SITE REPORT

Objectives

The Atlantic Advisory Panel proposed that Site 9 should be drilled on the northeastern flank of the Bermuda Rise (lat. 32° 37' N., long. 59° 10' W.), which is about 100 miles west of the Sohm Abyssal Plain. The bottom of this region consists of low linear ridges that are roughly parallel and oriented in a northwest-southeast direction. Scattered seamounts, some of which have peaks 2000 fathoms (3660 meters) below sea level, arise from the otherwise featureless sea floor between the ridges. The rise is dissected by deep valleys with steep flanks. Towards the east, these valleys are partially filled with turbidites of the Sohm Abyssal Plains.

The primary purpose in drilling Site 9 was to examine a sedimentary column where seismic reflectors were largely absent and to determine the age of sediments overlying acoustical basement in the examination of sea floor spreading. The basement trace is fairly rough (Figure 1), and Horizons A, B, and C have not been detected in the overlying 2600-2800 feet (4760-5120 meters), (0.90 seconds reflection time) of sediment. The upper several hundred feet (0.1-0.2 seconds reflection time) of sediment are acoustically laminated and, on the basis of piston cores, they were expected to represent a calcareous pelagic facies. The underlying sediment is acoustically transparent, except for a single weak reflector at a depth of 2200-2400 feet (4025-4390 meters), (0.75 seconds reflection time) below the sea floor.

Therefore, the following drilling prospectus was drawn up:

1) Attempt continuous coring of the upper acoustically-laminated sediments and the contact with the underlying acoustically-transparent sediment;

2) Attempt discontinuous coring at widely-spaced intervals in the acoustically-transparent sediment above the weak reflector.

3) Attempt to core the weak reflector.

4) Attempt continuous coring of the sediment between the weak reflector and the basement; and,

5) Attempt to core the basement rock.

The available well-logging procedure was to be followed.

Drilling and Coring Log

At 0800 hours, October 21, final positioning for Hole 9 (Figure 2) was achieved at latitude 32° 46.4' N and longitude 59° 11.7' W in a water depth of 16,285 feet (4965 meters) (corrected). Figure 3 is a tracing of the seismic record made while on station. Continuous coring procedures were initiated when the tungsten carbide bit reached the sea floor. The reader is referred to Tables 1 and 2 for a summary of coring operations.

The first core barrel was retrieved at 0505, October 22, and was found to be empty except for traces of sediment in the catcher liner. Apparently, the core had been cut but the soft sediment was not retained by the catcher. Cores 2, 3 and 4 had similar results, and the cause was attributed to the same condition. Quaternary microfossils were present in smear slides that were made from the traces of sediment in Cores 1, 2 and 4.
Core 5 was cut from 103 feet (31.4 meters) to 228 feet (69.5 meters), a distance of 125 feet (38.1 meters) in an effort to increase recovery by sediment compaction in the core. This attempt yielded 25 feet (7.6 meters) of highly disturbed sediment. For Core 6, a 30 foot (9.1 meter) core was cut but was lost through the catcher. Because of these adverse conditions, the decision was made to stop continuous coring, and the center bit was replaced. Drilling progressed to 630 feet (192 meters), where the sediments appeared to be more consolidated. Cores 7 through 12 yielded a low recovery of Miocene - Pliocene clay separated by intervals of water trapped in the liner. At 1613 feet (491.6 meters), the power sub failed, and the drill string became stuck in the hole because of the inability to rotate the pipe. After freeing the pipe, the hole was abandoned. Drilling had reached a depth of 2052 feet (625 meters) beneath the ocean floor.

Hole 9A was drilled at the same location and the same beacon, drill string and bit were used, after pulling the drill string to the sea floor. The intention at Hole 9A was to drill below the total depth of Hole 9 in order to sample older sediment and possibly the basement. For this reason, the first core was not taken until a depth of 2226 feet (678.6 meters) had been reached. The sediment recovered is a hard clay with Eocene cherts and radiolarian ooze. Deformation of the plastic liner caused extreme difficulty in extruding the core. Overheating of the bit appears to have produced this deformation. Several hundred feet of section was drilled before Core 2 was cut, which yielded only one foot of hard clay containing sparse coccoliths, foraminifera and Radiolaria of Upper Cretaceous age. The transparent liner was discolored to a cloudy white and badly deformed in the lower two feet, suggesting that the bit had become overheated. A 30 foot (9.1 meter) core of sediment directly below Core 2 was cut. Core 3, cut immediately below Core 2, contained 7 feet (2.1 meters) of clay. The power sub failed again, the center bit was replaced and drilling progressed by means of the rotary table and kelly. The sea was fairly high (four to six on the Beaufort scale) and the kelly rubbed against the horn, rounding off the corners to a minor degree exponential. As weather conditions deteriorated, the kelly bearing lifted from side to side as the ship rolled. At one time, the kelly bearing jumped out of the table and as a result the mounting pins were bent.

Because deformation of the liner restricted core recovery, the remaining cores at this site were taken without liners and were extruded using a hydraulic pump. The
sediments lying close to the basement are very well indurated, which may account for the relatively poor recovery in Cores 4 and 5. Basement rock was encountered beneath red indurated clays at 2740 feet (835.5 meters) and about 200 grams of igneous rock were recovered from the lower portion of Core 6, which was only about 1-foot long. Because of the high risk of damaging or of losing the drill string when in the bottom to the full depth of 2740 feet, or of the hole beginning to collapse, the drill string was raised to a penetration of only 2500 feet before attempting to either recover Core 6 or log the hole.

### TABLE 1
Drilling Summary

<table>
<thead>
<tr>
<th>Hour/Date</th>
<th>Core No.</th>
<th>Depth Below Sea Floor m</th>
<th>Core Cut m</th>
<th>Core Recov. m</th>
<th>% Core Recov.</th>
<th>No. Core Sec.</th>
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<td>5050 16565</td>
<td>9.14 30</td>
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<td>0045</td>
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<td>1.22 4</td>
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Note: Hole 9 was terminated when power sub failed and pipe stuck in hole.

TD = 18,389 feet
TABLE 1—Continued

<table>
<thead>
<tr>
<th>Hour/Date</th>
<th>Core No.</th>
<th>Depth Below Sea Floor m</th>
<th>Depth Below Sea Surface ft</th>
<th>Core Cut Core Recov. m ft</th>
<th>% Core Recov.</th>
<th>No. Core Sec.</th>
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Note: TD = 19,075 ft

---

38
<table>
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<tr>
<th>Core No.</th>
<th>Drilling Time (hr)</th>
<th>Depth Cored (ft)</th>
<th>Average Coring Rate (ft/hr)</th>
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Summary of Drilling and Coring at Site 9

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<th>WATER CONTENT</th>
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</table>

Figure 4. Summary of drilling and coring at Site 9.

2. Clay mixed and interbedded with nannofossil ooze for 7-8. Pale olive to green gray.
4. Yellow brown to greenish gray.

(Continued)
Zeolitic clay, dusky yellow brown, with cherty radiolarian ooze and cherty mudstone fragments and radiolarian ooze.

Zeolitic clay, very dark grayish brown, with traces of nannofossil ooze.

Clay, greenish gray, for 11-12.

Figure 4. Continued.
The Cores Recovered from Site 9

Figures 5 through 16 are the graphic summaries of the cores recovered at Site 9.

These figures show, for each core:

1. The stratigraphic age.
2. The natural gamma radiation
3. The bulk density, determined by the GRAPE (Gamma Ray Attenuation Porosity Evaluation) equipment
4. The length of the core in meters measured from the top of the core and the subbottom depth of the top of the cored interval.
5. The lithology (see key with Chapter 3).
6. The positions of the tops of each core section.
7. Some notes on the lithology.
<table>
<thead>
<tr>
<th>AGE</th>
<th>$\rho_B$ (gm/cc)</th>
<th>$\gamma$ (counts/2.5 min./3&quot; section)</th>
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<tr>
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### Lithologic Description

- **Portion of liner empty.**

- **108 ft (33 m)**
  - Calcareous radiolarian ooze
  - *Nannofossil marl ooze, gray, mottled.***

- **Silty marl with some radiolarians***
  - *Nannofossil marl ooze.*

- **Silty marl with some radiolarians, gray to gray-brown.***
  - *Nannofossil marl ooze***

- **Radiolarian ooze with non-skeletal carbonate silt, greenish gray.***

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*Figure 5. Hole 9 Core 5.*
LITHOLOGIC DESCRIPTION

1. Nannofossil marl to chalk ooze, olive gray and pale yellow brown.


3. Nannofossil chalk ooze with traces of radiolaria, yellow gray.

4. Radiolarian ooze interbedded with Nannofossil chalk & marl ooze.

5. Clayey mud and clayey silt.

6. Silty ?non-skeletal calcareous, clay interbedded with nannofossil chalk ooze, moderate brown to green gray.

7. Nannofossil chalk ooze, light olive gray to moderate brown.

Figure 5. Continued.
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<tr>
<th>AGE (counts/2.5 min./3” section)</th>
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LITHOLOGIC DESCRIPTION

Portion of liner empty.

649 ft (198 m)

*Nannofossils and clay*, mixed during coreing with nannofossil chalk ooze, pale olive.

Clay, gray.

