with salt water mud. Salinity profiles are essentially the same, with differences that can be explained by the uncertainty in actual sample depth when core recovery is low. The close agreement in salinity profiles shows that contamination by drilling fluid can be avoided with the normal procedures of sample collection and processing.

Light hydrocarbons.--No methane, ethane, or propane was detected.

[1]Kohout, F. A., Walker, E. H., Bothner, M. H., and Hathaway, J. C., 1976; Fresh ground water found deep beneath Nantucket Island, Massachusetts: Journal of Research of the U.S. Geological Survey, v. 4, No. 5, p. 511-515.


SALINITY (‰)
0
10
20
30
40
Fresh Water Mud
Salt Water Mud
100
200
300
Meters
Hole 6009

DATE: 8/12/76

CORE TABLE -- HOLE 6009

WATER DEPTH: 183 ft (55.7 m)

LATITUDE: 38°51.27'N
LONGITUDE: 73°35.47'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	215	245	30	30	9.1	1	1	.3	3	Stiff dark gray clay, live mahogany clam. Age: Pleistocene	27.4
2	245	275	30	60	18.3	1	2	.6	3	Stiff dark gray clay Collapsed liner Age: Pleistocene	32.5
3	275	305	30	90	27.4	3	10.7	3.3	36	Sticky pure light gray clay	17.7
4	305	336	31	121	36.9	Barrel top only	.3	.1	1	Dark brown clay Bottom of liner collapsed	
5	336	367	31	152	46.3	1	5	1.5	16	Stiff dark gray clay, shelly, sandy. Liner collapsed and twisted Age: Pleistocene	9.3
6	367	398	31	183	55.8	1	1	.3	3	Dark sandy clay and pure dark clay.	
7	398	429	31	214	65.2	0	0	0	0	No recovery	
8	429	461	32	246	75.0	0	0	0	0	No recovery	
9	461	492	31	277	84.4	2	9	2.7	29	Dark grayish brown silty clay and pea gravel	8.2
10	492	523	31	308	93.9	0	0	0	0	No recovery	

[1] RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 8/12-13/76

CORE TABLE -- HOLE 6009B

LATITUDE 38°51.27'N
LONGITUDE: 73°35.47'W

WATER DEPTH: 192 ft (58.5 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	224	249	25	25	7.6	1	3.5	1.1	14	Dark gray sandy clay	33.3
2	249	275	26	51	15.5	2	8.5	2.6	33	Core catcher empty. Dark gray coarse sand	
3	275	305	30	81	24.7	2	5.5	1.7	18	Dark gray smooth plastic clay	18.3
4	305	336	31	112	34.1	2	8.3	2.5	27	Dark gray clay	10.5
5	336	367	31	143	43.6	1	5.3	1.6	17	Dark gray clay, slightly silty	6.9
6	367	398	31	174	53.0	CC only	0.3	.09	1	Olive-gray silty clay with shells	
7	398	429	31	205	62.5	-	-	-	-	No recovery	
8	429	461	32	237	72.2	3	11.8	3.6	39	Dark gray slightly silty clay, plastic	6.9
9	461	492	31	268	81.7	2	6.3	1.9	21	Gray, slightly silty clay, plastic	
10	492	523	31	299	91.1	3	11.0	3.4	35	Gray, stiff, silty clay	
11	523	554	31	330	100.6	2	8.5	2.6	28	Gray, silty, stiff clay, micaceous	
12	554	586	32	362	110.3	6	27.8	8.5	87	Dark gray, silty, plastic clay	
13	586	617	31	393	119.8	1	4.0	1.2	13	Gray, sandy, clayey silt, stiff	
14	617	648	31	424	129.2	5	21.8	6.6	73	Dark gray clayey silt, micaceous, stiff	
15	648	679	31	455	138.7	3	14.8	4.5	49	Dark gray, clayey, silty sand, compacted Age: Pleistocene (?)	9.1

CORE TABLE -- HOLE 6009B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
16	679	710	31	486	148.1	1	2.8	.9	9	Gray clayey, stiff silt with fine gravel Age: Early Pliocene (?)	
17	710	741	31	517	157.6	1	1.5	.5	5	Very dark gray, sandy clay, plastic Age: Early Pliocene/Late Miocene	
18	741	772	31	548	167.0	2	8.2	2.5	27	Dark gray, stiff silty clay with fine gravel	
19	772	803	31	579	176.5	1	4.0	1.2	13	Dark gray, sandy, silty, stiff clay	
20	803	833	30	609	185.6	1	1.0	.3	3	Very dark gray, stiff sandy clayey silt Age: Miocene	
21	833	864	31	640	195.0	3	13.0	4.0	43	Dark gray, stiff, sandy clay Age: Miocene	
22	864	895	31	671	204.5	2	8.0	2.4	27	Dark gray, silty sandstone and partly consolidated silty sand Age: Miocene	
23	895	926	31	702	214.0	2	8.0	2.4	27	Fine grain, olive gray, silty clay Age: Miocene	
24	926	958	32	734	223.7	1	2.0	.6	3	Light olive-gray, stiff, sandy clay	15.4
25	958	988	30	764	232.8	1	.5	.2	2	Very coarse, graded sand Catcher in backward	

CORE TABLE -- HOLE 6009B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
26	988	1020	32	796	242.6	CC only	.2	.1	1	Washed sand, core barrel parts, siliceous claystone	
27	1020	1050	30	826	251.8	2	10.4	3.2	33	Dark gray, sandy clay; tan clay; gray, shelly clay	12.0
28	1050	1082	32	858	261.5	2	8.0	2.4	25	Dark, olive gray with some micaceous silt Age: Miocene (?)	
29	1082	1113	31	889	271.0	1	3.5	1.1	11	Dark-gray shell fragments, stiff	19.3
30	1113	1144	31	920	280.4	2	9.7	3.0	31	Dark gray, stiff clay	20.2
31	1144	1176	32	952	290.2	2	10.2	3.1	31	Coarse, gray sand	30.3
32	1176	1207	31	983	299.6	1	5.0	1.5	29	Coarse, gray sand	30.7

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6009

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		10	Stiff, dark gray sandy clay	7.5	7.76	2.9	.404	27.4	1.97	9.2
2	CC		19	Stiff, dark gray sandy clay	7.4	7.62	3.5	.424	32.5	1.08	5.7
3	3	140-150	28	Sticky light gray clay	(Saved for hydraulic permeability)						
3	3	100-110	28	Sticky dark gray clay		8.04	7.3	.144	17.7		
5	1	10-25	47	Stiff dark gray clay, sticky, shelly	8.0	8.40	7.8	.126	9.3	3.35	5.4
9	CC		85	Gray sandy clay, shelly	8.1	8.35	8.4	.190	6.5	36.2	40.2

Chemistry of Water Samples from Hole 6009B

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		8	Dark gray sandy shelly clay				.214	33.3	1.82	13.2
3	CC		25	Dark gray smooth plastic clay					18.3	1.45	4.68
4	CC		35	Dark gray clay					10.5	16.6	30.2
5	CC		44	Dark gray clay					6.9	4.80	5.6
8	CC		73	Olive gray silty clay, plastic					6.9	6.40	7.5
9	CC		82	Gray plastic clay	8.2	8.17	8.4		5.9	5.11	5.2
10	CC		92	Gray stiff silty clay	7.9	8.03	7.1	.097 .009 2 runs	6.1	5.30	5.6
11	CC		101	Gray stiff clay, micaceous	7.8	7.88	5.4	.204	6.7	8.37	9.7
12	CC		111	Dark gray plastic clay	7.7	7.69	5.0	.063 .095 2 runs	6.9	5.59	6.6
13	CC		120	Gray sandy clayey silt, stiff	7.6	7.84	4.1	.125	7.0	3.75	4.5
14	CC		130	Dark gray clayey silt, stiff	7.8	7.92	5.2	.177	9.1		
15	CC		139	Dark gray clayey sand, compact	8.2	8.14	5.5	.187	9.1		

Chemistry of Water Samples from Hole 6009B (continued)

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
17	CC		158	Very dark gray sandy clay, plastic	7.7	7.61	3.4	.251	11.5	4.93	9.9
19	CC		175	Dark gray sandy clay, stiff	7.8	7.74	4.4		14.4	4.37	10.7
21	CC		195	Dark gray stiff sandy clay	7.9				11.0	4.11	7.8
24	CC		224	Light gray stiff clay					15.4	4.15	11.2
27	CC		252	Dark gray sandy clay	7.6	7.93	8.1	.149	12.0	4.58	9.5
29	CC		271	Dark gray clay, shelly	7.6	8.00	8.6	.194	19.3	2.61	8.8
30	CC		281	Dark gray stiff clay					20.2		
31	2		291	Coarse gray sand and pea gravel					30.3*		
32	1		300	Coarse gray sand and pea gravel					30.7*		

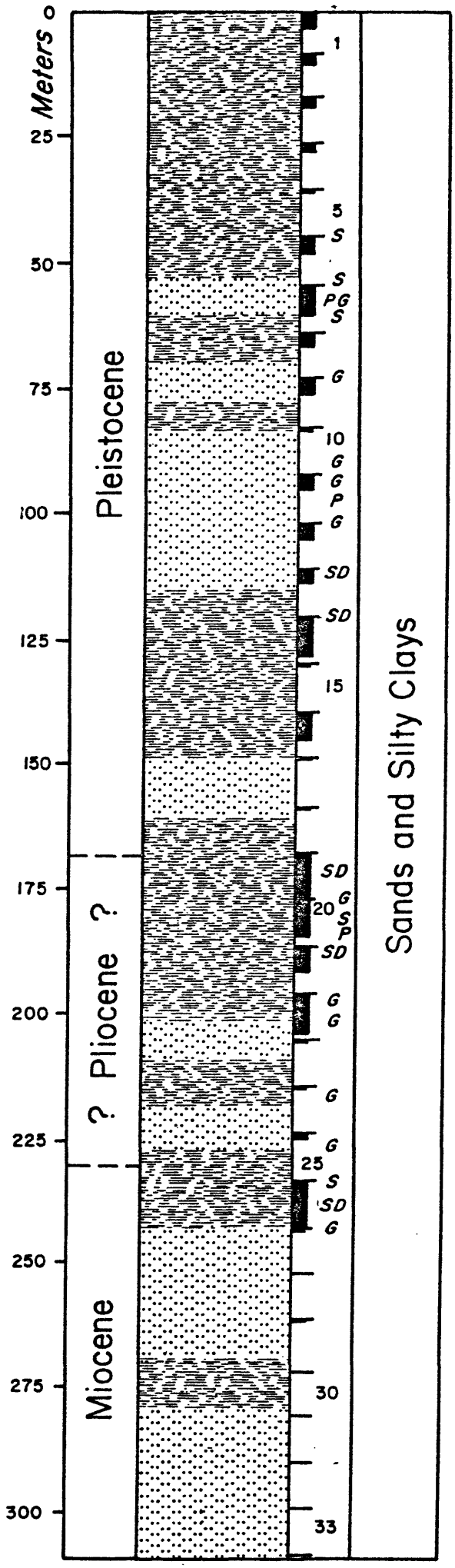
*Water drained out of end of core noticeably clearer than drilling fluid but also mixed with drilling fluid in both 31-2 and 32-1. The lower salinity than local seawater used for drilling fluid indicates a freshwater component of unknown salinity in this sand-gravel aquifer horizon.

6009 surface seawater sample	32.3
Salinity of the drilling fluid just prior to borehole logging	6.0

SITE 6010

Location and purpose.--The location of this site near the outer edge of the continental shelf 60 nautical miles (111 km) off Barnegat Inlet, New Jersey, was selected to provide data on geotechnical properties of sediments in the Baltimore Canyon Trough area, to determine if any freshwater aquifers extend this distance offshore in the continental shelf, to identify reflectors in geophysical profiles through the site, and to determine the stratigraphy of the younger sediments of the area.

Operations.--The drilling vessel arrived on location at 1400 on August 14, 1976. The seismic survey was received and the site tentatively approved at 1510 pending the results of a cross-line seismic profile. At 2115 the site received final approval and drilling began. By 1525 on August 15, thirty-three cores had been retrieved with an overall recovery of 31%. No drilling difficulties were encountered. The hole was displaced with fresh gel mud and logging was begun. All logs (except temperature) were completed at 0300 on August 16, the anchors were pulled and the ship was underway at 1445 to the next site.



HOLE 6010

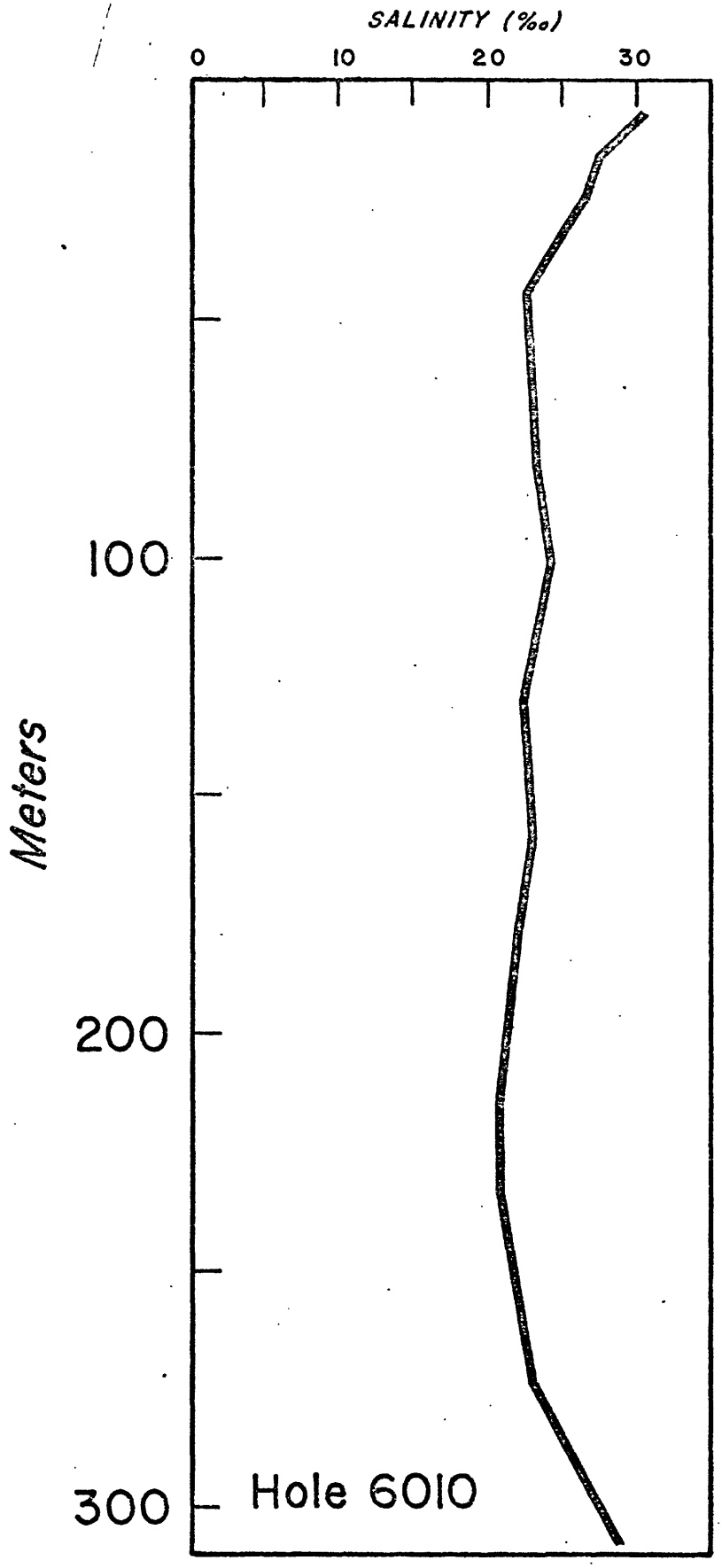
Lithology.--The section consists of 310 meters of Miocene through Pleistocene dark gray silty clays and gray to olive sands, usually fine grained. Glauconite and siderite occur in many of the cores.

Paleontology.--Planktic foraminifers and calcareous nannofossils are scarce. However, benthic foraminifers indicative of a shallow marine environment were found throughout the section. Pleistocene through Miocene sediments were encountered.

Interstitial water.--The salinity values decrease rapidly with depth through the upper 30 meters to values less than 24 o/oo and remain between 20 - 24 o/oo for most of the core length. The minimum in salinity is much less pronounced at this site than at Sites 6009 and 6008 and 6011 which are closer to shore. The site

is located in the more saline parts of the freshwater-saltwater transition as one approaches the shelf edge. (See interpretative diagram, appendix C.)

Light hydrocarbons.--No methane, ethane or propane was detected.


SALINITY (‰)
0
10
20
30
100
200
300
Meters
Hole 6010

DATE: 8/14-15/76

CORE TABLE -- HOLE 6010

WATER DEPTH: 249 ft (75.9 m)

LATITUDE: 39°03.29'N
LONGITUDE: 73°06.8'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
1	281	308	27	27	8.2	3	11.2	3.4	37	Clay, very dark gray, slightly silty, plastic Age: Pleistocene	30.2
2	308	336	28	55	16.8	2	7.8	2.4	26	Clay, very dark gray, plastic Age: Late Pleistocene	27.5
3	336	367	31	86	26.2	2	6.8	2.1	23	Clay, very dark gray, slightly sandy, plastic, fossiliferous Age: Late Pleistocene	26.7
4	367	398	31	117	35.7	2	6.0	1.8	20	Clay, very dark gray, very slightly sandy, very plastic Age: Early Pleistocene	
5	398	429	31	148	45.1	1	3.8	1.2	5	Clay, very dark gray, very slightly sandy, plastic	23.5
6	429	461	32	180	54.9	3	12.1	3.7	40	Clay, very dark gray, very slightly sandy, plastic, slightly fossiliferous	
7	461	492	31	211	64.3	4	20.5	6.2	66	Clay gray, very slightly silty, plastic Age: Pleistocene	
8	492	523	31	242	73.8	2	10.0	3.0	32	Clay, dark gray, sticky, slightly silty Age: Early Pleistocene	
9	523	554	31	273	83.2	3	11.0	3.4	36	Clay, dark gray, sticky, slightly silty Age: Early Pleistocene	23.3

CORE TABLE -- HOLE 6010 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
10	554	585	31	304	92.7	1	3.0	.9	10	Very dark grayish-brown sand, silty clay, shelly, micaceous Age: Early Pleistocene	
11	585	617	32	336	102.4	3	10.8	3.3	34	Very dark grayish-brown silty clay, micaceous, shelly	24.3
12	617	648	31	367	111.9	3	12.0	3.7	39	Olive gray micaceous clayey silt	
13	648	679	31	398	121.3	2	9.5	2.9	31	Olive-gray micaceous silty clayey fine sand	
14	679	710	31	429	130.8	6	25.5	7.8	82	Very dark gray-black fine sand, micaceous silty clay	22.3
15	710	742	32	461	140.5	1	3.0	0.9	9	Very dark gray-black, micaceous silty clay, some fine sand	
16	742	772	30	491	149.7	4	19.0	5.8	63	Very dark gray-black micaceous silty clay	
17	772	804	32	523	159.4	1	.8	.2	3	Very dark gray micaceous silty clay, some fine sand	22.9
18	804	834	30	553	168.6	1	2.0	.6	7	Very, very dark gray-black, some silt, mostly clay	
19	834	864	30	583	177.7	6	30.0	9.1	100	Dark gray, silty, micaceous clay Age: Pleistocene/Pliocene	22.0
20	864	896	32	615	187.5	6	26.3	8.0	82	Dark-gray micaceous silty clay Age: Pleistocene/Pliocene	
21	896	927	31	646	196.9	4	17.4	5.3	58	Dark-gray micaceous silty clay Age: Mid-Pliocene/Late Miocene	

CORE TABLE -- HOLE 6010 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
22	927	958	31	677	206.4	6	28.0	8.5	93	Clay, gray, stiff, glauconitic	
23	958	989	31	708	215.8	1	2.0	0.6	7	Sandy silt, dark blackish-green, glauconite rich.	20.7
24	989	1020	31	739	225.3	CC only	.1	TR	1	Silt, sandy, clayey, glauconitic, dark black-green	
25	1020	1051	31	770	234.7	1	4.5	1.4	15	Clay, gray, waxy, fossiliferous, stiff, slightly silty Age: Mid-Pliocene/Late Miocene	20.8
26	1051	1082	31	801	244.2	6	30.2	9.2	100	Clay gray, stiff, silty, some sand Age: Miocene	
27	1082	1113	31	832	253.6	1	3.3	1.0	11	Sand, dark-olive gray, clayey, glauconitic Age: Miocene	22.0
28	1113	1144	31	863	263.0	CC only	TR	TR	1	Sand, dark olive-gray shelly; sand, clayey, olive gray Age: Miocene	
29	1144	1176	32	895	272.8	CC only	.4	.1	1	Sand, fine, olive gray, clayey. Age: Miocene	23.0
30	1176	1207	31	926	282.3	CC only	TR	TR	1	Clay, olive-gray, slightly silty, plastic Age: Miocene	
31	1207	1238	31	957	291.7	CC only	TR	TR	1	Traces of fine sand on core catcher	

CORE TABLE -- HOLE 6010

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
32	1238	1269	31	988	301.2	CC only	TR	TR	1	Sand, gray, fine grained, unconsolidated, well sorted. Age: Miocene	28.7
33	1269	1300	31	1019	310.6	CC only	TR	TR	1	Traces of fine sand on core catcher	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6010

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		9	Gray sticky plastic clay	7.5	7.39	8.6	.133	30.2		
2	CC		17	Gray sticky plastic clay					27.5		
3	CC		27	Brownish gray sandy clay	8.0	8.00	2.12	.112	26.7	2.00	9.0
5	CC		46	Very dark gray clay, plastic, shells	8.1	7.86	1.49	.174	23.5	1.41	5.9
9	CC		84	Gray sandy clay	8.0	7.89	1.00	.138	23.3	2.05	8.5
11	3	140-150	103	Brownish gray compact clay	8.1	7.79	.580	.164	24.3	1.80	6.5
13	CC		122	Olive gray silty sandy clay	7.9						
14	CC		131	Blackish gray micaceous silty clay					22.3		
15	1	140-150	141	Blackisn gray silty sand	(Saved in core liner, taped, for hydraulic permeability)						
17	CC		160	Blackish gray micaceous, sandy silty clay	7.7	7.61	.352	.150	22.9	3.00	12.1

Chemistry of Water Samples from Hole 6010 (continued)

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
19	6	130-140	178	Blackish gray stiff clay, micaceous	7.4	7.63	.640	.131	22.0	1.81	3.8
23	CC		216	Dark blackish-green glauconitic clay	8.4	8.50	1.02	.198	20.7	2.83	6.9
25	CC		235	Silt, sandy, clayey, glauconite, stiff	7.9				20.8	3.10	11.2
27	CC		254	Greenish-brown glauconitic sand, micaceous	7.8	8.07	1.38	.199	22.0	2.10	8.0
29	CC		273	Greenish-brown glauconitic sand, micaceous	7.7	7.68	1.22	.191	23.0	2.01	8.2
32	CC		302	Sand, gray, unconsolidated, fine grained					28.7		

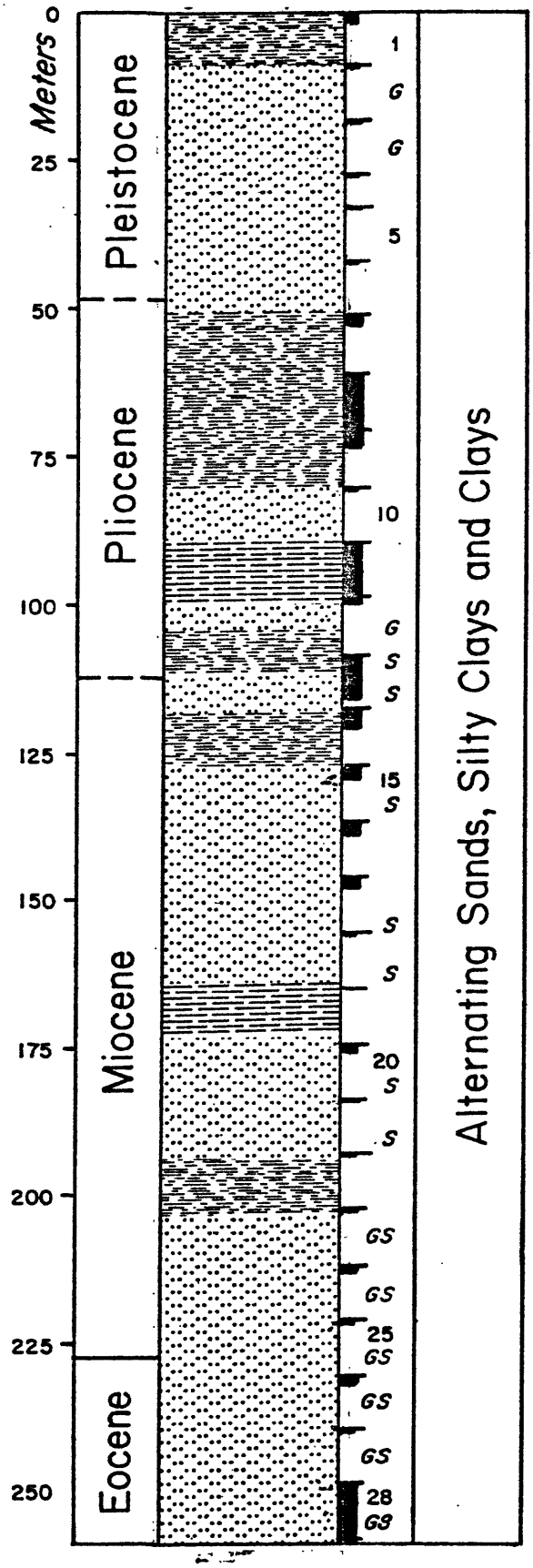
6010 Surface seawater .369 32.3

Salinity of the drilling fluid just prior to borehole logging 23.7

SITE 6011

Location and purpose.--The location of this site in the nearshore part of the continental shelf, 6 nautical miles (11 km) off Barnegat Inlet, New Jersey, was selected to determine if freshwater aquifers known in the coastal plain sediments onshore extend to this distance offshore, and to determine stratigraphy and geotechnical properties in the area.

