5. SITES 102-103-104 – BLAKE-BAHAMA OUTER RIDGE (NORTHERN END)

The Shipboard Scientific Party¹

INTRODUCTION

Geophysicists studying the deep-sea area off the Blake Plateau during the late 1950's concluded that the Blake-Bahama Outer Ridge is a foundered chain of islands and reefs structurally connected to the Cape Fear Arch off the Carolinas, (Hersey et al., 1959). During the early 1960's scientists of the Lamont-Doherty Geological Observatory made continuous seismic reflection profiles over the ridge and showed that it is a vast accumulation of sediments lying on a horizontal reflecting surface (Layer A) which in turn lies above the rough acoustic basement reflector (Ewing and Ewing, 1964). This discovery led to a number of concepts attempting to explain the processes of formation of such huge sediment bodies in the deep sea.

Ewing et al. (1966) suggested that much of the material forming the ridge had been eroded from the Blake Plateau by the Gulf Stream. Andrews (1967) suggested that the ridge was formed by an enormous slump from a proximal up-slope position, in this case from the Blake Plateau region.

Heezen and Hollister (1964) and Heezen et al. (1966) proposed that the ridge, as well as many other fine-grained sediment bodies in the deep sea, owes its shape and structure to the effects of mud-carrying, contour-following deep currents ("contour currents") associated with deep thermohaline circulation.

Bryan (1970) and Markl et al. (1970) combined these concepts, suggesting that interaction of turbid flow from the Blake Plateau with the southward-flowing contour current initiated the development of the ridge which subsequently was enlarged and perhaps somewhat reshaped by further deposition and erosion associated with the contour currents.

The Blake-Bahama Outer Ridge (Figure 1) includes deposits of several shapes and sizes, from dunes a few kilometers long and tens of meters in height, to ridges many hundreds of kilometers long and thousands of meters high (Markl et al., 1970).

The principal objective of Sites 102, 103 and 104 was to determine the geologic history of the Blake-Bahama Outer Ridge by investigating its structure, composition, rate of growth, and the provenance of constituent sediments.

OPERATIONS

The ship arrived at Site 102 on the crest of the Blake-Bahama Outer Ridge during the late hours of April 30, and drilling was commenced at 1120 hours on May 1. A light-set diamond bit was chosen for this hole. The bottom hole assembly was the same as that used for most of the holes of this leg, consisting mainly of bit and outer core barrel, eight drill collars, and three bumper subs.

The sediment was soft and penetration progressed smoothly for the first three cores. Drill string rotation and pumping were required below a depth of 100 meters, but there was no difficulty in penetration until a depth of about 620 meters was reached. At this depth, which correlates well with the prominent conformable reflector at 0.62 second below bottom in the profiler record (Figure 2a), the sediment became much firmer and drier, and penetration slowed severely. After more than twelve hours drilling in this zone with a penetration rate of only 3 m/hr, the hole was abandoned. There had been some speculation that the bit might have clogged or the seals were blown out of a bumper sub, rather than that the sediment caused difficult penetration; but when the string was recovered no equipment problem was found. Therefore, the sharp decrease in penetration rate must indicate a significant change in lithology at the depth of the prominent seismic reflector at 0.62 second. By comparing the data from this hole and Hole 103 (Figure 2b), it is obvious that the reflector is not a time boundary and, therefore, must result from diagenetic processes.

Most of the cores at this site contained substantial amounts of organic material and were gassy, usually partially extruding themselves from the plastic liners and creating gaps in the remaining sections. Chromatograph measurements indicate that the gas is principally methane with only a small fraction (usually less than 0.5 per cent) of ethane.

Hole 103 was drilled on the southwest flank of the Blake-Bahama Outer Ridge at a location where seismic
Figure 1. Bathymetry of the Blake-Bahama Outer Ridge system (after Mankl, et al, 1970). Track segments locate seismic profiler sections shown in Figures 2a, 2b and 2c.
profiler data indicated an outcropping of the deeper beds penetrated in Hole 102 (Figure 2b). Drilling commenced at 1400 hours on 5 May, 1970. The second core, taken at a subbottom depth of 40 meters, brought up late Miocene sediment which had not been reached in the crest hole until a depth of more than 500 meters.

After the difficulty experienced at Hole 102 in drilling the firmer sediment with the diamond bit, a drag bit was chosen to drill this hole. It appeared to perform well, and during the drilled interval above the deepest core, penetrated firm clay at a good rate. Unfortunately, after Core 7 was taken the hole began to show signs of serious collapse and had to be abandoned.

The sediment samples were very similar to those at Hole 102, consisting mainly of silty clay with appreciable amounts of organic material. All of the cores contained a substantial amount of gas, consisting primarily of methane with a trace of ethane.

After the collapse of Hole 103, enough time remained for about 36 hours more drilling, and a decision was made to drill a third hole (Hole 104) on the northeast flank of the ridge (Figure 2c) at approximately the same water depth as Hole 103, drilled on the southwest flank. Drilling commenced at 1400 hours on 7 May, 1970, in a water depth of 3821 meters. The 3-cone carbide button roller bit used for Hole 99A was employed again.

After only 3 or 4 meters of penetration, several hard, apparently thin beds were encountered, requiring bit rotation and a substantial amount of weight. The hard material, some of which was recovered in Core 1, appears as a finely laminated calcite “crust” covered with calcite-filled burrow-like structures.
Most of the cored section consisted of hemipelagic silty mud similar to that found in Holes 102 and 103. The deepest core, taken at a depth corresponding to that of the prominent conformable reflector at 0.62 second (Figure 2c) contained approximately 15 centimeters of very hard ankerite. This layer or nodule required several minutes to drill through and was as hard drilling as any of the cherts, limestones, or basalts cored in previous holes during this leg. The material underneath the ankerite appeared to be little different from that above it. Unfortunately, time had run out at this point, and drilling was terminated in order for the ship to make its scheduled arrival at Norfolk.

The situation with respect to gas in the sediments was about the same as at Holes 102 and 103. The chromatograph showed only a trace of ethane. The first three cores of Hole 104 had a strong odor of hydrogen sulfide (H₂S), but this diminished rapidly in the deeper part of the section.

**STRATIGRAPHY**

**Biostratigraphy**

Assemblages of abundant calcareous nannoplankton, planktonic foraminifera, dinoflagellates, Radiolari, and diatoms of Holocene to early middle Miocene age were encountered at these sites. Approximately 600 meters of middle Miocene, 300 meters of late Miocene, 350 meters of Pliocene and 220 meters of Pleistocene sediments are present.

The foraminiferal and nannoplankton assemblages contain the same tropical/subtropical components that have been observed in worldwide equatorial latitudes. They correspond well with the biostratigraphic zones established by Blow (1969), Martini and Worsley (1970), and the nannofossil zonation of Milow used on Leg 9. The composite section of Sites 102, 103 and 104 contains each of Zones N. 23 to N. 10/9 as defined by Blow (1969).

Two major stratigraphic boundaries (according to foraminiferal data) are documented; the Miocene-Pliocene in Core 2 at Site 103, and Pliocene-Pleistocene in Core 8 at Site 102. In addition, three major unconformities are present; one at Site 104 (Core 1), and two at Site 103 (within Core 1).

Pollen grains and spores occur in all the examined samples. Pleistocene grains consist mainly of pine,
scattered spruce and pteridophyte spores, which suggests transportation from a northerly source. Reworked grains of Cretaceous and Carboniferous ages are also present. In the upper and middle Miocene sediments, the pollen assemblages are more varied, containing appreciable amounts of oak pollen, grasses, sedges, alder and hickory; this suggests either a climate warmer than the Pleistocene in the same northerly direction, or increased stream discharge and marine currents, or change in source area. Reworked grains of Cretaceous age are also more common, some with excellent preservation, which suggests possible contributions from the Atlantic Coastal Plain or deep-sea deposits. The foraminifers offer little evidence with regard to source of sediment, except that some sublittoral forms are usually minor constituents of the foraminiferal assemblages. This indicates displacement from shallow water.

Foraminifera

Refer to the chapter titled "Neogene Foraminiferal Biostratigraphy" for a detailed analysis of the planktonic foraminiferal assemblages at Sites 102, 103 and 104.

Calcareaous Nannoplankton

Coring at Site 102 recovered sediment ranging in age from late Miocene to Quaternary. The first core, from 9 meters, contained a typical Pleistocene nannoplankton assemblage. The second core, from 27 meters, is also Pleistocene and represents perhaps a glacial interval judging from the common to abundant concentration of large specimens of Coccolithus pelagicus, a species that has a definite cold-water preference in modern oceans. Cores 3 to 8 were likewise assigned to

Figure 2c. Lithology and seismic stratigraphy at Site 104.
the Quaternary. The core catcher of Core 9 contains a few specimens of Discoaster brouweri and thus, was, assigned to the latest Pliocene N. 21 Zone of Blow. Core 10 contains an assemblage indicative of the lower part of N. 21. Core 12 was placed within Zone N. 20. Cores 13, 14 and 15 were assigned to the early Pliocene Zone N. 19, and Core 16 to either very low in Zone N. 19 or possibly to the upper part of Zone N. 18. Cores 17, 18 and 19 were considered to be late Miocene, Zone N. 18.

Coring at Site 103 recovered sediments ranging in age from Holocene at the sea floor to middle Miocene at a depth of 449 meters. Core 1 extends from the surface to a depth of 8 meters, and the bottom of the core contains an early Pliocene assemblage. In superposed sequence, Cores 2 through 7 recovered nannoplankton assemblages of late Miocene in Core 2 to middle Miocene in Core 7. In all but the lower two cores, nannoplankton are present in abundance and are well preserved. Core 6 contains only a few forms, and in Core 7 they are very rare. In these two cores solution effects are commonly observed on the foraminifera.

Cores from Site 104 recovered sediments as young as Quaternary at the top and as old as earliest middle Miocene at a depth of 617 meters. The top of the first core contains a Quaternary assemblage, but the sample from the core catcher was assigned to the late Miocene (probably Zone N. 17 of Blow). The remaining cores (2 through 10) revealed a gradual increase in age through the middle Miocene, terminating in the earliest middle Miocene Sphenolithus heteromorphus Zone (N. 9/10).

Dinoflagellates

Dinoflagellate cysts were recovered from all samples examined at Site 102. Operculodinium centrocarpum (Deflandre and Cookson), Tectatodinium pellitum Wall, and species of Spiniferites are common in the Quaternary assemblages of Cores 1 through 6. Achomosphaera ramulifera (Deflandre) occurs in the Pliocene cores, in addition to those species found also in the Quaternary. At Site 103, Hystrochosaeropsis obscurum new species was found in the cores of Miocene age. The Miocene cores contain a diversified assemblage of pollen grains, including those assigned to oak, hickory, Compositae and grasses. Reworked grains are scattered through the samples, including those of Cretaceous and Carboniferous ages.

Hystrochosaeropsis obscurum occurs in the Miocene cores of Site 104. Pentadinium taeniagerum Gerlach occurs in Core 10 at Site 104.

Rate of Sediment Accumulation

During late Miocene time, sediment at Site 102 accumulated at a rate of 2.5 cm/1000 yr. and increased to 13.7 cm/1000 yr. during the Pleistocene.

At Site 103 approximately 200 meters of late middle and early late Miocene sediment accumulated at a rate of 19.3 cm/1000 yr., and continued at this rate to the end of the Miocene. Rates through the early and middle Pliocene were about 2.6 cm/1000 yr.

At Site 104 middle Miocene sediments accumulated at a rate (19.5 cm/1000 yr.) similar to that calculated for the late middle and early late Miocene at Site 103. During the remainder of late Miocene time, a considerable drop in sedimentation rate (1.8 cm/1000 yr.) occurred at Site 104. In other words, during the late middle and early late Miocene the rate of accumulation at Site 103 (west flank of ridge) was approximately twice that at Site 104 (east flank of ridge). This suggests perhaps that the greatest amount of sediment was being supplied to the southwestern portion of the ridge during late Miocene time.