Figure 6. *Hole 9 Core 7.*
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<th>$\rho_B$ (gm/cc)</th>
<th>$\gamma$ (counts/2.5 min./3&quot; section)</th>
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<tr>
<td>3</td>
<td>3.5</td>
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</tr>
</tbody>
</table>

**LITHOLOGIC DESCRIPTION**

- **2** Nannofossil marl ooze, green gray.
- **3** Clay, mottled. Nannofossil marl ooze mixed by coring with nannofossil marl ooze dark green gray.
- **4** Clay, greenish gray.
- **Nannofossil chalk ooze, greenish gray.**
- **Clay.** 668 ft. (203 m)

*Figure 6. Continued.*
Figure 7. Hole 9 Core 8.

Portion of liner empty.

672 ft. (205 m)

Clay, dark greenish gray.

Nannofossil ooze mixed during coring with clay.

Clay

Portion of liner empty
Figure 7. Continued.

Clay, slightly mottled, greenish gray to dark green gray, with repeated thin (Ca. 1.5 cm) bands of yellow-brown "staining".

?Rhodochrosite in-filling of burrows.
Figure 8. Hole 9 Core 9.

Clay, dark greenish gray. Bands of yellow-brown "staining" throughout.
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<tr>
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<table>
<thead>
<tr>
<th>CM</th>
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<tbody>
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</table>

**LITHOLOGIC DESCRIPTION**

Portion of liner empty  
No sections 4 and 5

- Clay, pale olive,  
  moderate yellow brown and bluish gray.

**Figure 8. Continued.**
Figure 9. Hole 9 Core 10.

Clay, bluish gray to dark greenish gray.

?Non-skeletal carbonate silt and quartz silt present in small to moderate amounts.

Section 3 has scattered 1-2 mm “vugs” containing pure white zeolite crystals.
Clay, greenish gray. Quartz silt present in minor amounts.

Sections 4 & 5 have scattered 1-2 mm "vugs" containing pure white zeolite crystals.
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<th>$\gamma$ (counts/2.5 min./3&quot; section)</th>
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<tr>
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</table>

No Fossils

NO RECORDS AVAILABLE

1581 ft (482 m)

Clay, dark green gray.

1583 ft (482 m)

Figure 10.
Figure 11. Hole 9 Core 12.

Clay, greenish gray.
?Quartz silt present in minor amounts.

Portion of liner empty.
(No sections 2 & 3)
NO NATURAL GAMMA RECORDS

Clay, greenish gray.

Portion of liner empty.
(No section 4)

Clay, greenish gray.

Portion of liner empty.

1608 ft (490 m)

Portion of liner empty.
(No section 6)

Figure 11. Continued.
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**LITHOLOGIC DESCRIPTION**

- 2226 ft. (678 m)
- **Zeolitic clay**, dusky yellow brown, mottled
- Portion of liner empty.
  (No sections 2 & 3)

Figure 12. *Hole 9A Core 1.*
Figure 12. Continued.

Portion of liner empty.

Cherty radiolarian mudstone fragments, brown.

Zeolitic "red clay," dark brown to dark yellow brown

Portion of liner empty.

Zeolitic "red clay," dusky yellow brown, mottled. Contains disturbed fragment of radiolarian ooze, yellow-green.

2239 ft (682 m)
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**LITHOLOGIC DESCRIPTION**

No Records Available

Portion of liner empty.

.2507 ft (764 m)

Zeolitic clay, semi-indurated, moderate brown laminated light brown.

Cherty radiolarian mudstone fragment.

2509 ft (765 m)

Figure 13. Hole 9A Core 2.
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</thead>
<tbody>
<tr>
<td>10,000</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>No Records Available</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
<td>100</td>
<td>300</td>
<td>Portion of liner empty.</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>200</td>
<td>400</td>
<td>2521 ft (768 m)</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>300</td>
<td>500</td>
<td>Zeolitic clay, very dark grayish brown with dark brown layers.</td>
</tr>
</tbody>
</table>

Figure 14. *Hole 9A Core 3.*
Zeolitic clay, very dark grayish brown laminated in shades of brown

Fragments of *nannofossil chalk ooze*, reddish-yellow

Zeolitic clay, semi-indurated in part. Dark brown & yellowish red, diffusely laminated by color differences. Varicolored “clasts” of *Zeolitic clay*, green, orange-brown & red brown, present in some sections. “Clasts” may be remnants of more indurated layers which have been disrupted by coring.

2539 ft (774 m)

Figure 14. Continued.

2703 ft (824 m)

2707 ft (825 m)

Figure 15. Hole 9A Core 4.
Zeolitic clay, semi-indurated. Moderate to dark reddish brown, thinly laminated in shades of brown.

Portion of liner empty.

Zeolitic clay, semi-indurated, Dark reddish brown, finely laminated with white.

Dense manganese concretion present in this section.

2736 ft (834 m)

Figure 16. Hole 9A Core 5.
The Cores Recovered from Site 9

Figures 17 through 56 show details of the individual core sections of the cores from Site 9.

Each figure shows:
(1) A scale of centimeters from the top of each section.
(2) A photograph of the core section.
(3) The lithology (see key in Chapter 3).
(4) The positions of smear slides (x).
(5) Notes on the lithology, X-ray mineralogy, carbon content, expressed as a percentage of total sediment (see Chapter 9), the water content and the grain size (see Chapter 8). Colors are given with reference to the GSA Rock Color Chart.
Figure 17. Hole 9 Core 5 Section 1.
Snd. 0, Slt. 21.2, Cl. 78.8
Tot. C. 1.2, Org. C. 0.3, CaCO₃ 7.5

X-ray diffraction results (10-12 cm)
Montm. 0.0%
Chlor. 0.0
Mica 20.3
Clin. 0.0
Kao. 16.8
Quartz 29.7
K-feld. 6.5
Plag. 26.5
Calcite 0.0
Dolo. 10.1

5Y5/1 (M) to 5Y6/1 (M) to 10YR5/2 (M)
(gray to grayish brown)

50-62 cm: - *Nannofossil marl ooze.*
Nannos. 47%
Non. skel. carb. 45%

Snd. 0.1, Slt. 16.3, Cl. 83.6

62-150 cm: - *Radiolarian ooze w/ carbonate*
Non-skel. carb. 20-60%
Rads. 40-50%
Clay mins. 30-40%

Figure 18. *Hole 9 Core 5 Section 2.*
Figure 19. Hole 9 Core 5 Section 3.

0-17 cm: *Nannofossil marly silt*
- Nannos. 30%
- Quartz silt. 30%
- Nannofossil marly silt. 10%
- Organic C. 0.5, CaCO₃ 9.2

17-150 cm: *Nannofossil chalk ooze*
- Nannos. 65-98%
- Skeletal carb. 0-25%
- Clay mins. 0-5%
- Total C. 6.8, Org. C. 0.2, CaCO₃ 55.0
0-54 cm: *Marl ooze*, mottled.
Clay mins. 60%
Non-skel. carb. 35%
Qtz. silt. 5%

5Y4/1 to 5Y6/1 (olive gry.)

54-115 cm: *Nannofossil chalk ooze.*
Nannos. 85%
Non-skel. carb. 10%
Rads. etc. tr.

X-ray diffraction results (86-88 cm)
Montm. 0.0%
Chlor. 0.0
Mica 4.0
Clin. 0.0
Kao. 3.1
Quartz 5.8
K-feld. 0.0
Plag. 3.4
Calcite 79.2
Dolo. 3.5

115-122 cm: *Siliceous ooze.*
Clay mins. 60%
Non-skel. carb. 20%
Rads. etc 20%

122-129 cm: *Nannofossil chalk ooze*
129-135 cm: *Nannofossil marl ooze*
135-145 cm: *Nannofossil chalk ooze*
145-150 cm: *Clayey mud,* overlain by thin calcareous clayey silt.

Figure 20. *Hole 9 Core 5 Section 4.*
Snd. 0.0, Slt. 20.4, Cl. 79.6
Tot. C. 9.2, Org. C. 0.4, CaCO₃ 73.3

X-ray diffraction results (11-13 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Chlor.</td>
<td>0.0</td>
</tr>
<tr>
<td>Mica</td>
<td>34.0</td>
</tr>
<tr>
<td>Clin.</td>
<td>0.0</td>
</tr>
<tr>
<td>Kao.</td>
<td>22.8</td>
</tr>
<tr>
<td>Quartz</td>
<td>27.6</td>
</tr>
<tr>
<td>K-feld.</td>
<td>0.0</td>
</tr>
<tr>
<td>Plag.</td>
<td>8.9</td>
</tr>
<tr>
<td>Calcite</td>
<td>3.6</td>
</tr>
<tr>
<td>Dolo.</td>
<td>3.1</td>
</tr>
</tbody>
</table>

0-101 cm: *Silty calc. clay interbedded w/nannofossil chalk ooze.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay mins.</td>
<td>15-70%</td>
</tr>
<tr>
<td>Nannos.</td>
<td>0-75%</td>
</tr>
<tr>
<td>Qtz. silt</td>
<td>0-10%</td>
</tr>
<tr>
<td>Non-skel. carb.</td>
<td>10-20%</td>
</tr>
</tbody>
</table>

X-ray diffraction results (86-88 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Chlor.</td>
<td>0.0</td>
</tr>
<tr>
<td>Mica</td>
<td>27.1</td>
</tr>
<tr>
<td>Clin.</td>
<td>0.0</td>
</tr>
<tr>
<td>Kao.</td>
<td>25.0</td>
</tr>
<tr>
<td>Quartz</td>
<td>31.9</td>
</tr>
<tr>
<td>Plag.</td>
<td>16.0</td>
</tr>
</tbody>
</table>

101-108 cm: *Silty calc. clay. clay mins. 55%
Non-skel. carb. 40%
Nannos. + qtz. silt tr.