Operations.--The drilling vessel arrived on location at 2230 on August 16, 1976; a reflection seismic survey was received from the survey vessel M/V L'OLONNOIS, the site was approved and the ship anchored. Drilling began at 0530 on August 17 and by 2325 on that day, 29 cores had been retrieved for a total penetration of 260 meters and a recovery of 23%. Coring was terminated at this point because of caving or sloughing of the hole which caused excessive drag and plugging of the bit. Logging began at 0300 on August 18 and was completed at 1425. All logs including temperature were taken. The anchors were pulled and the ship was underway to the next site at 1930 on August 18, 1976.



HOLE 6011

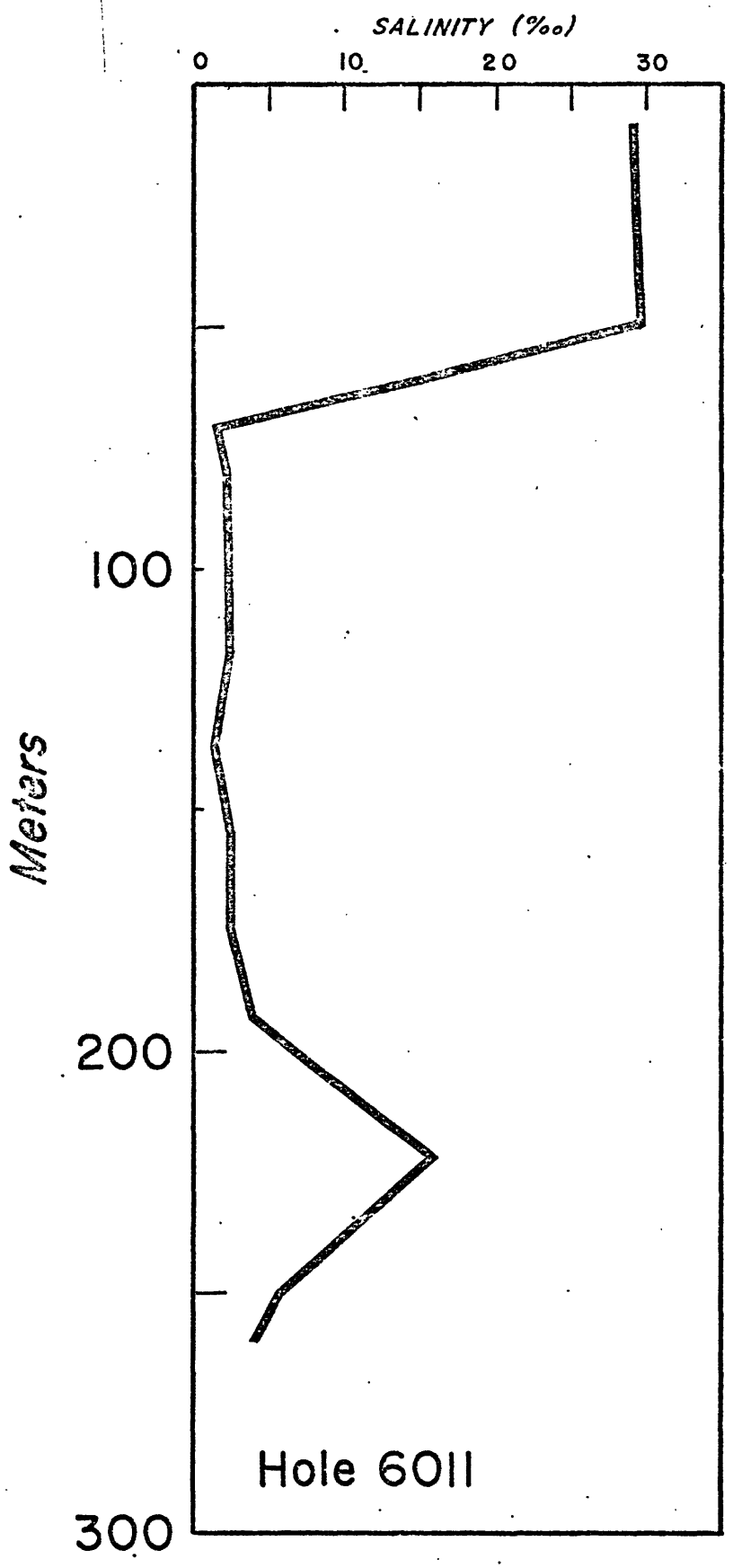
Lithology.--The section consists of 260 meters of alternating shelly sands, silty clays, clays and some gravel of Eocene and Miocene through Pleistocene age. Glauconite is common in the lower part of the section.

Paleontology. Planktic foraminifers and calcareous nannofossils are very sparse in the upper part of this core, although they occur in greater numbers in the Miocene and Eocene sediments found lower in the section. Zones rich in diatoms are found in the Miocene and younger strata. A shallow shelf environment of deposition is inferred.

Interstitial water.--This drill site penetrated approximately 125 meters of relatively fresh water, the greatest thickness encountered in this drilling program. Salinity decreased from 29 o/oo in the first core collected to 1.5 o/oo at 71 meters

and remained in the 2 - 3 o/oo range to 194 meters. Somewhat higher salinity of 15.7 o/oo at 224 meters was underlain by relatively fresher water of 5.5 o/oo in glauconitic sand. Although not conclusive, there were strong indications of flow at this well, possibly from the interval of fine to coarse gravel at 232 - 250 meters. The presence of relatively fresh water suggests that the freshwater-saltwater transition is considerably farther seaward than 6 miles from shore.

Light hydrocarbons.--No methane, ethane, or propane was detected.


SALINITY (‰)
0
10
20
30
100
200
300
Meters
Hole 6011

DATE: 8/17-18/76

CORE TABLE -- HOLE 6011

LATITUDE: 39°43.5'N
LONGITUDE: 73°58.6'W

WATER DEPTH: 73 ft (22.3 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	105	135	30	30	9.1	1	4.5	1.4	15	Olive gray silty clay	28.9
2	135	165	30	60	18.3	1	1.5	.5	5	Medium to coarse sand, fair amount heavy minerals	
3	165	195	30	90	27.4	1	2.0	.6	7	Medium to coarse sand	
4	195	212	17	107	32.6	1	1.0	.3	6	Fine to medium grained quartzose, unconsolidated sand with heavies	
5	212	243	31	138	42.1	1	0.2	.1	1	Cobbles with small amounts silt and clay	
6	243	273	30	168	51.2	1	.8	.2	2	Clayey silt and fine quartzose gravel	29.6
7	273	306	33	201	61.3	1	5.5	1.7	18	Fine to medium sand with clay and silt, well sorted, compacted gray-green	14.7
8	306	337	31	232	70.7	6	30	9.1	100	Clay and silt, fine sand, dark brown, cohesive	1.5
9	337	369	32	264	80.5	2	9	2.7	28	Clayey sand, fine to medium grain, dark green quartz sand, cohesive. Medium grained quartz sand, dark-green, water saturated, well sorted.	2.2

CORE TABLE -- HOLE 6011 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
10	369	400	31	295	89.9	1	1.2	.4	4	Black micaceous siltstone, sparse sand Age: Barren	
11	400	430	30	325	99.1	6	29.8	9.1	99	Clay, sandy, shelly, olive, micaceous quartz pebble	
12	430	461	31	356	108.5	1	3.4	1.0	11	Sand, fine, dark olive-gray, shell, clay lenses, sparse heavy minerals and mica. Age: Early Pliocene (?) - Early Miocene	
13	461	492	31	387	118.0	6	27.5	8.4	89	Silt, olive, micaceous sandy, siderite rhombs (?), sparse shell Age: Earliest Miocene	2.3
14	492	524	32	419	127.7	3	11.6	3.5	36	Silt, sandy, dark-grayish-brown, sparse shell	
15	524	555	31	450	137.2	2	5.3	1.6	17	Silt, sandy, dark-grayish-brown, sparse shell	1.5
16	555	586	31	481	146.6	2	7.0	2.1	23	Core catcher empty. Sand, gray medium grained	
17	586	617	31	512	156.1	2	6.0	1.8	19	Sand, dark gray, fine mica, sparse shell	2.3
18	617	648	31	543	165.5	1	2.8	.9	10	Sand, very coarse, shelly medium gray Sand, medium gray	

CORE TABLE -- HOLE 6011 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
19	648	680	32	575	175.3	CC only	TR	TR	1	Pure clay, gray, compacted, gravel, quartzose, scattered shell fragments	2.5
20	680	711	31	606	184.7	1	3.6	1.1	12	Sand, medium fine grained, gray, shell fragments Age: Early Miocene	
21	711	742	31	637	194.2	1	1.0	0.3	3	Sand, very fine grained, silty, very dark gray, scattered shell fragments Age: Early Miocene	3.9
22	742	773	31	668	203.6	1	1.0	0.3	3	Sand, fine grained, olive gray, silty	
23	773	803	30	698	212.8	1	1.0	0.3	3	Sand, coarse grained, dark gray, abundant heavies, shelly	
24	803	834	31	729	222.2	1	4.0	1.2	13	Fine gravel, gray-green, shell debris/clay, sandy dark-green	15.7
25	834	865	31	760	231.7	1	1.7	.5	5	Fine gravel, shell hash, gray Age: Mid to Late Eocene	
26	865	896	31	791	241.1	2	5.8	1.8	19	Fine gravel, shell hash, gray with clay lumps Age: Early to Mid-Eocene	
27	896	927	31	822	250.5	1	1.6	.5	5	Core catcher empty. Sand, fine grained, black-green, silty, glauconitic Age: Early to Mid-Eocene	5.5
28	927	958	31	853	260.0	6	29.5	9.0	98	Silty, clay, gray-green, micaceous, shelly Age: Early to Mid-Eocene	4.1

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6011

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		10	Gray clay, silty	7.2	7.29	.064 .200	.636	28.9	.99	4.8
6	CC		52	Gray sandy clay, gravel, pebbles	6.9	7.47	.176	.559	29.6	2.19	10.7
7	CC		62	Gray-green sandy clay, compacted	7.8			.014	14.7	13.6	34.9
8	CC		71	Dark brown clay, sandy	7.8	7.70	.080	.120	1.5	69.3	15.4
8	2	135-150	71		(Saved in core liner, taped for hydraulic permeability)						
9	CC		81	Dark green clayey sand	7.8	7.57	.096	.013	2.2	89.5	32.0
13	CC		119	Silt, olive, sandy, siderite rhombs, shells	8.2	7.56	.288	.308	2.3		
15	CC		138	Silt, sandy, dark grayish-brown, sparse sparse shell		7.90	.088		1.5		
15	2	130-140	138		(Saved in core liner, taped for hydraulic permeability)					11.6	2.6
17	CC		157	Dark gray sand	6.9	7.11	0.96	.280	2.3	17.8	6.8

Chemistry of Water Samples from Hole 6011 (continued)

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
19	CC		176	Gray clay, compact, gravel	7.3	7.70	.088 .048	.352	2.5	31.3	13.0
21	CC		195	Gray sand, shell fragments	8.2	7.61	.128	.333	3.9	21.2	14.6
24	CC		223	Fine gravel, gray-green clay				1.23 1.29	15.7		
27	CC		251	Black-green glauconitic sand	8.7	8.33	.112	.214	5.5	6.9	6.6
28	CC		261	Gray-green silty clay, shelly, extremely dense					4.1	4.6	2.9

Drilling fluid used during drilling 17.3

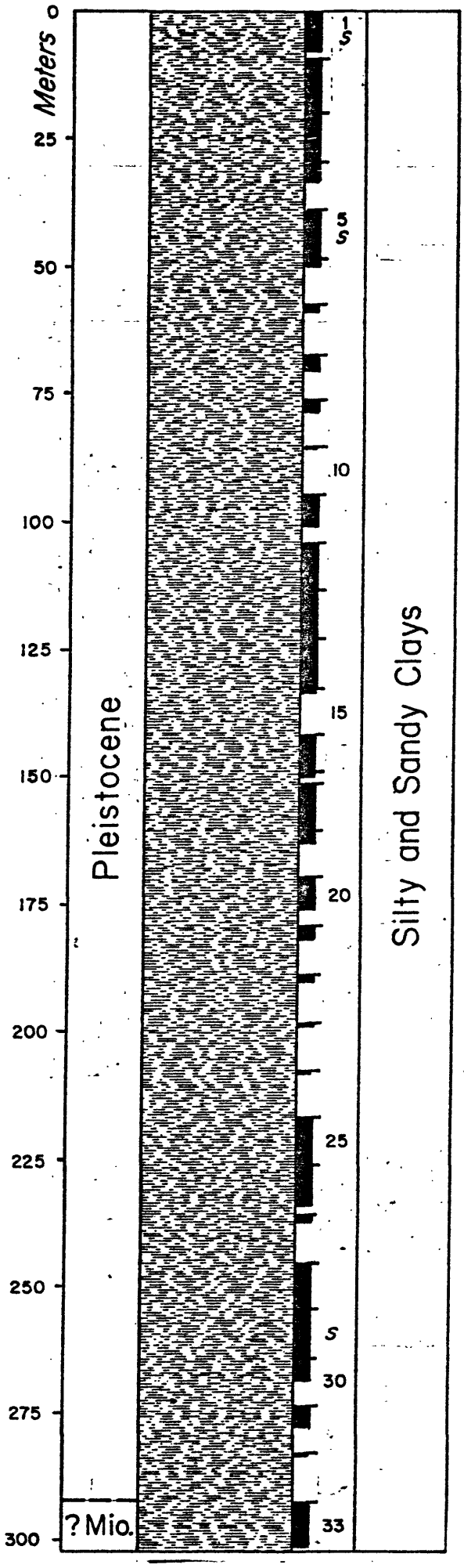
Drilling fluid just prior to borehole logging 3.7

SITE 6012

Location and purpose.--The location of this site on the continental slope near the axis of Block Canyon, 67 nautical miles (124 km) south of Montauk Point, Long Island, was selected to determine geotechnical properties of sediments in the environment of a submarine canyone on the continental slope, and to determine the stratigraphy at the shelf edge northeast of the Baltimore Canyon Trough area as a tie to the stratigraphy of the northern part of the continental shelf. A further purpose was to identify reflectors in geophysical profiles of the area, and to explore the possibility that freshwater aquifers extend to the shelf edge.

Operations.--The drilling vessel arrived at a point 6 miles west of the site at 1503 on August 19, 1976, to await moderating of the sea conditions, which at that time consisted of 5 to 8 foot swells and winds of 25 - 30 knots. The M/V L'OLONNOIS was also unable to make a site survey. At 0800 on August 20, the ship moved to the intended site; anchoring was completed and the site approved at 1800. Coring began at 2030 and by 2140 the next day, August 21, thirty-three cores with an overall recovery of 56% and a total penetration of 303.9 meters had been retrieved. The hole was prepared for logging by a "wiper" trip in which the string was lowered to the bottom of the hole to clear any obstructions, then raised to the level where logging could begin. At 0100 on August 22, the ES logging tool stuck at 47 meters. It was necessary to strip out the logging cable during retrieval of the drill string. Fourteen of the joints recovered were bent. Apparently during the cutting of cores 10 through 23, the bit repeatedly struck the bottom of

the hole owing to excessive heave of the ship in high swells. The 5-foot throw of the single bumper sub in the string (delivery had not yet been made on a replacement second bumper sub, ordered following previous loss of equipment down hole) was not sufficient to absorb the heave. The compressive stress on the long drill string bent the pipe. No further logging of Hole 6012 was possible after the bottom hole assembly was pulled from the hole. The anchors were pulled and the ship was underway at 1530 on August 22, 1976.



HOLE 6012

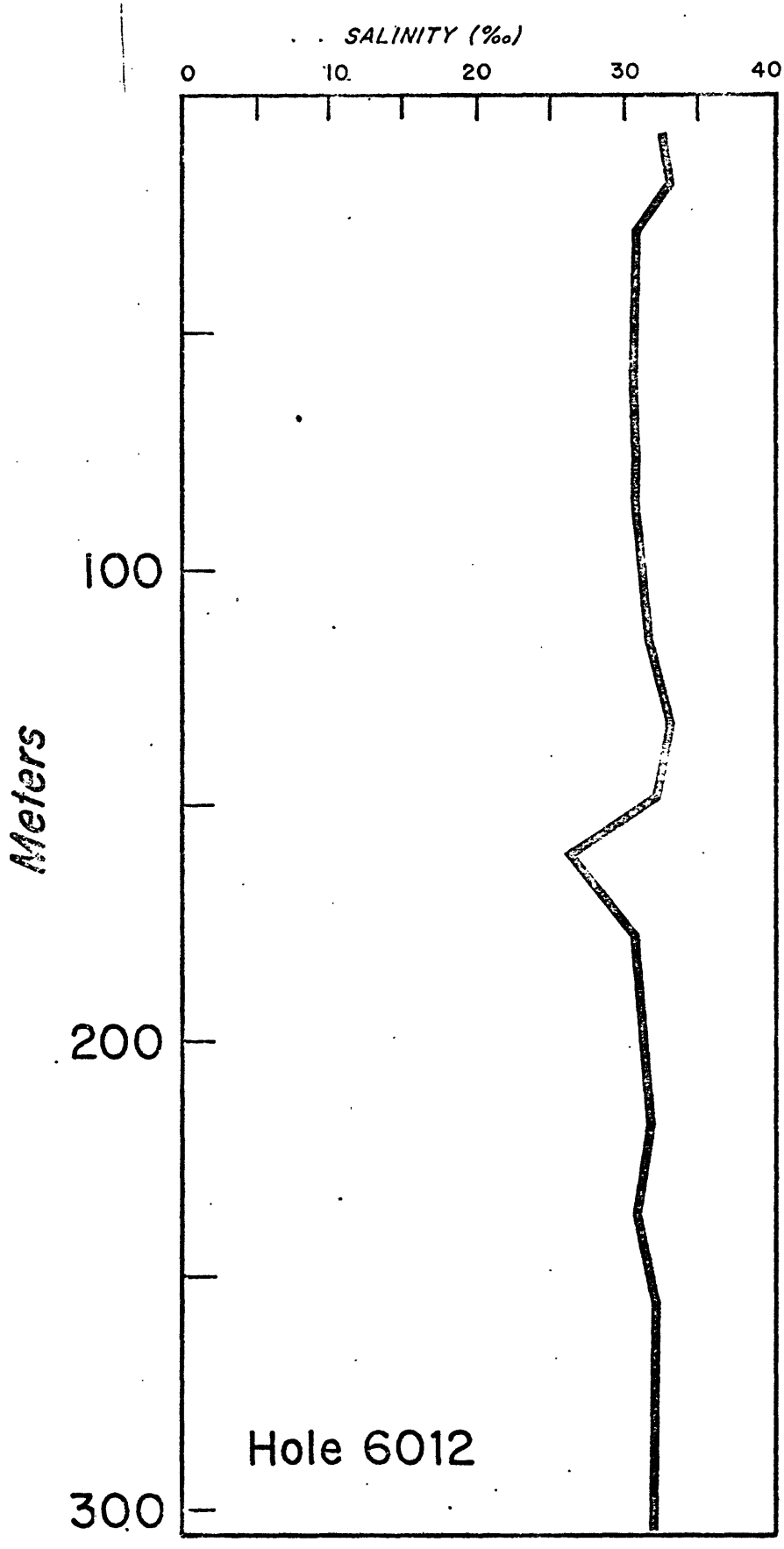
Lithology.--The section consists of 304 meters of silty and sandy gray to dark gray Pleistocene clays, gassy below 90 meters.

Paleontology. Planktic foraminifers and diatom-rich intervals are present, and calcareous nannofossils occur but are not abundant. There is some indication that the lowest part of the core may be of Miocene age. The environment of deposition is inferred to be middle to outer shelf.

Interstitial water. The salinity profile at this location is generally uniform in the 30 - 33 o/oo range which is typical of sites seaward of the shelf edge.

Light hydrocarbons. In core Hole 6012, three zones of methane were identified in which the concentration ranged from 4-253 x 10^3 ppm. These methane zones were at

core depths of 120 meters to 160 meters, 161 meters to 180 meters, and 200 meters to 300 meters. The sediments were gray to dark gray silty waxey Pleistocene clays. Ethane concentrations varied from 210 ppm to 10.5×10^3 ppm; and propane up to 1000 ppm.