Lithology

At Sites 102, 103 and 104—on the crest (3425 meters), southwest flank (3964 meters) and northeast flank (3811 meters), respectively, of the Blake-Bahama Outer Ridge—a total of 1727 meters of dark greenish-gray hemipelagic silty mud was penetrated; 192 meters of this material were recovered in 36 cores. Sediment age ranges from middle Miocene to Holocene. All three sites have in common the late Miocene foraminiferal biostratigraphic Zone N. 17 as well as correlative sediment types as determined by smear slide analysis. They will be treated together as one sequence representing the uppermost kilometer of ridge crest sediment.

Three main variations in the hemipelagic sediments are distinguished (1) siliceous, calcareous, and heavy mineral-rich Pleistocene sediments deposited at a rate of about 14 cm/1000 yr., (2) non-siliceous, siderite-pyrite-glaucconite-rich Pliocene and late Miocene sediments deposited at a rate of about 9 cm/1000 yr., (3) siliceous, noncalcareous, siderite-rich middle Miocene sediments deposited at a rate of about 19 cm/1000 yr.

Pleistocene Sediments (N. 22 - N. 23)

Approximately 220 meters of the Pleistocene was penetrated at Site 102; 72 meters of this were cored and 52 meters were recovered. The accumulation rate of almost 14 cm/1000 yr. is extremely high for a deep-sea environment, which is rarely over 5 cm/1000 yr. Less than 5 meters of the surface cores at Sites 103 and 104 were Pleistocene and, thus, the following discussion deals entirely with material recovered in Cores 1 through 8 at Site 102.

The upper 10 meters of sediment at Site 102 resemble the sediment recovered in piston cores taken on the
crest of the Blake-Bahama Outer Ridge by Lamont-Doherty scientists (Heezen et al., 1966). The upper half meter is Holocene yellow-brown and gray, laminated, silty, foraminiferal ooze. Smear slide examinations reveal an abundance of clay minerals, inorganic silt-sized detritus and organic debris, foraminifera and coccoliths, aragonite needles, and a flood of radiolarians, diatoms, and sponge spicules. Siliceous microfossils are almost totally lacking in the underlying Pliocene sediment. The abundant inorganic detrital silt laminae contain abundant heavy minerals.

Below the first few meters, the color becomes dark gray to grayish-brown; black patches of iron sulfide become quite abundant. Methane gas with traces of ethane becomes detectable below about 10 meters below bottom. Below a depth of about 100 meters, a few layers of rose-gray and mottled yellow-green silty clay occur. Siderite, dolomite and aragonite are found sporadically, and burrows are often filled with inorganic light-colored quartz silt.

A few hard, well-indurated crusts of limy mud containing cemented wormlike burrows and burrow-fillings were found at Site 104. Rather large fragments of hard lithographic limestone were found immediately below the crust. The lower limit of the fragments coincides with a major unconformity that separates the early Pleistocene from the late Miocene. Similar crusty surfaces have been found in modern sediments where strong bottom currents scour the sea floor thereby temporarily preventing deposition. It is the absence of Pliocene sediments at Site 104 which indicates recent periods of scouring or nondeposition on the east flank of the Blake-Bahama Outer Ridge.

Pliocene—Late Miocene Sediment (N. 21—N. 15)

At Sites 102, 103 and 104, a total of 687 meters of Pliocene (N. 18/19—N. 21) to late Miocene (N. 14/15) sediment was penetrated; 83 meters of this was recovered in 18 cores. This late Miocene sediment is very similar to the Pliocene material and thus the two will be treated as one lithologic unit. It is homogeneous, dark greenish-gray, silty hemipelagic mud, occasionally mottled with lighter olive-gray hues.

The distinction between Pleistocene and Pliocene-late Miocene sediments lies in minor mineralogic differences revealed by smear-slide analysis and an abundance of siliceous material. Within the Pleistocene, siderite, pyrite and glauconite make their first consistent appearance. They increase in amount with depth in the section. Many of the burrows are found to be filled with siderite silt. Aragonite needles and heavy minerals, common in the Pleistocene, become rare to absent in the older sediment. In the Pleistocene deposits radiolarians, sponge spicules and diatoms are very abundant, whereas in the Pliocene-late Miocene they are rare.

A significant change in mineralogy and palynology also occurs near the boundary between the late Miocene and middle Miocene. This boundary, penetrated at Sites 103 and 104, was not reached at Site 102 and thus the following discussion is based on smear slides obtained from these two correlative sites.

Middle Miocene Sediment (N. 14—N. 9)

A change at the late-middle Miocene boundary is a gradual decrease in abundance of heavy minerals. Foraminiferal tests and nannoplankton are almost totally lacking in smear slides of middle Miocene sediment. However, their decrease has been rather gradual since about middle Pliocene, and may reflect progressive dissolution of carbonate as a function of time and/or depth of burial. At the bottom of the oldest sediment recovered (Core 10, Site 104, Zone N. 10/9), a bed or nodule of ankerite was cored.

Below the middle Miocene-late Miocene boundary an increase in abundance of siliceous organisms occurs. Also, near this boundary an abrupt change in pollen and spore assemblages is noted. Pleistocene and Pliocene-late Miocene sediment contains spruce and fir pollen that appears to have been transported from northernly sources, whereas the middle Miocene sediment contains more temperate forms such as alder, hickory, oak, grasses and sedges that may have been derived from more proximal sources and thus have a more restricted transportational history.

DISCUSSION AND CONCLUSIONS

Cores recovered from these sites can be correlated on the basis of one common biostratigraphic zone (N. 17) as well as on the basis of similar sediment composition. Zone N. 16 is present in Holes 102 and 103. The nature of the sediments and the attitude of reflectors recorded on seismic reflection profiles (Markl et al., 1970) suggest that at least the upper 600 meters of the northern end of the Blake-Bahama Outer Ridge is a large accumulation of rapidly-deposited, hemipelagic, silty carbonaceous clay of Pliocene-Pleistocene age that has been transported to this region from the north by southerly-flowing bottom currents. Erosion has occurred along both flanks of the ridge. The underlying 600 meters of late and middle Miocene hemipelagic sediment recovered at Site 104 appear to have been derived from nearer sources. The upper 150 meters of sediment recovered at Site 102 appears to have been deposited as a conformable lens of Pleistocene hemipelagic silty clay on top of the Pliocene and middle Miocene accumulations.

The western flank of the ridge in the vicinity of Site 103 represents a continuation of the straight, east-west oriented slope running from the vicinity of "Nose" of the Blake Plateau to the ridge crest at approximately
30° 30' N. The unconformities apparent in the seismic profile near Site 103 must be related to the same processes that have formed this east-west linear slope. The unconformities and disturbed reflectors seen in profiles over the eastern flank of the Blake-Bahama Outer Ridge in the vicinity of Site 104 indicate erosion.

As discussed in a previous chapter, the Tertiary sediments at Site 101 at the southern end of the Blake-Bahama Outer Ridge have been transported from the north by southerly-flowing currents and, subsequently, penecontemporaneously sculpted and shaped by the Western Boundary Undercurrent (Heezen, Hollister and Ruddiman, 1966).

At Hole 102, the drilling-rate graph shows only one important break — that at a depth of 620 meters. In the appropriate region of the seismic record, there is only one reflector that could reasonably correlate with the drilling break; that is, the one at 0.62 second which is conformable to the topography and appears to cut across bedding planes. Such a correlation indicates an average sound velocity of 2.0 km/sec in the upper 600 meters of section. It is possible to divide the section into two layers and compute average velocities of 1.9 and 2.3 km/sec, respectively—as shown in the drilling-rate graph (Figure 3).

Drilling at Hole 103 did not achieve sufficient penetration to permit a velocity determination to be made.

At Hole 104, penetration was made at a uniform rate down to 615 meters where a very hard layer, or nodule, of ankerite was cored. Unfortunately, there was not enough time to drill deeper, so we cannot be certain whether the ankerite was an isolated nodule or part of an ankerite-rich zone. In any case, this drilling break is the only observed event to correlate with the reflector at 0.61 second. The correlation indicates an average sound velocity of 2.16 km/sec for the upper 600 meters, a value rather close to that computed for the section at Hole 102.

A sound velocity greater than 2 km/sec seems to be somewhat high for the hemipelagic mud cored at these sites, particularly when we consider that most of the material contained significant amounts of methane. However, if we assume a lower velocity for this material, we are faced with having to accept the fact that we drilled through the prominent reflector without noticing it and then encountered a significant drilling break underneath the reflector. This may indicate that it is the homogeneous zone beneath the reflector that resisted drilling, and the reflectivity of the zone just above it is due to factors not apparent in the normal examination of the cores.

Alternatively, we can accept the interval velocity of about 2 km/sec as a valid measurement and attribute the rather high velocity to the presence of the methane. Stoll et al. (1971) have pointed out that under usual deep sea conditions, the pressure and temperature in the uppermost few hundred meters of sediment are such that methane would exist as a hydrate—an ice-like substance. They further made laboratory measurements in which the speed of sound in water-saturated sand was observed to increase from about 1.7 km/sec to more than 2.5 km/sec after methane had been bubbled through the sample for several hours at 2° to 3° C and 800 to 1000 psi pressure. Although this may account for the abnormal sound velocity, this is not an obvious explanation of the reflector itself. The fact that it is so conformable to the sea floor and cuts across time lines ranging from mid-Miocene to Quaternary suggests that it is caused by a diagenetic process with a short time constant. It seems reasonable to assume that temperature would change much more rapidly than pressure with increasing depth in the sediment, so the diagenesis appears to have a strong tendency to follow an isotherm and, therefore, may be directly or indirectly related to the presence of gas.

REFERENCES


Figure 3a. *Site 102 summary chart*
Figure 3b. *Site 103 summary chart*
<table>
<thead>
<tr>
<th>Meters Below</th>
<th>Age</th>
<th>Calculated Seismic Velocity (km per sec)</th>
<th>Drilling Time in Minutes per Meter</th>
<th>Lithology</th>
<th>Core Number</th>
<th>Penetrometer Core Average ($x \times 10^7$ mm)</th>
<th>Average Rate of Accumulation (cm per 1000 years)</th>
<th>Lithology Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD = 617 m</td>
<td>Pleistocene</td>
<td>2.16</td>
<td>5 10 15</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late Miocene</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle Miocene</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3c. Site 104 summary chart
Hole 102
Latitude: 30°43.93'N.
Longitude: 74°27.14'W.
Water depth: 3426 meters (drill pipe); 3414 meters (PDR)

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Interval Cored (meters)a</th>
<th>Depth</th>
<th>Amount</th>
<th>Recovery</th>
<th>Subbottom Depth</th>
<th>Lithology</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3436-3445</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>Gray hemipelagic mud</td>
<td>Holocene- Late Pleistocene</td>
<td>Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3445-3454)</td>
<td>(9)</td>
<td></td>
<td>(18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3454-3463</td>
<td>9</td>
<td>8.7</td>
<td>27</td>
<td>Gray hemipelagic mud</td>
<td>Late Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3463-3494)</td>
<td>(31)</td>
<td></td>
<td>(58)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3494-3503</td>
<td>9</td>
<td>1.7</td>
<td>67</td>
<td>Gray hemipelagic mud</td>
<td>Late Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3503-3532)</td>
<td>(29)</td>
<td></td>
<td>(96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3532-3541</td>
<td>9</td>
<td>4.3</td>
<td>105</td>
<td>Gray hemipelagic mud</td>
<td>Late Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3541-3569)</td>
<td>(28)</td>
<td></td>
<td>(133)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3569-3578</td>
<td>9</td>
<td>9</td>
<td>142</td>
<td>Gray hemipelagic mud</td>
<td>Late Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3578-3608)</td>
<td>(30)</td>
<td></td>
<td>(172)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3608-3617</td>
<td>9</td>
<td>9</td>
<td>181</td>
<td>Gray hemipelagic mud</td>
<td>Early Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>7</td>
<td>3617-3626</td>
<td>9</td>
<td>9</td>
<td>190</td>
<td>Gray hemipelagic mud</td>
<td>Early Pleistocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3626-3655)</td>
<td>(29)</td>
<td></td>
<td>(119)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3655-3664</td>
<td>9</td>
<td>1.8</td>
<td>228</td>
<td>Gray hemipelagic mud</td>
<td>Early Pleistocene-Late Pliocene</td>
<td>Early Quaternary Quaternary</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3664-3702)</td>
<td>(38)</td>
<td></td>
<td>(266)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3702-3711</td>
<td>9</td>
<td>9</td>
<td>275</td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene</td>
<td>Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3711-3742)</td>
<td>(31)</td>
<td></td>
<td>(306)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3742-3751</td>
<td>9</td>
<td>9</td>
<td>315</td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene</td>
<td>Pliocene</td>
</tr>
</tbody>
</table>

