6. SITE 16

The Shipboard Scientific Party[1]

SURVEY DATA AND SITE BACKGROUND

This site is located over positive Magnetic Anomaly 5 on the western side of the Mid-Atlantic Ridge, following the recommendations of the JOIDES Atlantic Panel. At this location, Anomaly 5 has an amplitude greater than 200 gammas, compared to the negative anomaly to the west, and a relatively flat peak (Figure 1). Prior to arrival on this site, *R/V Vema* had executed a detailed geophysical survey from which the site selection was made.

The site is on the eastern side of a raised part of the sea floor with an elliptical shape in plain view, approximately 10 kilometers wide in an E-W direction and 30 kilometers long N-S. According to the *Vema* survey, the uplift has a peak of about 1515 fathoms uncorrected in the center, with depths of 1900 fathoms uncorrected at the extremities. The slopes are generally steepest in the E-W direction at the edges of the uplift, up to 200 m/km.

The detailed topography over the uplift consists of numerous small hills of amplitudes up to 200 meters (656 feet), but more generally less than 100 meters (328 feet) (Figure 2). The sediment cover is variable from 0 to 0.3 second reflection time from bottom to "basement" reflector, according to the *Vema* survey, with the greater thicknesses generally more common at the greater depths on the flanks of the uplift. The site was chosen over a small (40 to 60 meter) hill on the NE part of the uplift where the reflection time from bottom to "basement" reflector was apparently about 0.1 to 0.15 second (Figure 3). An air-gun record made after stopping on the site showed this reflection time to be more nearly 0.15 seconds although the record quality was poor and the drilling depth to "basement" (see below) suggests that it may have been greater.

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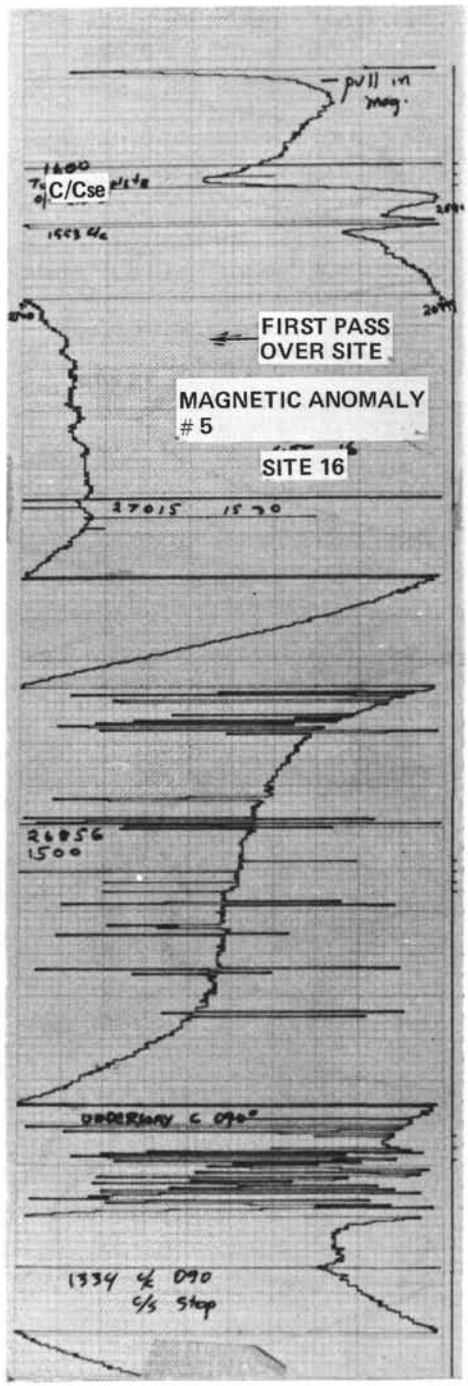