SALINITY (‰)
0
10
20
30
40
100
200
300
Meters
Hole 6012

DATE: 8/20-22/76

CORE TABLE -- HOLE 6012

LATITUDE: 39°59.57'N
LONGITUDE: 71°20.09'W

WATER DEPTH: 862 ft (262.7 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	894	924	30	30	9.1	5	24.5	7.3	82	Clay, gray, plastic, slightly silty, sticky Age: Late Pleistocene	32.7
2	924	960	36	66	20.1	6	30.5	9.3	85	Clay, sticky, gray, slightly silty Age: Late Pleistocene	32.9
3	960	991	31	97	29.6	6	30.5	9.3	100	Clay, sticky, gray, slightly silty Age: Late Pleistocene	
4	991	1022	31	128	39.0	3	13.6	4.1	45	Clay, very dark gray, plastic slightly silty Age: Late Pleistocene	30.8
5	1022	1052	30	158	48.2	6	30	9.1	100	Clay, very dark gray, slightly silty, sticky Age: Late Pleistocene	
6	1052	1083	31	189	57.6	1	4.7	1.4	16	Clay, very dark gray, slightly silty, plastic Age: Late Pleistocene	30.8
7	1083	1115	32	221	67.4	1	4	1.2	13	Clay, dark gray, slightly silty Age: Late Pleistocene	
8	1115	1145	30	251	76.5	3	12	3.7	40	Clay, dark gray, slightly silty, plastic Age: Late Pleistocene	31.7
9	1145	1175	30	281	85.7	2	9	2.7	30	Clay, gray, slightly silty plastic Age: Late Pleistocene	

CORE TABLE -- HOLE 6012 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
10	1175	1205	30	311	94.8	1	2.5	.8	8	Clay, gray, plastic Age: Late Pleistocene	30.5
11	1205	1237	31	343	104.5	5	22	6.7	69	Clay, gray, slightly silty, plastic Age: Pleistocene (?)	
12	1237	1268	31	374	113.9	6	30.5	9.3	100	Clay, gray, slightly silty, plastic Age: Late Pleistocene	31.4
13	1268	1299	31	405	123.4	6	30.5	9.3	100	Silty clay, gray	
14	1299	1330	31	436	132.9	6	30.5	9.3	100	Silty clay, gray, gaseous Age: Pleistocene (?)	33.0
15	1330	1361	31	467	142.3	1	3	1	10	Clay, very dark gray, plastic slightly silty Age: Pleistocene (?)	
16	1361	1384	23	490	149.4	5	23	7.0	100	Clay, dark gray, gaseous Age: Pleistocene	31.9
17	1384	1392	8	498	151.7	1	2.5	.8	31	Clay, dark gray with silt, plastic	
18	1392	1423	31	529	161.2	6	30.5	9.3	100	Brown-gray clay, silt, some fine sand Age: Barren	26.0
19	1423	1454	31	560	170.7	2	8.5	2.6	28	Clay, dark brown, slightly silty, plastic, carbonaceous Age: Pleistocene (?)	
20	1454	1485	31	591	180.1	8	20	6.1	67	No core liner used. Reddish brown sandy clay, stiff	

CORE TABLE -- HOLE 6012 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
21	1485	1516	31	622	189.6	2	8.5	2.6	28	Clay, sandy, silty, very dark gray, stiff, micaceous	
22	1516	1548	32	654	199.3	1	5.5	1.7	18	Clay, very dark gray, stiff, micaceous	
23	1548	1579	31	685	208.7	1	1	.3	3	Clay, very dark gray, stiff sandy laminations, silty	
24	1579	1611	32	717	218.5	1	2.9	.9	10	Clay, very dark gray, plastic slightly silty Age: Barren	31.5
25	1611	1641	30	747	227.7	6	30	9.1	100	Clay, dark gray, stiff, slightly silty, gaseous Age: Pleistocene	
26	1641	1672	31	778	237.1	6	25.5	7.8	85	Clay, dark gray, plastic slightly silty Age: Pleistocene	30.8
27	1672	1704	32	810	246.9	1	4.2	1.3	14	Clay, dark gray, plastic Age: Pleistocene	
28	1704	1735	31	841	256.3	6	30.5	9.3	100	Clay, waxy, very dark gray, slightly silty, plastic Age: Pleistocene (?)	31.8
29	1735	1766	31	872	265.8	6	30.5	9.3	100	Clay, waxy, dark gray, slightly silty, plastic Age: Pleistocene	

CORE TABLE -- HOLE 6012 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
30	1766	1797	31	903	275.2	4	15.6	4.8	52	Clay, sandy, plastic, dark gray Age: Pleistocene	
31	1797	1829	32	935	285	3	14.8	4.5	49	Clay, dark olive gray, slightly sandy, plastic Age: Pleistocene	31.7
32	1829	1860	31	966	294.4	1	2.8	1.3	9	Clay, sandy, dark gray, sticky Age: Pleistocene (?)	
33	1860	1891	31	997	303.9	6	28.2	8.6	94	Clay, dark olive gray, plastic, slightly silty Age: Probably Miocene	32.1

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples for Hole 6012

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S $^{o}/oo$	Rs Ω-m	F
1	CC		10	Sticky, gray clay	7.5	7.15	.640	.218	32.7	.974	5.13
2	CC		21	Sticky, gray clay	7.4	7.57	.664	.143	32.9	.928	4.88
4	CC		39	Sticky, gray clay	7.8	7.49	.624	.223	30.8	1.26	6.36
6	CC		58	Sticky, gray clay	7.9	7.72	.504	.409	30.8	1.17	5.91
8	CC		77	Stiff, gray clay	7.7	7.67	.424	.340	31.7	1.31	6.72
10	CC		95	Stiff, gray clay	7.8	7.69	.352	.295	30.5	1.10	5.5
12	CC		114	Stiff, gray clay	7.7	7.66	.20	.438	31.4	1.23	6.31
14	CC		133	Stiff, gray clay	7.7	7.57	.392	.05	33.0	1.16	6.14
16	5	130-140	149	Stiff, gray clay	7.7	7.51	.48	.370	31.9	2.08	10.67
18	CC		162	Brownish gray, sandy clay	7.8	7.56	.272	.450	26.0	1.19	5.29
20	CC		181		7.8	7.77	.208	.320	30.8	1.80	9.09
24	1	146-150	219	Dark gray, sticky clay	7.5	7.56	1.00	.350	31.5	1.74	8.92
26	CC		238	Dark gray, sticky clay	7.8	7.51	1.12	.340	30.8	1.32	6.67
28	CC		257	Gray, greenish, sticky clay	7.5	7.70	.96	.350	31.8	1.94	9.95

Chemistry of Water Samples from Hole 6012 (continued)

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
31	CC		285	Gray, sticky clay with some sand and pebbles to ¼" broken fragments of rounded white quartz pebbles	7.6	7.43	.84	.340	31.7	1.20	6.15
33	CC		304	Green, sticky clay with brown silty streaks	7.8	7.78	1.68	.310	32.1	1.84	9.53

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6012

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6012-1-5 140-150 cm max pene 30' 9.1m	sticky gray clay sonicated	ND	ND	ND
6012-4-3 140-150 cm max pene 128' 39m	clay, very dark plastic slightly silty sonicated	ND	ND	ND
6012-7-1 140-150 cm max pene 225' 68.6m	dark gray silty clay sonicated	ND	ND	ND
6012-10-1 140-150 cm max pene 311' 94.8m	dark gray slightly silty plastic sonicated	ND	ND	ND
6012-12-5 140-150 cm max pene 374' 114.0m	silty clay, gray core liner gas space	(253,575)	(2,310)	(197)
6012-13-1 140-150 cm max pene 405' 115.9m	silty gray clay core liner gas space	(124,614)	(441)	(98.5)
6012-13-6 140-150 cm 123.4m	silty gray clay sonicated	(42,090)	(7,590)	(46)
6012-16-4 max pene 490' 147.9m	dark gray clay core liner gas space	(250,194)	(2,709)	(965)
6012-16-5 max pene 490' 149.4m	dark gray clay core liner gas space	(21,735)	(756)	ND
6012-16-5 140-150 cm max pene 490' 149.4m	dark gray clay sonicated	(32,430)	(613)	(41)
6012-17-1 140-150 cm max pene 498' G.C. Run 1 151.7m	clay, dark gray with silt core liner gas pocket	(33,810)	(2,185)	(0)

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6012 (CONTINUED)

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING		CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6012-17-1 140-150 cm max pene 498' G. C. Run 2 151.7m	clay, dark gray with silt core liner gas pocket		(4140)	(210)	(0)
6012-17-1 140-150 cm max pene 498' G. C. Run 3 151.7m	clay, dark gray with silt 20 min sonicated		(10,350)	(588)	(0)
6012-18-6 140-150 cm max pene 529' 161.2m	brown-gray clay silt, some sand 10 min sonicated		(6325)	(361)	(0)
6012-18-6 140-150 cm 161.2m	brown-gray clay, silt 19 min sonicated		(9545)	(840)	(0)
6012-18-6 140-150 cm 161.2m	brown, gray, clay, silt 39 min sonicated		(4761)	(420)	(0)
6012-19-2 140-150 cm max pene 560' 170.7m	dark brown clay, slightly silty, plastic 10 min sonicated		(4761)	(420)	(0)
6012-19-2 140-150 cm 170.7m	dark brown clay, slightly silty, plastic 19 min sonicated		(5750)	(525)	(0)
6012-21-2 max pene 622' 189.6m	core liner gas space clay, sandy, silty, stiff, micaceous	Run 1	(236,670)	(10,500)	(394)
6012-21-2 189.6m	clay, sandy, silty, stiff, micaceous core liner gas space	Run 2	(38,595)	(2,100)	(217)
6012-25-3 max pene 747' 227.7m	core liner gas space clay, dark gray, stiff, slightly silty, gaseous		(253,575)	(2,100)	(946)

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6012 (CONTINUED)

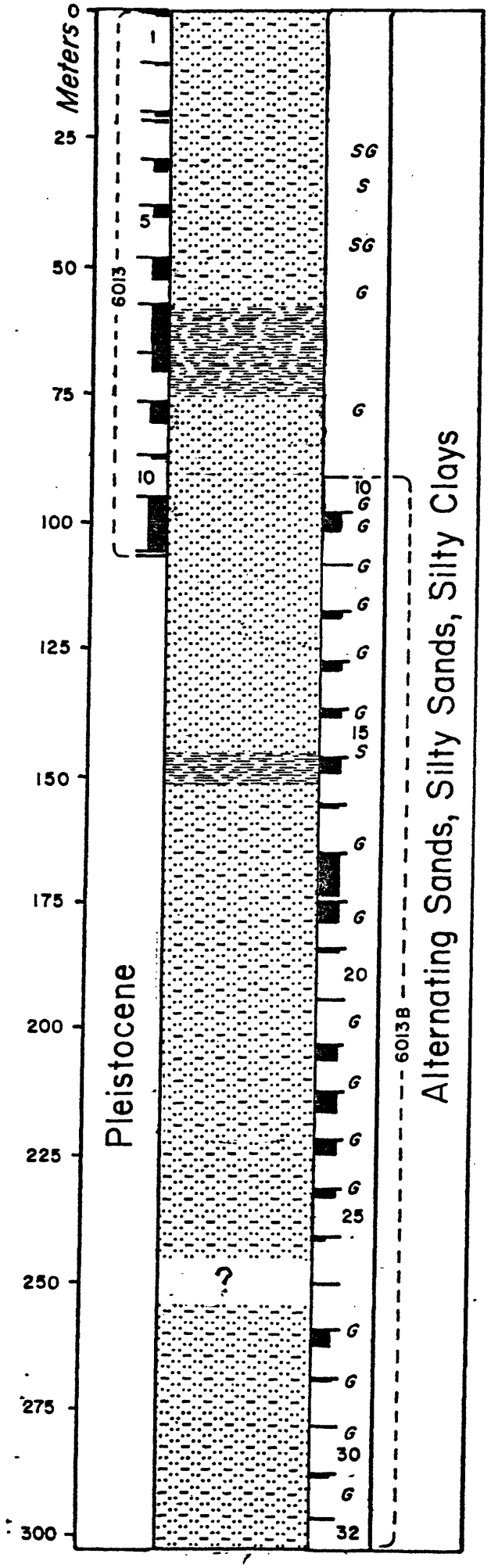
SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6012-25-6 227.7m	core liner gas space clay, dark gray, stiff, slightly silty, gaseous	(233,289)	(2,310)	(197)
6012-25-6 227.7m	core liner gas space stiff dark gray clay, slightly silty	(217,350)	(2,205)	(117)
6012-26-6 max pene 778' 237.1m	core liner gas space clay, dark gray, slightly silty, plastic	(171,465)	(2,310)	(138)
6012-28-2 max pene 795.2' 242.4m	core liner gas space clay, wavey, very dark, slightly plastic	(4,830)	(ND)	(ND)
6012-28-6 max pene 811' 246.9m	core liner gas space clay, wavey, very dark, slightly plastic	(250,194)	(5,250)	(965)
6012-30-4 max pene 903' 275.2m	core liner gas space clay, sandy, plastic, dark gray	(5,796)	ND	ND

SITE 6013

Location and purpose.--The location of this site near Hydrographer Canyon, 85 nautical miles (157 km) southeast of Nantucket was selected to provide data on the geotechnical properties of continental slope sediments in the northeast region, to determine the stratigraphy in this area, and to identify reflectors in geophysical profiles through the site.

Operations.--The drilling vessel arrived on location at 0600 on August 23, 1976. The site was approved and coring began at 1430. By 2205, ten cores had been retrieved. Core 11 had been cut at 2230 when the No. 3 anchor brake failed and the ship moved off station. Core 11 was retrieved at 0105 on August 24 and the drill string was pulled. With Core 11, the total penetration was 104.5 meters for an overall recovery of 31%. By 0200, August 24, the anchor winch was repaired, the ship repositioned and Hole 6013B was spudded-in. The interval from the mudline to 90.2 meters was drilled without coring. Since this approximated the interval of Cores 1 through 9 of Hole 6013, the first cores retrieved from Hole 6013B were labeled Core 10 et seq., unlike the system used at other multiple-hole sites of this project.

By 2035, twenty-three cores had been retrieved from Hole 6013B for a total penetration of 304.8 meters with an overall recovery of 18%. A wiper trip was made with the drill string, mud was spotted and logging began at 0040 on August 25. A full set of logs was completed at 0940. The hole was then plugged with cement and gel. Pulling of the anchors had to await the return of the M/V L'OLONNOIS and the repair of "kicker plate" on the No. 3 anchor winch. By 2210, August 25, all anchors were home and the ship was underway to the next site.



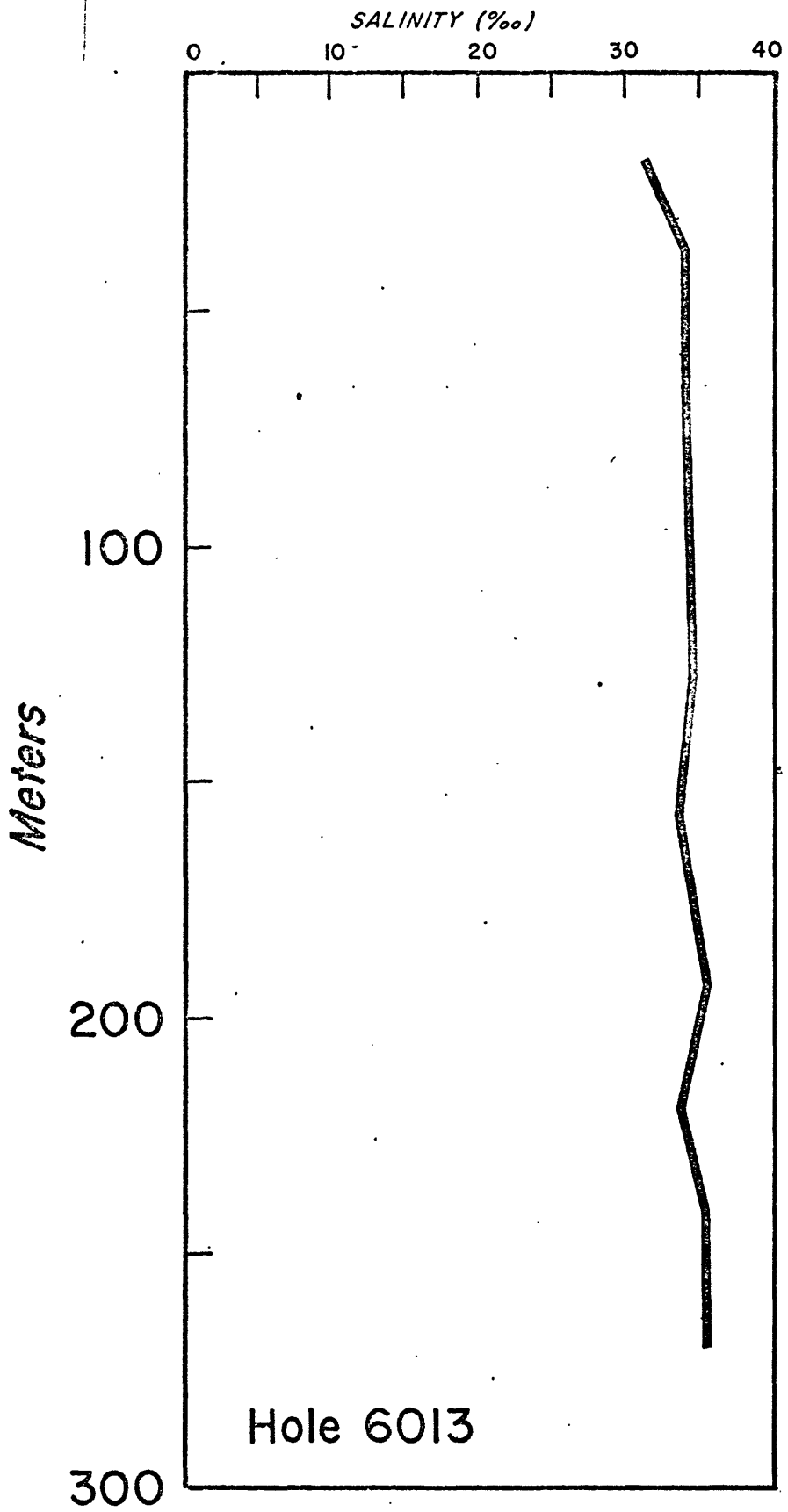
HOLES 6013 AND 6013B

Lithology.--The section consists of 305 meters of gray or dark gray (olive gray in the lower part) Pleistocene sands, silty sands, and silty clays in which glauconite was common. A few layers of sandstone occur near the bottom of the section.

Paleontology.--Planktic and benthic foraminifers occur throughout the section, although planktics are usually rare. Calcareous nannofossils are present, but not in abundance. Diatom-rich intervals were also encountered. A middle to outer shelf environment of deposition is inferred.

Interstitial water.--Typical of drilling sites seaward of the continental shelf edge, the salinity profile with depth remained uniform in the range of 31 - 35 o/oo. Alkalinity values were observed to increase with depth to values of about 80 meq/l in the lower 100 meters.

Light hydrocarbons.--The methane in this core hole occurred in two major zones, the first from 60 to 90 meters, and the second from 190 to 290 meters. The methane concentration in these Pleistocene sands and silty sandy clays ranged from a maximum of 282×10^3 ppm to 221×10^3 ppm in the 60 to 90 meter zone, and from 315×10^3 ppm to 339×10^3 ppm in the lower interval of 190 to 290 meters. Ethane concentrations ranged from 2.9×10^3 ppm to 8.6×10^3 ppm in the upper zone. In the lower zone, the ethane ranged from 1.0×10^3 ppm to 4.3×10^3 ppm, and propane up to 620 ppm.


SALINITY (‰)
0
10
20
30
40
100
200
300
Meters
Hole 6013

DATE: 8/23-24-25/76

CORE TABLE -- HOLE 6013

LATITUDE: 40°05.04'N
LONGITUDE: 68°52.13'W

WATER DEPTH: 799 ft (243.5 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	831	861	30	30	9.1	CC only	0.2	0.1	1	Siltstone, dark gray, moderately indurated, sandy quartzose Age: Late Pleistocene	
2	861	894	33	63	19.2	1	0.8	0.3	3	Massive dark gray, silty sandstone, moderately indurated, micaceous Age: Barren	31.3
3	894	924	30	93	28.3	1	0.8	0.3	3	Alternating dark gray, very fine grain sandstone, moderate to well indurated, and sandy silt. Age: Late Pleistocene (?)	
4	924	956	32	125	38.1	2	8.2	2.5	27	Dark clay, gray, sandy, micaceous scattered shell fragments, plastic Age: Pleistocene	33.9
5	956	987	31	156	47.6	2	5.9	1.8	20	Sandy silt, dark gray, punky, micaceous Age: Early Pleistocene	
6	987	1018	31	187	57.0	3	14.4	4.4	48	Sand, very fine, gray, silty, micaceous, quartzose, gaseous Age: Early Pleistocene	
7	1018	1050	32	219	66.8	6	30	9.1	100	Silt, sandy, very dark gray, punky, gaseous Age: Barren	34.0
8	1050	1080	30	249	75.9	2	9.9	3.0	33	Well sorted and round quartzose sand, micaceous, glauconitic, olive gray, loosely compacted	

CORE TABLE -- HOLE 6013 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
9	1080	1111	31	280	85.4	2	10.2	3.6	31	Silt, fine sand, rock fragments of basalt and granite, clayey, dark gray, shell fragments	
10	1111	1143	32	312	95.1	0	0	0	0	No recovery	
11	1143	1173	30	342	104.2	6	27	8.2	90	Medium-coarse sand with shell hash Age: Pleistocene	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 8/24-25/76

CORE TABLE -- HOLE 6013B

LATITUDE: 40°05.04'N
LONGITUDE: 68°52.13'W

WATER DEPTH: 783 ft (238.7 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
D.I. (1-9)	815	1111	296	296	90.2					Drilled Interval	
10	1111	1143	32	328	100	CC only	TR	TR	1	Split core liner, dark gray sand and sandstone, quartzose, well indurated	
11	1143	1173	30	358	109.1	2	10.5	3.2	35	Sand, very fine grained, silty, unconsolidated, dark gray, micaceous, quartzose Age: Pleistocene	
12	1173	1204	31	389	118.6	CC only	TR	TR	1	Fine, grained, sand, quartzose, glauconitic?, unconsolidated, sandstone fragments Age: Pleistocene	
13	1204	1236	32	421	128.3	1	3	1	10	Sand, silty, dark gray, quartzose, fine grained, glauconitic Age: Pleistocene	34.5
14	1236	1268	32	453	138.1	1	5	1.5	17	Sand, silty clay, micaceous, fine grained, quartzose, plastic Age: Early Pleistocene	
15	1268	1299	31	484	147.5	1	3.5	1.1	12	Sand, very fine grained, silty, quartzose, dark gray Age: Early Pleistocene	
16	1299	1330	31	515	157	3	11.5	3.5	37	Silt, dark gray, sandy, micaceous, punky Age: Early Pleistocene	33.8
17	1330	1362	32	547	166.7	1	1.9	.6	6	Clay, silty, plastic, dark gray, micaceous Age: Early Pleistocene	

CORE TABLE -- HOLE 6013B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
18	1362	1393	31	578	176.2	5	25	7.6	83	Sand, silty, dark olive gray, quartzose, micaceous, glauconitic, well sorted with sub rounded grains Age: Early Pleistocene	
19	1393	1423	30	608	185.3	3	12.5	3.8	42	Sand, fine grained, dark gray, plastic, quartzose Age: Early Pleistocene	
20	1423	1455	32	640	195.1	1	1.3	.5	4	Silt, sandy, dark greenish gray, plastic, micaceous Age: Early Pleistocene	35.6
21	1455	1486	31	671	204.5	CC only.	TR	TR	1	Collapsed liner. Silt, dark greenish gray, sandy, micaceous, plastic Age: Early Pleistocene	
22	1486	1517	31	702	214	3	10.7	3.3	36	Sand, very fine grained, silty, clay, plastic Age: Early Pleistocene	33.5
23	1517	1548	31	733	223.4	3	14.1	4.3	47	Sand, very fine grained, plastic dark olive gray, silty Age: Early Pleistocene	
24	1548	1579	31	764	232.9	2	10.1	3.1	34	Sand, very fine grained, dark olive gray, punky, micaceous, silty, gaseous Age: Early Pleistocene	
25	1579	1610	31	795	242.3	1	4.7	1.4	16	Sand, very fine grained, dark olive gray, punky, silty micaceous, quartzose Age: Early Pleistocene	35.3

CORE TABLE -- HOLE 6013B (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
26	1610	1641	31	826	251.8	1	1.1	.3	4	Sand, dark olive gray, punky, micaceous, very fine grained, silty Age: Early Pleistocene	
27	1641	1673	32	858	261.5	0	0	0	0	No recovery	
28	1673	1704	31	889	271	2	9.6	2.9	30	Sand, very fine grained, dark olive gray, quartzose, silty, punky, micaceous Age: Early Pleistocene	
29	1704	1735	31	920	280.4	1	2	.6	7	Sand, very fine grained, dark olive gray, silty, micaceous, quartzose Age: Early Pleistocene	
30	1735	1767	32	952	290.2	1	.7	.2	2	Sand, very fine grained, dark gray, silty, plastic, quartzose, micaceous Age: Early Pleistocene	
31	1767	1794	27	979	296.4	1	1	.3	3	Sand and sandstone, dark olive gray, fine grained, micaceous, quartzose, well indurated, slightly calcareous cement Age: Early Pleistocene	
32	1794	1815	21	1000	304.8	CC only	.7	.2	2	Sandstone, very fine grained, well indurated, quartzose, dark gray, finely calcareous cement	