Figure 4a. Core Summary table, Site 102.
<table>
<thead>
<tr>
<th>Core No.</th>
<th>Interval Cored (meters)</th>
<th>Depth</th>
<th>Amount</th>
<th>Recovery</th>
<th>Subbottom Depth</th>
<th>Lithology</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Drilled)</td>
<td>(3751-3789)</td>
<td></td>
<td>(38)</td>
<td></td>
<td>(353)</td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene Middle Pliocene Pliocene</td>
</tr>
<tr>
<td>11</td>
<td>3789-3793</td>
<td>4</td>
<td>3</td>
<td>357</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene Middle Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3793-3855)</td>
<td>(62)</td>
<td>(419)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene Middle Pliocene Pliocene</td>
</tr>
<tr>
<td>12</td>
<td>3855-3859</td>
<td>4</td>
<td>4.5</td>
<td>423</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene Middle Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3859-3909)</td>
<td>(50)</td>
<td>(473)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Pliocene Middle Pliocene Pliocene</td>
</tr>
<tr>
<td>13</td>
<td>3909-3912</td>
<td>3</td>
<td>4.4</td>
<td>476</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3912-3948)</td>
<td>(36)</td>
<td>(512)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Pliocene</td>
</tr>
<tr>
<td>14</td>
<td>3948-3949</td>
<td>1</td>
<td>1.4</td>
<td>513</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3949-3984)</td>
<td>(35)</td>
<td>(548)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Pliocene</td>
</tr>
<tr>
<td>15</td>
<td>3984-3985</td>
<td>1</td>
<td>1</td>
<td>549</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3985-4020)</td>
<td>(35)</td>
<td>(584)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Late Miocene Early Pliocene Pliocene</td>
</tr>
<tr>
<td>16</td>
<td>4020-4021</td>
<td>1</td>
<td>0.7</td>
<td>585</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Late Miocene Early Pliocene Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4021-4054)</td>
<td>(33)</td>
<td>(618)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Early Pliocene Late Miocene Early Pliocene Pliocene</td>
</tr>
<tr>
<td>17</td>
<td>4054-4055</td>
<td>1</td>
<td>1.5</td>
<td>619</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Miocene Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4055-4070)</td>
<td>(15)</td>
<td>(634)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Miocene Miocene</td>
</tr>
<tr>
<td>18</td>
<td>4070-4072</td>
<td>2</td>
<td>3.4</td>
<td>636</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Miocene Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4072-4095)</td>
<td>(23)</td>
<td>(659)</td>
<td></td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Miocene Miocene</td>
</tr>
<tr>
<td>19</td>
<td>4095-4097</td>
<td>2</td>
<td>1.5</td>
<td>661</td>
<td></td>
<td>Gray hemipelagic mud</td>
<td>Late Miocene Miocene</td>
</tr>
</tbody>
</table>

*aAll intervals are measured by drill pipe from the derrick floor which is 10 meters above water surface.

Figure 4a. Core Summary table, Site 102 (Cont)
Hole 103

Latitude: 30°27.08'N.
Longitude: 74°34.99'W.
Water depth: 3964 meters (drill pipe); 3992 meters (PDR)

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Interval Cored (meters)</th>
<th>Lithology</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3974-3982</td>
<td>Hemipelagic mud</td>
<td>Holocene-Late Pleistocene-Early Pliocene</td>
</tr>
<tr>
<td></td>
<td>(3982-4012)</td>
<td></td>
<td>Early Pliocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(3982-4012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4012-4021</td>
<td>Hemipelagic mud with dolomite-rich layer</td>
<td>Early Pliocene</td>
</tr>
<tr>
<td></td>
<td>(4021-4068)</td>
<td></td>
<td>Late Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4021-4068)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4068-4077</td>
<td>Hemipelagic mud</td>
<td>Late Miocene</td>
</tr>
<tr>
<td></td>
<td>(4077-4144)</td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4077-4144)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4144-4153</td>
<td>Hemipelagic mud</td>
<td>Late Miocene</td>
</tr>
<tr>
<td></td>
<td>(4153-4221)</td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4153-4221)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4221-4230</td>
<td>Hemipelagic mud</td>
<td>Late Miocene</td>
</tr>
<tr>
<td></td>
<td>(4230-4317)</td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4230-4317)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4317-4326</td>
<td>Hemipelagic mud</td>
<td>Late Miocene</td>
</tr>
<tr>
<td></td>
<td>(4326-4414)</td>
<td></td>
<td>Miocene</td>
</tr>
<tr>
<td>(Drilled)</td>
<td>(4326-4414)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4414-4423</td>
<td>Dark gray shale</td>
<td>Late Miocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Middle Miocene</td>
</tr>
</tbody>
</table>

*All intervals are measured by drill pipe from the derrick floor which is 10 meters above water surface.

Figure 4b. Core Summary table, Site 103.
**Hole 104**

**Latitude:** 30°49.65'N.  
**Longitude:** 74°19.64'W.  
**Water depth:** 3811 meters (drill pipe); 3833 meters (PDR)

<table>
<thead>
<tr>
<th>Core No.</th>
<th>Interval Cored (meters)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Depth</th>
<th>Amount</th>
<th>Recovery</th>
<th>Subbottom Depth</th>
<th>Lithology</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3821-3830</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>Hemipelagic mud worm-burrow crust</td>
<td>Holocene-Pleistocene-Late Miocene</td>
<td>Late Miocene</td>
</tr>
<tr>
<td>(Drilled)(3830-3857)</td>
<td>(27)</td>
<td>(36)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3857-3866</td>
<td>9</td>
<td>9</td>
<td>45</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Late Miocene</td>
</tr>
<tr>
<td>(Drilled)(3866-3883)</td>
<td>(17)</td>
<td>(62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3883-3892</td>
<td>9</td>
<td>9</td>
<td>71</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(3892-3954)</td>
<td>(62)</td>
<td>(133)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3954-3963</td>
<td>9</td>
<td>9</td>
<td>142</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(3963-4031)</td>
<td>(68)</td>
<td>210</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4031-4040</td>
<td>9</td>
<td>0</td>
<td>219</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(4049-4127)</td>
<td>(78)</td>
<td>(306)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4040-4049</td>
<td>9</td>
<td>9</td>
<td>228</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(4127-4136)</td>
<td>(86)</td>
<td>(401)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>4136-4222</td>
<td>9</td>
<td>3.6</td>
<td>315</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(4222-4231)</td>
<td>(86)</td>
<td>(495)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>4222-4231</td>
<td>9</td>
<td>4</td>
<td>410</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(4231-4316)</td>
<td>(85)</td>
<td>(495)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4316-4325</td>
<td>9</td>
<td>2.5</td>
<td>504</td>
<td>Hemipelagic mud</td>
<td></td>
<td>Middle Miocene</td>
</tr>
<tr>
<td>(Drilled)(4325-4436)</td>
<td>(111)</td>
<td>(615)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>4436-4438</td>
<td>2</td>
<td>1</td>
<td>617</td>
<td>Hemipelagic mud and ankerite layer</td>
<td></td>
<td>Middle Miocene</td>
</tr>
</tbody>
</table>

<sup>a</sup>All intervals are measured by drill pipe from derrick floor which is 10 meters above water surface.

Figure 4c. *Core Summary table, Site 104.*
Summary of Physical Properties, Hole 102
Summary of Physical Properties, Hole 103
Summary of Physical Properties, Hole 104
Summary of Physical Properties, Hole 104 (Cont'd)
Hole 102, Core 1 (0m to 10m)

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLOCENE</td>
<td></td>
<td>Foram-nannoplankton ooze; very soft, varicolored brown and gray. Clay, quartz, mica, common (2.5Y5/2).</td>
<td>Planktonic foraminifers: Globigerina calido., Globorotalia truncatulina (sinistral), Globigerina rubescens, Globorotalia truncatula f. rosea, Globorotalia obliqua, Globorotalia detrita.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hemipelagic carbonaceous silty clay; soft, plastic, dark gray (2.5YR3/1).</td>
<td>Hemipelagic carbonaceous silty clay; soft, plastic, dark gray (2.5YR3/1).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increasing abundance of dark iron sulfide specks and stains.</td>
<td>Increasing abundance of dark iron sulfide specks and stains.</td>
</tr>
<tr>
<td>LATE PLEISTOCENE</td>
<td></td>
<td>Faint rose-gray colored silty clay.</td>
<td>Faint rose-gray colored silty clay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fragments of detrital carbonate common in Section 2.</td>
<td>Fragments of detrital carbonate common in Section 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occasional faint mottling of lighter (5YR 6/1) material.</td>
<td>Occasional faint mottling of lighter (5YR 6/1) material.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clay sized rutile needles common in Section 3.</td>
<td>Clay sized rutile needles common in Section 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular calcite grains common in Section 4.</td>
<td>Irregular calcite grains common in Section 4.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bed and clast of firm clay. Rutile needles and fragments of detrital calcite in both Sections 5 and 6.</td>
<td>Rutile needles and fragments of detrital calcite in both Sections 5 and 6.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General Comments:</td>
<td>General Comments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Increasing abundance of diatoms and sponge spicules towards bottom.&quot;</td>
<td>&quot;Increasing abundance of diatoms and sponge spicules towards bottom.&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Dark iron sulfide specks throughout core.&quot;</td>
<td>&quot;Dark iron sulfide specks throughout core.&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Increasing abundance of quartz silt and heavy mineral grains towards bottom of core.</td>
<td>&quot;Increasing abundance of quartz silt and heavy mineral grains towards bottom of core.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;Carbonate average 15%</td>
<td>&quot;Carbonate average 15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calcite fragments abundant, rutile needles common.</td>
<td>Calcite fragments abundant, rutile needles common.</td>
</tr>
</tbody>
</table>

Core Catcher:
Calcitic nanofossils:
Gephyrocapsa oceanica, Emiliania huxleyi, Holoemilianellus ovatus.

Natural Gamma Penetrometer Radiation counts/3' cm: 1.25 min. x 10^3

<table>
<thead>
<tr>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gamma Penetrometer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chain-Sized Water Content-Porosity Wt-Bulk Density Sonic Velocity</td>
<td>cm</td>
<td>%</td>
<td>g/cc</td>
<td>km/sec</td>
</tr>
</tbody>
</table>
Hole 102, Core 2 (18m to 27m)

**Lithology**

- **Sample**: 194
- **Depth**: 20m

**Diagnostic Fossils**

**Calcareous Nanoplankton**:
- Ellipsoptacolithus laouwsu
- *Ceratotithus evii*
- *Cyclosporites leptopora*

**Core Catcher**

**Planktonic Foraminifers**: (Not specified)

**Core Comments**

- Sediment broken into foamy chunks due to gas expansion.
- Abundant black specks of iron sulfide common throughout.
- Abundant radiolarians, diatoms, and sponge spicules.
- Common organic matter and calcite fragments throughout.
- Increasing amount of sand, nanoplankton and radiolarians towards bottom of core.
- Carbonate average 10%.