Figure 1. *Magnetometer record in the vicinity of Site 16.*

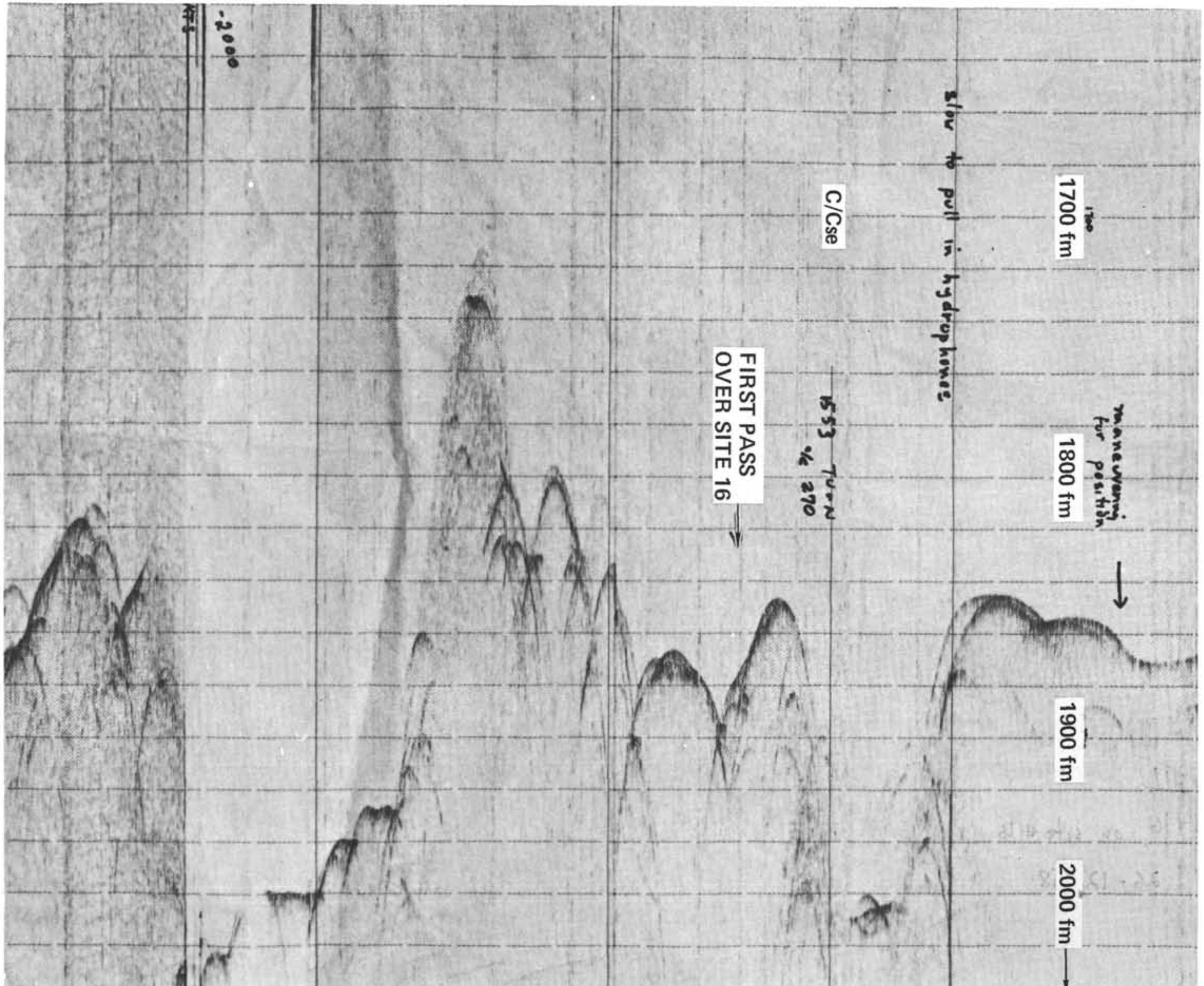


Figure 2. *Precision depth recording in the vicinity of Site 16.*

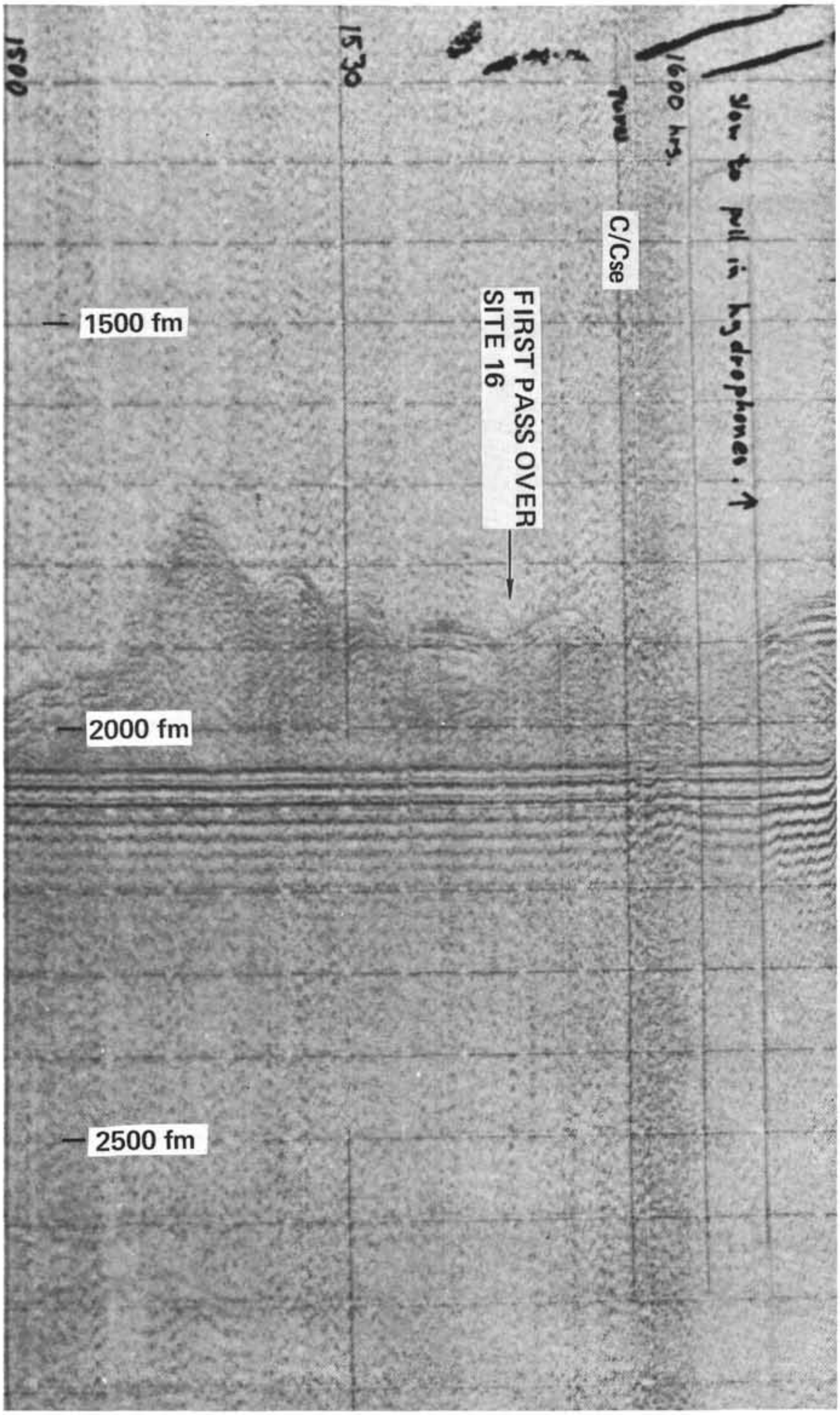


Figure 3. *Continuous seismic profiler record in the vicinity of Site 16.*

TABLE 1
Cores Recovered from Site 16

Core No.	Date/Time		Interval Cored (m below sea floor)	Core Retrieved (m)	Remarks
16-1	12-27-68	0610	0-9.2	9.0	–
16-2		0815	18.6-27.8	9.0	–
16-3		1030	36.6-45.8	9.0	–
16-4		1200	54.9-64.1	9.0	–
16-5		1415	85.7-94.9	9.0	–
16-6		1545	104.0-113.2	9.0	–
16-7		1730	113.2-122.3	9.0	–
16-8		1900	125.4-134.5	9.0	–
16-9		2045	134.5-143.7	9.0	–
16-10		2230	143.7-152.8	9.0	–
16-11	12-28-68	0010	152.8-162.0	9.0	–
16-12		0530	175.4-175.7	0.0	Basalt chip recovered from bit.
	Totals		100 m	99 m	

The site position, as determined from five navigational satellite fixes, is lat. 30° 20.15′S., long. 15° 42.79′W. Water depth is 3526 meters (11,325 feet) corrected (1876 fathoms uncorrected).

OPERATIONS

Positioning

At 1626 hours on 26 December, the marker beacon was put over the side in 3527 meters (11,328 feet) of water. Although the bottom topography is somewhat rough in the general area of this site, no difficulty was encountered with the beacon signal. By 1700 hours, the ship was maintaining position in automatic control. A situation existed whereby the swells, which were 3 to 5 meters (10 to 16 feet) in height, were coming from a direction roughly 90° from the direction of the ocean current. The magnitude of the current (about 1.5 knots) necessitated keeping the ship headed into it with the wind, sea and swell coming in from the bow and beam. It took 60 rpm on one screw to maintain position into the current. The bow wind and seas, and the beam swell caused considerable rolling of the ship. Five degree rolls were common and occasionally 10 degree rolls were experienced. This slowed down the drilling operations somewhat.

Around noon on 27 December the stern thrusters began acting irregularly. They would not reverse on command of the computer; this necessitated a shift to semi-automatic positioning. This situation was corrected within a couple of hours permitting return to automatic operation.

Drilling

The only significant drilling break at Site 16 occurred at a depth of 175 meters (574 feet) corresponding with contact with basement. Drilling through the softer sediments proceeded at rates varying from 15 to 35 m/hr. This change in rate did not appear to be correlated with the physical properties of the sediment, and it more than likely reflects the driller's reaction to other activities taking place on the rig floor. When basalt was encountered the drilling rate dropped to practically zero with only 0.3 meter (1 foot) being penetrated over a 3-hour period. Because of excessive roll of the ship, the bit was noted to bounce on the bottom causing large torque–enough to stop rotation occasionally. When the bit was recovered, it was found to be worn excessively and parts of it were broken. It is believed that bouncing and excursions over the bottom of the hole prevented core recovery in the basalt. One small chip of basalt was recovered from the bit.

Coring

A list of the cores collected, time of arrival on deck, interval cored and length is shown in Table 1. Eleven 9-meter (30-foot) cores of sediment were recovered completely, giving 99 meters (325 feet) sediment. The successful 100 per cent recovery is attributed, at least in part, to the use of a plastic sleeve core catcher in the less consolidated sediments. The poor recovery of basalt is discussed in the previous section on drilling.

PALEONTOLOGY

Pleistocene, Upper Pliocene, Lower Pliocene and Upper Miocene sediments were recovered from eleven out of the twelve cores. Core 12 was an attempt to core basalt, but none was recovered. However, small chips of basalt were recovered from the bit when it was retrieved from the hole. Coring was discontinuous down to 104 meters (341 feet) recovering give cores, and almost continuous from that depth to 162 meters (532 feet) recovering six cores. An interval of 13.4 meters (44 feet) above the basement was not cored. Time limitations aboard the ship and the soupy nature of most of the sediments which were cored prevented a majority of the cores from being slabbed and sampled in detail for geologic and paleontologic studies. The only major boundary cored was the Pliocene/Pleistocene in Core 2. The Tortonian/Messinian Stage boundary of the Upper Miocene probably occurs immediately above the core catcher of Core 8 on the basis of the calcareous nannoplankton.

The hole was drilled on the positive magnetic anomaly associated with Magnetic Anomaly 5 which has a suggested age of 9 million years using the correction of Heirtzler *et al.* (1968). The oldest sediments recovered approximately 13.4 meters (44 feet) above the basement basalt are Late Miocene (Tortonian) in age based on the calcareous nannoplankton. The planktonic foraminifera are nondiagnostic and only suggest a Late Miocene age for these sediments. On the basis of Chapter 2, Figure 3, these sediments are determined to have an equivalent radiometric age of approximately 11 million years. This is in rather close agreement to the suggested age of 9 million years based on the magnetic anomaly study, but the sediments immediately above the basalt could be slightly older.

Another purpose in drilling this hole was to study floral and faunal changes which may have taken place at 30° South Latitude. With a few exceptions, most of the planktonic foraminiferal faunas at this site are not those typical of tropical water. The exceptions are an Upper Pliocene fauna in the lower half of Core 3 and an Upper Miocene fauna in the lowermost part of Core 10. In general, the faunas consist of less than a dozen species below Core 2. The monotonous nature of these faunas is similar to that of modern temperate seas. Absence of some planktonic species might be attributed to a solution phenomenon; however, the fact that only the typical, tropical water species were removed is rather fortuitous. The calcareous nannoplankton floras throughout most of the cored stratigraphic sequence indicate that they are more eurytopic than the planktonic foraminifera. Most of the species found are those reported by Hay *et al.* (1967) from the Caribbean and the Gulf of Mexico areas and by Bukry and Bramlette (1968) from the tropical Atlantic and Pacific Oceans. A possible exception may be the Pleistocene assemblage which was not studied in any detail.

The sediments recovered at this site consist predominantly of plates of calcareous nannoplankton with varying amounts of planktonic foraminiferal tests and minor amounts of clay minerals. The amounts of accessories vary from lithologic unit to lithologic unit and are discussed in the next section.

The sediments in Core 1, from 0 to 9.2 meters (0 to 30 feet), and most of Core 2, from 18.6 to 27.8 meters (61 to 91 feet), are of Pleistocene age based on the planktonic foraminifera. The Pliocene/Pleistocene boundary is placed in Section 6 of Core 2 between samples from 11 to 13 centimeters and from 100 to 102 centimeters depth. The fauna above the boundary consists of: *Globorotalia crassaformis, G. inflata* (d'Orbigny), *G. truncatulinoides, G. tumida* (Brady), left coiling *G. menardii,* and right coiling *Pulleniatina obliqueloculata* (Parker and Jones). The fauna below is characterized by *Globorotalia tosaensis* with very rare *G. truncatulinoides, G. praedigitata* and *Globigerinoides obliquus* Bolli. The flora in Core 1 and most of Core 2 consists of *Ceratolithus cristatus* Kamptner, *Gephyrocapsa oceanica* Kamptner, *Helicopontosphaera kamptneri* Hay and Mohler and *Cyclococcolithus leptoporus* which indicate a Pleistocene Age. However, two floral changes occur in the lower part of Core 2. In Section 4 in the sample from 148 to 150 centimeters depth the first appearance of *Discoaster brouweri* is observed; and, in the core catcher, the first appearance of *Discoaster pentaradiatus* and *D. surculus* with *D. brouweri* occurs.