[1] RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6013

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		10	Hard clayey sand, gray-green	7.6			no fluid			
2	CC		20		7.0	7.56	1.44	.342	31.3	2.94	15.0
4	CC		38	Dark gray, silty clay with ¼" fine sand layers-micaceous	6.9	7.20	9.0	.200	33.9	1.21	6.54
7	CC		67	Gray-green, silty clay, gaseous	7.0		25.0	.202	34.0	2.47	13.4

Chemistry of Water Samples for Hole 6013B

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
13	CC		129	Gray loose fine sand with shell debris	6.9	7.59	38.24	.144	34.5	2.98	16.4
16	CC		157		7.3		55.84	.127	33.8	2.80	15.1
20	CC		195		7.0		75.2	.100	35.6	2.99	16.8
22	CC		214		7.1		81.6	.147	33.5	1.54	8.32
25	CC		243		7.0		83.2	.193	35.3	1.56	8.72
28	1	145-150	270	Dark gray, loose fine sand with shell debris	6.9		75.2	.212	35.4	1.51	8.44

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLES 6013 AND 6013B

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_3H_6	C_3H_8
6013-4-2 max pene 125' 38.1m	dark gray sandy clay plastic, shell fragments sonicated	ND	ND	ND
6013-6-2 max pene 187' 57.0m	sandy, very fine grain, silty micaceous, quartzose core liner gas space	(274,890)	(7,560)	(686)
6013-7-4 max pene 219' 66.7m	silty sandy, very dark gray core liner gas space	(221,340)	(8568)	(549)
6013-8-2 max pene 249' 75.9m	micaceous, sand, olive gray loose core liner gas space	(282,030)	(2932)	(680)
6013B-13-1 max pene 387' 118.0m	dark gray silty sand, quartzose sonicated	(ND)	(ND)	(ND)
6013B-18-5 max pene 578' 176.2m	dark olive gray silty sand, quartzose, micaceous, glauconitic core liner gas space	(325,017)	(4360)	(414)
6013B-19-3 max pene 608' 185.3m	fine grain sand, dark gray, plastic, quartzose core liner gas space	(339,570)	(3270)	(621)
6013B-22-3 max pene 702' 214.0m	very fine grain silty and clayey sand, plastic core liner gas space	(315,300)	(2834)	(580)
6013B-23-3 max pene 733' 223.4m	very fine grain, olive gray, plastic core liner gas space	(315,300)	(2800)	(494)
6013B-24-2 max pene 764' 232.9m	very fine grain silty sand, plastic core liner gas space	(325,017)	(1068)	(579)

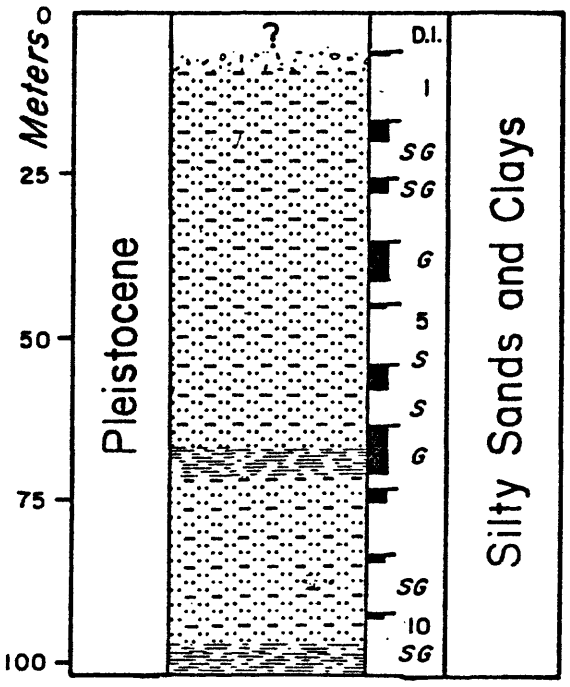
GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLES 6013 AND 6013B (CONTINUED)

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_3H_6	C_3H_8
6013B-25-1 max pene 795' 242.3m	very fine grain, dark olive gray, sand, micaceous core liner gas space	(325,000)	(2289)	(568)
6013B-28-2 max pene 889' 271.0m	very fine grain, dark olive gray silty sand, quartzose, micaceous core liner gas space	(320,166)	(1744)	(518)

SITE 6014

Location and purpose.--The location of this site on Georges Bank 108 nautical miles (200 km) southeast of Chatham, Cape Cod, Massachusetts was selected to determine geotechnical properties of the central shelf area of Georges Bank, to investigate the possibility of the existence of relict Pleistocene freshwater under Georges Bank, and to identify reflectors in high and medium resolution geophysical records through the site and determine the stratigraphy in the area.

Operations.--The drilling vessel arrived near the location at 0700 August 26, 1976. The M/V L'Olonnois completed the site survey at 0830 and the site was approved for drilling. Anchoring was completed at 1630, the hole was spudded-in and the first core retrieved at 1740. Drilling was slow and caving prevalent in the sandy sediments. The bit plugged and the core barrel stuck at 0530 on July 27 and had to be retrieved by pulling the drill string out of the hole. Core 10 was recovered at 0850. The total penetration was 102.4 meters and the overall recovery 27%. Because of the very difficult drilling conditions and serious risk to the downhole equipment no further drilling was attempted and the site was abandoned. The anchors were pulled by the drilling vessel without waiting for return of the anchor handling vessel M/V L'Olonnois and at 1500 August 27, 1976 the ship was underway to the next site.



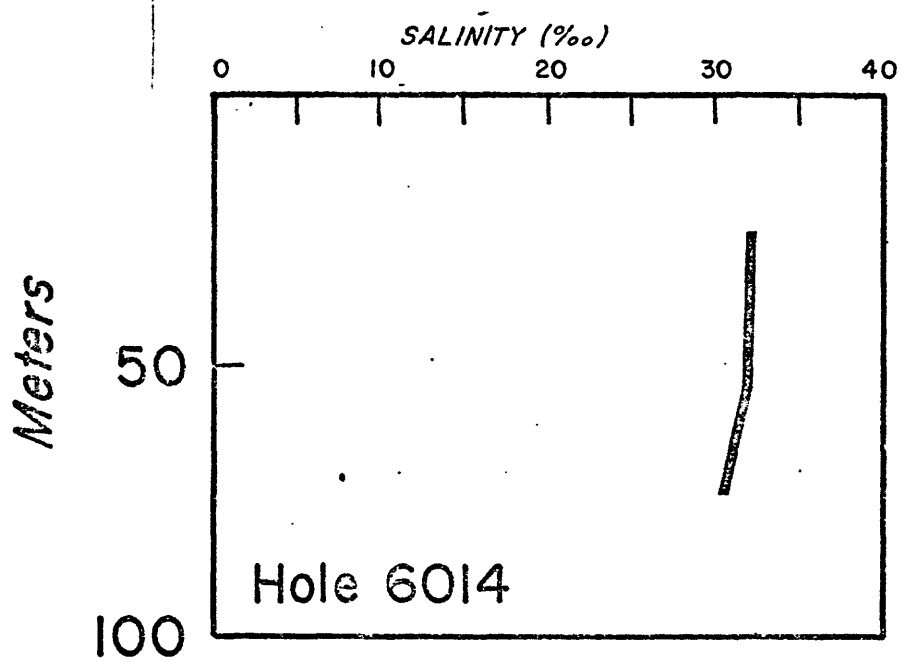
HOLE 6014

Lithology.--The section consists of 102 meters of shelly, glauconitic olive or gray silty sands and clays of Pleistocene age.

Paleontology.--Planktic and benthic foraminifers and calcareous nannofossils occur, but not in abundance. Diatoms are present in abundance at intervals. A shallow shelf environment of deposition is inferred.

Interstitial water.--Owing to severe drilling difficulties only three samples were recovered for water chemistry studies. The salinity showed a slight decrease with depth but no trends can be established with confidence.

Light hydrocarbons.--No samples suitable for gas analysis were recovered.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6014

DATE: 8/26-27/76

CORE TABLE -- HOLE 6014

WATER DEPTH: 229 ft (69.80 m)

LATITUDE: 40°48.33'N
LONGITUDE: 67°53.64'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	33.5
D.I.	261	281	20	20	6.1	0	0	0	0	Drilled interval	
1	281	315	34	54	16.5	1	.8	.2	TR	Till?, gray, poorly sorted, angular, shell fragments Age: Reworked Upper Cretaceous	
2	315	346	31	85	25.9	3	9.8	3.0	33	Clay, dark gray, slightly silty plastic, pelecypod shell fragments Age: Late Pleistocene	32.0
3	346	377	31	116	35.4	2	7.2	2.2	24	Clay, sandy, gray with shell fragments; medium to coarse grained silty sand Age: Late Pleistocene	
4	377	409	32	148	45.1	4	19.1	5.8	64	Sand, very fine grained, silty, quartzose, broken shell fragments, very dark gray	
5	409	440	31	179	54.6	1	1	.3	3	Sand, very fine grained, dark gray, silty with shell fragments, very fine grained calcareous sandstone, dark gray Age: Late Pleistocene	31.9
6	440	471	31	210	64.0	3	12.0	3.7	39	Sand, very fine grained, gray, silty, pebbles, sticky, micaceous Age: Late Pleistocene	
7	471	502	31	241	73.5	5 no liner	24	73	80	Silt, gray, clayey, very fine sand, micaceous, shells Age: Late Pleistocene	30.2

CORE TABLE -- HOLE 6014 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
8	502	534	32	273	83.2	1	5.5	1.7	17.2	Silt, very fine sand, dark gray, micaceous, clay, compacted Age: Late Pleistocene	
9	534	566	32	305	93	1	3	1	10	Coarse sand, granules and pebbles, large shell fragments, loose compacted, sticky, very fine sand, possible contamination Age: Early Pleistocene (?)	
10	566	597	31	336	102.4	1	2.5	.8	8	Greenish gray sandy silty clay with shell fragments Age: Pleistocene	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6014

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S $^{o}/oo$	Rs Ω-m	F
2	CC		26	Stiff, dark gray plastic clay	7.1	7.57	3.42	.461	32.0		
5	CC		54	Dark gray, soft fine sand, shell debris	7.5	7.60	3.04	.455	31.9		
7	CC		73	Dark gray, soft fine sand, shell debris, clayey	7.5	7.48	4.12	.438	30.2	1.51	7.55

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6014

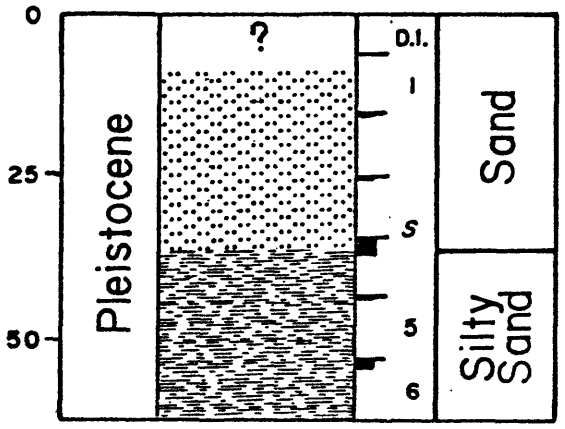
No samples suitable for light hydrocarbon analyses were recovered in the cores from this hole.

SITE 6015

Location and purpose.--The location of this site on the shelf edge and upper continental slope near the east side of Lydonia Canyon, 60 nautical miles (111 km) southeast of Nantucket, Massachusetts, was selected to provide data on geotechnical properties at the shelf edge in the Georges Bank region, to identify reflectors in the geophysical profiles through the location and to determine the stratigraphy in the area.

Operations.--The drilling vessel arrived near the location at 1825 on August 27, 1976 and awaited the completion of the reflection seismic survey of the site. The L'Olonnois returned from port at 0600 on August 28 and began its survey. One seismic line was completed but the second line had to await the repair of a broken valve. The ship completed anchoring and drilling began at 1530. The first 6.1 meters were drilled; no core was taken. The first two cores were sand with poor recovery. Below was dark gray stiff silty clay. At 2155 six cores had been retrieved for a maximum penetration of 62.8 meters and an overall recovery of 10%. Two and one-half hours were required to cut a seventh core. The drill had advanced about 9 meters by 0045 on August 29 when it became stuck. The pipe was worked for 10½ hours in attempts to free it, which included pulls of more than 400,000 lbs. These efforts managed to pull 4 joints and get the bumper sub above the mudline, but for the last 5 hours the pipe was firmly stuck and no movement occurred. At 1130 on August 29 the drill pipe broke at the kelly bushing, owing to fatigue of the pipe metal from heavy rolling and heave of the ship and the long period of working the stuck pipe. Lost were the bit, the inner core barrel containing core 7, the outer barrel, seven drill collars, one bumper sub

and 17 pipe joints. The anchors were pulled and the M/V L'Olonnois left for Davisville, R.I. to pick up replacement bottom hole equipment. At 1545 August 29, 1976, the drilling vessel was underway to a point about 60 nautical miles east of Nantucket to await a crew change.



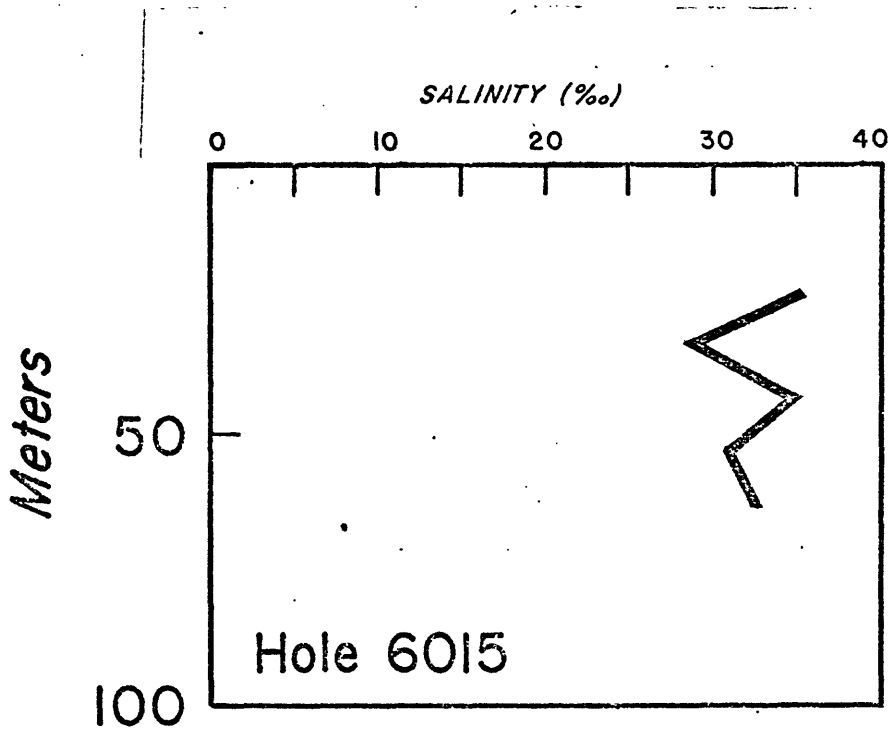
HOLE 6015

Lithology.--The lower part of the section is dark gray or dark olive silty Pleistocene clay with a few sand stringers. The upper 35 meters of the section is dark gray silty Pleistocene sand.

Paleontology.--Calcareous nannofossils are rare to common, and many reworked specimens of Late Cretaceous age are observed. Planktic and benthic foraminifers are present. An inner to middle shelf environment of deposition is inferred.

Interstitial water.--This site at the continental shelf edge showed small changes in salinity but no distinct trends. Alkalinity increased and calcium decreased with depth over the interval sampled.

Light hydrocarbons.--No methane, ethane, or propane was detected.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6015

DATE: 8/28-29/76

CORE TABLE -- HOLE 6015

LATITUDE: 40°23.11'N
LONGITUDE: 67°35.85'W

WATER DEPTH: 686 ft (209.1 m)

CORE	STRING DEPTH Feet Top	RKB[1] Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	34.0
D.I.	718	738	20	20	6.1	0	0	0	0	Drilled interval	
1	738	769	31	51	15.5	CC only	TR	TR	1	Trace, medium coarse grained sand	
2	769	800	31	82	25	1	1	.3	3	Sand, dark gray, silty, massive quartzose, very fine grained Age: Late Pleistocene	35.1
3	800	831	31	113	34.4	1	1.3	.4	4	Clay, dark gray, pure, plastic sand, very fine grained, silty, dark gray, shell fragments Age: Barren	29.1
4	831	862	31	144	43.9	2	9.2	2.8	31	Clay, dark gray olive gray, slightly silty, pyrite (?), stiff Age: Barren	34.8
5	862	893	31	175	53.3	1	1.7	.5	5	Clay, silty, dark gray to dark brown, stiff, shell fragments, some sand Age: Late Pleistocene	31.0
6	893	924	31	206	62.8	1	4.8	1.5	16	Clay, very dark gray, sandy, partly compacted, pyrite (?), scattered shells Age: Pleistocene	32.7

[1] RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6015

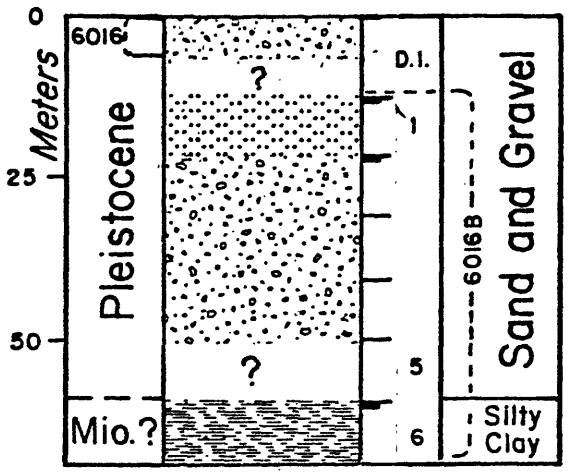
CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
2	CC		25	Dark gray, clayey sand with ¼" quartz pebbles	7.4		3.41	.398	35.1	2.00	11.11
3	CC		35	Dark gray, plastic clay with pebbles	7.6	7.77	3.30	.330	29.1	1.64	8.38
4	2	135-140	44	Dark gray, plastic clay	7.2	7.60	3.74	.348	34.8	1.50	8.58
5	1	145-150	53	Dark gray, silty clay with brown streaks, some shell débris	8.0	8.06	5.68	.196	31.0	2.57	13.65
6	1	145-150	62	Dark gray, silty clay	7.6	7.87	6.70	.143	32.7	2.13	11.55

SITE 6016

Location and purpose.--The location of this site at the west end of Georges Bank near Great South Channel 65 nautical miles (120 km) east of Nantucket was selected to provide data on geotechnical properties of possible Pleistocene channel fill sediments, to explore the possibility of the existence of relict Pleistocene freshwater under the Georges Bank region, to identify reflectors in geophysical profiles, and to determine the stratigraphy in the area.

Operations.--The drilling vessel waited at a point about 60 miles east of Nantucket until the return of the M/V L'Olonnois with replacement drilling equipment at 0400 on September 1, 1976. The D/V Glomar Conception got underway at 0600 for the location of site 6016 and at 1200 had arrived on location and received the site survey records. The site was approved, the ship anchored, and Hole 6016 was spudded-in at 1600. The drill made no progress after the first 2 feet. The string was picked up, and the ship moved about 10 meters and spudded in again; 6.7 meters were cored with very slow progress and poor recovery (core catcher sample only) of poorly sorted gravelly material. A new hole, 6016B, was started at 2200, drilled ahead 12.5 meters and coring was resumed. By 0330 on September 2 six cores had been retrieved for a total penetration of 68.9 meters with an overall recovery of 5%. A strong current (about 3 knots) was running athwart ship from port to starboard and the ship had to be repositioned by adjusting the anchors twice during coring. At 0415, after cutting core 7, the drill pipe twisted off 7 meters below the mudline in the pup joint just above the bottom hole assembly. The entire assembly, including the last carbide-button roller-cone bit available, the inner

core barrel with core 7, the outer core barrel, 6 drill collars, one bumper sub, and the pup joint were lost. The ship remained at anchor pending a decision regarding the ordering of replacement equipment and its delivery. At 0430 on September 4, the M/V L'Olonnois returned with new core barrels and drill collars; a drag bit would be delivered later by helicopter. The anchors were pulled and the ship was underway at 0500 September 4 to the next site.



HOLES 6016 and 6016B

Lithology.--The section is 60 m of Pleistocene sand and gravel, terminating at 69 m in a dark gray, clayey silt of Miocene age.

Paleontology.--Calcareous nannofossils are not abundant, but diatoms are present. The Miocene foraminiferal assemblage is mainly benthic and suggests deposition in a middle shelf environment.

Interstitial water.--Only one sample was collected for water salinity studies due to difficulties in recovering coarse sands and gravels. No trends in the water variables could be established.

Light hydrocarbons.--No methane, ethane, or propane was detected.

DATE: 9/1-2/76

CORE TABLE -- HOLE 6016

LATITUDE: 41°09.50'N
LONGITUDE: 68°41.83'W

WATER DEPTH: 218 ft (66.4 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	32.5
1	250	272	22	22	6.7	CC only	.5	.1	2	Gravel, sand, silty, clay, poorly sorted, dark gray, possibly till	

CORE TABLE -- HOLE 6016B

D.I.	250	291	41	41	12.5	0	0	0	0	Drilled interval	
1	291	321	30	71	21.6	1	2	.6	7	Sand, very coarse, washed, muddy sand, medium to dark gray with abundant pebbles	
2	321	352	31	102	31.1	1	2	.6	7	Gravel, dark gray, 1-2 cm with medium gray sand, muddy, decanted, disturbed	
3	352	383	31	133	40.5	CC only	.5	.1	2	Gravel, gray, 2 mm, quartzose, rock fragments, shell, few pebbles	
4	383	414	31	164	50.0	CC only	TR	TR	1	Gravel, gray, 2 mm, few pebbles to 3m, quartzose, rock fragments, one live clam (caving)	
5	414	445	31	195	59.4	0	0	0	0	No recovery	
6	445	476	31	226	68.9	1	4	1.2	13	Silt, dark gray, very clayey, stiff, micaceous Age: Miocene	31.9

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

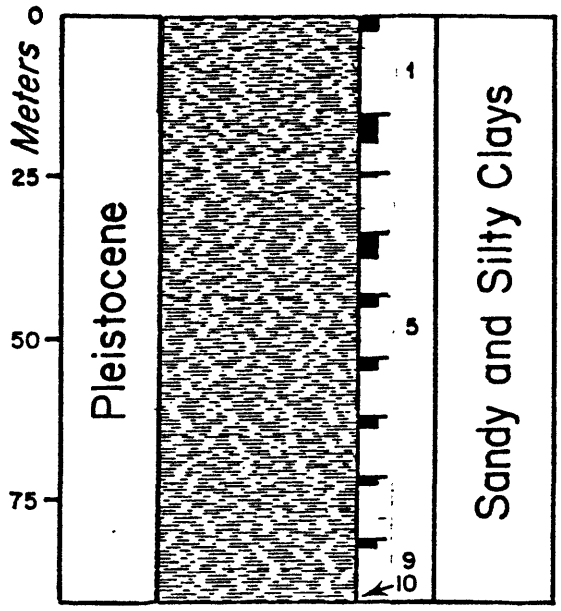
Chemistry of Water Samples from Hole 6016

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
6	CC		69	Black clayey silt, detectable H_2S	7.1	7.38	6.70	.424	31.9	1.61	8.39

SITE 6017

Location and purpose.--The location of this site in Franklin Basin north of Georges Bank, 93 miles (172 km) east of Cape Cod was selected to determine the stratigraphy of one of the structural basins of the Northeast region which has been speculated to be either Triassic or Jurrasic in age. The site was selected to try to resolve this question. A further purpose was to identify the age and characteristics of the basin sediments overlying the older structures.

Operations.--The D/V Glomar Conception arrived on location at 1230 September 4. At 2330 the site survey had been received from the M/V L'Olonnois, the site was approved and anchoring was completed. The first core was retrieved at 0020 on September 5 and by 0505 nine cores had been retrieved for a total penetration of 90.5 meters with a recovery of 20%. On core 10 the drill encountered a resistant layer and made no progress; coring was stopped at 0540 and preparations were made to log the hole. Electric (ES), gamma ray, neutron, and sonic logs were run. Logging tool difficulties prevented running formation density, caliper, and temperature logs. The hole was cemented, the anchors were pulled, and the ship was underway by 2200 on September 5, 1976.