**Gradual change to greenish gray color (5G6/1).**
### Hole 102, Core 3 (50m to 67m)

<table>
<thead>
<tr>
<th>SAMPLE INTERVAL</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hemipelagic carbonaceous silty clay; soft, plastic, dark grayish greenish gray (5G4/1) slight mottling of lighter shades.</td>
<td>CALCAREOUS NANNOPLANKTON: Gephyrocapsa oceanica, Emiliania huxleyi, Rhizosolenia, Stigmonella, Calcidiscus leptopus, Syracosphaera pulchra.</td>
</tr>
<tr>
<td>2</td>
<td>Dark specks of iron sulfide common throughout.</td>
<td>PLANKTONIC FORAMINIFERS: Globorotalia truncatulinoides (sinistral), Globigerella inflata, Eldredgeina polyedra.</td>
</tr>
<tr>
<td>3</td>
<td>Rutil needles common in top of section and rare in core catcher sample.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fragmental calcite rare in top and common in core catcher sample.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Carbonate average 25%.</td>
<td></td>
</tr>
</tbody>
</table>

**General Comments:**
- Dark specks of iron sulfide common throughout.
- Rutil needles common in top of section and rare in core catcher sample.
- Fragmental calcite rare in top and common in core catcher sample.
- Carbonate average 25%.
Hole 102, Core 4 (94m to 105m)

**Lithology**
- Hemipelagic carbonaceous silt; soft, plastic, greenish gray (5G5/1) with intense mottling of light greenish gray (5G6/1).
- Dark greenish gray (5G4/1) with mottling of brownish gray (5YR4/1) and greenish gray (5G6/1).
- Olive gray (5Y4/1) with moderate mottling of dark greenish gray (5GY4/1).

**General Comments:**
- Radiolarians, diatoms and sponge spicules rare throughout.
- Quartz silt abundant in upper portions of core.
- Nannoplankton increase towards bottom of core.
- Voids due to gas expansion.
- Carbonate average 5%.
- Black specks of iron sulfide common throughout core.
- Calcite fragments abundant and rutile needles rare throughout.

**Diagnostic Fossils**

**Calcareaous Nannoplankton:**
- Syracosphaera pulchra,
- Rhabdosphaera typhliceras,
- Cyanothece leptopora,
- Ceratolithus arctius

**Planktonic Foraminifers:**
- Globorotalia truncatulinoides (Dextral),
- Globorotalia cultrata (sinistral),
- Turborotalia inflata.

**Core Catcher**

**Grain-Size**

**Water Content-Porosity**

**Wet-Bulk Density**

**Sonic Velocity**
**Hole TOCENE Q. s**

Core: 133m to 142m

**General Comments:**
- Clay mineral content decreases towards the lower half of the core.
- Foraminifers increase in abundance towards the lower part of the core.
- Siltaceous forms are rare in core.
- Core highly disturbed throughout.
- Voids due to gas expansion.
- Black specks of iron sulfide common.
- Calcite fragments generally common, rutile needles generally rare.
- Slucosita common in Section 2.

**Lithology:**
- Hemipelagic carbonaceous silt
- Clay, soft plastic, greenish gray (5G5/1), slight mottling of olive gray (5G4/1) and brownish gray (5YR4/1).

**Diagnostic Fossils:**

**Calcereous Nanoplankton:**
- *EOpinolithus longicostatus*, *Epiphragmatolithus costatus*, *Maturhastra stylopilenta*, *Cهماcostrella jeppeana*, *Cephalonionlithus lepidopora*

**Planktonic Foraminifers:**
- *Globorotalia aulacostatum*, *Globorotalia aulacostatum (Family)*, *Globorotalia truempyolides (Dostovalov)*
- *Turborotalia cf. Lithistoida*, *Subulinella pseudosulina*

**Core Catcher**

**NATURAL GAMMA**

**PENETROMETER**

**GRAIN-SIZE**

**WATER CONTENT-POROSITY**

**WET-BULK DENSITY**

**SONIC VELOCITY**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Zone</th>
<th>Age</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
</table>
| 1     | 1    | 1   | Clay, soft plastic, greenish gray (5G5/1), slight mottling of olive gray (5G4/1) and brownish gray (5YR4/1). | **Calcereous Nanoplankton:**
|       |      |     |           | *EOpinolithus longicostatus*, *Epiphragmatolithus costatus*, *Maturhastra stylopilenta*, *Cهماcostrella jeppeana*, *Cephalonionlithus lepidopora* |
| 2     | 2    | 2   | Clay, soft plastic, greenish gray (5G5/1), slight mottling of olive gray (5G4/1) and brownish gray (5YR4/1). | **Planktonic Foraminifers:**
|       |      |     |           | *Globorotalia aulacostatum*, *Globorotalia aulacostatum (Family)*, *Globorotalia truempyolides (Dostovalov)* |
| 3     | 3    | 3   | Clay, soft plastic, greenish gray (5G5/1), slight mottling of olive gray (5G4/1) and brownish gray (5YR4/1). | **Core Catcher:**
<p>|       |      |     |           | <em>Turborotalia cf. Lithistoida</em>, <em>Subulinella pseudosulina</em> |</p>
<table>
<thead>
<tr>
<th>SOL</th>
<th>ZONE</th>
<th>SECTION</th>
<th>SAMPLE</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
</table>
| 1   | 1    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). | General Comments:  
- Abundance of voids due to expansion of gas. Sediment occasionally very foamy.  
- Some very soupy sediment in the void intervals.  
- Dark (W2) specks of iron sulfide common throughout.  
- Foraminifers decrease towards bottom of core.  
- Sponge spicules and diatoms are common throughout core.  
- Calcite fragments generally common throughout core.  
- Carbonate average 27%. |
| 2   | 2    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). | CALCAREOUS NANNOPLANKTON:  
- Ellipsoplaeolithus laeuenus  
- Gephyrooapsa oceanaica  
- Gyrolacocciithina tepitosa  
- Rhabodhchaera stylifera  
- Cepatothids aristatus |
| 3   | 3    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). | PLANKTONIC FORAMINIFERS:  
- G. aultrata (sinistral)  
- T. inflata |
| 4   | 4    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). | CALCAREOUS NANNOPLANKTON:  
- Ellipsoplaeolithus laeuenus  
- Gymnococciithina tepitosa  
- Gephyrooapsa oceanaica |
| 5   | 5    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). | CORE CLOSES |
| 6   | 6    | S5      | S5     | Hemipelagic carbonaceous silty clay; soft, plastic, greenish gray (5G5/1) with mottling of olive gray (5Y4/1). |

**DIAGNOSTIC FOSSILS**

**CALCAREOUS NANNOPLANKTON:**
- Ellipsoplaeolithus laeuenus  
- Gephyrooapsa oceanaica  
- Gymnococciithina tepitosa  
- Rhabodhchaera stylifera  
- Cepatothids aristatus

**PLANKTONIC FORAMINIFERS:**
- G. aultrata (sinistral)  
- T. inflata

**CALCAREOUS NANNOPLANKTON:**
- Ellipsoplaeolithus laeuenus  
- Gymnococciithina tepitosa  
- Gephyrooapsa oceanaica

**CORE CLOSES**
- PLANATOMIC FORAMINIFERS:
  - Turritella tenuis  
  - Turrilithus tenuimarginatus (Proshel)  
  - Turrilithus tenuimarginatus  
  - Turrilithus tenuimarginatus

**CALCAREOUS NANNOPLANKTON:**
- Ellipsoplaeolithus laeuenus  
- Gymnococciithina tepitosa  
- Gephyrooapsa oceanaica  
- Cepatothids aristatus
Hole 102, Core 7 (181m to 190m)

General Comments:
- Burrow fillings of silt sized quartz and feldspar.
- Black specks of iron sulfide throughout.
- Voids due to gas expansion.
- First hint of downhole trend towards fewer carbonate fragments in bottom of core (Section 5).
- Carbonate average 16%.

Sediment firmer from top of Section 3 downward.

Greenish gray (5G 5/1) with mottling of dusky yellow green (5GY 5/2) from top of Section 3 to Section 5.

Increased quartz silt content in upper part of Section 4 and first (downhole) abundant occurrence of siderite in silt layer. Dramatic lack of calcareous and siliceous tests in Section 4.

Gradual color change to dark greenish gray (5G4/1 and 5G3/1).

**DIAGNOSTIC FOSSILS**

**CALCAREOUS NANOPLANKTON:**
- Ellipsoplaeolithus laeunus
- Ceratolithus aracatus
- Cyaloaodolithina leptopora
- Disaolithina japonica
- Rhabdosphaera stylifera

**PLANKTONIC FORAMINIFERS:**
- Turborotalia inflata
- Turborotalia tosaensis
- Globorotalia truncatulina (sinistral)

**CORE CATCHER**

**NATURAL GAMMA PENETROMETER**

<table>
<thead>
<tr>
<th>RADIATION</th>
<th>PENETROMETER</th>
<th>GRAIN-SIZE</th>
<th>WATER CONTENT</th>
<th>POROSITY</th>
<th>WET-BULK DENSITY</th>
<th>SONIC VELOCITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>counts/cm^3</td>
<td></td>
<td>g/cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>100</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>11</td>
<td>100</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>12</td>
<td>100</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>13</td>
<td>100</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>14</td>
<td>100</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>15</td>
<td>100</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>16</td>
<td>100</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>17</td>
<td>100</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>19</td>
<td>100</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**CORE HOLE**

**CALCAREOUS NANOPLANKTON:**
- Ellipsoplaeolithus laeunus
- Ceratolithus aracatus
- Cyaloaodolithina leptopora
- Disaolithina japonica
- Rhabdosphaera stylifera

**PLANKTONIC FORAMINIFERS:**
- Turborotalia inflata
- Turborotalia tosaensis
- Globorotalia truncatulina (sinistral)
Hole 102, Core 8 (219m to 228m)

Hemipelagic carbonaceous silt
Clay soft, plastic, dark
Greenish gray (5G4/1), foamy
Nature due to gas.

General Comments:
- Voids due to gas expansion.
- Most of the "void" zones contain
  very mixed and soupy sediment.
- Radiolarians absent from this
  core to bottom of hole.
- Rare calcite fragments and
  rutile needle.
- Carbonate average 15%

DIAGNOSTIC FOSSILS

PLANKTONIC FORAMINIFERS:
Globorotalia truncatulinoides (dextral),
Turborotalia inflata

CALCAREOUS NANNOPLANKTON:
Gephyrocapsa oceanica,
Ellipsoplaeolithus leonensis,
Ceratolithus arcticus,
Habibogypsina stylifera

PLANKTONIC FORAMINIFERS:
Globorotalia truncatulinoides
T. inflata

CALCAREOUS NANNOPLANKTON:
Gephyrocapsa oceanica,
Ellipsoplaeolithus leonensis,
Ceratolithus arcticus,
Habibogypsina stylifera

CORE CATCHER

PLANKTONIC FORAMINIFERS:
Turborotalia inflata, T. acosta,
Globorotalia conomica

CALCAREOUS NANNOPLANKTON:
Gephyrocapsa oceanica,
Ellipsoplaeolithus leonensis,
Ceratolithus arcticus,
Habibogypsina stylifera
Hole 102, Core D (266m to 275m)

**Lithology**: Hemipelagic carbonaceous silt
- Slightly indurated plastic
- Greenish gray (5G5/1) with mottling of olive gray (5Y4/1)
- Pyrite nodule

**General Comments**:
- Black specks of iron sulfide common throughout.
- Finely bedded nature noticed for first time in the hole.
- Voids due to gas expansion.
- Silt content and nannoplankton increase toward bottom of core.
- Siliceous forms conspicuously absent.
- Siderite rhombs rare to common throughout, first consistent occurrence.
- Carbonate average 26%.
- Lens of pyrite silt.
- Pyrite nodule.