Core 3 is Late Pliocene (Astian-Piacenzian, undifferentiated) in age. The planktonic foraminiferal fauna consists of *Globigerinoides obliquus, Globorotalia inflata, G. crassula* Cushman and Stewart, *G. cibaoensis* Bermudez and *G. scitula* (Brady) in the upper part of Core 3 and *Globoquadrina altispira, Globigerina conglomerata, Globorotalia miocenica, G. multicamerata, G. crassula,* and *Globigerinoides obliquus* in the lower part. The first appearance of two distinct species is observed in this core, namely, *Globoquadrina altispira* in Section 3 and *Sphaeroidinellopsis seminulina* in Section 6. The calcareous nannoplankton occurring throughout the core are: *Discoaster brouweri, D. pentaradiatus, D. challengeri, Cyclococcolithus neogammation, Coccolithus pelagicus, Helicopontosphaera kamptneri* and *Ceratolithus rugosus.*

Lower Pliocene (Zanclian) sediments occur in Core 4, from 54.9 to 64.1 meters (180 to 210 feet), based on the calcareous nannoplankton and planktonic foraminifera. The calcareous nannoplankton consist of: *Discoaster brouweri, D. pentaradiatus, D. surculus, Ceratolithus rugosus, C. tricorniculatus, Reticulofenestra pseudoumbilica, Helicopontosphaera kamptneri* and *Cyclococcolithus leptoporus.* The planktonic foraminifera are: *Globorotalia margaritae, G. conomiozea, Globigerinoides obliquus, G. sacculifer, Globoquadrina altispira* and *Sphaeroidinellopsis seminulina.*

In Core 5, from 85.7 to 94.9 meters (281 to 311 feet), Core 6, from 104.1 to 113.1 meters (341 to 371 feet), Core 7, from 113.2 to 122.3 meters (371 to 401 feet), and Core 8, from 125.4 to 134.5 meters (410 to 442 feet), except for the core catcher of Core 8, the sediments are Late Miocene (Messinian) in age based on the calcareous nannoplankton. The boundary between the Tortonian and Messinian probably occurs immediately above the core catcher of Core 8. The planktonic foraminiferal faunas from these cores are characterized by temperate water species and permit only a broad age assignment of late Miocene to early Pliocene. Most of the sections of Core 5 through 8, except for the core catcher of Core 8, contain: *Discoaster brouweri, D. challengeri, Reticulofenestra pseudoumbilica, Ceratolithus tricorniculatus* and *Cyclococcolithus leptoporus.* The flora in the core catcher of Core 8 is similar to the above, but *Ceratolithus tricorniculatus* is absent. The significance of this species was discussed for Core 5 of Hole 15, and on this basis the Tortonian/Messinian boundary is placed immediately above the core catcher of Core 8.

The Tortonian (Upper Miocene) sediments are found in Core 9, from 134.5 to 143.7 meters (442 to 472 feet), Core 10, from 143.7 to 152.8 meters (472 to 501 feet), and Core 11, from 152.8 to 162 meters (501 to 531 feet), based on the calcareous nannoplankton.

The flora is characterized by *Discoaster brouweri, D. pentaradiatus, D. challengeri, Reticulofenestra pseudoumbilica* and *Cyclococcolithus leptoporus.* The planktonic foraminifera present are: *Globigerina nepenthes, Globoquadrina conglomerata, Globorotalia conoidea, G. conomiozea, G. miotumida, Globigerinoides bollii, G. ruber* and *Sphaeroidinellopsis seminulina;* and, they are assigned to a Late Miocene age.

It may be noteworthy that Blow (1969) indicates the first evolutionary appearance of *Globigerinoides ruber* (d'Orbigny) in his Zone N16 which is correlated with the lower part of the undifferentiated Tortonian/Messinian Stage. The presence of *G. ruber* in the lowest sample of this hole indicates its age to be no older than the Tortonian.

STRATIGRAPHY

The sedimentary section at Site 16 has been divided into three subsurface units, all of which could be traced to the adjacent sites to constitute formations. They are in descending order:

3-16-1-1	Albatross Ooze	Foraminiferal nannofossil chalk ooze.
3-16-4-5	Blake Ooze	Nannofossil chalk ooze
3-16-9-1	Challenger Ooze	Nannofossil chalk ooze

The late Cenozoic 3-16-1-1 Unit is a very pale brown to white foraminiferal nannofossil chalk ooze. This unit includes sufficient Holocene sediments so that the gamma ray count of the top 10 meters (33 feet) of sediments shows an exponential decrease (see Section on Natural Gamma Radiation). These sediments are particularly rich in foraminifera, which constitute almost half of the bulk volume. The underlying Pleistocene deposits contain less and variable amounts of foraminifera, ranging from 10 to 30 per cent. This unit was readily correlated with the top unit at Site 15 to constitute the Albatross Ooze.

The Plio-Miocene 3-16-4-5 Unit was separated from the unit above by a color change and by a decrease in the foraminifera content. Except for a few intercalations at top, these chalk oozes contain less than 5 per cent foraminifera. Many slides examined consist almost exclusively of nannofossils, with only traces of partially dissolved foraminiferal tests. Like its correlative at Site 15, this unit has the chalky white color typical of the Blake Ooze.

The Unit 3-16-9-1, consists also of nannofossil chalk oozes. It has been recognized minaly because of the brown colors. There is also a gradual increase in foraminifera content (to 5 per cent or more near the base of the unit) with a corresponding increase in the sand-size fraction of the oozes (see section on Grain Size). The authors found in the smear-slides more mica-like clay mineral flakes in these oozes. However, shore-based studies showed that their average terrigenous content is only slightly higher than that of the overlying oozes. This Upper Miocene unit is somewhat lighter and considerably less terrigenous than the Upper Miocene Unit 3-15-5-1. However, a correlation is ventured on the basis of their corresponding stratigraphic position, and of a parallel evolution in their lithological characters. In assigning Unit 3-16-9-1 as a part of the Challenger Ooze, the authors recognized a lateral facies change of this formation from dark marly zeolitic chalk oozes to lighter, less marly, non-zeolitic oozes; a change which may correspond to a decrease in ocean depth toward the axis of the Mid-Atlantic Ridge.

About 13 meters (43 feet) of sediments above the basement were not cored. A very small chip, some 1 mm^3, of dark gray aphanitic basalt was recovered from the outer drill bit after the drill string was pulled up. The age of the sediments lying directly above basalt is not known. Studies of contaminants recovered from drill bits did not reveal any fossil assemblages older than Upper Miocene.

The boundary between the Albatross and Blake Oozes was placed at the top of Section 3-16-4-5, at 61 meters (200 feet) BOB, because of a remarkable color change from a very pale brown above to a white color, which has a grayish cast typical of the Blake Ooze. The contact could be placed a few meters deeper if 5 per cent foraminifera content should be adopted as the creterion for an arbitrary separation. The boundary between the Blake and Challenger Oozes was placed at the top of the first light yellowish-brown ooze.

The sedimentation rates for the three formations at these sites are estimated as follows:

Albatross Ooze	61 m/3.5 m.y. or 1.8 cm/t.y.
Blake Ooze	73.5m/6.1 m.y. or 1.2 cm/t.y.
Challenger Ooze	40.9m/4 m.y. or 1.0 cm/t.y.

These rates are about twice as high as those for corresponding formations at Site 15.

The stratigraphy is summarized in Table 2.

PHYSICAL PROPERTIES

Natural Gamma Radiation

Natural gamma radiation counts at Site 16 ranged from zero to 2400 counts per 1.25 minutes per 7.6 centimeter core segment, with the highest counts being emitted from the top section, 3-16-1-1, which exponentially decreased to Section 3-16-1-6 within the Albatross Ooze (Figures 4A and 5A-16A). Natural radiation in Core 2 of the Albatross Ooze and below, in the Blake Ooze and Challenger Ooze, averaged about 100 counts. This exponential decrease occurred within a depth interval of 10 meters (33 feet), which may represent about 0.5 to 1.0 million years. Natural gamma radiation decreased about one-half within 150 to 200 centimeter depth intervals; thus, if a specific isotope is causing this phenomenon, its half life is probably on the order of 1.5 to 2.0×10^{-5} years. Some possible isotopes may be U^{234}, or Th^{230}, which could be present as a dissolved species or in particulate form. Another possibility is that this radiation phenomenon could have been created by an exponential change in sedimentation, which allowed clay minerals to accumulate (change in depth, source, topography or water mass). Smear slide sampling indicated 5 to 10 per cent of clay minerals in Cores 1 and 2. However, only one smear slide per section was

TABLE 2
Stratigraphy Site 16

Age	Cored Interval (m)	Formation Name	Probable Interval (m)	Probable Thickness (m)	Description
Pleistocene to Lower Pliocene	0-9 18.6-27.8 36.6-61.0	Albatross Ooze 3-16-1-1	0-61	61.0	Very pale brown to white foraminiferal nannofossil chalk ooze. 10 to 35 per cent foraminifera.
Lower Pliocene to Upper Miocene	61.0-64.1 85.7-94.9 104-122.3 125.4-134.5	Blake Ooze 3-16-4-5	61-134.5	73.5	White nannofossil chalk ooze. Foraminifera decrease from 0 to 8 per cent near top, to 0 to 2 per cent near bottom of unit. 5 to 10 per cent clay minerals are present.
Upper Miocene	134.5-162	Challenger Ooze 3-16-9-1	134.5-175.4	40.9	Very pale brown to light yellow brown marly nannofossil chalk ooze. Foraminifera rare, increasing to 5 per cent near bottom. Clay minerals 10 to 15 per cent.
?	175.4	Basement 3-16-OB	175.4-?	?	Dark gray aphanitic basalt.

examined, during which time this radiation phenomenon was unknown. A more detailed study will be necessary to be certain of its origin.