HOLE 6017

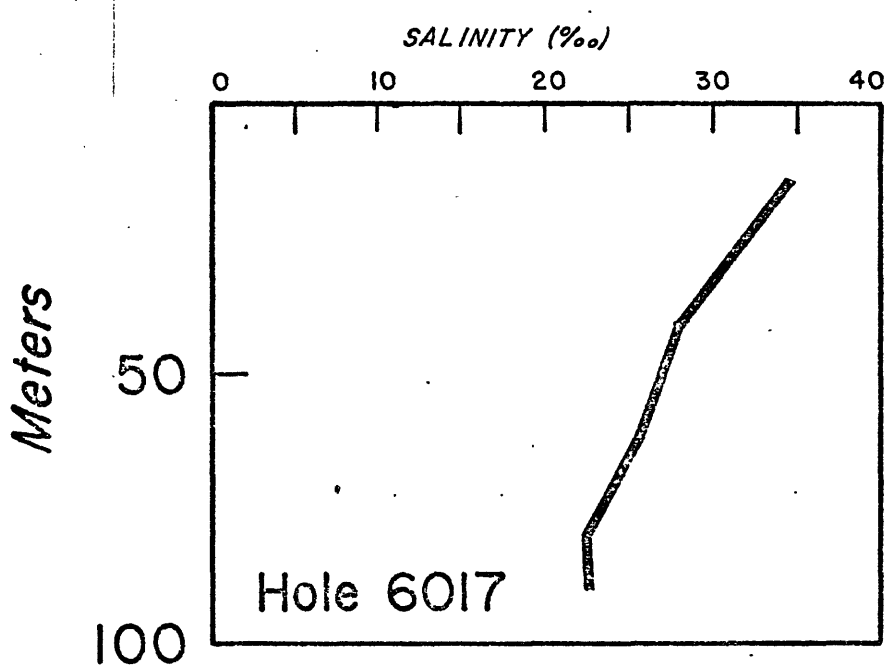
Lithology.--The section consists of 90 meters of soft sticky or plastic dark olive gray sandy or silty clay containing scattered pebbles of basalt or granite to as much as 5 cm in diameter.

Paleontology.--Miocene and Eocene microfossils and calcareous nannoplankton have been reworked into the sandy Pleistocene clays that were penetrated. In the deepest core, a rich assemblage of Middle Eocene bryozoans, foraminifers, and calcareous nannofossils was recovered. Their excellent preservation and the abundance of fresh glauconite suggest a nearby source of Eocene strata.

Interstitial water.--The salinity at this location showed a sharp decrease with depth, from 34.5% at 15 m to 22.5% at 90 m. This trend is consistant with the observations made on the continental shelf off New Jersey and suggests that zones of relatively fresh water may also

be present under Georges Bank possibly emplaced by subaerial processes during a low stand in sea level.

Light hydrocarbons.--Only methane was detected in the upper 62 meters of core section. Methane ranged from 1193 ppm to 1431 ppm in gray, firm plastic clays.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6017

DATE: 9/5/76

CORE TABLE -- HOLE 6017

LATITUDE: 42°10.45'N
LONGITUDE: 67°57.51'W

WATER DEPTH: 783 ft (238.7 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
1	815	865	50	50	15.2	2	8.5	2.6	17	Clay, gray, sandy, soft, sticky, pebbles, 4 cm, quartzose, and brick (?) Age: Pleistocene	34.6
2	865	895	30	80	24.4	3	12.9	3.9	43	Clay, gray, firm, plastic, slightly sandy, coarse Age: Pleistocene	
3	895	925	30	110	33.5	1	1.0	.3	3	Clay, gray, firm, plastic, slightly sandy, coarse Age: Pleistocene	
4	925	957	32	142	43.3	3	11.9	3.6	37	Clay, firm, plastic, sandy, medium coarse Age: Pleistocene	28.1
5	957	988	31	173	52.7	1	5	1.5	16	Clay, gray, firm, plastic slightly silty, coarse Age: Pleistocene	
6	988	1019	31	204	68.2	2	8	2.4	26	Clay, gray, silty, stiff, plastic Age: Pleistocene	25.3
7	1019	1049	30	234	71.3	1	4.8	1.5	16	Clay, gray, silty, trace of sand, coarse, firm, plastic Age: Pleistocene	
8	1049	1081	32	266	80.8	1	3.7	1.1	12	Clay, gray, sandy, medium to coarse, soft, plastic Age: Pleistocene	22.4

CORE TABLE -- HOLE 6017 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
9	1081	1112	31	297	90.5	1	2.7	.8	9	Mud, gray, very sandy, medium to coarse, stiff, plastic Age: Pleistocene	
10	1112	1112	0	297	90.5	1	1.0	.3	0	Mud, gray, sandy, medium to coarse, stiff, plastic, probably cavings. Age: Pleistocene	22.5

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6017

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	1	140-150	16	Sandy, pebbly clay	7.41	7.47	3.95	.408	34.55	.717	4.91
4	2	130-140	44	Sandy, silty clay	7.20	7.64	6.40	.414	28.1	2.18	12.04*
6	2	140-150	69	Sandy clay	7.19	7.55	6.85	.356	25.3	1.44	6.94
8	1	140-150	81	Clay	7.38	7.59	6.47	.394	22.4	2.13	9.35
10	CC		91	Sandy clay	7.40	7.82	5.20	.426	22.5	2.53	10.78

*Machine probably nulled improperly

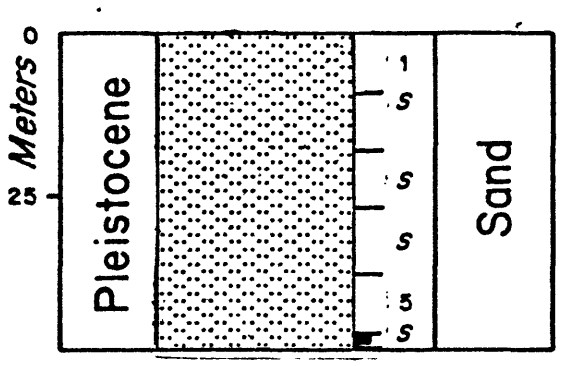
GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6017

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6017-2-3 max pene 80' 24.4'	gray firm clay, plastic slightly sandy sonicated	1193	ND	ND
6017-4-2 max pene 142' 43.3'	firm clay, plastic, sandy sonicated	1431	ND	ND
6017-6-2 max pene 204' 62.8'	stiff gray silty clay, plastic sonicated	1376	ND	ND

SITE 6018

Location and purpose.--The location of this site is that of the COST G-1 hole. It is on Georges Bank 90 nautical miles (167 km) east of Nantucket and it was selected to provide data on the geotechnical properties of the upper 330 meters of sediments which were not investigated by the COST program. Of particular interest were the properties and probable competence of a resistant layer at 210 to 230 meters depth.

Operations.--The drilling vessel arrived on location at 0830 on Sept. 6, 1976. This site was approved and the anchors set by 1200. Hole 6018 was spudded-in at 1500 using the new diamond-impregnated drag bit and five cores were recovered by 2400. During the cutting of core 6 the pipe stuck. It was freed after two hours of working the pipe, and the string was pulled out of the hole. Core 6 was recovered from the outer core barrel at 0300, September 7. The bumper sub was bent sometime during the drilling. No spare bumper subs remained on board so the M/V L'Olonnois was sent to Davisville, R.I. to pick up new parts for repair of the bumper sub. The anchors were pulled before departure of the L'Olonnois, and the Glomar Conception was underway at 1530 on September 7, 1976 to a position about 60 miles east of Nantucket to await the return of the supply vessel. The L'Olonnois returned at 0730 on September 9, off loaded the bumper sub mandrill and supplies, and both vessels were underway to the next site by 0835.



HOLE 6018

Lithology.--The section consists of 49 m of coarse shelly Pleistocene sands and possibly some silty clay.

Paleontology.--Most of the cores contained only scattered specimens of shallow-water benthic foraminifers. Calcareous nannoplankton are present. The bottom part of core 4 (37 m) contains a typical high-nutrient foraminiferal assemblage with vitreous organic particles and pyritized diatoms.

Interstitial water.--Coarse sands at this location permitted recovery of only one sample for water chemistry that was uncontaminated. Consequently, no trends could be established.

Light hydrocarbons.--No samples suitable for gas analyses were recovered.

DATE: 9/6-7/76

CORE TABLE -- HOLE 6018

LATITUDE: 40°55.90'N
LONGITUDE: 68°18.14'W

WATER DEPTH: 152 ft (46.3 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	32.9
1	183	213	30	30	9.1	0	0	0	0	Sandy (?) interval, no recovery	
2	213	243	30	60	18.2	CC only	.5	.2	2	Coarse, shelly sand Age: Pleistocene	
3	243	272	29	89	27.1	CC only	.5	.2	2	Sand, shell fragments Age: Pleistocene	
4	272	304	32	121	36.9	1	1	.3	3	Coarse sand, shell fragments dark green mud (bottom 10 cm) Age: Plio-Pleistocene	31.7
5	304	335	31	152	46.3	0	0	0	0	No recovery	
6	335	342	7	159	48.5	2	6	1.8	86	Sand, medium to coarse quartz, glauconite, rock fragments, shells Age: Pleistocene	31.8

Chemistry of Water Samples from Hole 6018

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
4	CC	Bottom	37	Clay-small pieces		7.65	3.91	.398	31.7		
6	2	90-100	49	Sand-mixed and invaded		8.74	2.54	.570	31.8		

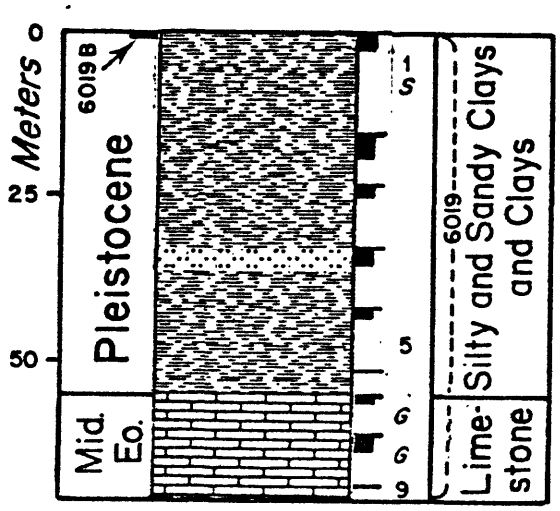
SITE 6019

Location and purpose.--The location of this site was chosen on the north flank of Georges Bank, 76 nautical miles (141 km) east of Cape Cod to determine the age and physical properties of a prominent reflector that occurs under much of Georges Bank and unconformably overlies dipping beds of the continental margin sedimentary wedge. The reflector appears to be continuous with that occurring between 210 and 230 meters depth at site 6018. At site 6019 the reflector appears less than 100 meters below the sea floor. A further purpose was to determine the geotechnical properties of a lenticular body of sediment occurring in the upper part of the section on the north flank of Georges Bank.

Operations.--The drilling vessel arrived on location at 1720 on September 9, 1976, the site was approved and anchoring was completed by 2005. The drill string was lowered and the driller reported tagging bottom at 594 ft (181 m). This depth did not agree with the echo sounder and air-gun records which showed a depth of about 560 ft (170 m). Coring proceeded and by 1215 on September 10, nine cores had been retrieved. Very soft, spongy material with high gas content was found in the first two cores. Drilling progress was slow and the drag bit produced high torque (500 amps on the turntable motor). Cores 5 and 6 encountered probable gravel (much clatter of the kelly in the kelly bushing) and very slow progress (2 hours per core). Cores 7 and 8 encountered hard limestone, and core 9 made no progress. Coring was stopped at this point and the hole was prepared for logging. At 1515 the ES logging tool would not go past a penetration depth of 34 meters. Working the logging tool failed to make it go deeper; the hole had apparently bridged. The ES log was run from 34 meters to 15 meters penetration and further logging attempts were

cancelled. The hole was plugged with cement and the drill string was retrieved. The bit was badly worn; the welded core-size modification inserts were gone and the bit was no longer useable.

The ship was moved 8 meters to the northeast to try for a mudline punch-core to determine bottom depth and resolve the discrepancy between the drillers water depth and the sonic depth. Seven feet of core were recovered from the interval 602 to 607 feet RKB. This is equivalent to 570 to 575 feet water depth. The actual water depth was probably 568 to 570 feet (173 to 173.7 meters) rather than the drillers estimate of 594 feet (181 meters). The very soft gassy bottom was probably not felt by the driller during the drilling of hole 6019 until more resistant material was encountered at about 8 meters below the mudline. Deterioration of the weather prevented pulling anchors until the following morning. At 0830 on September 11 the Glomar Conception was underway to the next site.



HOLE 6019

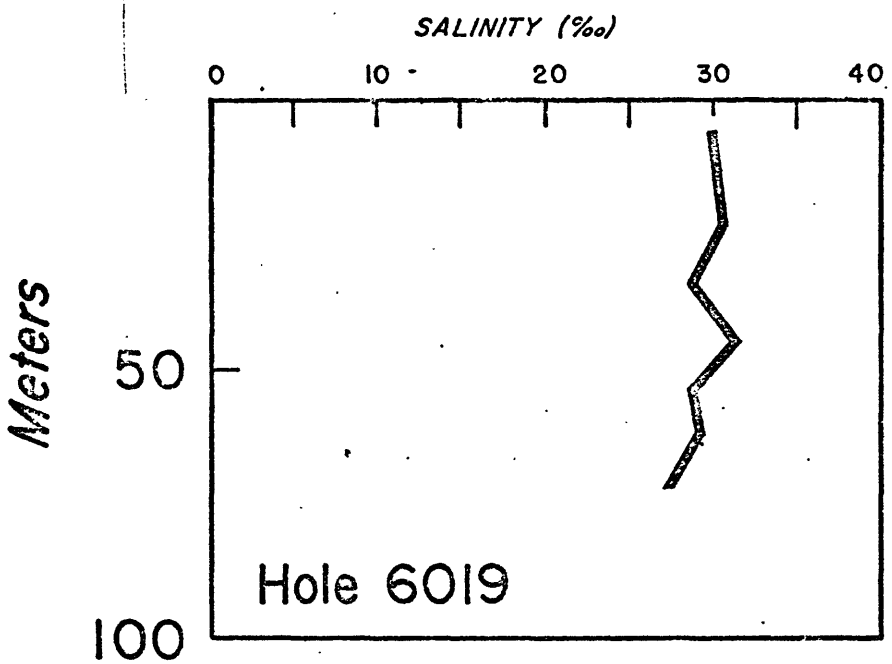
Lithology.--Dark green, glauconitic clay and hard limest. one of Eocene age is overlain by 55 meters of gravel and sandy, dark olive clays of Pleistocene age. The top of the section consists of soft, spongy, or fluffy dark olive clay with much gas.

Paleontology.--The Pleistocene strata contain sparse foraminiferal remains but are rich in diatoms near the surface. As in hole 6017, the Pleistocene sediments contain a rich, reworked Middle Eocene assemblage of micro- and nannofossils. The Middle Eocene sediments encountered at the bottom of this hole contain diverse foraminiferal and calcareous nannofossil assemblages indicative of outer shelf and upper slope environments. These Eocene strata are believed to be the source for the redistributed Eocene faunas recovered at site 6017.

Interstitial water.--The salinity of interstitial water generally

decreased with depth from 34.9% at 7 m to 27.3% at 73 m again suggesting same freshwater influence at depth as observed at site 6017. Strong H_2S was present in cores 1 and 2 and high alkalinity at the surface of this hole reflect the brozenic reduction of sulfate and corresponding increase in bicarbonate ion.

Light hydrocarbons--The upper 18 meters of sediment at this site is composed of a very black, soft clay with abundant diatoms. The sediment had a strong, fetid odor of H_2S. Methane concentrations in the three samples collected ranged from 332 $x10^3$ to 339 $x10^3$ ppm. Ethane and propane were not detected.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6019

Tables for SITE 6019 follow.

DATE: 9/9-10/76

CORE TABLE -- HOLE 6019

WATER DEPTH: 570 ft (173.7 m)

LATITUDE: 41°49.27'N
LONGITUDE: 68°16.39'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
										Surface water	33
1	602	654	52	52	15.9	2	9.6	2.9	31	Very soft, sticky black clay, H_2S, diatomaceous Age: Quaternary	34.9
2	654	679	25	77	23.5	3	11.6	3.5	46	Very soft, sticky black clay, H_2S Age: Pleistocene (?)	
3	679	710	31	108	32.9	2	7	2.1	23	Gray sand at top, dark gray, sandy clay at bottom Age: Pleistocene, reworked Eocene	31.4
4	710	741	31	139	42.4	6	8.5	2.6	27	Dark gray to black, slightly silty clay, drill fluid contamination Age: Pleistocene, reworked Eocene	28.7 30.5
5	741	772	31	170	51.8	1	4.5	1.4	15	Dark gray, slightly silty clay, sa d and gravel at bottom Age: Pleistocene, reworked Eocene	31.4
6	772	782	10	180	54.9	CC only	.7	.2	7	Dark sandy clay Age: Pleistocene, reworked Eocene	28.8
7	782	803	21	201	61.3	1	1.3	.4	5	Light green-gray calcareous fossiliferous clay Age: Middle Eocene	29.3

CORE TABLE -- HOLE 6019 (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
8	803	834	31	232	70.7	1	5.5	1.7	18	Dark green-gray glauconitic calcareous clay Age: Middle Eocene	27.3
9	834	837	3	235	71.6	CC only	.1	.1	1	Bright green-gray glauconitic calcareous clay smear on cc Age: Middle Eocene	

CORE TABLE -- HOLE 6019B

1	602	607	5	5	1.5	2	6.9	2.1	100	Gas expansion, dark gray clay, H_2S, diatomaceous Age: Quaternary	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6019

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	1	140-150	16	clay H_2S	7.35	7.64	61.20	.325	34.9	0.616	4.31
3	2	131-150	33	clay		7.78	28.72	.220	31.4	1.173	6.70
4	6	140-150	43	silty clay	7.68	8.20	10.65	.393	28.7	1.367	7.12
4	CC			stiff clay					30.5		
5	1	140-150	52	clay		7.56	11.44	.228	31.4	1.386	7.83
6	CC		55	sandy clay	7.60	8.44	4.67	.363	28.8	1.710	8.77
7	1	140-150	62	calcareous sandy clay	7.30	7.56	4.82	.278	29.3	1.695	8.78
8	1	140-150	71	sandy clay, glauconitic	7.73	8.25	2.58	.298	27.3	5.576	26.18

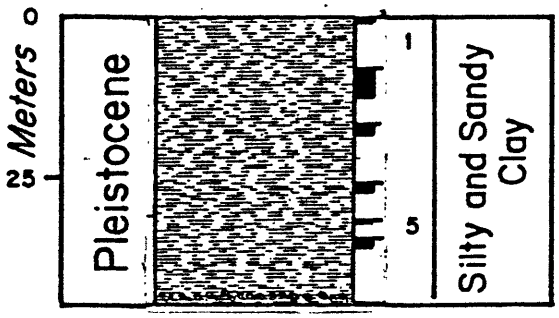
GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6019

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6019-1-2 max pene 28' 8.5m	dark gray silty clay core liner gas space	(332,900)	ND	ND
6019-2-2 max pene 53' 16.2m	dark gray silty clay core liner gas space	(339,297)	ND	ND
6019-3-2 32.9m	slightly sticky gray clay core liner gas space	(336,125)	ND	ND

SITE 6020

Location and purpose.--The location of this site, 30 nautical miles (56 km) east of the central New Jersey coast line was chosen during the cruise to test the hypothesis that the freshwater zones found at site 6009 and 6011 are continuous. The salinity gradient between the previous sites could then be determined and the limits of the aquifer better defined and tentatively mapped. A further purpose was to determine geotechnical properties and stratigraphy.

Operations.--The drilling vessel arrived on location at 0830 on September 13. The site was approved and the ship anchored by 1300. Hole 6020 was spudded-in at 1400 and six cores had been retrieved at 1812 for a total penetration of 43.9 meters and a recovery of 23%. At 1825, while cutting core 7, the drill string stuck. The pipe was worked to try to free it until 1130 on September 14 when the bottom hole assembly parted at the bumper sub. Initial calculations showed the break to be one foot below the mudline. Lost were a drag bit, one outer core barrel, one inner core barrel, 3 drill collars and the housing of the bumper sub. Recovered were 2 joints, 3 drill collars and the mandrill of the bumper sub. The anchors were pulled and the ship was underway to the next and last site at 1120 on September 15, 1976.



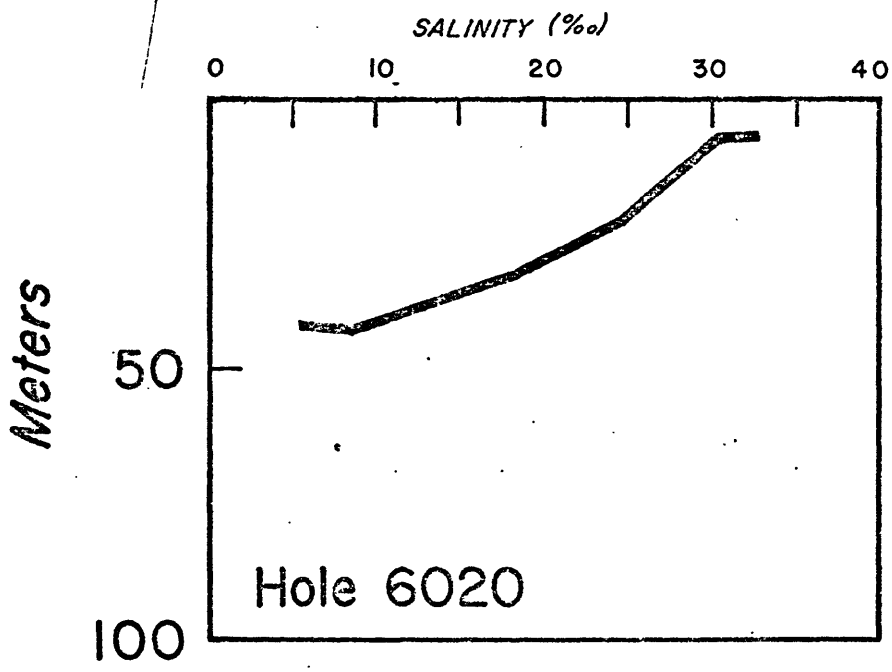
HOLE 6020

Lithology.--Section consists of 44 m of shallow marine Pleistocene dark gray or dark olive gray silty and sandy clays. A pebble gravel occurs at the base.

Paleontology.--Planktic and benthic foraminifers and calcareous nannofossils are not abundant. Inner and middle shelf assemblages predominate.

Interstitial water.--Salinity changes rapidly with depth from 33% at 7 m to 5.8% at 43 m. This trend is consistent with results obtained from holes 6008, 6011 near the coastline, and holes 6009 and 6010 further offshore. These data support the contention that a lens of relatively fresh water (<6%) extends to considerable distance (>60 km) offshore. Calcium values in the lower part of the hole decreased with salinity suggesting a dilution of salt water with fresh-water containing low calcium.

Light hydrocarbons.--No methane, ethane or propane was detected.