108-150 cm: *Nannofossil chalk ooze.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nannos.</td>
<td>75%</td>
</tr>
<tr>
<td>Clay mins.</td>
<td>15%</td>
</tr>
<tr>
<td>Non-skel. carb.</td>
<td>10%</td>
</tr>
</tbody>
</table>

Figure 21. Hole 9 Core 5 Section 5.
20-91 cm: - Brecciated during coring.
Clasts: - *Nannofossils and clay.*
Clay mins. 70%
Nannos. 20%
Matrix: *Nannofossil chalk ooze.*
Nannos. 80%

99 Tot. C. 0.5, Org. C. 0.2, CaCO₃ 2.5

5Y5/1 (M)
(Gry.)

91-150 cm: - *Clay.*
Mottled and swirled, poss. due to coring.
Clays 80%
Nannos. 10%

X-ray diffraction results (124-126 cm)

127 Snd. 0.0, Slt. 10.6, Cl. 89.4

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>27.0%</td>
</tr>
<tr>
<td>Chlor.</td>
<td>0.0</td>
</tr>
<tr>
<td>Mica</td>
<td>17.3</td>
</tr>
<tr>
<td>Clin.</td>
<td>0.0</td>
</tr>
<tr>
<td>Kao.</td>
<td>19.9</td>
</tr>
<tr>
<td>Quartz</td>
<td>25.8</td>
</tr>
<tr>
<td>K-feld.</td>
<td>3.9</td>
</tr>
<tr>
<td>Plag.</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Figure 22. Hole 9 Core 7 Section 1.
0-113:—Badly disturbed by coring. *Nannofossil marl ooze*
Nannos. 75%
Clay mins. 25%

X-ray diffraction results
(92-94 cm)
Montm. 28.8%
Chlor. 0.0
Mica 18.7
Clin. 0.0
Kao. 19.8
Quartz 23.2
K-feld. 3.6
Plag. 6.0

113-115 cm:—Clay, mottled.

135-150 cm:—*Coccolith marl ooze*
Cocc. 75%
Clay mins. 25%

Figure 23. *Hole 9 Core 7 Section 2.*
Total C. 0.6, Org. C. 0.2, CaCO₃ 3.3

Entire sect. brecciated by coreing.
Clasts: Clay
Matrix: Nannofossil marl ooze.
Nannofossils 40%
Clay mins. 60%

X-ray diffraction results (75-77 cm)
Montm. 19.3%
Chlor. 0.0
Mica 21.5
Clin. 0.0
Kao. 21.6
Quartz 31.9
Plag. 5.7
Figure 25. *Hole 9 Core 7 Section 4.*
Section disturbed.

5GY3/2
(Grysh. olive grn.)

Clay.

Figure 26. Hole 9 Core 8 Section 1.
Whole section badly disturbed.
0-38 & 61-150 cm:—
*Clay*, w/black streaks.

X-ray diffraction results
(16-18 cm)

- **Montm.**: 29.7%
- **Chlor.**: 0.0
- **Mica**: 15.6
- **Clin.**: 0.0
- **Kao.**: 20.5
- **Quartz**: 24.1
- **K-feld.**: 3.5
- **Plag.**: 6.6

38-61 cm:— *Nannofossil ooze* between clay clasts

- **Nannos.**: 60%
- **Clay mins.**: 40%

X-ray diffraction results
(69-71 cm)

- **Montm.**: 25.2%
- **Chlor.**: 0.0
- **Mica**: 21.8
- **Clin.**: 0.0
- **Kao.**: 18.3
- **Quartz**: 31.2
- **Plag.**: 3.5

5GY4/1

**Tot. C.**: 0.6, **Org. C.**: 0.3, **CaCO3**: 2.5

---

Figure 27. *Hole 9 Core 8 Section 2.*
Figure 28. Hole 9 Core 8 Section 3.
Figure 29. Hole 9 Core 8 Section 4.
Figure 30. Hole 9 Core 8 Section 5.
Figure 31. Hole 9 Core 8 Section 6.

X-ray diffraction results
(7-9 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>35.9%</td>
</tr>
<tr>
<td>Chlor.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Mica</td>
<td>16.2%</td>
</tr>
<tr>
<td>Clin.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Kao.</td>
<td>19.9%</td>
</tr>
<tr>
<td>Quartz</td>
<td>24.1%</td>
</tr>
<tr>
<td>K-feld.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Plag.</td>
<td>3.9%</td>
</tr>
</tbody>
</table>

Snd. 1.4, Slt. 9.6, Cl. 89.0
5GY4/1 (Dk. grnsh. gry.)

Section sheared by coring. Badly disturbed between 100 & 150 cm.

Clay, mottled w/scattered small streaks of dk. gry.

Clay mins. 100%

Small nodules 11-28 cm. Bands of yell. brown staining throughout. (10YR5/8 (m))

X-ray diffraction results
(80-83 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Montm.</td>
<td>24.4%</td>
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<tr>
<td>Chlor.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Mica</td>
<td>18.0%</td>
</tr>
<tr>
<td>Clin.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Kao.</td>
<td>20.7%</td>
</tr>
<tr>
<td>Quartz</td>
<td>30.3%</td>
</tr>
<tr>
<td>K-feld.</td>
<td>2.4%</td>
</tr>
<tr>
<td>Plag.</td>
<td>4.1%</td>
</tr>
</tbody>
</table>
Section badly disturbed between 0 & 126 cm.

Clay. Some layers contain authigenic carbonate
Clay mins. 40-100%
Carbonate 0-60%

X-ray diffraction results (11-13 cm)
Montm. 26.5%
Chlor. 0.0
Mica 15.1
Kao. 27.3
Quartz 28.4
Plag. 2.7

X-ray diffraction results (90-92 cm)
Montm. 35.0
Mica 18.7
Kao. 21.5
Quartz 22.7
Plag. 2.0

Figure 32. Hole 9 Core 9 Section 1.
Figure 33. Hole 9 Core 9 Section 2.
<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
<th>X-ray Diffraction Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>Snd. 0.0, Slt. 2.0, Cl. 98.0.</td>
<td>Montm. 37.1, Mica 14.6, Kao. 23.3, Quartz 25.0</td>
</tr>
<tr>
<td>50</td>
<td>5Y5/2 (m) (Olive gry.)</td>
<td>Clay</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>Clays—100%. Core disturbed from 118-150 cm. Yellow-brown bands present throughout.</td>
</tr>
<tr>
<td>90-93</td>
<td></td>
<td>X-ray diffraction resultsMontm. 36.8, Mica 12.4, Kao. 23.3, Quartz 27.5</td>
</tr>
</tbody>
</table>

Figure 34. Hole 9 Core 9 Section 3.
Complete section badly disturbed.

Clay

Clays 95%

Carbonate (non-skel.) 5%

X-ray diffraction results (120-123 cm)

Montm. 35.5%

Mica 12.7

Kao. 23.5

Quartz 28.3

Figure 35. Hole 9 Core 9 Section 6.
Figure 36. Hole 9 Core 10 Section 1.

10Y5/1
(Pale Olive)

10YR5/4
(Mod. yell. brn.)

5B6/1
(Bluish gry.)

Complete section disturbed.
Clay
Clay 85-100%
Carb. silt (non-skel.) 0-15%

Tot. C. 0.4, Org. C. 0.2, CaCO₃ 1.7.

X-ray diffraction results
(90-93 cm)
Montm. 45.7%
Mica 12.6
Kao. 17.9
Quartz 20.7
K-feld. 0.0
Plag. 1.8
Figure 37. Hole 9 Core 10 Section 2.
Figure 38. Hole 9 Core 10 Section 3.
Snd. 0.0, Slit. 7.6, Cl. 92.4

X-ray diffraction results
(10-12 cm)

Tot. C. 0.4, Org. C. 0.2, CaCO$_3$ 1.7
Montm. 51.2%
Mica 13.6
Kao. 17.6
Quartz 17.6

Section disturbed.

Clay.
Dark gry. streaks.
Clay 100%

X-ray diffraction results
(72-74 cm)
Montm. 45.1%
Mica 9.8
Kao. 18.3
Quartz 26.8

White 1-2 mm specs throughout section contain pure zeolite crystals.

Figure 39. Hole 9 Core 10 Section 4.
Snd. 0.1, Slt. 9.5, Cl. 90.4

X-ray diffraction results (3-5 cm)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>43.7%</td>
</tr>
<tr>
<td>Mica</td>
<td>13.5</td>
</tr>
<tr>
<td>Kao.</td>
<td>19.3</td>
</tr>
<tr>
<td>Quartz</td>
<td>23.5</td>
</tr>
</tbody>
</table>

Tot. C. 0.6, Org. C. 0.3, CaCO$_3$ 2.5

5G5/1 (grnsh gry)

Complete section disturbed.

Clay w/
minor grn. black streaks.

Snd. 0.0, Slt. 10.6, Cl. 89.4.

Clay minerals 90%

?Qtz. silt 10%

White 1-2mm specs throughout section contain pure ? zeolite crystals.