Porosity, Wet-Bulk Density and Water Content

Porosity, water content, and wet-bulk densities ranged from 49 to 80 (?) per cent, 33 to 46 per cent, and from 1.35 (?) to 1.88 g/cc, averaging about 63 per cent, 38 per cent, and 1.65 g/cc (Figures 4A and 5A-16A). Site 16 porosities vary irregularly with an apparent decrease (70 to 58 per cent) with increasing depth through the Albatross Ooze, the Blake Ooze, and the Challenger Ooze. Wet-bulk densities, of course, were inversely related to porosity, Sound velocity appears to correlate directly with the wet-bulk densities. As a result of core disturbance, these data may not represent *in situ* values.

Sediment Sound Velocity

Sediment sound velocities as Site 16 ranged from 1.48 to 1.62 km/sec and averaged about 1.52 km/sec at ambient laboratory conditions (Figures 4A and 5A-16A). In general, velocity irregularly increased with depth through the Albatross Ooze, Blake Ooze, and Challenger Ooze. It had an apparent direct relationship with wet-bulk density and a very weak inverse correlation to porosity and a questionable inverse correlation to natural gamma radiation. These cores were disturbed somewhat, thus, temperature-pressure corrected values probably would not necessarily represent *in situ* velocities.

Thermal Conductivity

Measured values of thermal conductivity at Site 16 ranged from about 2.5 to 3.1 x 10^{-3} cal/°C cm sec. An overall increase, but with some scatter, was observed between the surface and 60 m. depth. Values from 60 m. to 110 m. were uniform at 2.9 x 10^{-3} cal/°C cm sec. A relatively low value, about 2.5 x 10^{-3} cal/°C cm sec., was measured at 130 m. depth, and the highest values were measured on cores between 140 m. depth and the bottom of the hole.

Penetration

Complete penetration was attained by the penetrometer in all cores from Site 16, except for a value of 80 × 10^{-1} mm in 3-16-4-3, which slowly penetrated to the liner after the initial release.

Interstitial Water Salinity

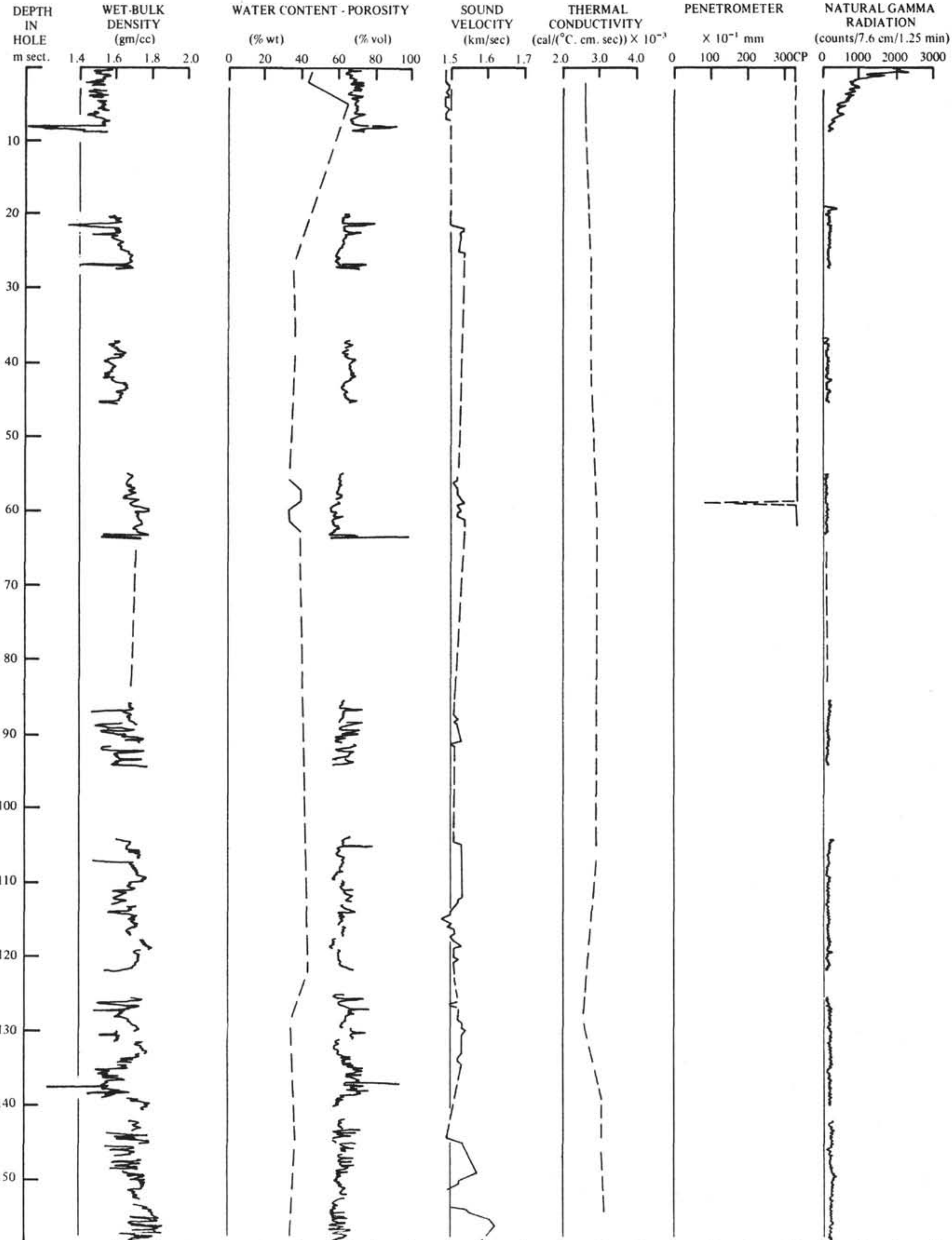
Interstitial water samples were not collected at Site 16.

THE CORES RECOVERED FROM SITE 16

The following pages present a graphic summary of the results of drilling and coring at Site 16.

The first illustrations show a summary of the physical properties of the cores, the positions of the cores and cored intervals and some notes on the lithology and ages of the cores recovered from the holes.

Following this summary are more detailed displays of the individual cores recovered from Site 16. These two-page displays show the physical properties of the cores, the age assignments made on the basis of paleontology, a graphic representation of the lithology of the cores, some notes on the lithology, and notes regarding the diagnostic fossil species present. Symbols have been used for graphic display of lithology to give a general impression only, rather than a detailed representation, and these are supplemented by the lithology notes. For this reason, a detailed key has not been prepared. Interspersed among the core descriptions are photographs of the cores, where photographs are available. In general, every attempt has been made to locate photographs of the cores adjacent to, or as close as practicable to, the relevant Core Summaries. Where sections of core are of special interest, detailed Section Summaries are inserted.



*"0" = laboratory atmospheric background count of 1550.

Figure 4A. *Summary of the physical properties of the cores recovered from Hole 16.*