SALINITY (‰)
0
10
20
30
40
Meters
50
100
Hole 6020

DATE: 9/13/76

CORE TABLE -- HOLE 6020

WATER DEPTH: 128 ft (39 m)

LATITUDE: 39°25.41'N
LONGITUDE: 73°35.63'W

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	31.5
1	160	186	26	26	7.9	1	3.1	.9	12	Dark gray, silty clay Age: Pleistocene	
2	186	214	28	54	16.5	3	13.5	4.1	48	Dark gray, silty clay Age: Pleistocene	
3	214	243	29	83	25.3	2	5.9	1.7	20	Slightly silty sticky gray clay Age: Pleistocene	23.4
4	243	263	30	103	31.4	2	6	1.8	30	Dark gray, sandy, sticky clay Age: Pleistocene	
5	263	272	9	112	34.1	1	1	.3	11	Gray, sandy clay, shells Age: Pleistocene	18.4
6	272	304	32	144	43.9	1	4.5	1.4	14	Pebble gravel (rounded) and gray clay Age: Pleistocene (?)	5.8

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6020

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		8	Silty clay	7.42	7.57	3.23	.413	30.9	1.52	8.35
1	1	50-70	8	Silty clay		7.70	2.72	.406	32.95		
3	2	130-140	26	Sandy clay	7.62	7.92	3.42	.498	23.4	1.28	5.45
5	CC		35	Sandy clay	7.80	8.10	2.39	.468	18.4	1.96	6.41
6	1	140-150	44	Sandy clay	7.82?	8.20	2.41	.262	8.6	6.58	9.48
6	1	91	44	Sandy clay					5.8		
6	1	73-81	44	Sandy clay				.245			

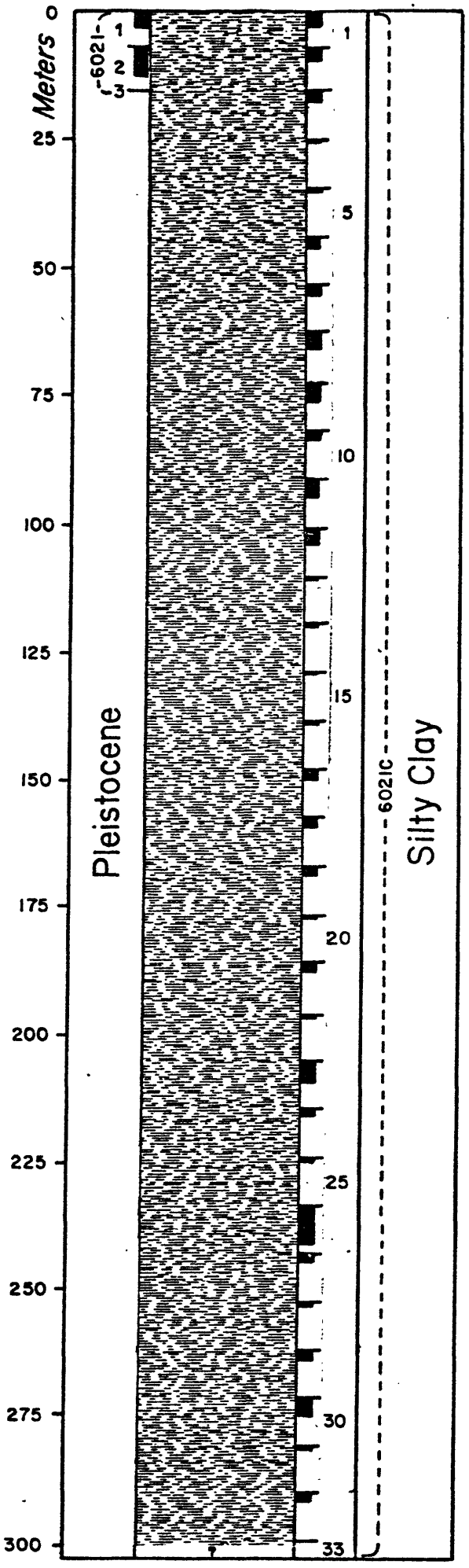
SITE 6021

Location and purpose.--The location of this site and the continental slope 75 nautical miles (139 km) east of Atlantic City, New Jersey was chosen to determine the geotechnical properties of the sediments in the upper continental slope for evaluation of possible slope stability problems. An effort was made to locate the site on a smooth slope or gentle shoulder rather than a canyon wall or gully in order to avoid the possibility of valley erosion of the sediments. A further purpose of the site was to determine if any fresh water influence occurred in the upper slope.

Operations.-- The drilling vessel arrived on location at 1730 on September 15. The reflection seismic surveys were made at this site by "minisparker" rather than air-gun as with all the other sites. The minisparker records were transferred to the Glomar Conception by the L'Olonnois and the site was approved. All anchors were down by 2315 but were allowed to "soak" for one hour before testing because of the great water depth (298.1 meters) and the probably poor holding ground. The anchor tension tests were successful and hole 2021 was spudded-in at 0220 on September 16 using a new, carbide-studded drag bit. On retrieval of core 3 at 0600 the inner core barrel was found bent. The drill string was pulled to inspect the outer core barrel which was also found bent. An attempt to straighten the outer core barrel by heating and stressing it in a large vise appeared to be successful but after cooling and hoisting the barrel to the rig floor the barrel re-assumed its bent shape. No spare outer core barrel was aboard. The decision was made to drill the hole with the bit in a drill collar rather than a core barrel, then log the hole through the open bit. At 1600, September 16, hole 2021B was spudded-in; no coring was planned

except experimental punch coring with a jury-rigged core barrel. Attempts to do this at 48.7 meters and 154.5 meters were unsuccessful, due to lack of a core catcher on the barrel extension, which allowed any core that might have been cut to wash out.

The drill reached 304.8 meters penetration at 0920 on September 9. The hole was prepared for logging which began at 1145. The sonic tool "hung-up" just below the bit in clay that had bridged-over the hole. Two wiper trips were necessary to clear the hole. All logs were completed at 0130 on September 18. The hole was plugged with cement and the drill string was pulled out of the hole. The bottom hole assembly was fitted with a new outer core barrel and hole 2021C was spudded-in at 0645, September 18. Thirty-two cores were recovered by 2340 on that day. On core 33, the inner barrel stuck and could not be retrieved. The drill string was pulled and at 0010 on September 19 core 33 was removed from the outer core barrel. The inner barrel had jammed in the lower bearing before reaching the bit. The anchors were pulled and the ship was underway at 1200 to a point off Atlantic City, New Jersey where the scientific party was transported ashore by helicopter and the Geological Survey equipment, supplies and cores were transferred to the M/V L'Olonnois for transport to Davisville, R.I.. The D/V Glomar Conception was released to Global Marine Inc. at 1700 on September 19, 1976.



HOLES 6021 and 6021B and 6021C

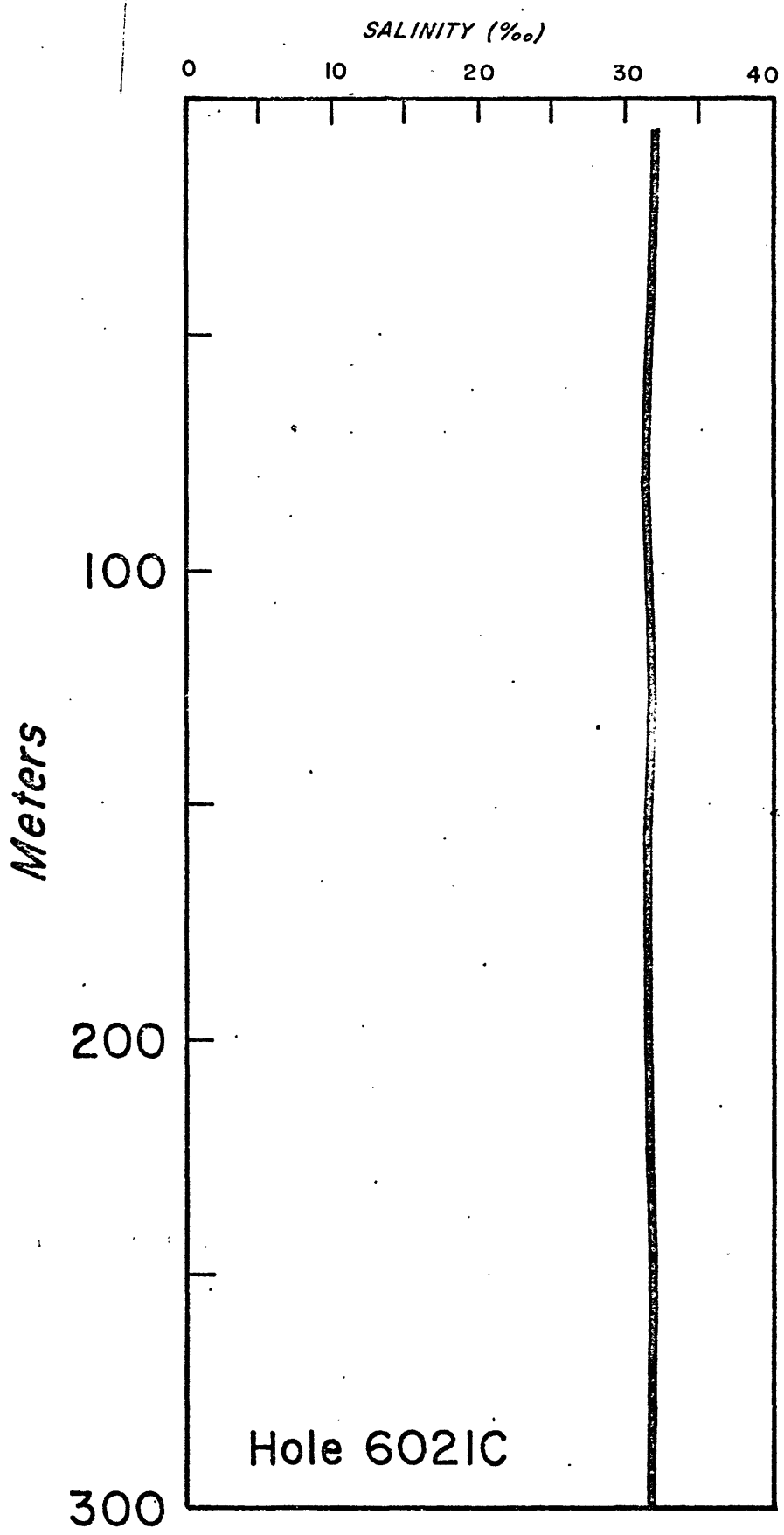
Lithology.--The section is composed of a thick series (305 m) of Pleistocene dark gray to medium gray silty clays.

Paleontology.--Calcareous nannofossils are present but not abundant. Foraminifers are well-represented, however, and indicate deposition in shelf and slope environments.

Interstitial water.--At this location the salinity of interstitial water remained in the 31-32% range as was observed in other drill sites seaward of the shelf edge.

Light hydrocarbons.--The light hydrocarbons occur in two major zones, from 36 to 92 meters, and from 101 to 293 meters. The methane concentration in the upper interval ranged from 4755 ppm to 293 x 10^3 ppm, whereas the lower interval had a range of 282 x 10^3 ppm to 412 x 10^3 ppm. Ethane was detected in all the samples analyzed, and ranged from 36 ppm to 2895 ppm in

the upper zone, and from 1500 ppm to 10×10^3 ppm in the lower zone. Propane ranged from 81 to 206 ppm in the upper interval, whereas in the lower zone, the propane concentrations varied from 207 ppm to 1350 ppm.


SALINITY (‰)
0
10
20
30
40
100
200
300
Meters
Hole 6021C

DATE: 9/16-17/76

CORE TABLE -- HOLE 6021

LATITUDE: 38°57.92'N
LONGITUDE: 72°49.20'W

WATER DEPTH: 978 ft (298.1 m)

CORE	STRING DEPTH Feet Top	RKB[1] Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
										Surface water	32.7
1	1010	1033	23	23	7.0	3	11.7	3.6	51	Dark gray laminated sandy clay Age: Pleistocene	30.8
2	1033	1060	27	50	15.2	4	17	5.2	63	Dark gray laminated sandy clay Age: Pleistocene	32.1
3	1060	1060	-	-	-	1	1.7	.5	-	Cavings	

CORE TABLE -- HOLE 6021B

D.I.#1	1010	1170	160	160	48.7	-	-	-	-	Drilled interval	
1	1170	1170	0	160	48.7	*	*	*	*	Attempted punch core, smear of gray clay on core barrel Age: Pleistocene	
D.I.#2	1170	1517	347	507	154.5	-	-	-	-	Drilled interval	
2	1517	1517	0	507	154.5	*	*	*	*	Attempted punch core, smear of gray clay on core barrel Age: Pleistocene	
D.I.#3	1517	2010	493	1000	304.8	-	-	-	-	Drilled interval	

[1] RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

DATE: 9/18/76

CORE TABLE -- HOLE 6021C

LATITUDE: 38°57.92'N
LONGITUDE: 72°49.20'W

WATER DEPTH: 988 ft (301.2 m)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
										Surface water	32.7
1	1020	1045	25	25	7.6	2	9.5	2.9	38	Dark gray laminated sandy clay	32.1
2	1045	1072	27	52	15.8	2	7.4	2.3	27	Dark gray sandy clay, flakey texture (gassy)	
3	1072	1104	32	84	25.6	2	5.8	1.8	18	Dark gray sandy clay, flakey texture (gassy)	31.7
4	1104	1135	31	115	35.1	1	1.0	0.3	3	Dark gray sandy clay, flakey texture (gassy)	
5	1135	1166	31	146	44.5	1	0.8	0.2	2	Dark gray sandy clay, flakey texture (gassy)	
6	1166	1197	31	177	54.0	1	5.6	1.7	18	Dark gray sandy clay, flakey texture (gassy)	
7	1197	1228	31	208	63.4	2	8.3	2.5	26	Dark gray silty clay (gassy)	31.4
8	1228	1259	31	239	72.8	3	11.0	3.4	35	Dark gray silty clay	
9	1259	1290	31	270	82.3	3	11.6	3.5	37	Dark gray silty clay	31.5
10	1290	1321	31	301	91.7	2	7.8	2.4	25	Dark gray silty clay	
11	1321	1353	32	333	101.5	3	13.6	4.1	44	Dark gray silty clay	
12	1353	1384	31	364	110.0	3	12.2	3.7	39	Dark gray silty clay	
13	1384	1415	31	395	120.4	1	1.5	0.5	1	Dark gray silty clay	
14	1415	1446	31	426	129.8	1	3.2	1.0	10	Dark gray silty clay (gassy)	31.9

CORE TABLE -- HOLE 6021C (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SALINITY ‰
15	1446	1478	32	458	139.6	1	0.9	0.3	3	Dark gray silty clay (gassy) (sock folded - blocked core)	
16	1478	1509	31	489	149.1	1	4.5	1.4	15	Dark gray sandy clay (gassy)	
17	1509	1540	31	520	158.5	1	5.3	1.6	17	Dark gray silty clay (gassy)	31.6
18	1540	1572	32	552	168.3	2	6.9	2.1	22	Dark gray silty clay (gassy) moderately dry, pebbly. Methane 4 X 10^5 ppm	
19	1572	1603	31	583	177.7	2	6.4	2.0	21	Dark gray silty clay (gassy). Methane 4 X 10^5 ppm	
20	1603	1634	31	614	187.2	1	1.8	0.5	6	Dark gray silty clay. Methane 4 X 10^5 ppm	
21	1634	1666	32	646	196.9	2	6.3	1.9	20	Dark gray silty clay. Methane 4 X 10^5 ppm	31.6
22	1666	1697	31	677	206.4	1	1.0	0.3	3	Dark gray silty clay	
23	1697	1728	31	708	215.8	3	12.0	3.7	38	Dark gray silty clay (gassy)	
24	1728	1760	32	740	225.6	1	3.5	1.1	11	Dark gray silty clay (gassy)	31.7
25	1760	1791	31	771	235.0	1	2.8	0.9	9	Core catcher empty, dark gray silty clay (gassy)	
26	1791	1822	31	802	244.5	1	22	6.7	71	Medium gray clay (gassy)	
27	1822	1853	31	833	253.9	1	4.5	1.4	15	Medium gray clay (gassy)	31.9

CORE TABLE -- HOLE 6021C (CONTINUED)

CORE	STRING DEPTH Feet RKB[1] Top	Bottom	PENETRATION Feet	Cumulative Feet	Meters	NO. OF SECTIONS	RECOVERY Feet	Meters	%	LITHOLOGY -- AGE (Core catcher sample)	SAL-INITY ‰
28	1853	1884	31	864	263.4	1	2.5	0.8	8	Medium gray silty clay (gassy)	
29	1884	1916	32	896	273.1	2	8.5	2.6	27	Medium gray silty clay (gassy)	
30	1916	1947	31	927	282.6	2	10.5	3.2	35	Medium gray silty clay (gassy)	
31	1947	1977	30	957	291.7	1	2.0	0.6	1	Medium gray silty clay (gassy)	
32	1977	2007	30	987	300.8	1	4.5	1.4	2	Medium gray silty clay (gassy) Age: Pleistocene	
33	2007	2020	13	1000	304.8	-	-	-	-	No recovery	

[1]RKB=Relative to Kelly Bushing; Kelly bushing is 32 feet above water line

Chemistry of Water Samples from Hole 6021

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	3	140-150	7	Sandy clay	7.49	8.02	11.31	.236	30.8	1.17	6.84
2	4	140-150	16	Sandy clay	7.6	7.61 7.72 7.74	14.55 14.78 14.67	.177	32.1	1.45	8.36

Chemistry of Water Samples from Hole 6021C

CORE	SEC.	INTERVAL	MAX. DEPTH (m)	LITHOLOGY	PUNCH IN pH	pH	Alk Meq/l	Ca g/l	S °/oo	Rs Ω-m	F
1	CC		8	Sandy clay	7.52	7.84	14.60	.209	32.1	2.11	12.27
3	2	140-150	26	Sandy clay	7.35	7.71	6.37	.253	31.7	.82	4.66
7	2	140-150	64	Sandy clay	7.38	7.60	5.96	.198	31.4	1.08	6.0
9	3	140-150	83	Silty clay	7.4	7.55	5.63	.220	31.5	1.04	5.56
14	1	140-150	130	Silty clay	7.42	7.72	6.54	.186	31.9	1.26	6.56
17	1	140-150	159	Silty clay	7.50	7.76	4.93	.225	31.6	1.26	6.46
21	2	140-150	197	Silty clay	7.58	7.81	6.18	.260	31.6	1.80	10.74
24	1	130-140	226	Silty clay	7.70	7.85	10.38	.136	31.7	1.38	8.02
27	1	140-150	254	Silty clay	7.55	8.01	13.85	.170	31.9	1.61	9.53
30	2	130-140	283	Silty clay	7.40	7.79	10.89	.248	31.8	1.35	7.85
32	1	140-150	301	Silty clay	7.43	7.96	3.45	.241	31.7	1.37	7.10

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6021C

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_3H_6	C_3H_8
6021C-1-3 max pene 25' 7.6m	dark gray, laminated sandy clay sonicated	(356)	ND	ND
6021C-2-4 max pene 40' 12.2m	dark gray sandy clay sonicated	(1339)	ND	ND
6021C-3-2 max pene 84' 25.6m	dark gray sandy clay sonicated	(285)	ND	ND
6021C-4-1 max pene 115' 35.1m	dark gray sandy clay sonicated	(4755)	(36)	ND
6021C-6-1 max pene 177' 54.0m	dark gray sandy clay core liner gas space	(229,018)	(2895)	(206)
6021C-7-2 max pene 208' 63.4m	dark gray sandy clay sonicated	(81,786)	(2714)	(81)
6021C-8-3 max pene 239' 72.8m	dark gray silty clay sonicated	(19,305)	(542)	ND
6021C-9-3 max pene 270' 82.3m	dark gray silty clay sonicated	(10,237)	(649)	ND
6021C-10-2 max pene 301' 91.7m	dark gray silty clay sonicated	(1,997)	(325)	ND
6021C-11-3 max pene 333' 101.5m	dark gray silty clay core liner gas space	(292,930)	(8,108)	(1013)
6021C-12-3 max pene 364' 111.0m	dark gray silty clay core liner gas space	(282,278)	(3,378)	(1013)
6021C-14-1 max pene 426' 129.8m	dark gray silty clay core liner gas space	(282,278)	(1,508)	(723)

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6021C (CONTINUED)

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6021C-16-1 max pene 489' 149.1m	dark gray clayey sand core liner gas space	(282,278)	(2,116)	(429)
6021C-17-1 max pene 520' 158.5m	dark gray silty clay core liner gas space	(287,604)	(2,094)	(404)
6021C-17-1 158.5m	dark gray silty clay sonicated	(15,406)	ND	ND
6021C-18-2 max pene 551' 168.0m	dark gray silty clay core liner gas space	(410,102)	(10,135)	(1240)
6021C-19-2 max pene 582 177.4m	dark gray silty clay core liner gas space	(410,102)	(10,135)	(827)
6021C-21-2 max pene 644' 196.3m	dark gray silty clay core liner gas space	(412,765)	(3,137)	(207)
6021C-23-3 max pene 708' 215.8m	dark gray silty clay core liner gas space	(287,760)	(7,239)	(1240)
6021C-24-1 max pene 740' 225.6m	dark gray silty clay core liner gas space	(287,538)	(7,239)	(1157)
6021C-25-1 max pene 771' 235.0m	dark gray silty clay core liner gas space	(287,604)	(3,378)	(289)
6021C-26-5 max pene 802' 244.5m	medium gray clay core liner gas space	(286,538)	(10,617)	(1240)
6021C-27-1 max pene 833' 253.9m	medium gray clay core liner gas space	(284,941)	(6,273)	(1157)
6021C-28-1 max pene 864' 263.4m	medium gray silty clay core liner gas space	(284,941)	(6,273)	(1034)
6021C-29-2 max pene 896' 273.1m	medium gray silty clay core liner gas space	(287,604)	(5,309)	(1351)

GASEOUS HYDROCARBON CONCENTRATION IN SAMPLES FROM HOLE 6021C (CONTINUED)

SAMPLE	LITHOLOGY AND METHOD OF SAMPLING	CONCENTRATION PPM CH_4	C_2H_6	C_3H_8
6021C-30-2 max pene 927' 282.6m	medium gray silty clay core liner gas space	(287,604)	(6,237)	(1240)
6021C-31-1 max pene 957' 291.7m	medium gray silty clay core liner gas space	(290,267)	(7,239)	(1240)

APPENDIX A

CROSS SECTIONS SHOWING REGIONAL STRATIGRAPHIC RELATIONSHIPS

by Page C. Valentine and C. Wylie Poag

Cross section of the South Carolina continental margin.-- The location of this cross section is shown in Figure A-1. The section itself (Figure A-2) is actually a composite of two sections: one extends from the South Carolina Coastal Plain southeastward across the Continental Shelf and the Blake Plateau where it is joined to a second section that trends northeastward across the Blake Spur and Continental Slope. Stratigraphic relationships depicted on this cross section result from the study of two onshore holes in the Coastal Plain and three offshore wells. Coastal Plain stratigraphy is derived from studies on the U.S.G.S. Clubhouse Crossroads core and from information provided by the South Carolina Geological Survey on the Kiawah Island well (Zupan and Abbott, this report, Figure B-4). Offshore stratigraphic interpretations result from a study of Hole 6004 and published reports on JOIDES Hole 4[1] and DSDP Hole 390[2].

In contrast to the thick sedimentary wedge underlying the continental margin north of Cape Hatteras, the Cenozoic strata of the South Carolina margin are very much thinner and less continuous in their extent seaward and presumably also laterally. These beds are marine and principally of shelf and and upper slope origin. Sediments of Paleocene age exhibit the most continuity along the section illustrated here (Figure A-2); they are encountered in all

[1]Charm, W. B., Nesteroff, W. D., and Valdes, S., 1969, Detailed stratigraphic description of the JOIDES cores on the continental margin off Florida: U. S. Geological Survey Prof. Paper 581-D, 13 p.

[2]Benson, W. E., Sheridan, R. E., Enos P., Freeman, T., Gradstein, F., Murdmaa, I. O., Pastouret, L., Schmidt, R. R., Stuermer, D. H., Weaver, F. M., and Worstell, P., 1976, In the North Atlantic: deep-sea drilling: Geotimes, v. 21, n. 2, p. 23-26.