**Calcitic Nannoplankton**:
- Ellipsoplaeolithus laounosus
- D. pentaradiatus
- Cyathocoelia leptopora
- Helioopontosphaera kamptneri
- Ceratolithus cristatus

**Planktonic Foraminifers**:
- Turborotalia inflata
- G. conozooeis
- Turborotalia onkoerii
- Globorotalia limbata
- Turborotalia onkoerii

**Dinoflagellates**:
- Aplathosphaera ramulifera

**Natural Gamma Penetrometer**
- Radiation counts/37

**Penetrometer**
- Clay-silt-sand %

**Grain-Size**
- Water content-porosity
- Wet-bulk density
- Sonic velocity
**Lithology:**
- Hemipelagic carbonaceous silty clay, firm, plastic, greenish gray (5G5/1).

**Diagnostic Fossils:**

**Calcareous Nanoplankton:**
- Ellipsoplaeolithus lacunas
- Disaster brouweri, D. pentaradiatus
- Ceratolithus rugosus
- Cylindroplacolithus leptoporin

**Planktonic Foraminifers:**
- Globigerinoides escavus
- Globobulloina incognita
- G. veafooid
- G. donnelloni

**Core Catcher:**
- Calcareous Nanoplankton:
  - Ellipsoplaeolithus lacunas
  - Disaster brouweri, D. pentaradiatus
  - Ceratolithus rugosus
  - Cylindroplacolithus leptoporin

**General Comments:**
- Black specks of iron sulfide throughout.
- Voids due to gas expansion.
- Entire core has strong odor of mercaptans.
- Quartz and feldspar silt increase towards bottom of hole.
- Siliceous forms rare throughout.
- Siderite rare to abundant.
- Carbonate average 14%.

Occasional faint mottling of light olive gray (5Y5/2) in Sections 3 thru 5.

Occasional worm burrows, siderite abundant in Section 4.

Gradual color change to dark greenish gray (5G4/1).

White lens of quartz-feldspar silt
Hole 102, Core 11 (353m to 357m)

<table>
<thead>
<tr>
<th>Age</th>
<th>ZONE</th>
<th>Depth (m)</th>
<th>Section No</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Late Pleistocene</td>
<td></td>
<td>1</td>
<td>Hemipelagic carbonaceous silt, clay-fine, plastic, dark greenish gray (5G6/1).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>52-54</td>
<td>1</td>
<td>General Comments:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>1</td>
<td>- Siderite common throughout.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>- White specks and glass rare to common.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>2</td>
<td>- Silt, pyrite, foraminifers and sponge spicules increase towards bottom of core.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>- Unusually abundant sponge spicules.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>2</td>
<td>- Voids due to gas expansion.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>- Carbonate average 18%.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td></td>
<td>3</td>
<td>Calcareaous Nanoplankton:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>3</td>
<td>Artioplocystus pseudowittling, Artiaplocystus pseudowittling, Ellipsoplaeola variabilis, Sphenolithus abies,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>Calcareaous Nanoplankton:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>3</td>
<td>Zeugodiscus pseudowittling, D. asymmetricus, Sphenolithus abies.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>Core Catcher</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55</td>
<td>3</td>
<td>Calcareous Nanoplankton:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>Artioplocystus pseudowittling, D. asymmetricus, Sphenolithus abies.</td>
<td></td>
</tr>
</tbody>
</table>

**NATURAL GAMMA PENETROMETER**

- **PENETRATOR**
  - **GRAIN-SIZE**
  - **WATER CONTENT - POROSITY**
  - **WET-BULK DENSITY**
  - **SONIC VELOCITY**

<table>
<thead>
<tr>
<th>Count/37 K</th>
<th>cm</th>
<th>clay-silt-sand</th>
<th>% weight</th>
<th>% vol</th>
<th>g/cc</th>
<th>kn/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 min. X 10^3</td>
<td>0.20</td>
<td>0</td>
<td>20</td>
<td>40</td>
<td>60</td>
<td>80</td>
</tr>
</tbody>
</table>
Hole 102, Core 12 (419m to 423m)

Lithology

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Depth (m)</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>419</td>
<td>Hemipelagic carbonaceous silt, clay, firm, plastic, dark greenish grey (5G4/1).</td>
<td>- Voids due to gas expansion.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>421</td>
<td>Hemipelagic carbonaceous silt, clay, firm, plastic, dark greenish grey (5G4/1).</td>
<td>- Siliceous forms absent.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>422</td>
<td>Hemipelagic carbonaceous silt, clay, firm, plastic, dark greenish grey (5G4/1).</td>
<td>- Siderite common throughout.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>423</td>
<td>Hemipelagic carbonaceous silt, clay, firm, plastic, dark greenish grey (5G4/1).</td>
<td>- Calcite fragments common at bottom.</td>
</tr>
</tbody>
</table>

Carbonate average 21%.

Silt abundant.

PLANKTONIC FORAMINIFERS:
- Globigerinidae extima
- Globigerinoides extima
- Globigerinoides ruber
- Globigerinella subplicata
- G. seminolina

PLANKTONIC FORAMINIFERS:
- Retiaulofenestra pseudoumbilica
- Sphenolithus abies
- D. pentaradiatus
- Helicolenus sp.

Sphaeroidinellopsis subdehiscent

Globigerinoides ruber

DIAGNOSTIC FOSSILS

CALCAREOUS NANOPHANKTON:
- Retiaulofenestra pseudoumbilica
- Sphenolithus abies
- D. pentaradiatus
- Helicolenus sp.

NATURAL GAMMA PENETROMETER

GRANIE SIZE WATER CONTENT POROSITY WET-BULK DENSITY SONIC VELOCITY

counts/30' X 10^3

1.25 min X 10^3

% weight clay-silt-sand

% wt % vol g/cc

km/sec

Figure showing graph and data related to natural gamma, grain size, water content, porosity, wet-bulk density, and sonic velocity.
Hole 102, Core 13 (473m to 476m)

**LITHOLOGY**

- Hemipelagic carbonaceous silty clay, slightly indurated, pyrrhotite, greenish gray (5G4/1).

**General Comments:**
- Voids due to gas expansion.
- Siderite common throughout.
- Siliceous forms absent.
- Carbonate average 16%.

- Abundant sand and silt grains of heavy minerals, quartz, pyrite and glauconite.

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Globorotalia margaritae
- Pulleniatina primalis
- Globoquadrina altispira
- Globigerinoides extremus

**CALCAREOUS NANNOPLANKTON:**
- D. pentaradiatus
- Sphenolithus abies
- Retiulofenestra pseudoumbilica
- Heliosphaerina kamptneri
- H. eifell

**DINOFLAGELLATES:**
- Allohelisphera vaxttuli

**GRAIN-SIZE WATER CONTENT-POROSITY WET-BULK DENSITY SONIC VELOCITY**

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>Hemipelagic carbonaceous silty clay</td>
<td>Globorotalia margaritae, Pulleniatina primalis, Globoquadrina altispira, Globigerinoides extremus</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Abundant sand and silt grains of heavy minerals, quartz, pyrite and glauconite</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PLANKTONIC FORAMINIFERS:**
- Globorotalia margaritae
- Pulleniatina primalis
- Globoquadrina altispira
- Globigerinoides extremus

**CALCAREOUS NANNOPLANKTON:**
- D. pentaradiatus
- Sphenolithus abies
- Retiulofenestra pseudoumbilica
- Heliosphaerina kamptneri
- H. eifell

**DINOFLAGELLATES:**
- Allohelisphera vaxttuli
### Hole 102, Core 14 (512m to 513m)

**Lithology:**
Hemipelagic carbonaceous silty clay, slightly indurated firm, dark greenish gray (5G4/1).

**General Comments:**
- Voids due to gas expansion.
- Siderite common throughout.
- Siliceous forms absent.
- Carbonate average 19%.

**Diagnostic Fossils**

**Planktonic Foraminifera:**
- Globorotalia margaritae
- Pullenia primalis
- Globorotalia extrus
- Globigerinoides extrus

**Oinoflagellates:**
- Achomosphaera ranrufa

**Calcareous Nanoplankton:**
- Diestoaster asperus
- D. rugosus
- Cuculosa unguiculata
- Sphenolithus abies
- Ceratolithus rugosus

**Core Catcher Nanoplankton:**
- Lepidasthila pseudoumbilla
- Asymmetricus

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Section No.</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hole 102, Core 15 (548m to 549m)

**Lithology:**
Hemipelagic carbonaceous silty clay, firm, dark greenish gray (5G4/1) with mottling to grayish olive (10Y4/2).

**General Comments:**
- Voids due to gas expansion.
- Siderite common.
- Carbonate average 20%.

**Diagnostic Fossils**

**Planktonic Foraminifera:**
- Globigerina nepenthes
- Globorotalia lirata
- Globorotalia margaritae
- Globorotalia altispirea
- Globigerinoides extrus

**Oinoflagellates:**
- Achomosphaera ranrufa

**Calcareous Nanoplankton:**
- D. extrus
- D. rugosus
- Cuculosa unguiculata
- Sphenolithus abies
- Ceratolithus rugosus
- Lepidasthila pseudoumbilla

**Core Catcher Nanoplankton:**
- Lepidasthila pseudoumbilla
- Asymmetricus

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Section No.</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Hole 102, Core 16 (584m to 585m)

**Lithology:**
- Hemipelagic, carbonaceous, silty
- Clay, indurated, dark greenish gray (5G4/1).

**General Comments:**
- Concentrations of quartz and feldspar silt in burrows.
- Siderite grains common.
- White fluorescent material in core catcher sample.
- Carbonate average 14%.

**Diagnostic Fossils**
- **Calcareaous Nanoplankton:**
  - Retiulofenestra pseudoumbilica
  - Sphenolithus abies
  - Dissoaster asyrmetriaus
  - D. eurichis
  - D. brouweri
  - D. hallengeri
  - Ceratolithus triagnulatus

**Planktonic Foraminifers:**
- Globorotalia plesiotumida
- Turrbitoalteria multiloba
- Globigerina nepenthes
- Globorotalia margaritae

**Core Catcher**
- **Calcareaous Nanoplankton:**
  - Calcareous marine plankton:
  - Globorotalia plesiotumida
  - Sphenolithus abies
  - Dissoaster asyrmetriaus
  - D. eurichis
  - D. hallengeri
  - Ceratolithus triagnulatus

### Hole 102, Core 17 (618m to 619m)

**Lithology:**
- Hemipelagic, carbonaceous silty
- Clay, indurated, dark greenish gray (5G4/1).

**General Comments:**
- Sponge spicules and diatoms common; only occurrence below core 11.
- Abundant pyrite spheres in core catcher.
- Siderite rare.
- Carbonate average 14%.

**Diagnostic Fossils**
- **Calcareaous Nanoplankton:**
  - Calcareous marine plankton:
  - Globorotalia plesiotumida
  - Sphenolithus abies
  - Dissoaster asyrmetriaus
  - D. eurichis
  - D. hallengeri
  - Ceratolithus triagnulatus

**Planktonic Foraminifers:**
- Globigerinoides extremus
- Globorotalia margaritae
- Turrbitoalteria multiloba
- Globigerina nepenthes
- Globorotalia margaritae

**Core Catcher**
- **Calcareaous Nanoplankton:**
  - Calcareous marine plankton:
  - Globorotalia plesiotumida
  - Sphenolithus abies
  - Dissoaster asyrmetriaus
  - D. eurichis
  - D. hallengeri
  - Ceratolithus triagnulatus

---

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Section</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Miocene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Miocene</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**NATURAL GAMMA**

**PENETROMETER**

**GRAIN-SIZE**

**WATER CONTENT-POROSITY**

**WET-BULK DENSITY**

**SONIC VELOCITY**

---

**NATURAL GAMMA RADIATION**

**PENETROMETER**

**GRAIN-SIZE**

**WATER CONTENT-POROSITY**

**WET-BULK DENSITY**

**SONIC VELOCITY**
Hole 102, Core 18 (634m to 636m)

- Hemipelagic carbonaceous silty clay, fine, brittle, dark greenish gray (5GY4/1) to greenish black (5G2/1).
- Thin sand lens of fragments of echinoid spines and siderite rhombs.