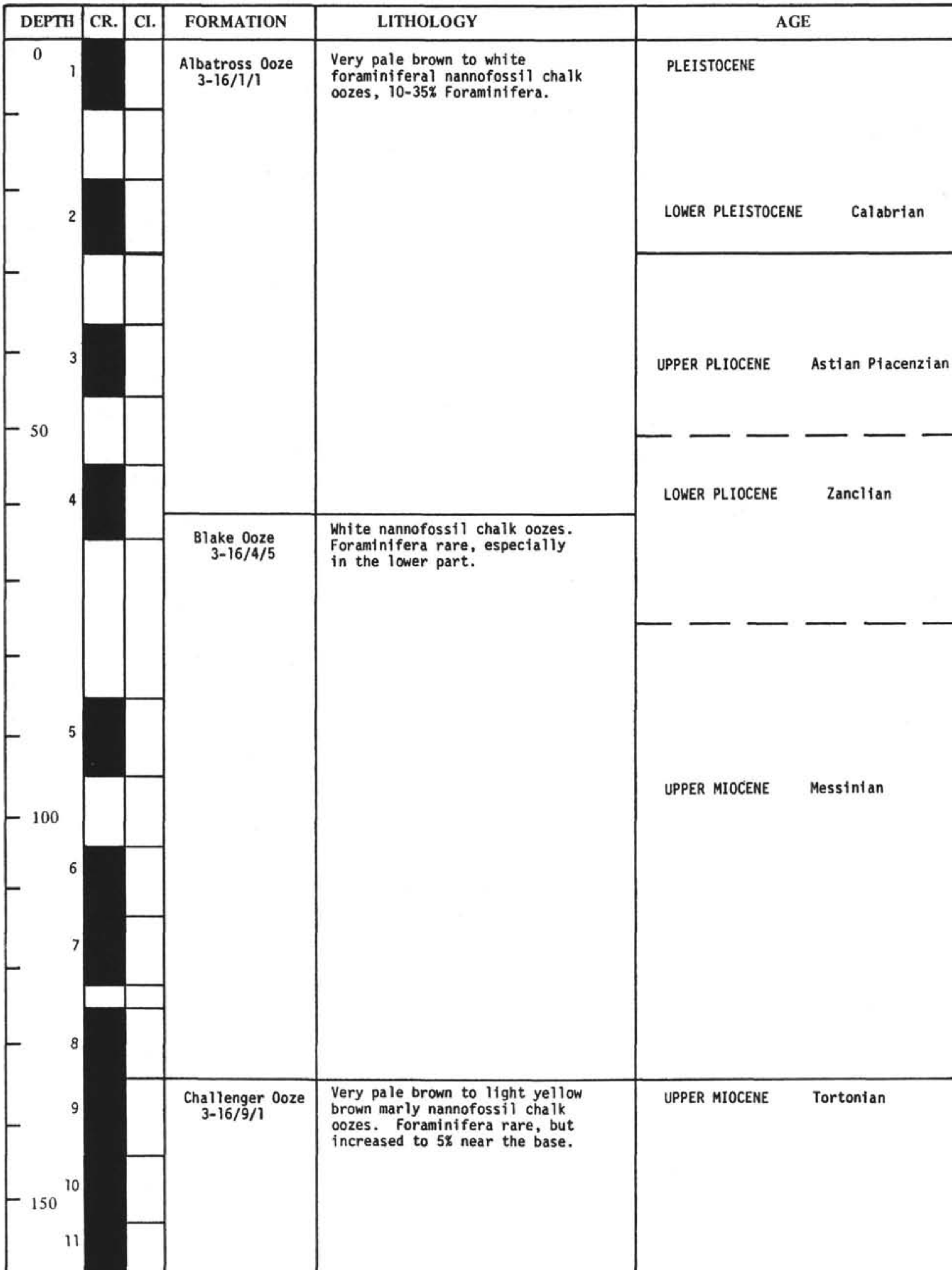
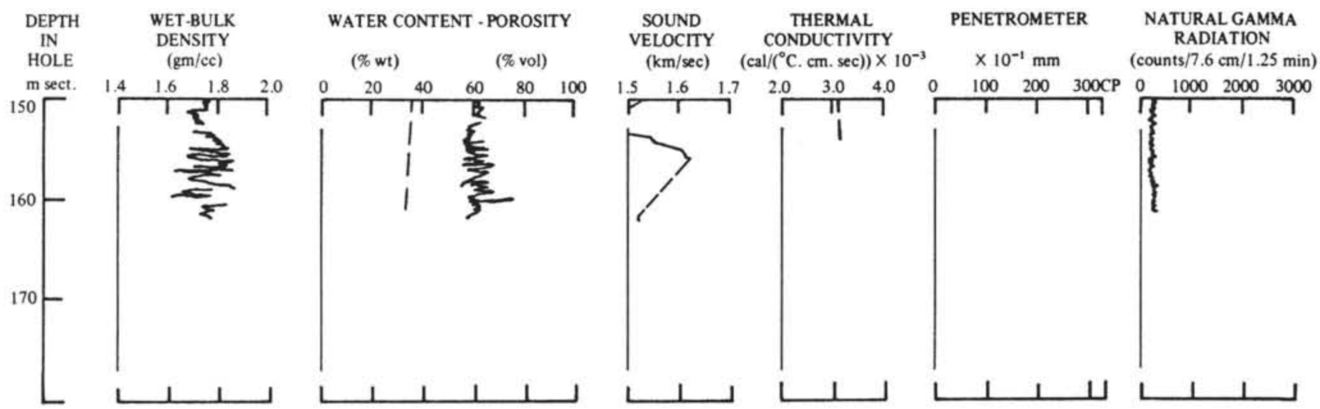


Figure 4B. *Summary of the cores recovered from Hole 16. (Depth in meters below sea bed; C.R. = core recovered; C.I. = cored interval.)*

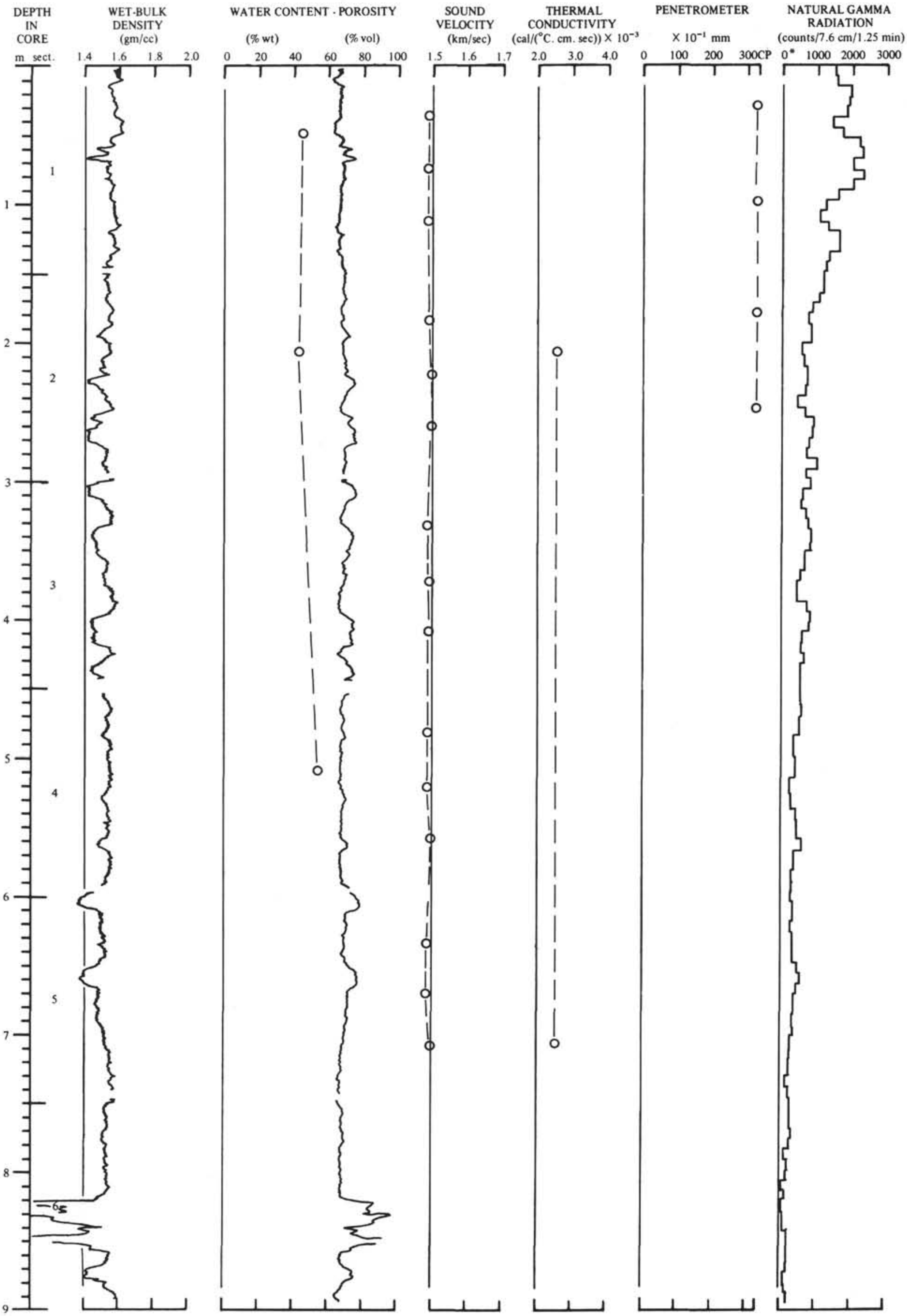


*"0" = laboratory atmospheric background count of 1550.

Figure 4A. *(Continued)*

DEPTH	CR.	CI.	FORMATION	LITHOLOGY	AGE
150			Challenger Ooze (cont'd)	Yellow brown marly chalk oozes.	UPPER MIOCENE Tortonian
12			Basement 3-16/0B	Basalt	

Figure 4B. *(Continued)*



* "0" = laboratory-atmospheric background count of 1550.

Figure 5A. *Physical properties of Core 1, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
PLEISTOCENE		1	1		FN	(Core disturbed)	Planktonic foraminifera: *Globorotalia truncatulinoides, G. inflata, G. hirsuta, Orbulina universa, Globigerinoides conglobatus, G. ruber, G. sacculifer, Globigerinella aequilateralis, Candeina nitida.* Calcareous nannoplankton: *Gephyrocapsa oceanica, Coccolithus pelagicus, Ceratolithus cristatus, Helicopontosphaera kamptneri.*
		2	2				
		3, 4	3			ALBATROSS OOZE	
		5	4		FN OPENED AT END	Very pale brown (10YR7/4) to white (10YR8/2) foram-nannofossil chalk ooze. 3-25% foram	Flora and fauna similar to above.
		6, 7	5		NOT OPENED		
		8	6		NOT OPENED		Core catcher: Flora and fauna similar to above.