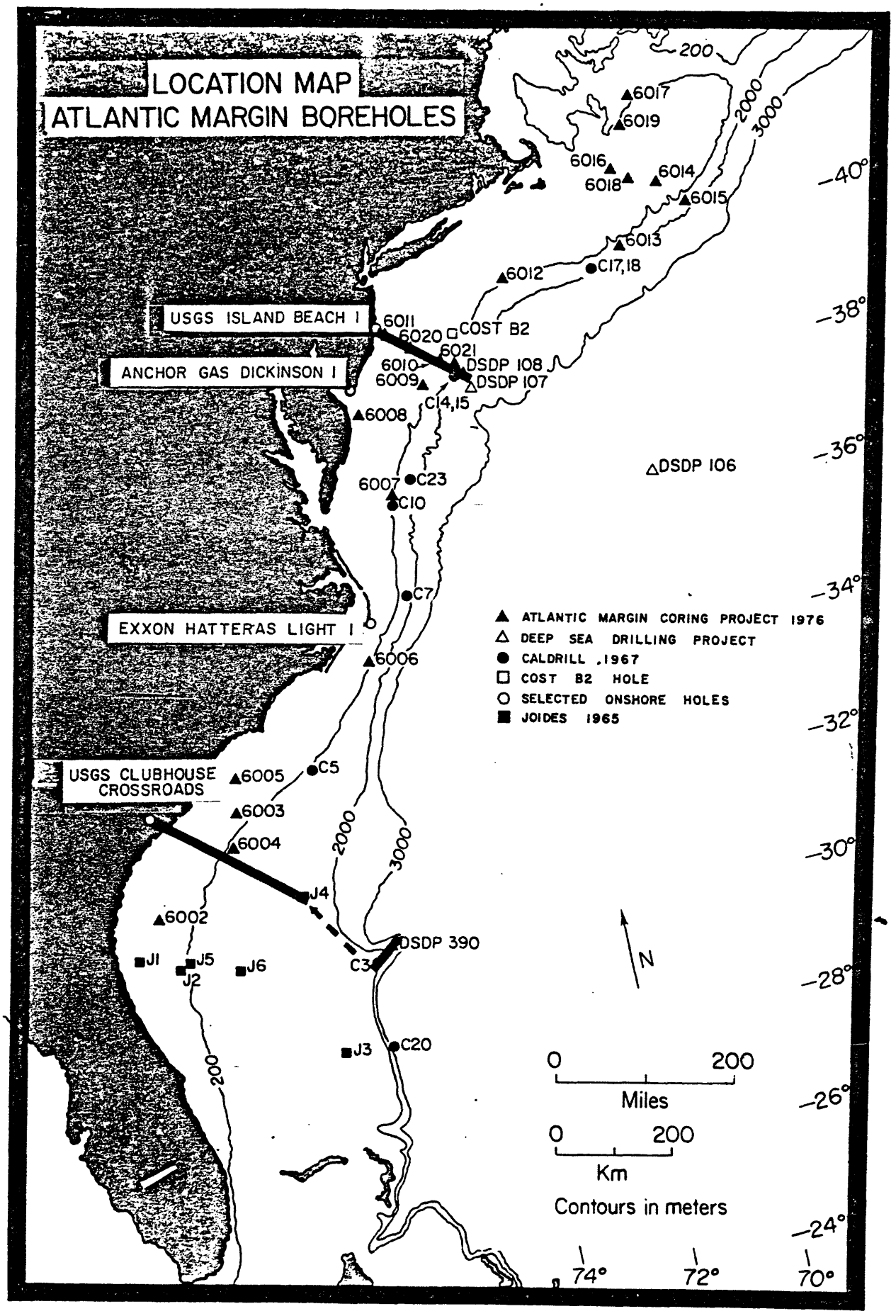


FIGURE A-1. Map showing location of Atlantic margin boreholes.

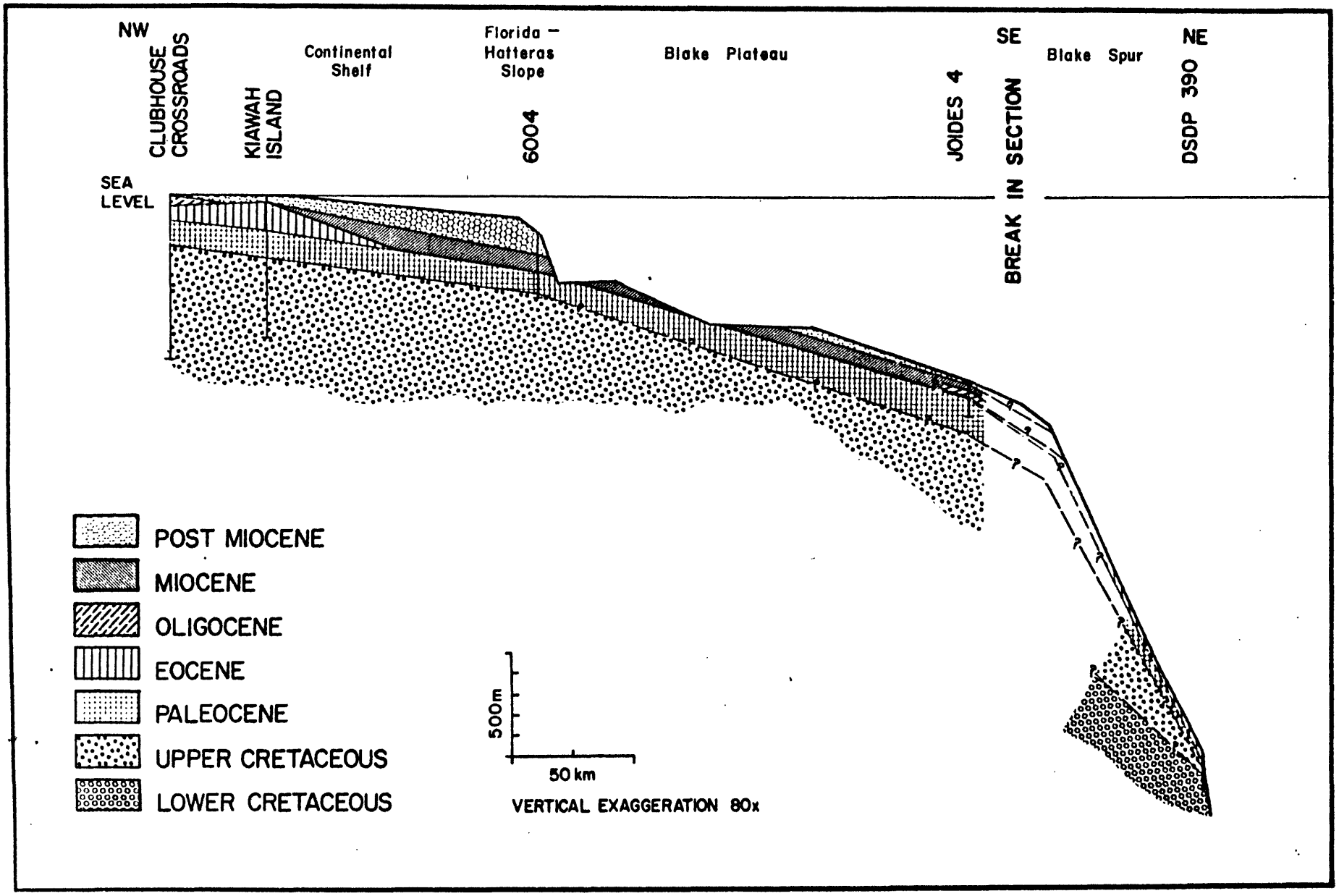


FIGURE A-2. Cross section of South Carolina continental margin.

the boreholes and are most probably exposed on the Blake Spur. Eocene strata, on the other hand, are discontinuous beneath the continental margin. Sediments of Eocene age are widespread beneath the Coastal Plain and extend some distance offshore beneath the shelf, but they are absent beneath the outer shelf and the inner Blake Plateau, recurring beneath the outer Blake Plateau and cropping out on the Blake Spur. Oligocene beds are also widespread beneath the Coastal Plain but do not occur beneath the shelf or the inner Blake Plateau. They are reported, however, from JOIDES 4 beneath the outer Blake Plateau.

Neogene and Quaternary strata are widely distributed within the sediments underlying the continental margin, excepting the Blake Spur where older sedimentary beds form the sea bed. Miocene sediments are not encountered in the two Coastal Plain wells treated here.

The discontinuity and thinness of the Cenozoic strata beneath this part of the continental margin is presumably the result of both subaerial and submarine erosion interacting with tectonic processes such as the uplift of the Cape Fear Arch.

The extent of Cretaceous strata beneath the continental margin is less well known. The oldest beds beneath the Coastal Plain are Cenomanian, reported from the Clubhouse Crossroads well. Upper Cretaceous strata have been penetrated in Hole 6004 on the Florida-Hatteras Slope. Interpretations of seismic records indicate that Cenozoic deposits beneath the Blake Plateau depicted in Figure A-2 probably form a relatively thin veneer over a thick sequence of Upper and Lower Cretaceous rocks.

Off-shore cross section of the continental margin.--This section (Figure A-3) approximately parallel the coastline from Florida to New Jersey (see location map, Figure A-1, for sites of boreholes; not to scale in hori-

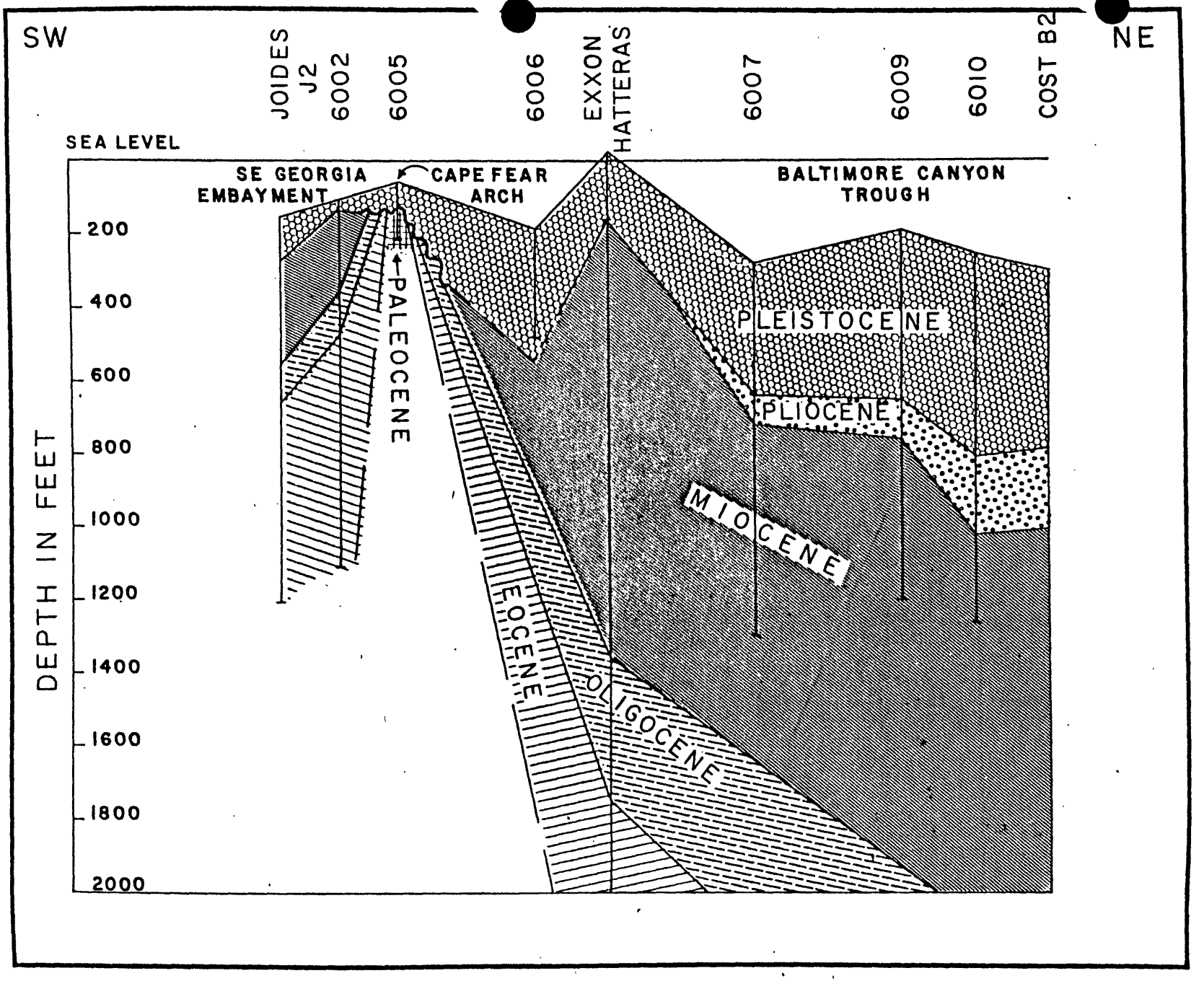


FIGURE A-3. Cross section along the Atlantic margin approximately parallel to coast.

zontal direction). The most striking feature of the cross section is the thinning and erosional truncation of the Tertiary strata across the Cape Fear Arch. Upper Eocene through Miocene beds were encountered in the Southeast Georgia Embayment, underlying the thin Pleistocene. However, the only Tertiary unit remaining in Hole 6005, atop the Cape Fear Arch is composed of shallow-water, marine Paleocene clay and limestone. Northward the Tertiary beds thicken significantly in the Baltimore Canyon Trough, as first seen in the Exxon Hatteras Light 1 well. Examination of samples from the holes of the Atlantic Margin Coring Project corroborated the thickening of the Miocene, Pliocene and Pleistocene sediments in this area. There is some evidence that detailed studies will reveal a much thicker Pliocene section in Hole 6007.

Cross section of the New Jersey continental margin.--The cross section (Figures A-1 and A-4) trends perpendicular to the New Jersey continental margin and incorporates stratigraphic information from three onshore holes in the Coastal Plain and seven offshore wells in the Continental Shelf and Slope. The stratigraphy of the onshore Holes, NJ-BU-P-3, NJ-BU-P-4, and NJ-OC-T-1, (which is the U.S.G.S. Island Beach 1), is taken from Brown, Miller, and Swain[1]. Offshore stratigraphic relationships derive from studies of the U.S.G.S. Atlantic Margin Coring Program Holes (6009, 6010, 6011, 6020, and 6021), the COST B2 well, and DSDP Hole 108[2].

[1]Brown, P. M., Miller, J. A., and Swain, F. M., 1972, Structural and stratigraphic framework, and spatial distribution of permeability of the Atlantic Coastal Plain, North Carolina to New York: U.S. Geological Survey Prof. Paper 796, 79 p.; (see pl. 41).

[2]Hollister, C. D., Ewing, J. I., et al., 1972, Initial Reports of the Deep Sea Drilling Project, Volume 11: Washington, D.C., U.S. Government Printing Office, p. 357-364.

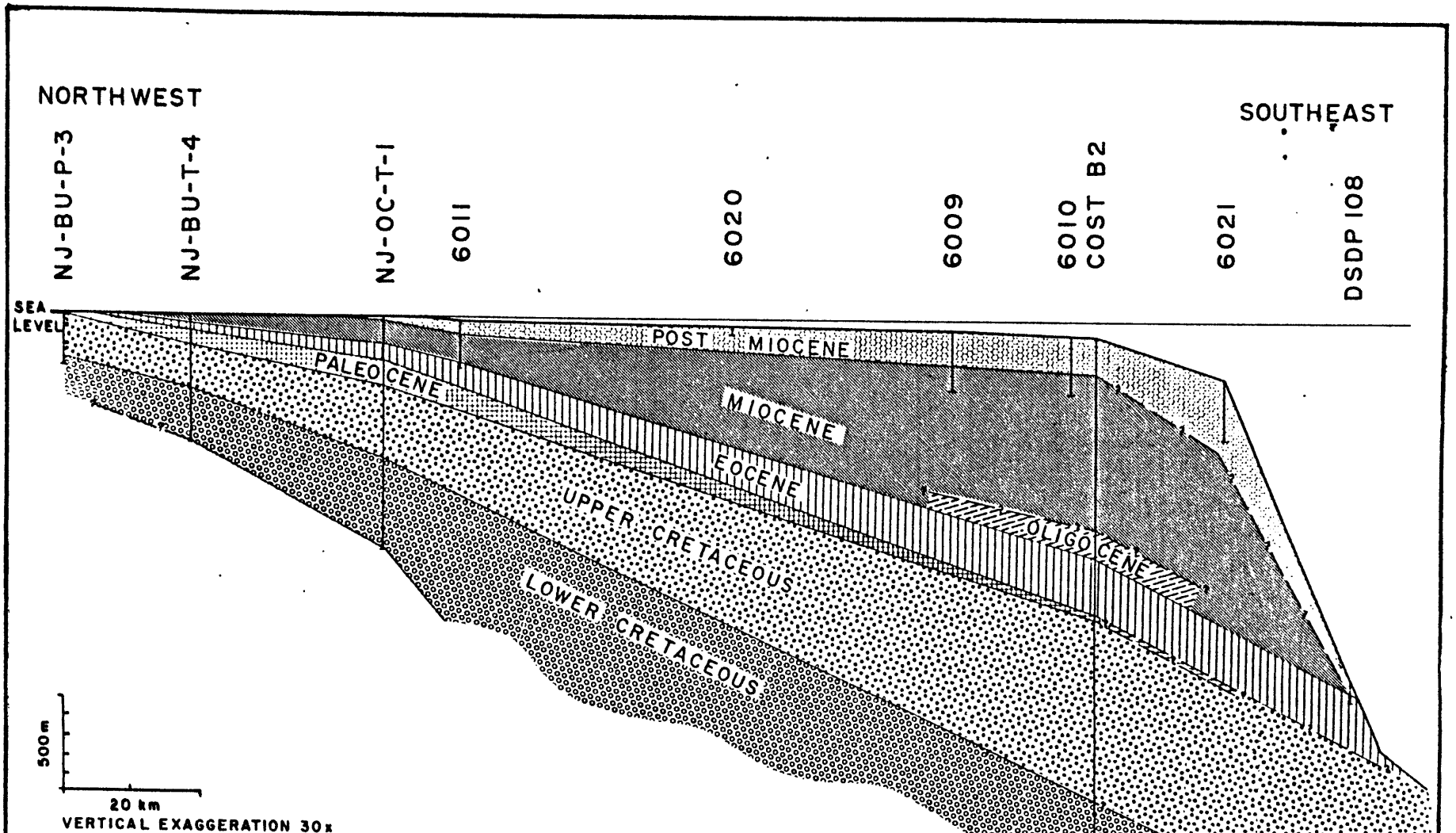


FIGURE A-4. Cross section of New Jersey continental margin.

The sedimentary strata of the Atlantic Coastal Plain continental margin are exposed in the New Jersey Coastal Plain, thicken seaward, and are encountered in the Continental Slope under a veneer of post-Tertiary sediment. Cenozoic beds reach their maximum thickness beneath the outer Continental Shelf and Slope, and Cretaceous strata arepresumed to exhibit a similar trend.

The lower Cretaceous sediments are chiefly of non-marine, terrestrial origin, although shallow marine environments are also represented. The upper Cretaceous beds, on the other hand, are mostly shallow marine in origin.

Paleogene strata are highly fossiliferous and were deposited in marine shelf environments. The Eocene strata in particular exhibit a rich marine fauna indicative of outer shelf and upper slope conditions. The Eocene beds are exposed in the New Jersey Coastal Plain, thicken seaward beneath the Continental Shelf, and are found in the Continental Slope where they were penetrated at DSDP site 108. The attitude and distribution of the Eocene strata are better known than are the other Tertiary sediments represented in this section, and being generally widespread beneath the continental margin, may provide an important datum for future biostratigraphic studies of this region. Sediments of Oligocene age have not been reported in surficial deposits or the deep wells of the New Jersey Coastal Plain, but approximately 500 feet of Oligocene marine strata were encountered in the COST B2 well, and it is possible that these beds have an appreciable lateral extent off shore.

Excepting the lower Miocene marine shelf sediments reported from COST B2, the Neogene and Quaternary strata are represented by a thick wedge of predominately marginal marine and deltaic beds. These sediments contain very sparse planktic foraminifer and calcareous nannofossil assemblages. Benthic foraminifers are present, however, and very rich diatom floras are encountered at intervals throughout this sedimentary sequence.

APPENDIX B

COMPARATIVE GEOLOGY OF ONSHORE AND OFFSHORE SOUTH CAROLINA

by

ALAN-JON ZUPAN and WILLIAM H. ABBOTT
Division of Geology
South Carolina State Development Board
Columbia, S.C. 29210

INTRODUCTION

The South Carolina Coastal Plain is underlain by a southerly thickening wedge of Upper Cretaceous through Holocene terrigenous and carbonate sediments. Toward the northwest, the beds pinch out at the Fall Line on the igneous and metamorphic rocks of the Piedmont; toward the northeast they have been uplifted and partly eroded on the southwest limb of the Cape Fear Arch (Fig. B-1). At the coastline, the sediments are 402 meters thick at the South Carolina-North Carolina boundary, and at least 1,020 meters thick at the South Carolina-Georgia boundary. The oldest sediments that have been dated are of middle Cenomanian age (Cape Fear Formation, 692-751 m.y., U.S.G.S. Clubhouse Crossroads core). Sediments of the Cape Fear Formation overlie basalt flows, the radiometric ages of which are earliest Late Cretaceous and latest Early Cretaceous. Metamorphic basement consisting of chlorite schist has been penetrated only in the Calabash and Myrtle Beach drill holes near the crest of the Cape Fear Arch. A generalized stratigraphic section for coastal South Carolina is illustrated in Figure B-2.

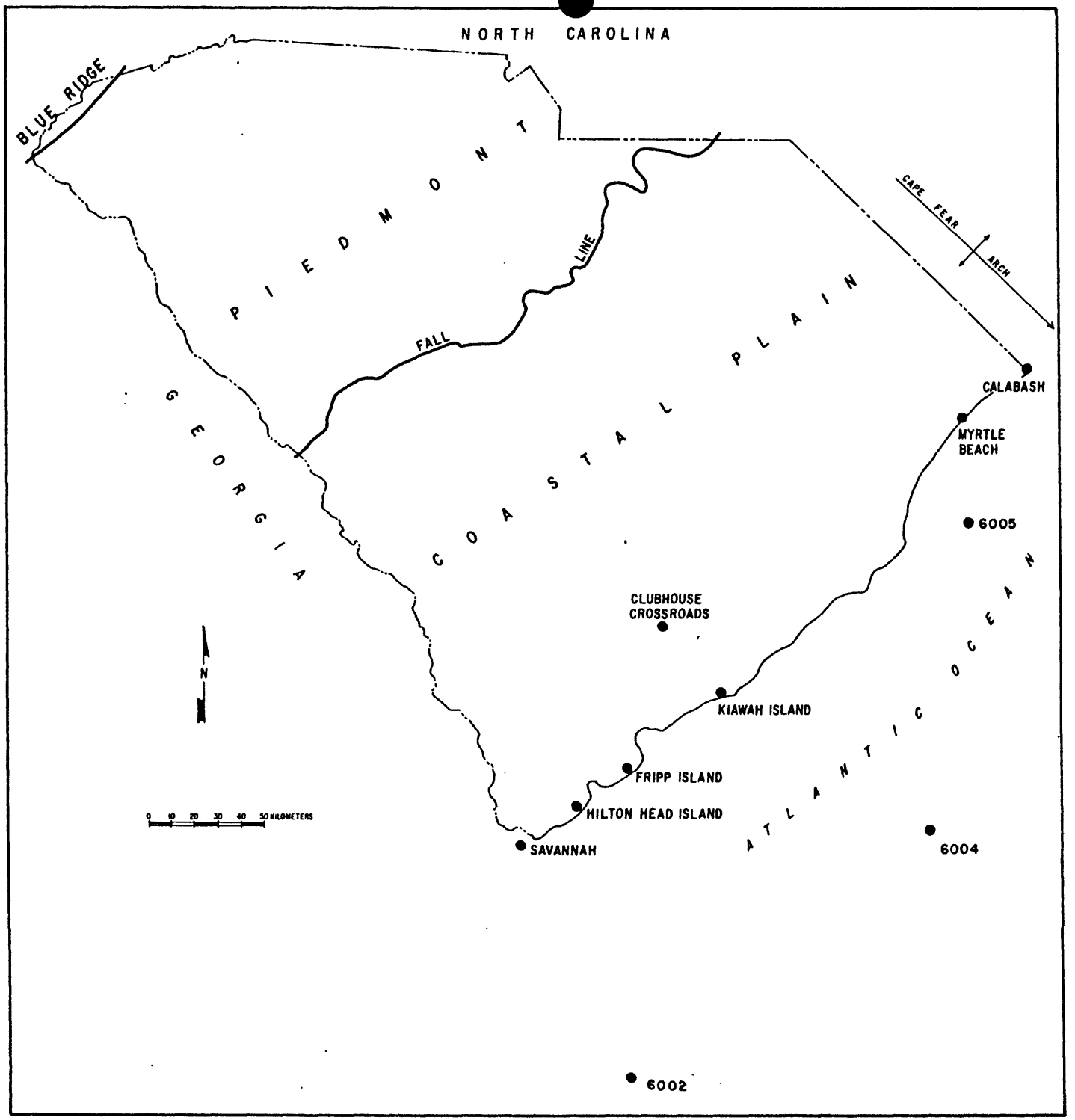


FIGURE B-1. Locality map of onshore and offshore drill holes.