Figure 40. Hole 9 Core 10 Section 5.
Figure 41. Hole 9 Core 10 Section 6.
X-ray diffraction results
(130-132)

Montm. 64.3%
Mica 6.4
Kao. 7.2
Quartz 16.5
Rhod. 4.4

Complete section disturbed.

Clay, w/well-consolidated
fragments in soft disturbed
matrix.

Figure 42. Hole 9 Core 11 Section 1.
Figure 43. Hole 9 Core 12 Section 1.

Complete section disturbed.

5G5/1 (Grnsh. gry.)

Clay.
Clay mins. 90%
?Qtz. silt 10%
Figure 44. Hole 9 Core 12 Section 5.

X-ray diffraction results (17-19 cm)

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montm.</td>
<td>49.1%</td>
</tr>
<tr>
<td>Chlor.</td>
<td>12.7%</td>
</tr>
<tr>
<td>Mica</td>
<td>9.2%</td>
</tr>
<tr>
<td>Kao.</td>
<td>5.8%</td>
</tr>
<tr>
<td>Quartz</td>
<td>20.8%</td>
</tr>
<tr>
<td>Plag.</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

Complete section disturbed

Clay

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay mins</td>
<td>90%</td>
</tr>
<tr>
<td>?Qtz silt</td>
<td>5%</td>
</tr>
</tbody>
</table>

5G5/1 (Grnsh. gry.)

Snd. 0.1, Slt. 6.4, Cl. 93.5

5G5/1
Snd. 0.5, Slt. 6.1, Cl. 93.4
Tot. C. 0.4, Org. C. 0.0,
CaCO$_3$ 3.0
10YR2/2
(Dusky yell. brn.)

Section disturbed.

Zeolitic clay,
mott. w/orange brown.
Zeolites 50%
Clay mins. 50

Figure 45. *Hole 9A Core 1 Section 1.*
Complete section disturbed.

70-82 cm: *Cherty rad. mudstone.* Contains rad. "ghosts".

**Zeolitic red clay:**
- Clay mins. 100%
- Mixed w/clayey silt:
- Zeolites 60%
- Clay mins. 40%

Figure 46. *Hole 9A Core 1 Section 4.*
Snd. 12.9, Slt. 12.3, Cl. 74.8

7.5YR3/2
(Dk. brn.)

Whole sect. disturbed.

Zeolitic clay.
Mottled w/brown buff.
Zeolites + clay  100%
Buff areas: –
Clay mins.  95-100%
Zeolites  5%

X-ray diffraction results
(21-24 cm)

Mica  14.1%
Clin.  28.6
Kao.  21.0
Quartz  26.7
Plag.  4.2
Side.  5.4

Figure 47. Hole 9A Core 1 Section 5.
Whole sect. disturbed.

X-ray diffraction results
(37-39 cm)

- Mica: 10.0%
- Clin.: 25.8
- Kao.: 18.2
- Quartz: 25.8
- Plag.: 7.7
- Dolo.: 7.7
- Side.: 4.8

Zeolitic clay
Mottled w/lt. brn.
Zeolites + clay
mins. 100%

At 16 cm., large mottle of
rad. ooze, (yell. green)
Rads. 35%
Clay mins. 60%

Figure 48. Hole 9A Core 1 Section 6.
Figure 49. Hole 9A Core 2 Section 1.

Whole sect. disturbed.

Zeolitic clay,
indurated. Light brn. laminae.
Zeolites 30-60%
Clay mins. 70-40%

Cherty rad. mudstone fragment

X-ray diffraction results (40 cm)

<table>
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<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mica</td>
<td>2.1%</td>
</tr>
<tr>
<td>Clin.</td>
<td>20.8</td>
</tr>
<tr>
<td>Quartz</td>
<td>4.2</td>
</tr>
<tr>
<td>Plag.</td>
<td>9.1</td>
</tr>
<tr>
<td>Side.</td>
<td>1.0</td>
</tr>
<tr>
<td>Cris.</td>
<td>62.8</td>
</tr>
</tbody>
</table>
Figure 50. Hole 9A Core 3 Section 1.

Zeolitic clay, with dark brn. layers.
Clay mins. 80%
Zeolites 20%

X-ray diffraction results
(82-84 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mica</td>
<td>5.6%</td>
</tr>
<tr>
<td>Clin.</td>
<td>22.8%</td>
</tr>
<tr>
<td>Quartz</td>
<td>7.7%</td>
</tr>
<tr>
<td>K-feld.</td>
<td>2.8%</td>
</tr>
<tr>
<td>Plag.</td>
<td>2.9%</td>
</tr>
<tr>
<td>Calcite</td>
<td>2.6%</td>
</tr>
<tr>
<td>Side.</td>
<td>1.4%</td>
</tr>
<tr>
<td>Cris.</td>
<td>54.2%</td>
</tr>
</tbody>
</table>

X-ray diffraction results
(143-144 cm)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mica</td>
<td>3.7%</td>
</tr>
<tr>
<td>Clin.</td>
<td>26.2%</td>
</tr>
<tr>
<td>Kao.</td>
<td>6.6%</td>
</tr>
<tr>
<td>Quartz</td>
<td>6.6%</td>
</tr>
<tr>
<td>K-feld.</td>
<td>2.4%</td>
</tr>
<tr>
<td>Plag.</td>
<td>1.9%</td>
</tr>
<tr>
<td>Side.</td>
<td>1.0%</td>
</tr>
<tr>
<td>Cris.</td>
<td>56.5%</td>
</tr>
</tbody>
</table>

Sect. somewhat disrupted.
Sect. partly disrupted

X-ray diffraction results
(49-51 cm)

Clin. 22.4%
Quartz 4.5
Plag. 2.2
Side. 0.9
Cris. 70.0

Zeolitic clay. Laminated w/shades of brown.
Zeolites 30-70%
Clay mins. 70-30%

X-ray diffraction results
(113-115 cm)

Mica 3.6%
Clin. 28.2
Kao. 1.8
Quartz 7.1
K-feld. 2.8
Side. 1.0
Cris. 55.5

120-139 cm: - Fragments of Nannofossil chalk ooze.
Cocc. 80%
Clay. mins. 20%

Figure 51. Hole 9A Core 3 Section 2.
X-ray diffraction results (14-18 cm)

- Mica: 5.3%
- Clin.: 42.9
- Kao.: 2.4
- Quartz: 10.1
- K-feld.: 3.5
- Plag.: 3.0
- Rhod.: 1.9
- Side.: 1.9
- Cris.: 29.0

Whole sect. disturbed.

Variecolored “clasts” present: green, orange-brn. and red-brn.

Figure 52. Hole 9A Core 3 Section 3.
Figure 53. Hole 9A Core 3 Section 4.
X-ray diffraction results
(25 cm)

- Mica: 3.0%
- Clin.: 24.2
- Quartz: 7.5
- K-feld.: 1.6
- Plag.: 1.6
- Cris.: 61.5

Sect. disrupted from 25-128 cm.

Zeolitic clay, thinly laminated in shades of brown.
- Zeolites: 40%
- Clay mins.: 55%
- Qtz. silt: 5%

X-ray diffraction results
(114 cm)

- Mica: 2.0%
- Clin.: 32.0
- Quartz: 9.6
- K-feld.: 0.0
- Plag.: 2.1
- Side.: 1.4
- Cris.: 52.9

Figure 54. Hole 9A Core 4 Section 1.
X-ray diffraction results (30 cm)

- Mica: 5.2%
- Quartz: 86.2%
- Hema.: 8.6%

Whole sect. disrupted.

**Zeolitic clay**

Semi-indurated, laminated thinly in shades of brown.

- Zeolites: 30-40%
- Clay mins.: 70-60%
- Qtz. silt: 0-2%

Max. dip of bedding in core is 9°.

X-ray diffraction results (75 cm)

- Mica: 8.5%
- Clin.: 6.8%
- Quartz: 84.7%

Figure 55. *Hole 9A Core 5 Section 1.*
X-ray diffraction results
(34-35 cm)

Mica  4.2%
Quartz  84.1
Hema.  11.7

Whole sect. consists of fragmented sections.

Zeolitic clay, laminated finely w/white Semi-indurated.

X-ray diffraction results
(50-51 cm)

Mica    2.1%
Clin.   21.8
Quartz  7.1
Side.   1.2
Cris.   67.8

Dense 5 cm. dia. manganese concretion in this sect.

Figure 56. Hole 9A Core 5 Section 2.
Lithology

Based on limited samples, there are two basic lithologies in the sediments from Holes 9 and 9A. The upper 700 foot (213 meter) section is composed predominantly of calcareous and siliceous oozes and the lower 2040 foot (622 meter) section is largely a non-calcareous, sparsely fossiliferous to non-fossiliferous clay. An examination of washings and cavings from the holes did not indicate the presence of any other varieties of sediment.

The biogenic ooze is Upper Miocene, Pliocene and Quaternary. The beds contain appreciable amounts of silt-sized irregular fragments of dolomite of indeterminate origin. Below 700 feet (213 meters) to a total depth of 2738 feet (835 meters), clayey and indeterminate fine-grained sediments predominate, ranging in age from Upper Miocene to at least as old as Upper Cretaceous. Dolomite fragments occur only sparsely at two or three thin horizons within these clays. Cherty sediments, formerly radiolarian ooze of Eocene Age, occur in poorly developed horizons between about 2200 feet (671 meters) and 2490 feet (759 meters).