Figure 5B. *Core 1, Hole 16.*

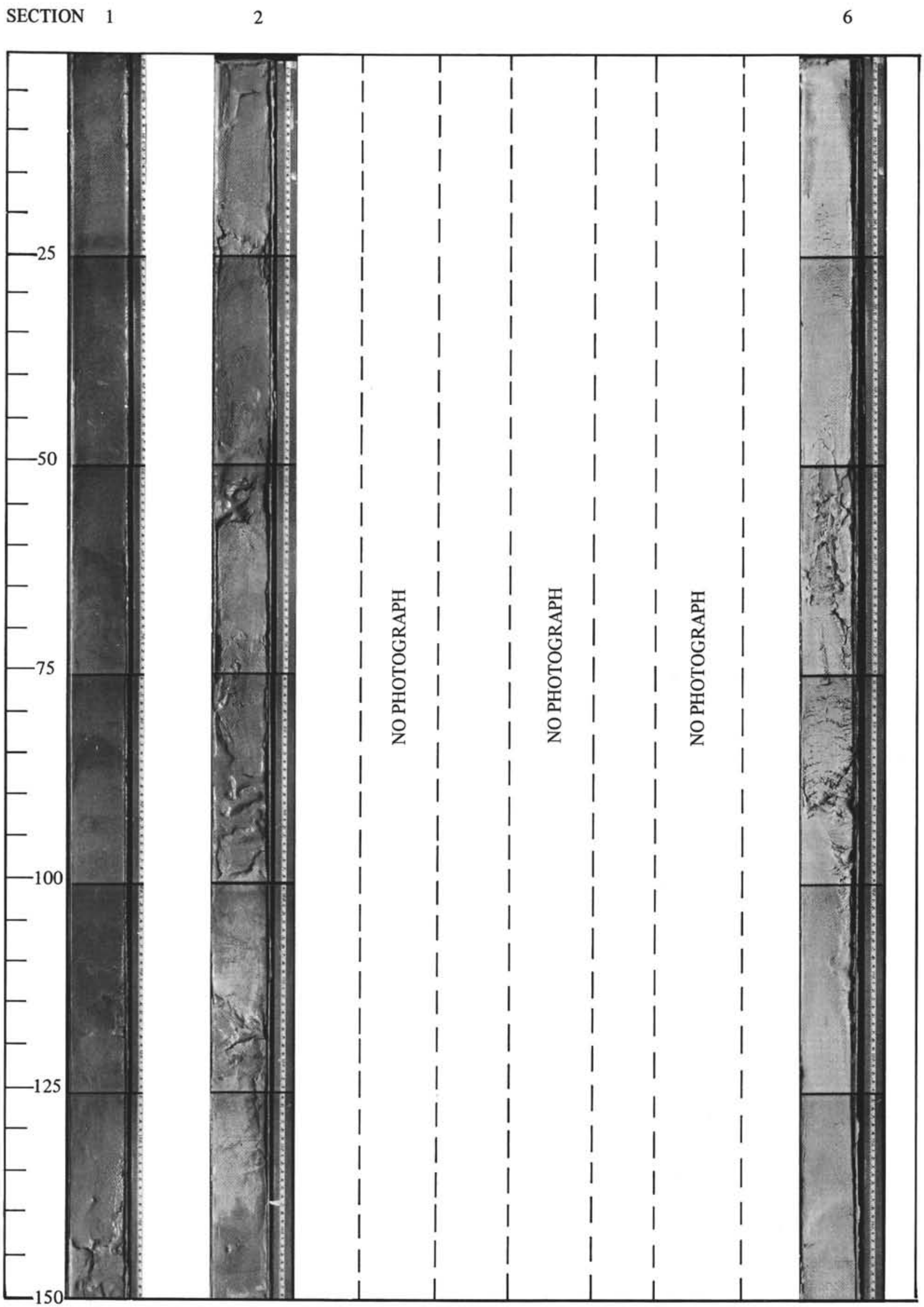


Plate 1. *Core 1, Hole 16.*

SECTION 1

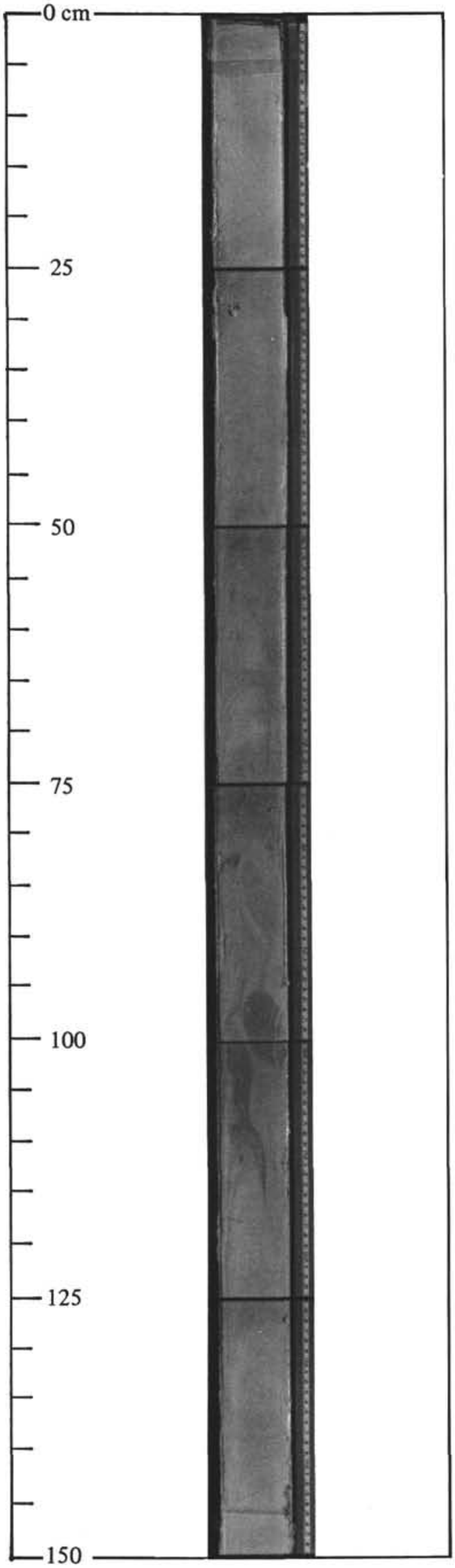
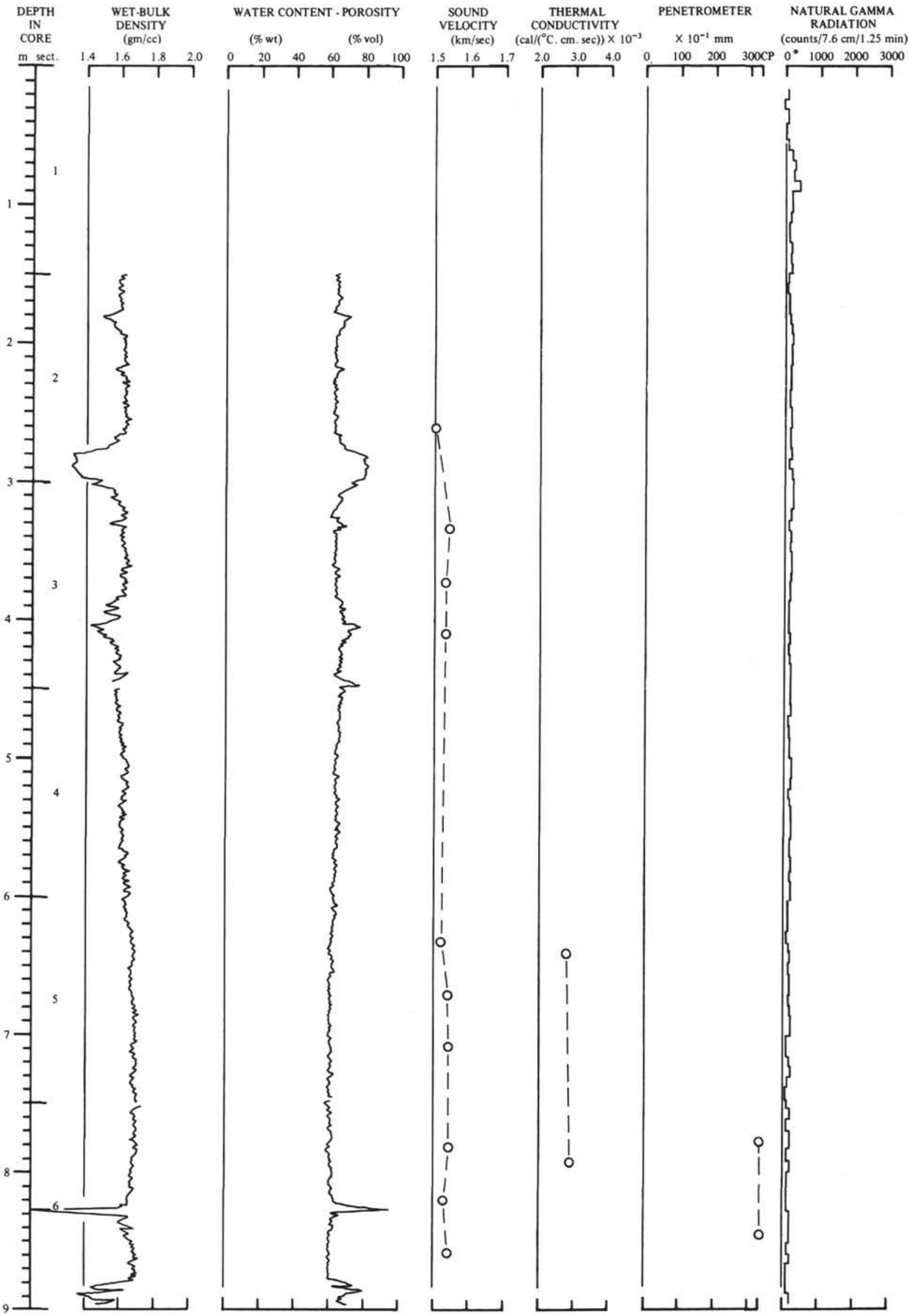


Plate 2. *Core 2, Hole 16.*



* "0" = laboratory-atmospheric background count of 1550.