General Comments:
- Most of this core is disturbed by coring operation. Darker beds are highly contorted; lighter speckled beds are relatively undisturbed.
- White specks are foram tests and burrow fillings of quartz, feldspar and pyrite grains.
- Voids due to gas expansion.
- Siderite common throughout.
- Carbonate average 11%.

CALCAREOUS NANNOPLANKTON:
- Pseudoscyphus triornioulatus
- Retzius pseudoradiatus
- D. challengeri,
- D. variabilis

PLANKTONIC FORAMINIFERS:
- Globigerina nepentihi,
- G. limbata (sinistral),
- G. obovata,
- G. oblonga easter.

CORE DECAYER
DINOPHYTELLITES:
- Thalassiosira Rossellina

CALCAREOUS NANNOPLANKTON:
- Syrinchnietes triornioulatus
- Scissurella pulexanemia,
- D. challengeri,
- D. variabilis
- S. Rossellina
- Retzius pseudoradiatus
- Sphenolithis obovata
Hole 102, Core 19 (659m to 661m)

Hemipelagic, carbonaceous, silty clay, pyrite, bittern, dark greenish gray (5GY4/1) to lighter gray (5GY4/1). Flat siderite nodule.

General Comments:
- Most of this core is disturbed by coring operation. Darker beds are highly contorted; lighter speckled beds are relatively undisturbed.
- White specks are foram tests and burrow fillings of quartz, feldspar and pyrite grains.
- Voids due to gas expansion.
- Siderite common throughout.
- Carbonate average 11%.

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Turborotalia aoostensis
- Turborotalia continuosa
- T. clemenciae
- Globorotalia mevotwana
- Globigerina altispira
- Globigerina nepenthodes
- Globigerina piovenskaya
- Sphaeroidellopsis subdehiscentia

**CORE CATCHER DINOFLAGELLATES:**

**CALCAREOUS NANOPLANKTON:**
- No data provided.

**NATURAL GAMMA RADIATION**

**PENETROMETER**

**GRAIN-SIZE**

**WATER CONTENT-POROSITY**

**WET-BULK DENSITY**

**SONIC VELOCITY**
**Hole 103, Core 1 (0m to 9m)**

**Lithology**

- **Glossohemia Formation**
  - Hemipelagic silt and sandy clay; soft, varying in color from greenish gray (5G6/1) to dark yellowish orange (10YR5/4).
  - Light brown foramin sand (5YR6/6) with heavy minerals.
  - Grayish green clay.
  - Color becoming predominantly greenish gray (5G6/1) to olive gray (5Y4/1).
  - Dark iron sulfide specks common below middle of Section 4.

**General Comments:**
- Upper 4 meters of core badly deformed.
- Foraminifers decrease dramatically below the top of Section 2.
- Lighter shade of brown and orange in foraminifer rich layers of Section 2 only.
- Quartz silt common throughout.
- Carbonate average 22%.
- Quartz and feldspar silt abundant.

**Diagnostic Fossils**

**PLANKTONIC FORAMINIFER:**
- Sphaeroidinella exogastra
- Globorotalia truulata
- Globigerinoides extremus
- Globorotalia exilia

**PLANKTONIC FORAMINIFER:**
- Globorotalia truncatuloides
- Turborotalia inflata

**CALCAREOUS NANNOPLANKTON:**
- Ceratolithus rugosus, C. tricorniculatus
- Discoaster asyrina, D. pentarradiatus, Cyclocoelinites macintyrei

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFER:**
- Globorotalia trunculoides
- Turborotalia inflata

**CALCAREOUS NANNOPLANKTON:**
- Ceratolithus rugosus, C. tricorniculatus
- Discoaster asyrina, D. pentarradiatus, Cyclocoelinites macintyrei

**DINOFLAGELLATES:**
- Aschaphora xanaduans

**PLANKTONIC FORAMINIFER:**
- Globorotalia marginata
- Globigerinoides dentsignatus
- Globigerinoides trunculoides extremus

**CALCAREOUS NANNOPLANKTON:**
- Discoaster asyrina, D. pentarradiatus, Cyclocoelinites macintyrei
- Globorotalia trunculoides

**NATURAL GAMMA PENETROMETER**
- Penetration:
  - 1.25 min. X 10^9 counts/37 * weight
  - 1.25 min. X 10^9 counts/37 * weight
  - 1.25 min. X 10^9 counts/37 * weight

**GRAIN-SIZE WATER CONTENT-POROSITY WET-BULK DENSITY**
- Natural Gamma
  - Penetration
  - Grain Size
  - Water Content
  - Porosity
  - Wet Bulk Density

**SONIC VELOCITY**
- km/sec
  - 1.3
  - 1.4
  - 1.5
  - 1.6
  - 1.7
  - 1.8
  - 1.9
  - 2.0
  - 2.1
  - 2.2
  - 2.3
  - 2.4
  - 2.5
  - 2.6
  - 2.7
  - 2.8
  - 2.9
  - 3.0
  - 3.1
  - 3.2
  - 3.3
  - 3.4
  - 3.5
  - 3.6
  - 3.7
  - 3.8
  - 3.9
  - 4.0
  - 4.1
  - 4.2
  - 4.3
  - 4.4
  - 4.5
  - 4.6
  - 4.7
  - 4.8
  - 4.9
  - 5.0
  - 5.1
  - 5.2
  - 5.3
  - 5.4
  - 5.5
  - 5.6
  - 5.7
  - 5.8
  - 5.9
  - 6.0
  - 6.1
  - 6.2
  - 6.3
  - 6.4
  - 6.5
  - 6.6
  - 6.7
  - 6.8
  - 6.9
  - 7.0
  - 7.1
  - 7.2
  - 7.3
  - 7.4
  - 7.5
  - 7.6
  - 7.7
  - 7.8
  - 7.9
  - 8.0
  - 8.1
  - 8.2
  - 8.3
  - 8.4
  - 8.5
  - 8.6
  - 8.7
  - 8.8
  - 8.9
  - 9.0
Hole 103, Core 2 (39m to 48m)

<table>
<thead>
<tr>
<th>ZONE</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hemipelagic carbonate clay, light soft plastic, medium bluish gray (5B6/1) mottled with yellowish gray (5Y8/1) and greenish gray (5G4/1). General Comments: - Foraminifers rare throughout core. - Core has strong odor of H2S. - Pyrite common to abundant throughout core. - Only concentration of dolomite in Otago Ridge holes: Section 6. - Carbonate average 20%. Small pyrite lined burrows, also quartz and feldspar lined burrows.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dolomite zone begins here and continues to end of core. Dolomite in form of rhombs, very abundant, dispersed in the clay.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Color becoming dark greenish gray (5G4/1) and medium bluish gray (5B6/1) with mottling of yellowish gray (5Y8/1) and greenish gray (5G4/1).</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Core Catcher

PLANKTONIC FORAMINIFERS: - Globorotalia menardii, - Globigerina bulloides - Dibatagia assemblage - Globigerina nepessee - Globorotalia magnifica - Globorotalia albarica

DIAGNOSTIC FOSSILS:

- Acmaphothesis ventriculus - Ceratolithus tricorniculatus - Sphenolithus abies

CALCAREOUS NANNOPLANKTON:

- Ceratolithus tricorniculatus - Sphenolithus abies - Retiulinochitaceae - Sphenolithus abies - Phosphatilus abies

Cores: 1 to 6
Hole 103, Core 3 (94m to 103m)

- Burrow filled with siderite
  - Hemipelagic, carbonaceous, silty clay; soft, plastic, dark greenish gray (5GY4/1) with mottling of light olive gray (5Y5/2).
  - Dusky yellow siderite lens.

General Comments:
- Voids due to gas expansion.
- First downhole occurrence of siderite in hole 103.
- Carbonate average 4%.
- Siderite lens.
- Hard calcite/dolomite nodule.

DIAGNOSTIC FOSSILS

CALCAREOUS NANOPHANXTON:
- Reticulofenestra pseudoumbilica
- Cylindroolithina maβintyvet^j
- D. • variabilis
- D. ehallengeri
- Sphenolithus abiee

PLANKTONIC FORAMINIFERS
- Gl. plesiotumida
- Gl. eibaoensis
- Globoquadrina altispina
- Sphaeroidinellopsis subdehiscens
- D. ammantina

DINOFLAGELLATES:
- Achnomonas rarmlifera
- Heteriohophaei opsis

NATURAL GAMMA PENETROMETER METATE WATER CONTENT-POROSITY WET-BULK DENSITY SONIC VELOCITY

[Graph with data points and labels]
Hole 103, Core 4 (170m to 179m)

**General Comments:**
- Upper 2 meters very disturbed.
- First occurrence of siliceous forms (radiolarians, diatoms, and sponge spicules) in Hole 103.
- Voids due to gas expansion.
- Carbonate average 8%.

**Light olive gray (5Y6/1) siderite silt lens, siderite replacing nannoplankton.**

**DIAGNOSTIC FOSSILS**

**CALCAREOUS NANNOPLANKTON:**
- D. variabilis
- D. ohallengeri
- D. kugleri
- Sphenolithus abies
- Reticulofenestra pseudowaginator
- Helicosphaera intermedius

**DINOFLAGELLATES:**
- Hystrichosphaeropsis obscurum
- Adechyclus ramuliferus

**PLANKTONIC FORAMINIFERS:**
- Sphaeroidinellopsis seminula
- Cribroquadrina altispina
- Globigerina nepenthes

**CORE CATCHER**

**PLANKTONIC FORAMINIFERS:**
- Turborotalia acutangula
- G. plesiotumida
- Globigerina nepenthes
- Globoquadrina altispina
- Sphaeroidinellopsis subdehiscens

**DINOFLAGELLATES:**
- Hystrichosphaeropsis obscurum
- Adechyclus ramuliferus

**CALCAREOUS NANNOPLANKTON:**
- D. variabilis
- D. ohallengeri
- Sphenolithus abies

**NATURAL GAMMA PENETROMETER**

Counts/11

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Natural Gamma</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>1.25 min. x 10^3</td>
</tr>
</tbody>
</table>

**GRAIN-SIZE**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Clay</th>
<th>Silt</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**WATER CONTENT**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Water Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**POROSITY**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Porosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**WET-BULK DENSITY**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Wet-Bulk Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>1.25 g/cm^3</td>
</tr>
</tbody>
</table>

**SONIC VELOCITY**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sonic Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>170-179</td>
<td>1.25 m/s</td>
</tr>
</tbody>
</table>
Hole 103, Core 5 (247m to 256m)

- **Lithology**: Hemipelagic, carbonaceous, silty clay, firm, plastic, dark greenish gray (5GY4/1) with mottling of light olive gray (5Y5/2).
- **Diagnostic Fossils**: Dusky yellow lens of siderite.

**General Comments**:
- Voids due to gas expansion.
- Burrow fillings are principally aragonitic.
- Core contains unusually abundant nannoplankton.
- Planktonic Foraminifers: **Globoquadrina globosa**, **G. advena**.
- Siderite common.
- Carbonate average 20%.

Hole 103, Core 6 (343m to 352m)

- **Lithology**: Hemipelagic, carbonaceous, silty clay (claystone); well indurated, crumbly.
- **Diagnostic Fossils**: Vertical fractures.