Sediments of the uppermost 1600 feet (488 meters) irrespective of mineralogy, are dominantly olive gray to dark grey-green with localized yellow-brown bands. In the interval between about 1600 feet (488 meters) and 2200 feet (761 meters) the dominant hue changes to yellow-brown and red-brown, increasing notably in intensity, to very dark reddish brown in the lowermost 30 feet (9 meters) above basement.

Basement rock is a finely vesiculated glassy basalt, associated with well-indurated sediments. Dense manganese concretions, having botryoidal and dendritic forms, occur within the dark red-brown silty clays immediately overlying the basement. Pure zeolite, clinoptilolite, occurs in small white pockets or segregations (1 to 2 millimeters across) in some sections of the core, in addition to being a major component of the sediments of Hole 9A.

Manganese mineralization and iron enrichment, present in the sediments overlying basement, suggest some form of hydrothermal processes, possibly related to fumarole activity associated with underlying igneous activity. Such activity may have continued during the early stages of sedimentation, thus affecting the deepest sediments.

The chertified Eocene radiolarian ooze occurring between 2200 feet (671 meters) and 2490 feet (759 meters) is mineralogically similar to some of the cherts cored in Hole 8A. Age relationships are also equivalent, within the age resolution of radiolarian fossil remains. Unlike samples from Hole 8A, no terrigenous silt-sized material was noted in Hole 9A in association with the cherty material, although a considerable gap in the sample record exists above the cores containing chert fragments. However, it is of interest to note that this cherty material occurs approximately at the boundary between olive-grey and red-brown sediments, a relationship also observed in earlier holes (Hole 7A, Leg 1).

Physical Measurements

Ship Laboratory Measurements

Natural Gamma-Radiation

Natural gamma radiation varies with depth of burial or degree of compaction of sediment, as well as with mineralogy. The lowest values, on an arbitrary scale, are for the least compacted calcareous cores and are quite low, being about 1200 cpm above background. The small amount of associated siliceous ooze has a slightly higher count, probably indicating a somewhat larger proportion of potassium-bearing detrital minerals. Below the predominantly calcareous sediment, clayey sediments, admixed and interbedded with calcareous material, yield about 2000 cpm above background at a sediment depth of about 650 feet (198 meters). In conjunction with two thin zones of authigenic carbonate, probably rhodochrosite, the gamma activity is somewhat higher than is characteristic for the surrounding material—probably indicating the presence of significant proportions of potassium-bearing zeolites. Below 100 feet (328 meters) in the sediment, compaction and possible increased proportions of potassium-bearing zeolite minerals cause a continuous increase in the count rate from 2120 to 2680 cpm above background. No adequate measurements were made below 1049 feet (319.8 meters) because of broken and incomplete cores.

X-Radiography

The average exposure time required for X-ray photographs to achieve adequate exposure was found to be a qualitative measure of density. Times range from 2.8 seconds more or less smoothly up to about 7.8 seconds with other instrument settings being constant. No notable structures were noted on X-radiographs.

Gamma-Ray Attenuation Porosity Evaluator (GRAPE)

Porosity, as determined by gamma-ray attenuation, showed a smooth reciprocal relationship to density; it decreased downward with increasing density. The only significant reversals in this trend occurred in the depth ranges of interbedded clays and calcareous muds.

The gamma-attenuation traces show detailed relationships to individual beds. In general, the nanofossil cores are more porous than the clayey muds. Conspicuous exceptions to this are two thin beds of authigenic carbonate, in Core 8 which have much lower porosity and higher density.
Typical values of porosity are: 60 to 70 per cent for the upper 200 feet (60.9 meters) of foraminiferal coccolith ooze containing much detritus; 45 to 50 per cent for the clayey muds at about 650 feet (198 meters) and 55 per cent for the calcareous sediments at this depth; 45 per cent for clayey muds at 1000 to 1500 feet (328 to 457 meters), depth of burial; and, 40 to 43 per cent for one determination at about 2500 feet (762 meters). These values from gamma-ray attenuation show a close coherence relationship to values obtained during the water content calculations.

The most significant variation in density is an increase with depth. This variation is smooth and shows few reversals except in Cores 7 and 8 (Hole 9) where clays are intermixed and interbedded with nannofossil-foraminiferal oozes. In the upper 200 feet (60.9 meters), typical values range from 1.46 to 1.63. In the intermediate mixed clays and calcareous muds at about 650 feet (198 meters), values range from 1.62 to 1.81 with the lower values belonging to the more pure calcareous nannofossil oozes and the lowest values to radiolarian-rich ooze. In the deeper clays below 1000 feet (328 meters) densities range generally above 1.8 and increase only slightly with depth to 2487 feet (758 meters), below which no satisfactory determinations are available. Gamma attenuation values are about 7 per cent higher than values calculated from core section weight.

Penetrometer

Needle penetration into the sediments generally decreased downward at this site, as would be expected from general increase in compaction with depth. Penetration was generally bound to be variable in cores that had been disturbed, and is considered a good indication of coring disturbance, where evidence for this is otherwise obscure.

Sonic Velocity

Measurements of sonic velocity at 1 atmosphere pressure by the Winokur method yielded values that were lower than velocities measured in situ by combination of seismic profiling and drilling. Averaging of these values for cored intervals gave velocities of 1.49 km/sec at 100 feet (32.8 meters)—(Core 5), 1.55 at 650 feet (198 meters)—Cores 7 and 8, 1.62 at 1000 feet (328 meters)—Cores 9 and 10 and, 1.8 at 2200 feet (670 meters)—Core 1, Hole 9A. No measurements from deeper than this level were possible because the sediment was either broken or not recovered in plastic liners (see Drilling and Coring Log). Values from cored intervals were averaged; these average values were then arbitrarily assigned to depth ranges extending halfway to the adjacent cored interval, except at the top and bottom where the values were extended to the extremities of the section. The depth weighted averaging yielded 1.68 km/sec. This value, determined by a measurement parallel to the bedding, is somewhat below the in situ average velocity measured vertically through the section by combination of penetration and seismic profile. The scatter of the data is substantial and probably comes largely from imperfections in the cores and in their contact to the plastic liner material.

Paleontology and Biostratigraphy — Summary

<table>
<thead>
<tr>
<th>Nannofossils</th>
<th>Foraminifera</th>
<th>Radiolaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole 9, Core 1:</td>
<td>Hole 9, Core 1: Insufficient material recovered for foraminiferal examination.</td>
<td>Hole 9, Core 1: Radiolaria absent.</td>
</tr>
<tr>
<td>A very small sample was recovered adhering to the core catcher. The sample consisted mainly of late Quaternary coccolithic ooze along with some detrital materials, chiefly calcareous. The following calcareous nannofossils were identified: <em>Emiliania huxleyi</em>, <em>Gephyrocapsa</em> spp., <em>Ceratolithus</em> sp., <em>Umbilicosphaera mirabilis</em>, *Um-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Down-Hole Logging

In-pipe gamma-ray, neutron and interval velocity logging were planned for Hole 9A. Because the pipe had a tendency to stick in the hole, no open-hole logging was attempted. In an attempt to reduce the hazard of having the pipe stuck in the hole, the bit was raised to 2429 feet (740 meters) below the ocean floor before in-hole logging.

The gamma-ray neutron log was run from 18,745 feet (5715 meters) to 16,236 feet (4950 meters). The difference of 49 feet (16 meters) between the driller’s depth and the logger’s depth is unusually great, but the reason is not apparent. The records do not appear to be reliable.
<table>
<thead>
<tr>
<th>Nannofossils</th>
<th>Foraminifera</th>
<th>Radiolaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>bellosphaera sp. and Coccolithus pelagicus.</td>
<td>Hole 9, Core 2: Insufficient material recovered for foraminiferal examination.</td>
<td>Hole 9, Core 2: Rare fragments of Radiolaria and diatoms.</td>
</tr>
</tbody>
</table>

**Hole 9, Core 2:**
A small sample was recovered adhering to the core catcher. The sample consists of a poorly sorted mixture of silt and contains abundant late Quaternary calcareous nannofossils, including Emiliania huxleyi, Umbellosphaera sp., Gephyrocapsa spp., Ceratolithus sp., and Coccolithus pelagicus. Also present are some reworked nannofossils from the Upper Miocene-Pliocene (Discoaster pentaradiatus) and Cretaceous (Eiffellithus turrisselfeli, Arkhangelskiella).

**Hole 9, Core 4:**
A small sample was recovered adhering to the core catcher, and consists mainly of silt and clay-size detrital material including quartz and calcareous debris, and abundant late Quaternary calcareous nannofossils, including Emiliania huxleyi, Gephyrocapsa spp., Ceratolithus sp., Coccolithus pelagicus, Discolithina japonica, Cyclcoccolithus leptoporus, Rhadborphaera clavigera and Umbilicosphaera mirabilis. Also present are some reworked calcareous nannofossils of Tertiary (Sphenolithus abies, Zygodiscus) and Cretaceous (Chiasmolithus) Age.