Figure 6A. *Physical properties of Core 2, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER PLEISTOCENE	CALABRIAN	1	1	LOST, VERY SOUPY	FN OPENED AT END	(Core disturbed, very soupy)	Planktonic foraminifera: *Globorotalia crassaformis, G. inflata, G. tumida, G. tosaensis, G. truncatulinoides, Globigerinoides conglobatus, Sphaeroidinella dehiscens.* Calcareous nannoplankton:* *Ceratolithus cristatus, Gephyrocapsa oceanica, Helicopontosphaera kamptneri, Cyclococcolithus leptoportus, Coccolithus pelagicus.*
		2 3	2		OPENED AT END N	ALBATROSS OOZE	Flora similar to above.*
		4	3		OPENED AT END FN	White (10YR8/2) foram-nannofossil chalk ooze. 15-35% foram	Flora similar to above. Fauna similar to above with *Globorotalia menardii* (L)
?	?	5	4		OPENED AT END FN		Planktonic foraminifera: *Globorotalia truncatulinoides, G. inflata, G. tumida, G. crassula, G. exilis, G. cibaoensis, G. menardii* (L) (L), *Globigerinoides ruber, G. conglobatus, Pulleniatina obliquiloculata* (R). Calcareous nannoplankton: *Discoaster browveri* (abundant), *Cyclococcolithus leptoporus, Helicopontosphaera kamptneri, Gephyrocapsa oceanica, Ceratolithus cristatus, Coccolithus pelagicus.*
UPPER PLIOCENE	ASTIAN-PIACENZIAN	6 7	5		OPENED AT END FN		Flora similar to above Fauna similar to above with *Globigerinoides obliquus.*
		8	6		FN N	Inclusions of light gray (10YR7/2) foram-nannofossil chalk ooze. See Section Summary	Flora and fauna similar to above. Core catcher: Planktonic foraminifera: *Globorotalia tosaensis, G. crassaformis, Pulleniatina obliquiloculata* (R), *P. primalis* (R), *Globigerinoides obliquus, G. conglobatus, Candeina nitida, Sphaeroidinella dehiscens.* Calcareous nannoplankton: *Discoaster browveri, D. pentaradiatus, D. surculus, Ceratolithus cristatus, C. rugosus, Helicopontosphaera kamptneri, Coccolithus pelagicus, Cyclococcolithus leptoporus.*

* These samples contain reworked *Discoaster* spp.

Figure 6B. *Core 2, Hole 16.*

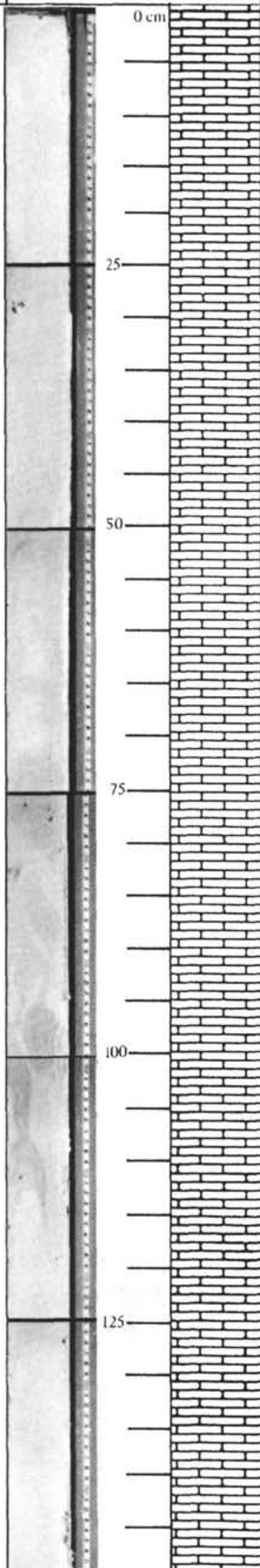
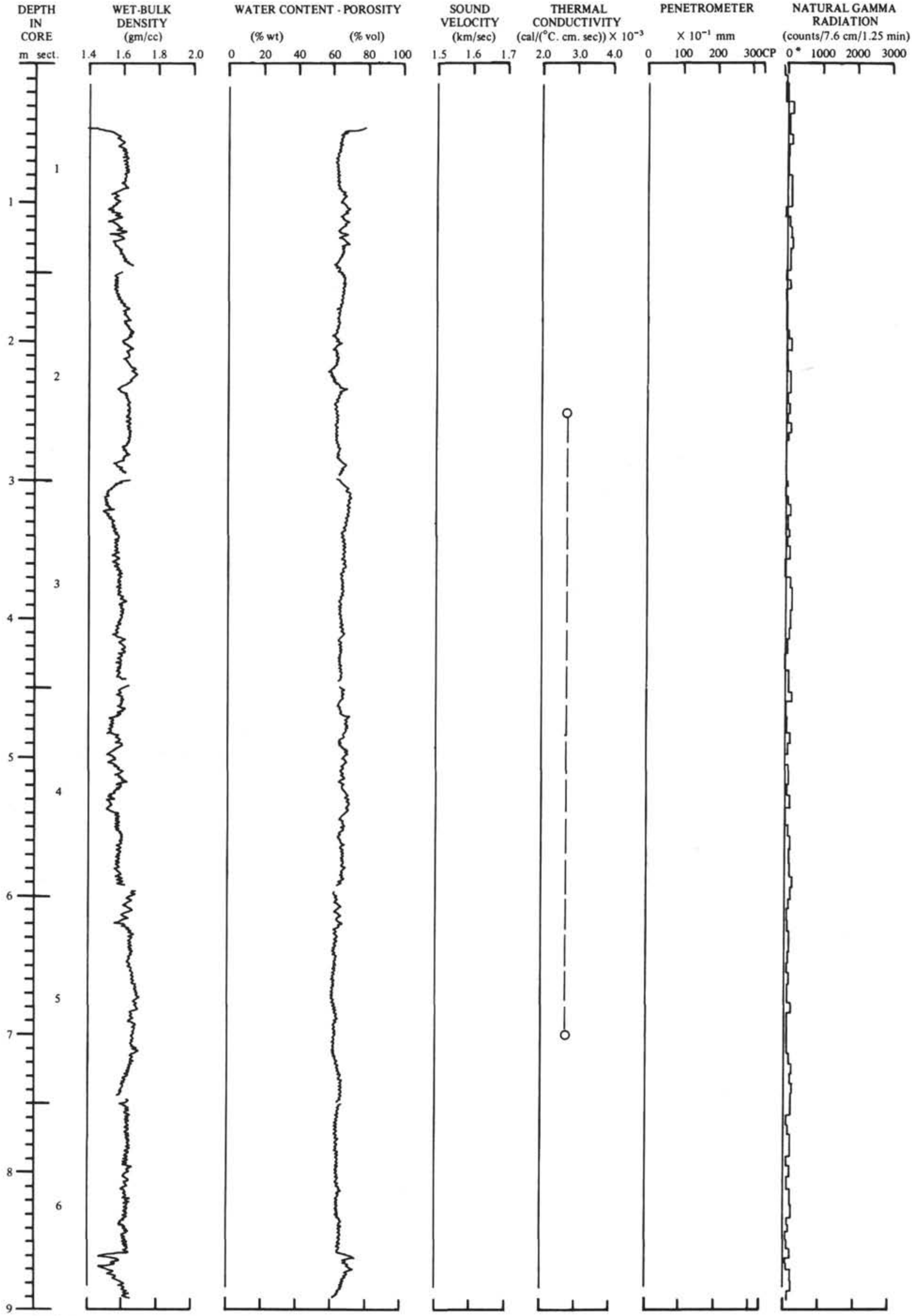
AGE	STAGE	LITHOLOGY	SAMP. INT.	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER PLIOCENE	ASTIAN-PIACENZIAN			Fm. ALBATROSS OOZE Foram-nannofossil chalk ooze 15% foram 8% clay minerals (white, 10YR8/2) with inclusions of light gray (10YR7/2) Core disturbed-rather soupy, any layering squeezed and distorted to mottling and inclusions.	Flora and fauna: See core summary sheet. Core catcher: Planktonic foraminifera: *Globorotalia tosaensis, G. crassaformis, Pulleniatina obliquiloculata* (R), *P. primalis* (R), *Globigerinoides obliquus, G. conglobatus, Candeina nitida, Sphaeroidinella dehiscens.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. surculus, Ceratolithus cristatus, C. rugosus, Helicopontosphaera kamptneri, Coccolithus pelagicus, Cyclococcolithus leptoporus.*