ERA	SYSTEM	SERIES	FORMATION	
CENOZOIC	QUATERNARY	Holocene		Light-gray and tan, fine to coarse grained quartz sand and interbedded clay.
		Pleistocene	Undifferentiated	Undifferentiated: Light-gray, tan, orange, red and black interbedded with quartz sands and gravels.
			Waccamaw	Waccamaw Fm.: Tan, fine-grained, very fossiliferous quartz sands.
	TERTIARY	Pliocene	Duplin	Duplin Fm.: Tan, very fossiliferous quartz sands, and non-fossiliferous interbedded tan quartz sands and gray silty clays.
		Miocene	Hawthorne	Hawthorne Fm.: Brown, medium-to-coarse-grained, phosphatic quartz sands, quartzitic limestones, and olive green dolomitic silty clays with minor interbedded cristobalite.
		Oligocene	Cooper	Cooper Fm.: Greenish-gray to olive brown, slightly glauconitic and phosphatic, very microfossiliferous, clayey, quartzitic, bioclastic sand.
		Eocene	Santee	Santee Fm.: Yellowish-gray, slightly glauconitic, very microfossiliferous, quartzitic bioclastic sand; white to creamy yellow, glauconitic, quartzitic, molluscan limestone; white, glauconitic, phosphatic, quartzitic, bryozoan-pelecypod limestone. Black Mingo Fm.: White, microfossiliferous, quartzitic limestone.
		Paleocene	Black Mingo	Black Mingo Fm.: Interbedded gray-green silty clays and clayey quartz sands with thin, quartzitic, shelly limestones Beaufort (?) Fm.: Yellowish-to-greenish-gray, micro-fossiliferous, silty clay or sandy clay.
MESOZOIC	CRETACEOUS	UPPER CRETACEOUS	Peedee	Peedee Fm.: Dark green or gray, micaceous, glauconitic, microfossiliferous, fine-grained sandy silts and silty clays with thin indurated calcareous sandy silts.
			Black Creek	Black Creek Fm.: Lignitic, laminated medium to dark gray clay interbedded with medium gray to yellow quartz sands, locally phosphatic and glauconitic.
			Middendorf	Middendorf Fm.: Light-gray, white, tan and red fine-to coarse-grained, micaceous, arkosic quartz sands with interbedded lenses of white, gray or pink, quartzitic, kaolinitic clays.
			Cape Fear	Cape Fear Fm.: Red to brown, nodular clays with some interbeds of arkosic sands; and thinly interbedded olive-gray quartz sands and clays.

FIGURE B-2. Generalized stratigraphic section for coastal South Carolina.

CROSS SECTION OF COASTAL SOUTH CAROLINA

The cross section of South Carolina's Coastal Plain (Figure B-3) is based on a series of deep water well tests. The correlations are based primarily on paleontological data, but lithologic correlation was necessary in some instances.

Figure B-3 depicts a southwesterly thickening section of Upper Cretaceous through Pleistocene sediments. Beneath a thin cover of Pliocene/ Pleistocene sediments, progressively younger Tertiary beds are truncated by erosion southwestward off the Cape Fear Arch, which was active during the Tertiary.

A single hypothetical fault is drawn between the Kiawah Island and Fripp Island holes, although several faults may be present. The evidence for faulting in this area includes: 1) unusual thickening of the sedimentary section, 2) anomalous patterns in correlating geophysical logs in the area (Richard Inden, personal communication and Larry Hays, personal communication), and 3) a report of a fault with a throw of 33 meters offsetting the Oligocene-Eocene contact in this vicinity (by Mike Higgins and others, personal comm.).

COMPARISONS OF OFFSHORE AND ONSHORE STRATIGRAPHY FOR SOUTH CAROLINA

Within the Southeast Georgia Embayment (off Georgia and South Carolina), three sites were cored during the Atlantic Margin Coring Project. The first site, Hole 6002 (latitude 21°08.57'N, longitude 80°31.05'W) is approximately 144 km east of Brunswick, Georgia.

Holes 6004 and 6004B (latitude 32°03.98'N, longitude 79°05.86'W) are in the Florida-Hatteras slope approximately 200 km southeast of Charleston, South Carolina.

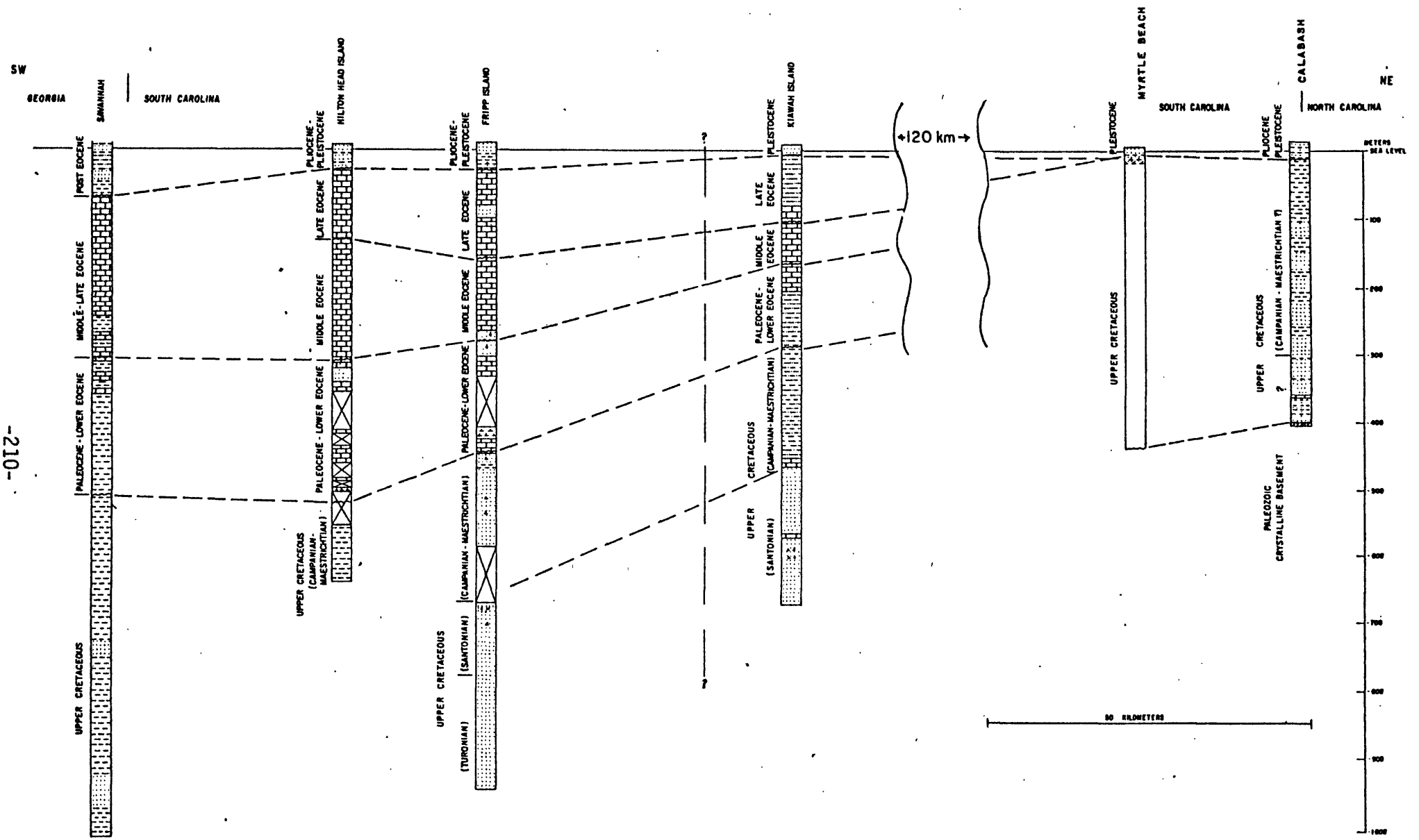


FIGURE B-3. Cross section along coastal South Carolina.

Hole 6005 is about forty kilometers east of Georgetown, South Carolina (latitude 33°15.10'N, longitude 78°44.08'W).

The oldest offshore sediment recovered in the cores was 14 meters of Upper Cretaceous clay in Hole 6004 (Figure B-4). The sediment is a firm olive-gray, silty calcareous clay or claystone, lithologically similar to the onshore Peedee Formation. In Hole 6004, this unit contains foraminifers and Campanian calcareous nannofossils. This dual age is also present onshore in South Carolina, where in some sections of the Peedee and Black Creek Formations, the foraminifers are younger than the nannofossils. This problem has not yet been resolved.

Paleocene sediments were recovered in both Hole 6004 and Hole 6005. In Hole 6004, the sediment was a hard, gray calcareous clay to claystone which is lithologically similar to the updip Black Mingo Formation onshore and the lower portion of the downdip Black Mingo (Beaufort (?)) Formation onshore. Sediments of this same lithology were cored in Hole 6005 although there they are overlain by an indurated gray limestone of Paleocene age. The latter sequence also occurs in the Black Mingo (Beaufort (?)) Formation as described from the U.S.G.S. Clubhouse Crossroads Corner core, Dorchester County, South Carolina, in which an upper Paleocene to lower Eocene limestone overlies a Paleocene dark gray claystone.

Eocene sediments consisting of indurated calcilutite and nonindurated calcilutite and calcarenite were recovered only in Hole 6002 (Figure B-5). These carbonates represent deeper water facies than the Eocene carbonate formations in South Carolina and Georgia. Preliminary age designations are not specific enough to allow precise correlation of the Hole 6002 Eocene carbonates with individual units of the onshore Eocene carbonates.

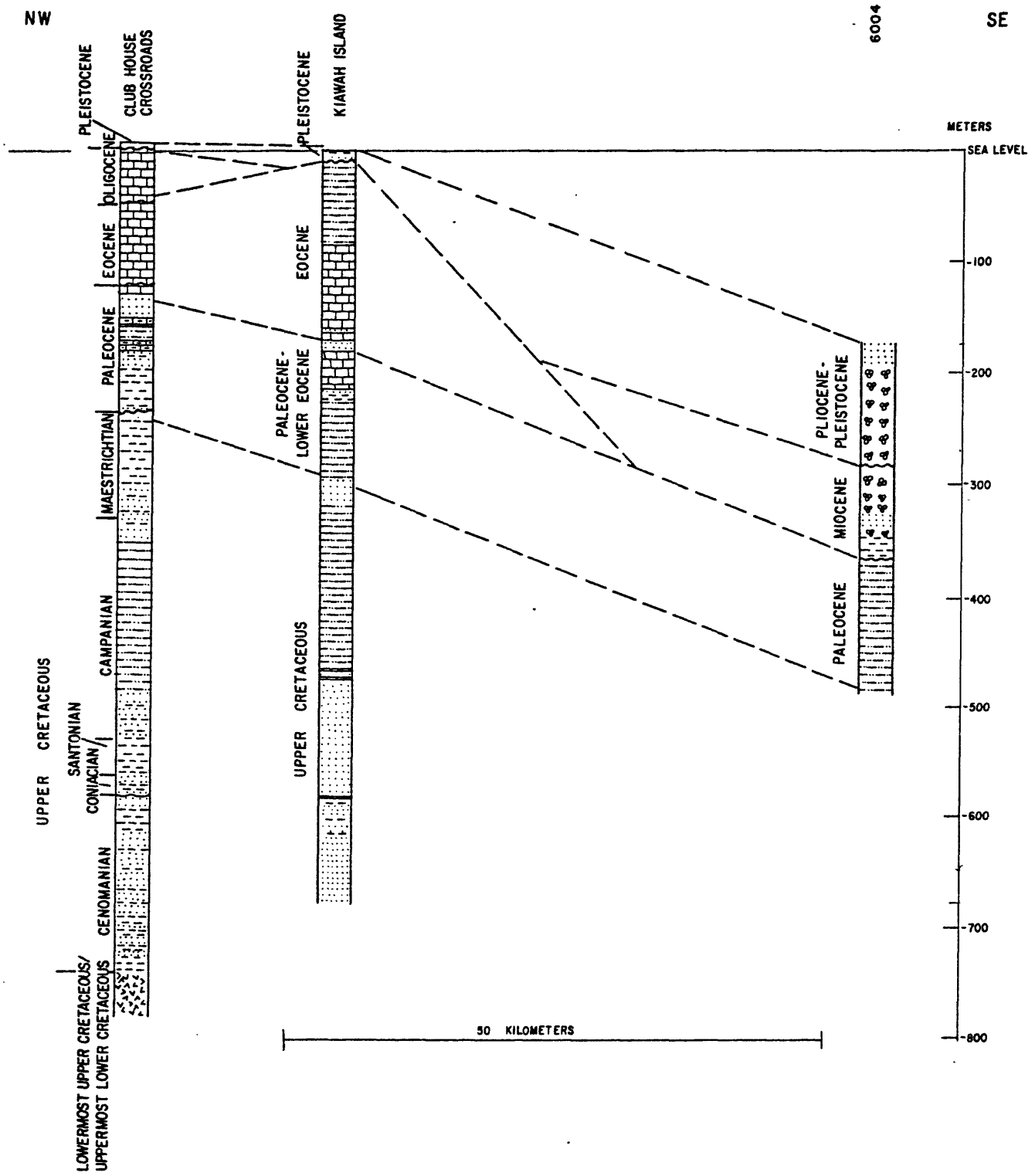


FIGURE B-4: Cross section between the U.S.G.S. Clubhouse Crossroads and Hole 6004.

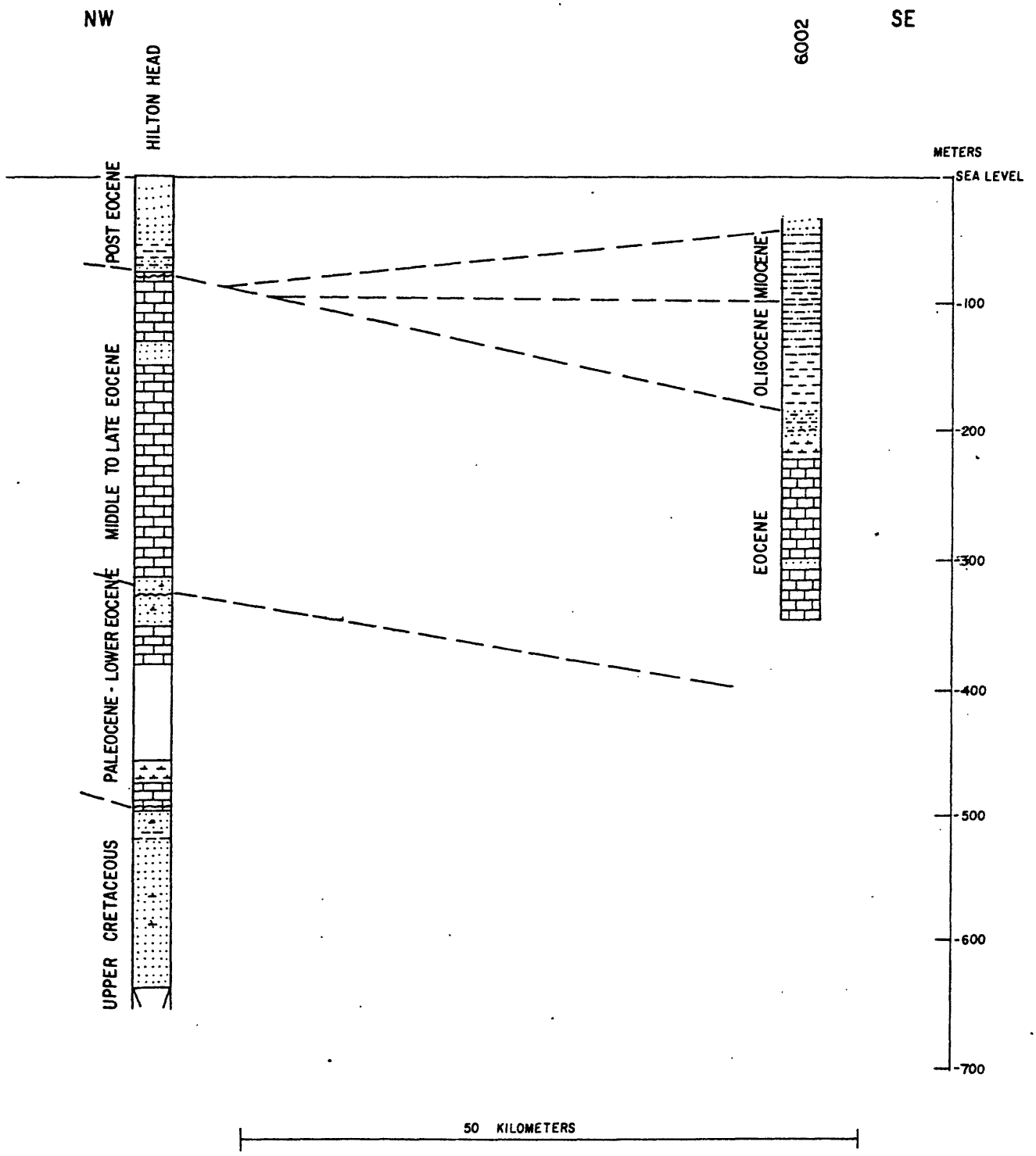


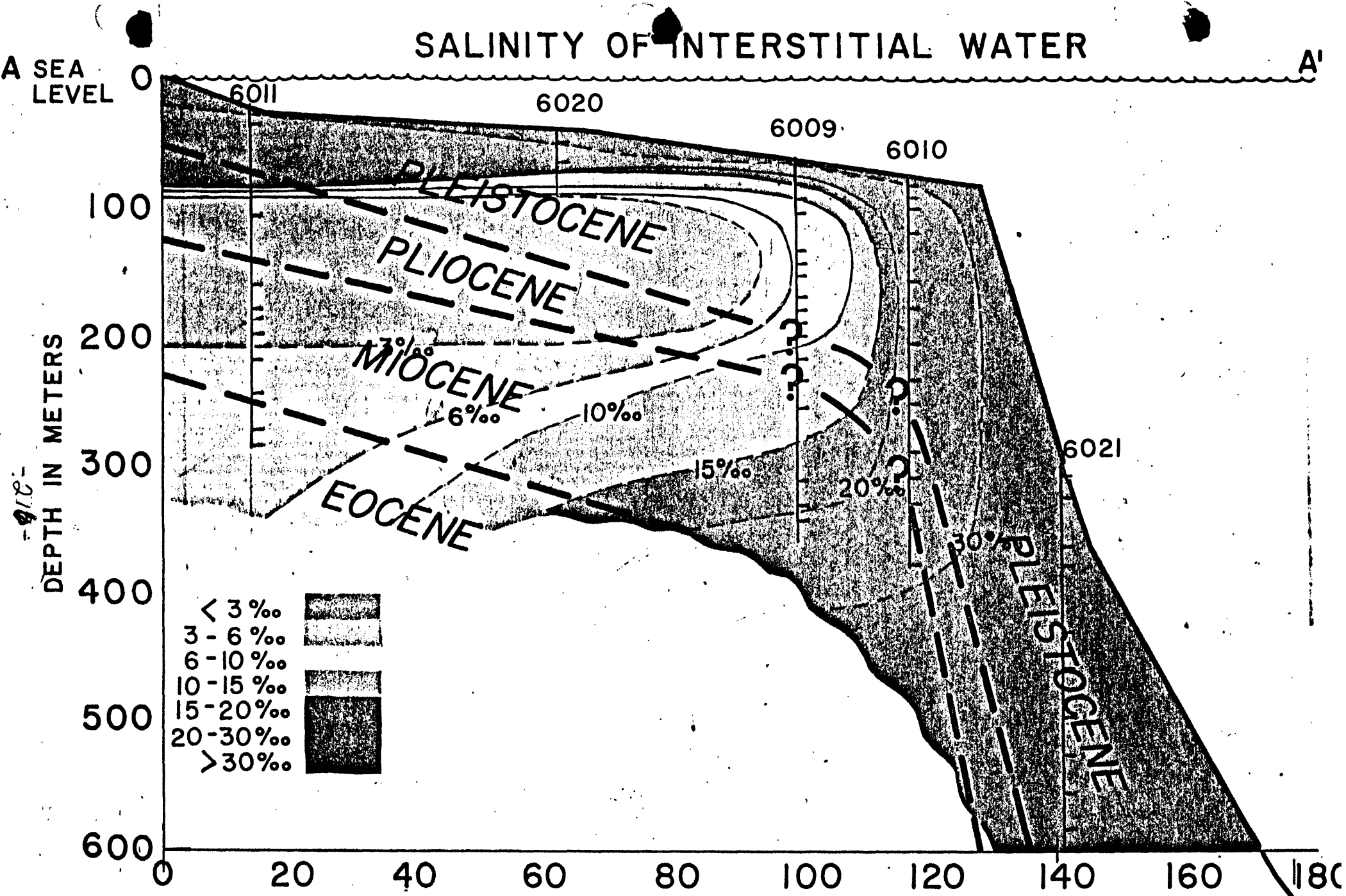
FIGURE B-5. Cross section between the Hilton Head and Hole 6002.

The Eocene carbonate unit from Hole 6002 grades into an olive, calcareous, silty clay of Oligocene age. In Core 9 of Hole 6002, a late Oligocene age based on foraminifers was determined. This unit is similar lithologically and biostratigraphically to the Oligocene Cooper Formation of onshore South Carolina.

In Hole 6002, the olive, calcareous silty Oligocene clay is overlain by an olive, diatomaceous silty clay in the Miocene interval. The middle Miocene portion of this unit is equivalent to the upper Hawthorne Formation of South Carolina and Georgia (Coosawhatchie Clay in South Carolina). Middle Miocene sediments were also recovered in Hole 6004, but these foraminiferal sands are of deeper water origin than Miocene sediments of the Coastal Plain.

APPENDIX C

Cross section showing zone of low salinity interstitial water extending seaward under the continental shelf off central New Jersey. Interpretive salinity contours by Francis A. Kohout.



CROSS SECTION OF ZONE OF DIFFUSION OFFSHORE
BARNEGAT LIGHT, NEW JERSEY

-316-

APPENDIX D

GEOPHYSICAL BOREHOLE LOGS

Geophysical borehole logs were run in 10 of the holes of the Atlantic Margin Coring Project. For those holes in which a complete set of logs could be run, the set consists of the following:

1. Electric log (ES)
   - (a) Spontaneous potential
   - (b) Resistivity, long normal
   - (c) Resistivity, short normal
   - (d) Resistivity, lateral
2. Gamma Ray (natural gamma) and Neutron (neutron porosi)
3. Compensated Formation Density (gamma-gamma) and Caliper.
4. Sonic log (integrated transit time)

   (Variable Density Sonic was also run in hole)
5. Temperature

The vertical scales of the logs are in feet relative to Kelly bushing (RKB). The distance from the Kelly bushing to sea level was 32 feet for all logs.

Copies of the uninterpreted logs may be obtained by contacting:

~~Appalachian Log Service~~
~~Post Office Box 13239~~
~~Pittsburgh, Pennsylvania 15243~~

See below

For a listing of the logs available for each hole, see the above section: SUMMARY OF HOLES.

ELSI - PI
105 West Wall
P. O. Box 3150
Midland, Texas 79701

Phone 915-682-0591