**Hole 9, Core 5:**
Calcareous nannofossils are present throughout Core 5, and they may be rare to abundant. The following species were identified indicating a middle and early Quaternary Age: Gephyrocapsa spp., Coccolithus pelagicus, Ceratolithus cristatus, Umbilicosphaera mirabilis, Cyclcoccolithus leptoporus, Rhadborphaera clavigera, Helicopontosphera carteri, Discolithina japonica and “Discolithus” phaseolus cf. Coccolithus cricetus, which is rare or lacking near the top, but becomes more abundant in the lower part of Core 5. The extinction of this species appears to be an excellent

**Hole 9, Core 4:**
The core catcher yielded a rich assemblage dominated by planktonic foraminifera; all the species known to be living in the Sargasso Sea are present, including Globorotalia truncatulinosides (completely keeled), G. hirsuta, G. menardii, G. inflata, Pulleniatina obliquiloculata, and various species of Globigerinoides, including G. ruber with red tests. Pink tests were also observed in Globigerina rubescens. The age of this assemblage, as indicated by the foraminifera, is late Pleistocene; an assignment of Zone N.22 (upper part) or N.23 of Blow’s 1968 zonation is suggested.

**Hole 9, Core 5:**
The foraminiferal fauna recovered from this core is well preserved and composed largely of species endemic to low latitudes (e.g., Panartus tetrathalamus tetrathalamus Haeckel, Pterocanium praetextum praetextum (Ehrenberg), Botryocystis scutum (Harting), Spongaster tetrata tetrata Ehrenberg and Euchitonias spp.) A few species endemic to middle latitudes can be found (e.g., Lithocampe sp., Spongaster tetrata irregularis Nigrini, Actinomma mediumum Nigrini and Eucyrtidium acuminatum - Ehrenberg) along with rare specimens of one form endemic to subarctic waters (Styptosphaera? spumacea Haeckel). All of the above mentioned
marker within the Pleistocene as it is completely lacking in samples above Core 5. Also present at several levels in Core 5 is silt and clay-size detritus, consisting chiefly of calcareous and quartz fragments. Other levels appear to be relatively free of detritus and consist almost entirely of coccolith ooze.

Hole 9, Core 6:
A small sample was recovered adhering to the core catcher, and consisted largely of silt and clay-size debris with calcareous nannofossils being common. The following species are identified: cf. Coccolithus cricotus, Cyclococcolithus leptoporus, Umbilicosphaera mirabilis, Coccolithus pelagicus, Ceratolithus cristatus, Discoaster brouweri (very rare) and Gephyrocapsa sp. (rare). The presence of abundant cf. Coccolithus cricotus, rare Gephyrocapsa oceanica, and very rare Discoaster brouweri—the last named probably reworked upwards by burrowing organisms—indicates the proximity of the Plio-Pleistocene boundary below Core 6, so that the age assigned to this level very probably should be early Pleistocene.

Hole 9, Core 7:
Calcereous nannofossils are common to abundant throughout most of Core 7, and indicate a late Miocene to middle Pliocene Age for this interval. The following species were recorded: Discoaster brouweri, D. surculus, D. pentaradiatus, D. variabilis, D. challengeri, Reticulofenestra pseudoumbilica, Spheno-

Hole 9, Core 6:
Radiolaria absent.

Hole 9, Core 7:
Radiolaria absent.

Hole 9, Core 7:
Samples from this core yielded very poor and dwarfed foraminiferal faunas which demonstrate unfavorable ecologic conditions, possibly related to excessive depth of deposition. Benthonic foraminifera are present, including Quinqueloculina and Triloculina with corroded tests. A precise age assign-
<table>
<thead>
<tr>
<th>Nannofossils</th>
<th>Foraminifera</th>
<th>Radiolaria</th>
</tr>
</thead>
<tbody>
<tr>
<td>tarhabdus sp., ?Cylindralithus gallicus, Ceratolithoides kampnerti, Tetralitythus murus. The last three species indicate a probable Maestrichtian Age for the assemblage however, it appears that the nannofossils in this sample may have been mixed in from some level above Core 2, as no undisturbed nannofossil bearing sediments were identified within the core.</td>
<td>The genera Heterohelix, and Hedbergella are represented by single specimens with thin shells, sometimes broken. Benthoic foraminifera are as common as (or more common than) the planktonics. The relative abundance of primitive forms with arenaceous tests such as, Saccamina, Reophax and Glomospira should be pointed out. Similar co-occurrences of primitive arenaceous forms and of planktonic foraminifera belonging to the family Heterohelicitidae, without Globotruncana, are known from some Upper Cretaceous formations of the Italian peninsula which are characterized by low rates of sedimentation and are interpreted as deep-sea deposits.</td>
<td>Hole 9A, Core 3: Rare, poorly preserved Cretaceous Radiolaria are found throughout the core.</td>
</tr>
<tr>
<td>Hole 9A, Core 3:</td>
<td>Hole 9A, Core 3:</td>
<td>Hole 9A, Core 3:</td>
</tr>
<tr>
<td>A small lump (about 1 cc) of reddish sediment included with other disturbed sediment in Section 2 of this core consisted almost entirely of Upper Cretaceous nannofossils, the assemblage being identical to that encountered in Core 2. This lump probably caved in from some level near or above that of Core 2.</td>
<td>No foraminifera present.</td>
<td>No foraminifera present.</td>
</tr>
<tr>
<td></td>
<td>Hole 9A, Core 4:</td>
<td>Hole 9A, Core 4:</td>
</tr>
<tr>
<td>No calcareous nannofossils.</td>
<td>No foraminifera present.</td>
<td>Same as Hole 9A, Core 3.</td>
</tr>
<tr>
<td></td>
<td>Hole 9A, Core 5:</td>
<td>Hole 9A, Core 5:</td>
</tr>
<tr>
<td>No calcareous nannofossils.</td>
<td>No foraminifera present.</td>
<td>A sparse and poorly preserved radiolarian fauna similar to that of Cores 3 and 4 is found in Core 5. However, the core catcher sample contains a relatively rich and well-preserved assemblage including a number of species of Dictyomitra, Pseudoaulophaucus sp., Theocapsoma sp., Gongylothorax verbeeki (Tan Sin Hok), Theocampe sp. and Hemicryptocapsa sp. (?conara Foreman). Sponge spicules are also in the core catcher sample.</td>
</tr>
<tr>
<td>Hole 9A, Core 6:</td>
<td>Hole 9A, Core 6:</td>
<td>Hole 9A, Core 6:</td>
</tr>
<tr>
<td>The core catcher of this core yielded a calcareous nannofossil assemblage identical to that of Cores 2 and 3. Doubtless these nannofossils also had their origin as cavings from above the</td>
<td>The core catcher of Core 6 yielded a very poor foraminiferal assemblage similar to that of Core 2, including Gumbelitria cretacea, Heterohelix globulosa, Hedbergella</td>
<td>The core catcher contains rare, poorly preserved Cretaceous Radiolaria.</td>
</tr>
</tbody>
</table>
### Nannofossils

<table>
<thead>
<tr>
<th>Nannofossils</th>
<th>Foraminifera</th>
<th>Radiolaria</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>lithus abies</em>, Ceratolithus sp., Cyclococcolithus leptoporus, C. acquiscutum and Helicopontosphaera sp.*</td>
<td>The absence of Ceratolithus tricorniculatus in all of Core 7 suggests a probable early Pliocene, rather than late Miocene Age for this core.</td>
<td></td>
</tr>
</tbody>
</table>

Hole 9, Core 8: Section 2 of Core 8 yielded an excellent assemblage of calcareous nannofossils indicating a late Miocene (Messinian) to early Pliocene Age. The assemblage contains the following species: *Sphenolithus abies*, *Reticulofenestra pseudoumbilica*, *Discoaster brouweri*, *D. surculus*, *D. pentaradiatus*, *Cyclococcolithus leptoporus*, *Ceratolithus rugosus* and *Ceratolithus tricorniculatus*. The last named species, though relatively rare, has the narrowest stratigraphic range of the above species and, therefore, is age definitive for this level.

Hole 9, Core 8: Spheroolithus abies, Reticulofenestra pseudoumbilica, Discoaster brouweri, D. surculus, D. pentaradiatus, Cyclococcolithus leptoporus, Ceratolithus rugosus and Ceratolithus tricorniculatus. The last named species, though relatively rare, has the narrowest stratigraphic range of the above species and, therefore, is age definitive for this level.

Hole 9, Core 8: Same as for Hole 9, Core 7.

Hole 9, Core 8: No siliceous microfossils.

### Foraminifera

**Cores taken below this level at Hole 9 are barren of both calcareous and siliceous microfossils.**

Hole 9A, Core 1: Foraminifera absent.

Hole 9A, Core 2: A sample taken from the core catcher of Core 2 yielded several characteristic Upper Cretaceous nannofossils, including *Arkhangelkskiiella* sp., *Prediscosphera cretacea*, *Micula* sp., *Tetralithus aculeus*, *Cre-

Hole 9A, Core 2: The foraminiferal fauna is extremely poor. Planktonic foraminifera are present, but none of them belong to the genus *Globotruncan*, the most important and usually the most common in the Upper Cretaceous.

Hole 9A, Core 2: The catcher sample contains poorly preserved Cretaceous Radiolaria (*Dictyonemira* spp., and members of the families Amphipygndacidae and Pseudaulophacidae).
level of Core 2, and were mixed with the sediment in the core catcher. *monmouthensis, Saccammina complanata, Reophax, Ammodiscus, Glomospira, Gyroidinoides nitidus, Globorotalites michelinianus,* and *Gavelinella whitei* indicating a probable Senonian Age.