**General Comments**:
- Very well bedded, fissile, crumbly.
- Abundant spicules and diatoms.
- Dusky yellow lenses of siderite (replacing nannoplankton).
- Carbonate average 12%.
**Hole 103, Core 7 (440m to 449m)**

**LITHOLOGY**

- **Lithology:** Hemipelagic, carbonaceous, silty claystone, brittle, dark greenish gray (5GY4/1) with irregular lenses of olive gray (5Y4/1).
- **General Comments:** Abundant burrow fillings of pyrite crystals.
- **Calcicarous Nanofossils:**
  - *Reticulofenestra pseudoumbilica*, *Abundant burrow fillings of Coccolithus pelagicus*, *Discoaster variabilis*.

**CORE CATCHER**

- **Quartz and feldspar abundant.**
- **Dinoflagellates:**
  - *Hystrichosphaeropsis obscurum* abundant.
- Only a few chunks of brittle, crumby mud recovered.

**Grain-Size Water Content-Porosity Wet-Bulk Density Sonic Velocity**

**Table:**

<table>
<thead>
<tr>
<th>Age</th>
<th>Zone</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hemipelagic, carbonaceous, silty claystone, brittle, dark greenish gray (5GY4/1) with irregular lenses of olive gray (5Y4/1).</td>
<td>Abundant burrow fillings of pyrite crystals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calcicarous Nanofossils: <em>Reticulofenestra pseudoumbilica</em>, <em>Coccolithus pelagicus</em>, <em>Discoaster variabilis</em>.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dinoflagellates: <em>Hystrichosphaeropsis obscurum</em> abundant.</td>
</tr>
</tbody>
</table>

**Diagram:**

- **NATURAL GAMMA PENETROMETER**
- **PENETROMETER**
- **GRAIN-SIZE**
- **WATER CONTENT-POROSITY**
- **WET-BULK DENSITY**
- **SONIC VELOCITY**
**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Hemipelagic calcareous silty clay and clay, firm, light yellowish brown (10YR 6/4) becoming grayish green (10G 4/2).
- Hemipelagic silty clay, pale green (5G 3/2) becoming pale olive brown (5Y 6/4), including clay nodule of olive yellow (5Y 6/6).
- Color grading to greenish black (5G 2/1), pale green (5G 7/2) with spots of olive yellow (5Y 6/6).
- Light yellowish brown (10YR 6/4) layer.
- Burrow filling of micritic limestone.
- Color grading to dark greenish gray (5G 3/1), pale olive and olive yellow.
- Sandy hemipelagic calcareous clay.
- Core disturbed from about 400 cm to 550 cm.
- Hemipelagic carbonate silty clay, disturbed, with nodules and fragments of micritic limestone, dark greenish gray (5G 3/1).
- Abundant clay sized calcite fragments.
- Light mottling of olive gray (5Y 4/4).
- Carbonate average 18%.

**CALCAREOUS NANNOPLANKTON:**
- Globigerina rubescens
- Sphenolithus abies
- Calcarina quinqueramus
- D. exilis.

**DINOFLAGELLATES:**
- Peridiniun nutiformes

**PLANKTONIC FORAMINIFERS:**
- Turborotalia inflata
- Globigerina saccula Contestaster quinqueramus
- Pseudovolvox pseudosiliquosus
- P. obtusifera
- P. aciculata
- P. varians
- P. triqueta

**CALCAREOUS NANNOPLANKTON:**
- Globigerina rubescens
- Sphenolithus abies
- Calcarina quinqueramus
- D. exilis
**Lithology**

- **Mesoicastic carbonaceous silty clay; soft, plastic, dark greenish gray (5G4/1) with grayish olive mottling (10Y4/2).**

  **General Comments:**
  - Upper 10cm contains fragments of gray lithographic limestone.
  - Abundant pyrite burrow fillings.
  - Strong odor of H₂S.
  - Pyrite common to abundant throughout.
  - Unusually abundant nannoplankton.
  - Carbonate average 12%.

  **Color**
  - Becoming medium bluish gray (5B7/1) with moderate mottling of light bluish gray (5B5/1).

**Diagenetic Fossils**

**Planktonic Foraminifera**
- [List of species]

**Calciferous Nanoplankton**
- [List of species]

**Dinoflagellates**
- [List of species]

---

**Natural Gamma Penetrometer Radiation**

<table>
<thead>
<tr>
<th>Core Zone</th>
<th>NGR Count/cm³ x 10³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

**Grain-Size Water Content-Porosity Wet-Bulk Density Sonic Velocity**

<table>
<thead>
<tr>
<th>Core Zone</th>
<th>Grain Size</th>
<th>Water Content</th>
<th>Porosity</th>
<th>Wet-Bulk Density</th>
<th>Sonic Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>2</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>3</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>4</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>5</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>6</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>7</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>8</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>9</td>
<td>20 40 60 80 100</td>
<td>1.25 1.4 1.6 1.8 2.0</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
<td>1.2 1.3 1.4 1.5 1.6</td>
<td>1.7 1.8 1.9 2.0</td>
</tr>
<tr>
<td>AGE</td>
<td>DEPTH</td>
<td>LITHOLOGY</td>
<td>DIAGNOSTIC FOSSILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>-----------</td>
<td>--------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>0</td>
<td>Hemipelagic carbonaceous silt</td>
<td>Calcareaous Nanoplankton: Diatomites, Catenaster alatus, Sphenolithus abie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>0</td>
<td>silt</td>
<td>DINOFLAGELLATES: Hystricocapsa echinata, Palinoprotheca armata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>0</td>
<td>silt</td>
<td>CORE CATCHER</td>
<td>Planktonic Foraminifera: Globigerina nepenthes, Globoquadrina dehiscens, Qu. abeona, Qu. alliplana, Sphenolithus subdehiscens, Qu. membranacea</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>0</td>
<td>silt</td>
<td>CORK CATCHER</td>
<td>Calcareaous Nanoplankton: Diastromitica poli, D. variabilis, D. challenger</td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>0</td>
<td>silt</td>
<td>DINOFLAGELLATES: Hystericapsa echinata, Palinoprotheca armata</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General Comments:**
- First occurrence of diatoms and sponge spicules (downhole) in Hole 104. They remain abundant to bottom of hole.
- Burrow-like structures with siderite filling.
- Carbonate average 11%.

**Pyrite nodule.**
Hole 104, Core 4 (133m to 142m)

**Lithology:**
- Hemipelagic carbonaceous silt with dark yellow mottling (T5G5/1).
- Soft, greenish gray with dusky yellow mottling (9Y6/4).

**General Comments:**
- Upper 3 meters badly deformed.
- Voids due to gas expansion.
- Abundant 5cm thick layers of indurated clay due to coring.
- Siderite common to abundant in yellow material.
- Abundant diatoms and sponge spicules.
- Carbonate average 7%.

**Abundant diatoms in soft material.**

**PLANKTONIC FORAMINIFERS:**

**DIAGNOSTIC FOSSILS**
- *CALCAREOUS NANNOPLANKTON: D. bollii, D. variabilis, Coelosphericus pseudoumbilicus, Sphenolithus abies, Reti•cuZofenestra pseudoumbilic.*

**CORE CATCHER**
- Abundant diatoms in soft material.

<table>
<thead>
<tr>
<th>Age Zone</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
</table>
|          |           | **PLANKTONIC FORAMINIFERS:** *Globoquadrina advena, Sphaeroidinellopsis subdehiscens, D. bollii, D. variabilis, Coelosphericus pseudoumbilicus, Sphenolithus abies, Reti•cuZofenestra pseudoumbilic.*
| 1        |           |                    |
| 2        |           |                    |
| 3        |           |                    |
| 4        |           |                    |
| 5        |           |                    |
| 6        |           |                    |
| CC       |           |                    |

**NATURAL GAMMA PENETROMETER**
- Radiation counts/3" X 10^5.

**GRAIN-SIZE WATER CONTENT-POROSITY WET-BULK DENSITY**
- Sonic velocity.

**GRANULARITY**
- Clay-ilt-sand % wt. % vol. g/cc km/sec.

**GRAIN-SIZE WATER CONTENT-POROSITY WET-BULK DENSITY**
- Sonic velocity.

**CAPSULES**
- Abundant diatoms in soft material.
**Hole 104, Core 6 (219m to 228m) (no recovery at Core 5)**

**LITHOLOGY**

- Hemipelagic, carbonaceous silt-clay; plastic, grayish olive (T0Y4/2).

**General Comments:**
- Frequent layers of relatively indurated clay interbedded throughout core - due to coring.
- Voids due to gas expansion.
- Diatoms and sponge spicules common to abundant throughout.
- Carbonate average 14%.

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Globigerinoides subquadratus
- Turrborotalia siakensis

**CALCAREOUS NANNOPLANKTON:**
- D. exilis
- D. bollii
- Sphinctodinia abies
- Retoulofenestra pseudoumbilica
- Sphenolithus abies

**COR Core Catcher**

**PLANKTONIC FORAMINIFERS:**
- Sphaeroidinellopsis subdehiscent
- S. seminulina,
- Globigerinoides subquadratus,
- Turrborotalia siakensis

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis

<table>
<thead>
<tr>
<th>Aisle</th>
<th>Zone</th>
<th>Definition</th>
<th>Section No</th>
<th>Sample Interval</th>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemipelagic, carbonaceous silt-clay; plastic, grayish olive (T0Y4/2).</td>
<td>Globigerinoides subquadratus, Turrborotalia siakensis</td>
</tr>
<tr>
<td>General Comments:</td>
<td>Frequent layers of relatively indurated clay interbedded throughout core - due to coring.</td>
</tr>
<tr>
<td>Voids due to gas expansion.</td>
<td>Diatoms and sponge spicules common to abundant throughout.</td>
</tr>
<tr>
<td>Carbonate average 14%.</td>
<td></td>
</tr>
</tbody>
</table>

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Globigerinoides subquadratus
- Turrborotalia siakensis

**CALCAREOUS NANNOPLANKTON:**
- D. exilis
- D. bollii
- Sphinctodinia abies
- Retoulofenestra pseudoumbilica
- Sphenolithus abies

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis

**CORE CATCHER**

**PLANKTONIC FORAMINIFERS:**
- Sphaeroidinellopsis subdehiscent
- S. seminulina,
- Globigerinoides subquadratus,
- Turrborotalia siakensis

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemipelagic, carbonaceous silt-clay; plastic, grayish olive (T0Y4/2).</td>
<td>Globigerinoides subquadratus, Turrborotalia siakensis</td>
</tr>
<tr>
<td>General Comments:</td>
<td>Frequent layers of relatively indurated clay interbedded throughout core - due to coring.</td>
</tr>
<tr>
<td>Voids due to gas expansion.</td>
<td>Diatoms and sponge spicules common to abundant throughout.</td>
</tr>
<tr>
<td>Carbonate average 14%.</td>
<td></td>
</tr>
</tbody>
</table>

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Globigerinoides subquadratus
- Turrborotalia siakensis

**CALCAREOUS NANNOPLANKTON:**
- D. exilis
- D. bollii
- Sphinctodinia abies
- Retoulofenestra pseudoumbilica
- Sphenolithus abies

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis

**CORE CATCHER**

**PLANKTONIC FORAMINIFERS:**
- Sphaeroidinellopsis subdehiscent
- S. seminulina,
- Globigerinoides subquadratus,
- Turrborotalia siakensis

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis

<table>
<thead>
<tr>
<th>Lithology</th>
<th>Diagnostic Fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemipelagic, carbonaceous silt-clay; plastic, grayish olive (T0Y4/2).</td>
<td>Globigerinoides subquadratus, Turrborotalia siakensis</td>
</tr>
<tr>
<td>General Comments:</td>
<td>Frequent layers of relatively indurated clay interbedded throughout core - due to coring.</td>
</tr>
<tr>
<td>Voids due to gas expansion.</td>
<td>Diatoms and sponge spicules common to abundant throughout.</td>
</tr>
<tr>
<td>Carbonate average 14%.</td>
<td></td>
</tr>
</tbody>
</table>

**DIAGNOSTIC FOSSILS**

**PLANKTONIC FORAMINIFERS:**
- Globigerinoides subquadratus
- Turrborotalia siakensis

**CALCAREOUS NANNOPLANKTON:**
- D. exilis
- D. bollii
- Sphinctodinia abies
- Retoulofenestra pseudoumbilica
- Sphenolithus abies

**DINOFLAGELLATES:**
- Hu8trepichyopsis obscipularis
Hole 104, Core 7 (306m to 315m)

Lithology: Hemipelagic, carbonaceous, silty clay; plastic, grayish olive (TOP/42).