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>monmouthensis, Saccammina complanata, Reophax, Ammodiscus, Glomospira, Gyroidinoides nitidus, Globorotalites michelinianus,</em> and <em>Gavelinella whitei</em> indicating a probable Senonian Age.</td>
<td></td>
</tr>
</tbody>
</table>

**PLATE 1**

*Radiolaria*

(All figures ×200)

A Unidentified Spumellarian Radiolaria; 2-9A-3-3, 0-3 cm (X21/0).

B Unidentified Spumellarian Radiolaria; 2-9A-3, core catcher (F26/1).

C *Pseudoaulophacus* sp., 2-9A-2, core catcher (K39/3).

D *Gongylothorax verbeeki* (Tan Sin Hok); 2-9A, core catcher (M38/0).

E *Theocapsomma* sp.; 2-9A-5, core catcher (Y17/1).

F *Hemicryptocapsa* sp.; (?conora Foreman); 2-9A-2, core catcher (H-49/0).

G *Theocampe* sp.; 2-9A-3-2, 78-80 cm (Y20/2).

H *Dictyomitra* sp.; 2-9A-5, core catcher (F40/4).

I *Dictyomitra* sp.; 2-9A-5, core catcher (W40/3).

J *Dictyomitra* sp.; 2-9A-2, core catcher (G51/3).

K *Dictyomitra* sp.; 2-9A-4-1, N133-6 cm (032/2).

L *Dictyomitra* sp.; 2-9A-3-1, 50-2 cm (C35/1).
SUMMARY

Rates of Sediment Accumulation

The reader is referred to the Cruise Leg Synthesis for discussion of the basic assumptions involved in these calculations.

In Holes 9 and 9A four cored intervals allowed the authors to make some calculations concerning the rate of sediment accumulation. They are as follows:

1) Base of Core 6 (Hole 9), near the Pliocene-Pleistocene boundary; 1.8 m.y. at 78 meters beneath the sea floor.
2) Base of Core 9 (Hole 9), dated as the Miocene-Pliocene boundary; 6 m.y. at 213 meters.
3) Base of Core 1 (Hole 9A), Eocene; 44 m.y. at 683.2 meters.
4) Base of Core 6 (Hole 9A), Senonian; 85 m.y. at 764.9 meters.

(This age is based on a very sparse foraminiferal assemblage.) The calculated rates of sediment accumulation are:

<table>
<thead>
<tr>
<th>Interval</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleistocene to Recent:</td>
<td>Pleistocene to Recent:</td>
</tr>
<tr>
<td>4.3 cm/1000 yr.</td>
<td>4.3 cm/1000 yr.</td>
</tr>
<tr>
<td>Pliocene (basal) to Pleistocene:</td>
<td>Pliocene (basal) to Pleistocene:</td>
</tr>
<tr>
<td>3.2 cm/1000 yr.</td>
<td>3.6 cm/1000 yr.</td>
</tr>
<tr>
<td>Eocene to basal Pliocene:</td>
<td>Eocene to Recent:</td>
</tr>
<tr>
<td>1.2 cm/1000 yr.</td>
<td>1.6 cm/1000 yr.</td>
</tr>
<tr>
<td>Upper Cretaceous to Eocene:</td>
<td>Upper Cretaceous to Recent:</td>
</tr>
<tr>
<td>0.2 cm/1000 yr.</td>
<td>0.9 cm/1000 yr.</td>
</tr>
</tbody>
</table>

The progressive increase in the rate of sediment accumulation from the Cretaceous to the Recent appears clear both in the interval and cumulative rates.

Discussion

A number of acoustical reflectors were noted in the top 0.1 seconds reflection time of sediment on the Vema profiler records of the Hole 9 survey area. These reflectors overlie 0.65 seconds of acoustically transparent sediments and were the objective of the first five coring attempts. Only Core 5 returned with sediment, but it had been so badly disturbed by the coring process that meaningful physical measurements were impossible to make. Rapid lithologic changes, basically between calcareous oozes and clays in Core 5, contrast with the uniform sedimentary composition of the underlying acoustically transparent layer, suggesting that the reflectors are related to these lithologic changes.

The weak reflector observed at 0.75 seconds on profiler records may be a zone of cherty radiolarian ooze. The age of the deepest core taken at Hole 9 is Upper Miocene. The first core of Hole 9A recovered Eocene cherty radiolarian ooze, and the second core recovered fragments of cherty radiolarian ooze in zeolitic Upper Cretaceous sediments. These chert pieces were not similar to the surrounding sediments and may have come from the cored interval.

If a significant chert layer is present above the first core at Hole 9A then the drilling record would certainly have shown a decrease in the rate of penetration. Unfortunately, the particular record which contains this information is missing. The rate at which these two cores at Hole 9A were cut was considerably less than that of any of the overlying sediments of Hole 9 or of some of the underlying Cretaceous (or older) sediments at Hole 9A. Thus, the reflector probably lies between the Miocene and the Eocene and may be the upper surface of a partially silicified layer. Possibly the reflector is correlative with the silicified Eocene Radiolaria deposits which were noted at Sites 7 and 8.

The thick accumulation of acoustically transparent sediment seen on profiler records is composed dominantly of clay. Based on the few cores recovered, it is generally free of calcareous components, except in the upper Cenozoic and Upper Eocene sections. Radiolaria are found rarely in the Quaternary cores and in somewhat greater numbers in the Eocene and Upper Cretaceous cores. These clays and zeolitics may have formed from the alteration of volcanic material that could have originated from seamounts in the area north and northeast of Bermuda. The profiler records at Sites 7, 8 and 10 suggest that these characteristically thick and acoustically transparent sediments are not very extensive to the east, west and south, although they may be present for a considerable distance northward which would suggest that the dominant winds and currents remained fairly constant throughout the period of deposition.

Most of the sediments in the cores taken at Hole 9A have a reddish hue which increases in intensity near the basement where the consolidated clays are brick red. The red color stems from oxidized iron (hematite 11.7 per cent in one sample) which may have originated from iron rich waters that emanated from the basement.

The scientists on Leg 1 identified a major lithologic change in Tertiary sediments on the Bermuda Rise, from turbidites at depth to "red clay" above. The Bermuda Rise is presently too high to receive turbidite
deposits from the continental margin, so the transition to red clay was interpreted as the time the rise formed. According to their interpretation, the transition was gradual, commencing in the Middle Eocene and apparently ending at about the Miocene-Pliocene boundary.

There were no turbidites sampled at Hole 9 which could be compared with the Leg 1 data. However, there is a transition in Hole 9 from non-calcareous red clay to foraminiferal calcareous deposits. The deepest sampled calcareous sediments occur at 700 feet (213 meters) and barren red clay at about 1000 feet (305 meters). The next oldest dated sediment (age determined by Radiolaria) is Eocene and occurs at 2200 feet (670 meters). It would appear that the rise uplifted the area at Hole 9 from below to above the carbonate compensation zone during the late Miocene. However, no evidence was noted that would indicate the time at which the uplift was terminated. An alternative explanation would be that the sediment accumulation at Hole 9 raised the floor of the ocean above the compensation depth, thus achieving the same transition without calling on tectonism. An additional complication is that the depth of compensation may have fluctuated with time. In reality, all three factors may have played a role in varying degrees to produce the resultant transition.

REFERENCES


APPENDIX – MICROPALEONTOLOGICAL DETERMINATIONS

Lists of Selected Planktonic and Benthonic Foraminifera and Age Determinations by M. B. Cita.

Sample 9-5-1, 40-42 cm (depth unknown, about 69 to 78 meters below the mud line):


Age determination: Pleistocene, Globorotalia truncatulinoides Zone N.22.

Sample 9-5-1, 83-86 cm (depth unknown, about 69 to 78 meters below the mud line):

Rare foraminifera, including benthonics: Allomorphina pseudopima, Globigerina glutinata and sp. Also present Globorotalia truncatulinoides, G. inflata, G. hirsuta, G. acostaensis (?) pseudopima, Globigerina quinqueloba (often dwarfed), Globigerinoides ruber, etc. Benthonic foraminifera include: Nonion, Cibicides, Pyrgo, Cassidulina, Eponides, Triloculina, Lagena.

Age determination: Pleistocene, Globorotalia truncatulinoides Zone N.22.

Sample 9-5-1, 120-122 cm (depth unknown, about 69 to 78 meters below the mud line):

Abundant, minute debris of planktonic foraminifera. Rare entire tests, some of them partly dissolved. Globorotalia inflata, Globigerina eggeri, Orbulina universa, Globigerinita spp., dwarfed specimens of Globigerina quinqueloba (?). Also present Triloculina, Quinqueloculina seminulum, Lagena, Cibicides.

Age determination: probably Pleistocene.

Sample 9-5-3, 37-40 cm (depth unknown, about 69 to 78 meters below the mud line):

Abundant, minute debris of planktonic and rare entire tests including: Globorotalia truncatulinoides, G. inflata, G. hirsuta, Orbulina universa. Also present Allomorpha trigona, Nonion, Eponides, Triloculina, Lagena.

Age determination: Pleistocene, Globorotalia truncatulinoides Zone N.22.

Sample 9-5-3, 120-123 cm (depth unknown, about 69 to 78 meters below the mud line):

Abundant broken tests of planktonic foraminifera: Globorotalia menardii, G. inflata, G. acostaensis (?) pseudopima, G. hirsuta, Orbulina universa, Globigerina quinqueloba (often dwarfed), Globigerinoides ruber, etc. Benthonic foraminifera include: Nonion, Cibicides, Pyrgo, Cassidulina, Eponides umbonatus, etc.

Age determination: Pleistocene.

Sample 9-5-4, 43-46 cm (depth unknown, about 69 to 78 meters below the mud line):

Numerous broken tests of planktonic foraminifera and very rare entire specimens comprising Globigerinita glutinata and Globigerina sp. Also present Gaudryinidae, Pyrgo, Quinqueloculina, Eponides, Cibicides, Pullenia, Lagena.

Age determination: None.

Sample 9-5-4, 107-110 cm (depth unknown, about 69 to 78 meters below the mud line):

Rich planktonic assemblage with Globorotalia truncatulinoides, G. tosaensis, G. hirsuta, G. crassaformis, G. inflata, rare left coiling Globorotalia menardii, Orbulina universa, Candeina nitida, Globigerinoides conglobatus,
G. trilobus, G. elongatus, G. ruber, Globigerina quinqueloba, Pulleniatina obliquiloculata obliquiloculata etc.

Age determination: early Pleistocene, lower part of the Globorotalia truncatulinoides Zone N.22.

Sample 9-5-5, 50-52 cm (depth unknown, about 69 to 78 meters below the mud line):

Rare assemblage of planktonic foraminifera with Globorotalia inflata (dominant species), G. scitula, Globigerina eggeri, G. quinqueloba, G. cf. pachyderma, G. bulloides, Globigerinoides glutinata, Globigerinoides ruber, G. trilobus. Also present rare Ostracods and benthonic foraminifera including Eponides umbonatus, Cassidulina sp., Pyrgo sp.

Age determination: probably Pleistocene.

Sample 9-5, core catcher (depth probably 69 to 78 meters below the mud line):

Foraminifera fairly abundant, with many broken tests of planktonic species. Globorotalia truncatulinoides (also transitional to G. tosaensis), G. crassaformis (common), G. inflata, G. scitula, Globigerina eggeri, G. bulloides, Globigerinoides elongatus, G. conglobatus, G. trilobus, G. sacculifera, G. ruber (never with pink tests), Pulleniatina obliquiloculata obliquiloculata. Also present rare Ostracoda, Pullenia quinquela, Globocassidulina subglobosa, Virgulina schreibersiana, Lagena etc.

Age determination: early Pleistocene, lower part of the Globorotalia truncatulinoides Zone N.22.

Sample 9-6, core catcher (depth about 78 meters below the mud line):

Assemblage very poor, comprising Globorotalia truncatulinoides also transitional to G. tosaensis, G. crassaformis, G. hirsuta, Globigerinoides ruber (never with pink tests), G. trilobus, G. elongatus, Globigerina quinquela, G. tetraceramata Globigerinoides glutinata. Also present Allomorpha trigna, Virgulina, Lagena, Nonion, Eponides.

Age determination: early Pleistocene, lower part of the Globorotalia truncatulinoides Zone N.22.

Sample 9-7-1, 50-52 cm (depth about 195 meters below the mud line):

Assemblage extremely poor, with Orbulina universa, Globigerina quinquela, Globigerinoides glutinata and the benthonics Allomorpha trigna, Cibicides, Eponides, Pullenia, Cassidulina.

Age determination: Miocene or younger.

Sample 9-7-2, 135-137 cm (depth about 197 meters below the mud line):

Assemblage very poor, with many broken tests of planktonic foraminifera. Globigerina nepenthes, G. ciperoensis angustiumbilicata, G. microstoma, Orbulina universa, Globigerinoides ruber. Among the benthonics are present Cassidulina, Eponides, Cibicides, Lagena, Pleurostomella, Textularia, Nonion, Pullenia quinqueloba, Allomorpha trigna.

Age determination: uncertain, due to the scarcity of the fauna, which is not younger than the Lower Pliocene and not older than the Tortonian.

Sample 9-8-2, 58-60 cm (depth about 205 meters below the mud line):

Fauna very poor and strongly affected by solution. Many broken tests of planktonic foraminifera. Globigerina nepenthes, Globigerinoides bollii, Globigerinoides sp. Benthonic foraminifera predominant, including Textularia spp., Quinquela, Trilocula, Lagena, Pleurostomella, Cibicides, Eponides, Globocassidulina subglobosa, Allomorpha trigna, Vaginulina, etc. Small fish teeth also present.

Age determination: Upper Miocene to Lower Pliocene.

Sample 9-8-4, 78-81 cm (depth about 207 meters below the mud line):

Assemblage very poor, including Globigerina nepenthes, G. bulloides, G. quinquela, Globorotalia aff. margaritae, Globigerinoides glutinata, Globigerinoides ruber.

Age determination: As above.

Sample 9A-2, core catcher (depth about 760 meters below the mud line):


Age determination: Upper Cretaceous, probably Senonian.

Sample 9A-6, core catcher (depth about 834.5 meters below the mud line):

Extremely rare foraminifera, including planktonic species (Gumbelitria cretacea, Heterohelix globulosa, Hedbergella monomouthus, H. holmdelensis), benthonic forms with arenaceous test (Saccammina complanata, Sorosphaera sp., Reophax sp., Ammodiscus sp., Glomospira sp.), and with calcitic test (costate Nodosariids, Gyroidinoides nitidus, Globorotalites michelinianus, Gavelinella whitei, Heterolepa sp.).

Age determination: Upper Cretaceous, probably Santonian to Campanian.

Calcareous Nannofossil Determinations by S. Gartner.

Sample 9-1, smear from core catcher:

Emiliania huxleyi, Gephyrocapsa sp., Umbellosphaera sp., Umbilicosphaera mirabilis, Ceratolithus cristatus, Coccolithus pelagicus.

Age determination: late Quaternary.

Sample 9-2, smear from core catcher:

Gephyrocapsa sp., Emiliania huxleyi, Umbellosphaera sp., Ceratolithus cristatus, Coccolithus pelagicus.

Age determination: late Quaternary.

Sample 9-4, smear from core catcher:
Gephyrocapsa sp., Emiliania huxleyi, Ceratolithus cristatus, Coccolithus pelagicus, Discolithina japonica, Cyclococcolithus leptoporus, Rhabdosphera clavigera, Umbilicosphaera mirabilis.
Age determination: late Quaternary.

Sample 9-5-1, 7 cm:
Gephyrocapsa sp., Coccolithus pelagicus.
Age determination: middle Quaternary.

Sample 9-5-1, 16.5 cm:
Same, plus Ceratolithus cristatus.
Age determination: middle Quaternary.

Sample 9-5-1, 127-128 cm:
Gephyrocapsa sp., Coccolithus pelagicus.
Age determination: middle Quaternary.

Sample 9-5-2, 7-8 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-2, 124-125 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-3, 12-13 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-3, 106-107 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-4, 40-41 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-4, 94-95 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-5, 19-20 cm:
As above.
Age determination: middle Quaternary.

Sample 9-5-5, 118-119 cm:
Age determination: early-middle Quaternary.

Sample 9-5-5, core catcher:
Gephyrocapsa oceanica, cf. Coccolithus cricotos, Umbilicosphaera mirabilis, Cyclococcolithus leptoporus, Rhabdosphera clavigera, Helicopontosphaera kamptneri, Discolithina japonica, Discolithus phaseolus, Ceratolithus cristatus.
Age determination: early-middle Quaternary.

Sample 9-6, core catcher:
Age determination: early-middle Quaternary.

Sample 9-7-1, 48.5-49.5 cm:
Age determination: early Pliocene.

Sample 9-7-1, 84-85 cm:
As above.
Age determination: early Pliocene.

Sample 9-7-1, 119-120 cm:
Discoaster brouweri, D. variabilis, D. surculus, D. pentaradiatus, Reticulofenestra pseudoumbilica, Sphenolithus abies, Ceratolithus sp.
Age determination: early Pliocene.

Sample 9-7-2, 41-42 cm:
As above.
Age determination: early Pliocene.

Sample 9-7-2, 134-135 cm:
As above.
Age determination: early Pliocene.

Sample 9-7-3, 17-18 cm:
As above.
Age determination: early Pliocene.

Sample 9-7, core catcher:
As above.
Age determination: early Pliocene.

Sample 9-8-2, 53-54 cm:
Age determination: late Miocene—early Pliocene (probably Messinian).

Sample 9-8-2, 123.5 cm:
As above.
Age determination: late Miocene—early Pliocene.

Sample 9-8 core catcher:

Sample 9-9-2, 14-15 cm:
Barren.

Sample 9-9, core catcher:
*Reticulofenestra* sp.
Age determination: not determinable.

Sample 9-10, core catcher:
Barren.

Sample 9-11, core catcher:
Barren.

Sample 9-11, core catcher:
Barren.

Sample 9A-2, core catcher:
*Cylindricalithus gallicus*, *Ceratolithoides kamptneri*, *Arkhangelskiella* sp., *Prediscosphaera cretacea*, *Micula* sp., *Cretarhabdus danicus*, *Tetralithus aculeus*, *Tetralithus murus*, *Maslovela barmesae*.
Age determination: probably Maestrichtian.

Sample 9A-3-2, 135 cm:
As above.
Age determination: probably Maestrichtian.

Sample 9A-6, core catcher:
As above.
Age determination: probably Maestrichtian.