General Comments:
- Abundant layers of relatively indurated layers interbedded throughout core - due to coring.
- Voids due to gas expansion.
- Concentrations of white quartz and feldspar silt in burrows.
- Diatoms and sponge spicules abundant.
- Siderite present throughout.
- Carbonate average 20%.

 DIAGNOSTIC FOSSILS

PLANKTONIC FORAMINIFERS:
- Globoquadrina advena, Sphaeroidinellopsis seminulum, Turborotalia pseudoumbilicalis

CALCAREOUS NANOPLANKTON:
- Planorotalia exigua, D. bollii, D. variabilis, C. helicopsis, Sphenolithus abieus, Sphaeroidinellopsis pseudoumbilicalis, Retiaulofenestra pseudoumbilicalis

CORE CATCHER

PLANKTONIC FORAMINIFERS:
- Globoquadrina dehiscens, Gq. advena
- Sphaeroidinellopsis seminulum, Globigerinoides subquadratus
- Turborotalia pseudoumbilicalis, Turborotalia sphenolithus

NATURAL GAMMA PENETROMETER GRAIN-SIZE WATER CONTENT POROSITY WET-BULK DENSITY SONIC VELOCITY

NATURAL GAMMA RADIATION
- 1.25 mm x 10^3 counts/1.25 mm

GRAIN-SIZE
- 1.25 mm x 10^3 cm

WATER CONTENT POROSITY WET-BULK DENSITY
- 1.2 g/cc km/sec

SONIC VELOCITY
- 1.25 mm x 10^3 cm

- 1.2 g/cc km/sec
Hole 104, Core 8 (401m to 410m)

**LITHOLOGY DIAGNOSTIC FOSSILS**

**Hemipelagic, carbonaceous, silt clay, firm, greyish olive (10YR2).**

**General Comments:**

- Yields due to gas expansion.
- Alternate firm and plastic layering due to coring operation.
- Vertical fracturing in harder layers.
- Diatoms and sponge spicules abundant.
- Carbonate average 20%.

**CALCAREOUS NANNOPLANKTON:**

- Discoaster exilis
- D. variabilis
- D. bullata
- Sphenolithus abies
- Helicopontosphaera kamptneri

**DINOFLAGELLATES:**

- Hystrichosphaeropsis ovata
- Hystrichosphaeropsis ramulifera

**PLANKTONIC FORAMINIFERS:**

- Turrilucina praefohsi
- T. peripheroacuta
- T. continuosa
- G. siakensis
- Globorotalia praemenardii
- Sphaeroidinellopsis seminulina
- Rotaliella dehiscens

**DISCOASTER:**

- Discoaster exilis
- D. variabilis
- D. bullata
- Helicopontosphaera kamptneri
- Ovolutinella angulata
Hole 102, Core 11, Sect. 3

<table>
<thead>
<tr>
<th>AGE</th>
<th>ZONE</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LATE PLIOCENE</td>
<td>Turborotalia termathea N. 21 Reticulofenestra pseudomiliacea</td>
<td>Hemipelagic carbonaceous silty clay; dark greenish gray (5G 4/1), moderately indurated but plastic. Siderite, sponge spicules, clay minerals abundant. Quartz, pyrite, plant debris common. Diatoms, mica, glass and glauconite rare. Light colored specks are siderite concentrations. Voids due to gas expansion.</td>
<td>CALCAREOUS NANNOPLANKTON: Discoaster brouweri, D. pentaradiatus, D. asymmetricus, Reticulofenestra pseudomiliacea, Cyclococcolithina macintyreii, Helicopontosphaera sellii</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PLANKTONIC FORAMINIFERS: Globigerinoides extremus, Globorotalia micoenica, Gl. multicoamerata, Globoquadrina altispira, Gg. venezuelana</td>
</tr>
<tr>
<td>AGE</td>
<td>ZONE</td>
<td>LITHOLOGY</td>
<td>DIAGNOSTIC FOSSILS</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------</td>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>LATE MIocene</td>
<td>Hemipelagic, siliceous, silt clay; dark greenish gray (5G 4/1), indurated. Clay minerals abundant. Radiolarians, plant debris, quartz, mica.</td>
<td><strong>CALCAREOUS NANNOPLANDTON:</strong> Ceratolithus tricorniculatus, Discoaster quinqueramus, D. exilis, D. challenger, Reticulofenestra pseudoumbilica, Sphenolithus abies.**</td>
</tr>
<tr>
<td></td>
<td>Globotruncana planctomumida N.17</td>
<td>Calcium minerals abundant, nannoplankton, calcite fragments, diatoms, sponge spicules and pyrite.</td>
<td><strong>PLANKTONIC FORAMINIFERS:</strong> Globoquadrina altispira, Sphaeroidinellopsis seminulina, Globorotalia margaritae, Globigerina nepenthes.</td>
</tr>
<tr>
<td></td>
<td>Ceratolithus tricorniculatus</td>
<td>Nannoplankton, calcite fragments, diatoms, sponge spicules and pyrite common.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clay minerals abundant, nannoplankton, diatoms, sponge spicules, plant debris, pyrite common. Calcite fragments, siderite quartz, glauconite rare.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pyrite spheres and clay minerals abundant. Diatoms, sponge spicules, common. Nannoplankton, quartz, mica, dolomite rhombs, rare.</td>
<td></td>
</tr>
</tbody>
</table>
Hemipelagic silty carbonaceous clay, varying between dark greenish gray (5G 4/1) and light greenish gray (5GY 4/1).

Light beds are relatively undisturbed - dark layers reveal distortion caused by coring operation.

Voids are due to gas expansion.

Siderite nodule.

White specks are concentrations of foraminifers or quartz and feldspar silt.

Pyrite occurs as frambooidal grains in burrow fillings.

Clay minerals dominant. Quartz, plant debris, and nannoplankton are common.

Foraminifers rare.

**PLANKTONIC FORAMINIFERS:**
- *Globorotalia miosea*,
- *Globoigerina nepenthes*,
- *Globorotalia merotumida*,
- *Turborotalia continuosa*,
- *Turborotalia alemenciae*

**CALCAREOUS NANNOPLANKTON:**
- *Reticulofenestra pseudumbilica*,
- *Discoaster quinqueramus*,
- *D. kugleri*,
- *D. exilis*,
- *Ceratolithus tricorniculatus*,
- *Helicopontosphaera kamptneri*
**Hole 103, Core 3, Section 6**

<table>
<thead>
<tr>
<th>AGE</th>
<th>ZONE</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>CALCAREOUS NANNOLANKTON: Discoaster challengeri, D. variabilis, D. quinquernus, D. broweri, Sphenolithus abies, Reticulofenestra pseudoumbilica</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PLANKTONIC FORAMINIFERS: Globorotalia plesiowmida Gl. altamountensis, Globigerina nepenthes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DINOFLAGELLATES: Achnonoephaera ramulifera</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LATE MIOCENE</td>
<td>Hemipelagic silty carbonaceous clay, dark greenish gray (5GY 4/1) mottled with light olive gray (5Y 5/2), soft, plastic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dolomite nodule.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE</td>
<td>ZONE</td>
<td>LITHOLOGY</td>
<td>DIAGNOSTIC FOSSILS</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>LATE MIOCENE</td>
<td>L. carbonatita continua</td>
<td>Hemipelagic silty carbonaceous clay; dark greenish gray (5GY 4/1) mottled with light olive gray (5Y 5/2) firm, plastic.</td>
<td><strong>CALCAREOUS NANNOPLANKTON:</strong> Discoaster variabilis, D. ex zlib, D. bollii, D. hamatus, D. quinqueramus, Sphenolithus abies, Reticulofenestra pseudowurmblica.</td>
</tr>
<tr>
<td></td>
<td>D. variabilis</td>
<td>Burrow (?) fillings composed of aragonite. Voids due to gas expansion. Clay minerals and nanno-plankton abundant. Plant debris and pyrite common. Dolomite and foraminifers rare.</td>
<td><strong>DINOFLELLATES:</strong> Hystriospheraopsis obscursum, Aachomosphaera ramulifera</td>
</tr>
</tbody>
</table>
Hemipelagic carbonaceous silty clay, grayish olive green (5GY 3/2) with lenses of dusky yellow. Evenly bedded. Sediment is very crumbly and fractured. Clay minerals abundant. Quartz, diatoms, sponge spicules, plant debris common.

White lenses are predominantly siderite replacing nannoplankton.

Calcereous nannoplankton: Discoaster variabilis, D. exilis, D. challengeri, Helicopontosphaera itampineri, Reticulofenestra pseudoumbilica, Scoyphosphaera amphora

Planktonic foraminifera: Globocaudina dehiscens, Globigerina nepenthes

Planktonic foraminifera: Globigerina nepenthes, Globocaudina advena

Dinoflagellates

Hystriochosphaeropsis obscurn, Achomosphaera ramulifera
Hole 104, Core 1, Section 6

<table>
<thead>
<tr>
<th>AGE</th>
<th>ZONE</th>
<th>LITHOLOGY</th>
<th>SAMPL. INT.</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
</table>
| LATE MIOCENE | Globorotalia plastomatina | Hemipelagic silty carbonaceous clay, dark greenish gray (5G 4/1) to olive gray (5Y 4/1), soft and plastic. Clay minerals abundant. Quartz, feldspar and organic matter common. | F | -F | PLANKTONIC FORAMINIFERS: 
Turborotalia inflata |
| | Turborotalia acostaensis/Floborotalia menziesi | | SS | SS | 
CALCAREOUS NANNOPLANKTON: 
Discoaster quinqueramus, D. exilis, D. variabilis, Sphenolithus abies |
| | | | CN | CN | 
DINOFLAGELLATES: 
Operculodinium centrocarpum, Acholeposphaera ramulifera |
| | | | F | F | PLANKTONIC FORAMINIFERS: 
Turborotalia inflata, Globigerina nepenthes |
<table>
<thead>
<tr>
<th>AGE</th>
<th>ZONE</th>
<th>LITHOLOGY</th>
<th>SAMP. INT</th>
<th>LITHOLOGY</th>
<th>DIAGNOSTIC FOSSILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIDDLE MIOCENE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Orbula
sutura/ T. peripheroronda | | | | | |
| Sphenolithus heteromorphus N. 97 | | | | | |
| | | Ankeritic limestone, greenish gray (5GY 5/1) | | | |
| | | Hemipelagic, siliceous, silty mudstone. Clay minerals, diatoms, sponge spicules abundant. Siderite, radiolarians | | | |
| | | Irregular bedding throughout. | | | |

**CALCAREOUS NANNOPLANKTON:**
- Sphenolithus heteromorphus
- Discococcolithus bollii, D. exilis
- Cyclocoelolithina neogammatin, C. eopelagicus, Helico- pontosphaera kampfneri

**DINOFLAGELLATES:**
- Achomosphaera ramulifera, Svalbardella sp.
- Hystrichosphaeropsis obscurum

**CALCAREOUS NANNOPLANKTON:**
- Sphenolithus heteromorphus
- Helico- pontosphaera kampfneri
- Discococcolithus exilis, D. bollii
- Cyclocoelolithina neogammatin, C. eopelagicus
- Reticulofenestra pseudoumbilica

**DINOFLAGELLATES:**
- Achomosphaera ramulifera, Svalbardella sp.
- Spiniferites sp. A

**PLANKTONIC FORAMINIFERS:**
- Orbula suturalis
- Turborotalia siakensis, T. peripheroronda, Globo- quadrina dehiscens