Figure 7. *Summary of Section 6, Core 2, Hole 16.*

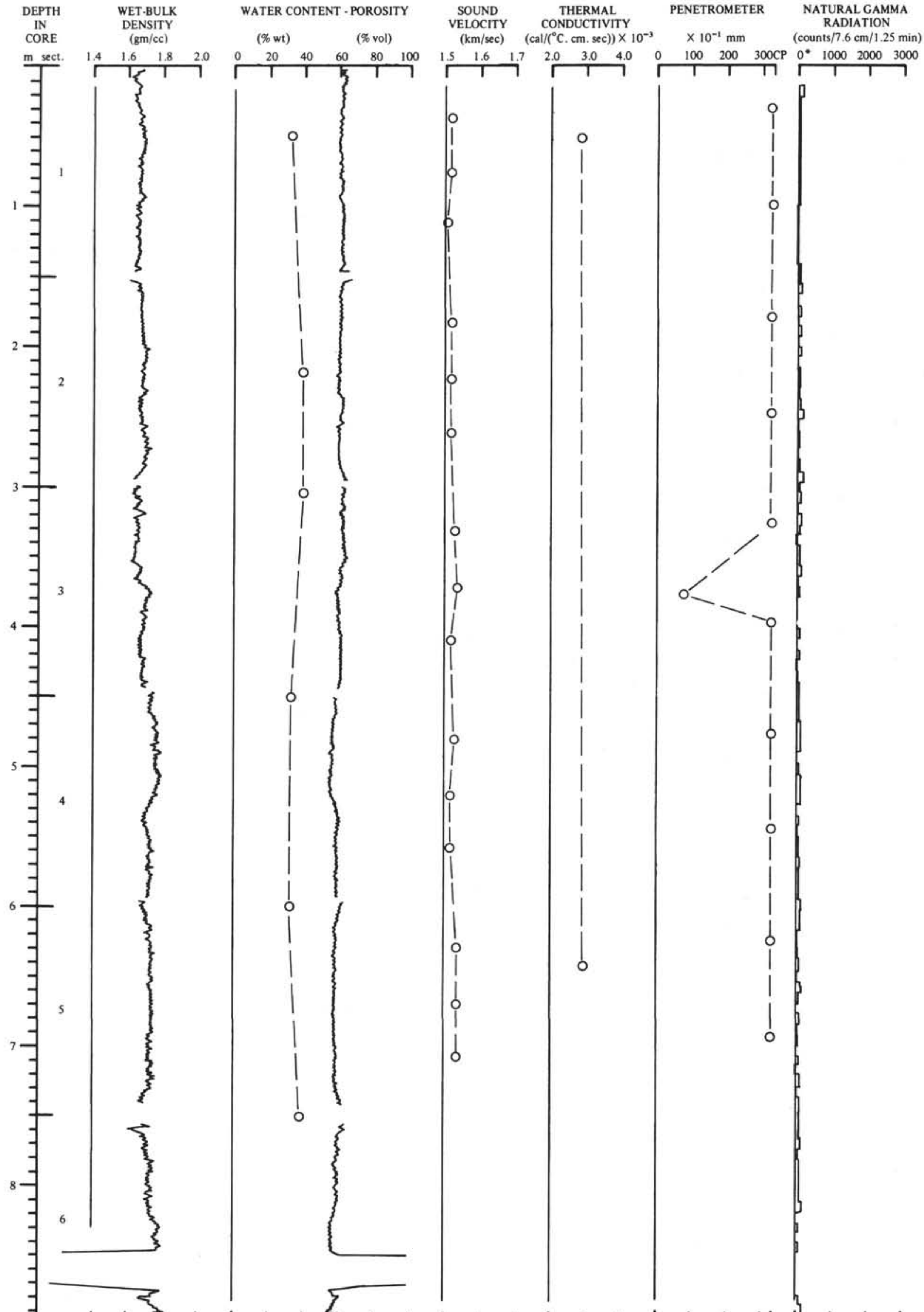


* "0" = laboratory-atmospheric background count of 1550.

Figure 8A. *Physical properties of Core 3, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER PLIOCENE	ASTIAN-PIACENZIAN	1	1		OPENED AT END FN	(Core disturbed)	Planktonic foraminifera: *Globigerinoides obliquus, G. conglobatus, G. ruber, Globorotalia inflata, G. crassula, G. cibaoensis, G. scitula* (R). Calcareous nannoplankton: *Discoaster brouweri, D. surculus, D. pentaradiatus, Cyclococcolithus leptoporus, Coccolithus pelagicus, Helicopontosphaera kamptneri, Ceratolithus rugosus.*
		2, 3	2		OPENED AT END FN		Flora and fauna similar to above.
		4	3		OPENED AT END FN	ALBATROSS OOZE White (10YR8/2) foram-nannofossil chalk ooze 3-25% foram.	Planktonic foraminifera *Globoquadrina altispira, Globorotalia miocenica* (R), *G. multicamerata, G. crassula, G. scitula, G. crassaformis, Globigerinoides obliquus, Globoquadrina conglomerata.* Calcareous nannoplankton. Flora similar to above.
		5, 6	4		OPENED AT END FN		Flora and fauna similar to above.
		7	5		OPENED AT END FN		Flora and fauna similar to above.
		8	6		OPENED AT END FN		Flora similar to above. Fauna similar to above with first appearance of *Sphaeroidinellopsis seminulina.* Core catcher: Flora and fauna similar to above.

Figure 8B. *Core 3, Hole 16.*



* "0" = laboratory-atmospheric background count of 1550.

Figure 9A. *Physical properties of Core 4, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER PLIOCENE	ZANCLIAN	1	1		FN		Planktonic foraminifera: *Globorotalia margaritae, G. inflata, G. conoidea, G. conomiozea, Globigerinoides obliquus, G. sacculifer, Globoquadrina altispira, Sphaeroidinellopsis seminulina.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. surculus, Ceratolithus tricorniculatus, C. rugosus, Reticulofenestra pseudoumbilica, Helicopontosphaera kamptneri, Cyclococcolithus leptoporus, Coccolithus pelagicus.*
		2	2		N	ALBATROSS OOZE	Flora similar to above.
		3, 4	3		N	White (10YR8/1-8/2) foram-nannofossil chalk ooze 8% foram.	Flora similar to above.
		5	4		FN		Flora and fauna similar to above.
		6, 7	5		N	BLAKE OOZE	Flora similar to above.
		8	6		OPENED AT END; FN	White (10YR8/1-8/2) nannofossil chalk ooze 0-3% foram.	Flora and fauna similar to above. Core catcher: Flora and fauna similar to above.

Figure 9B. *Core 4, Hole 16.*

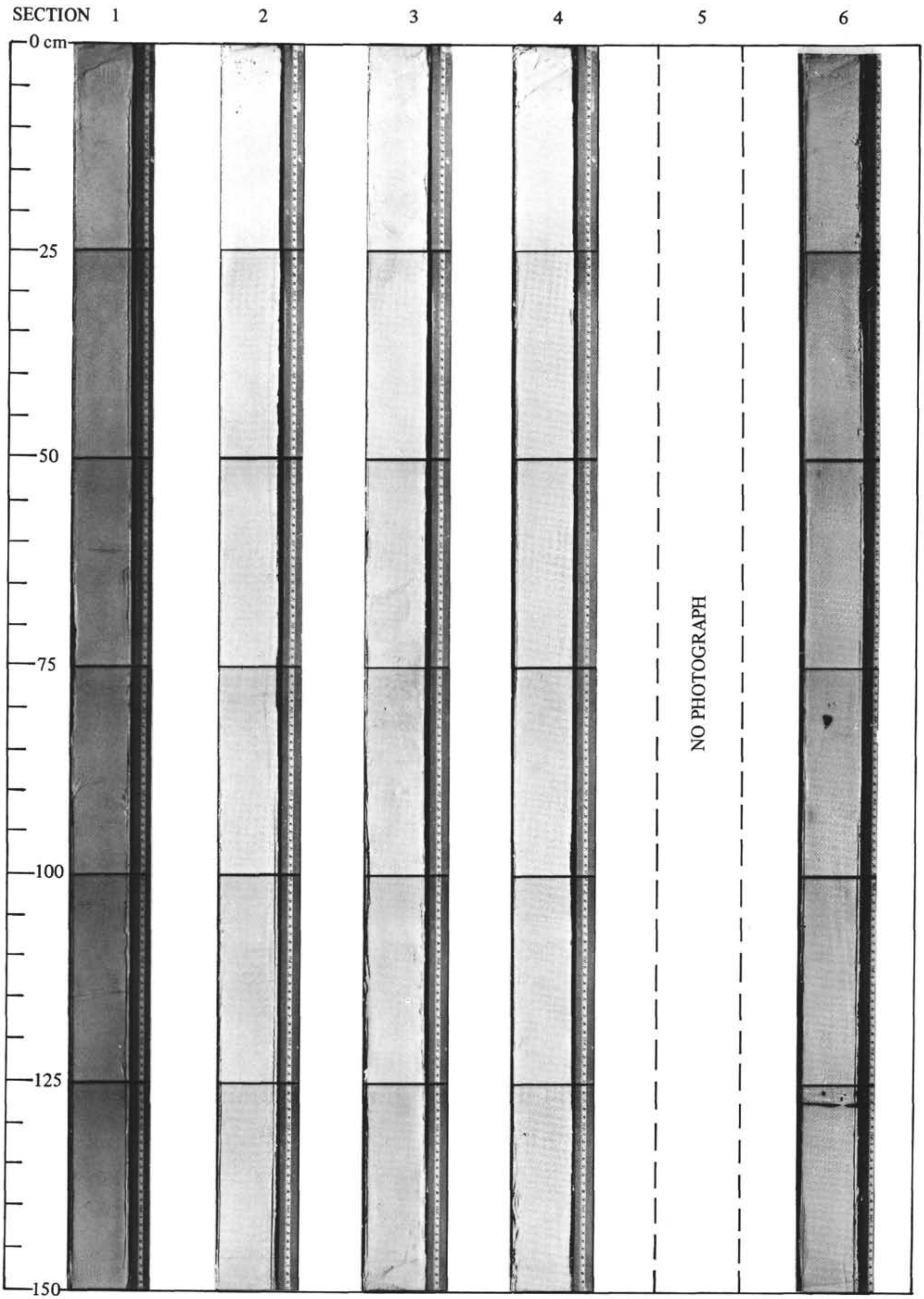
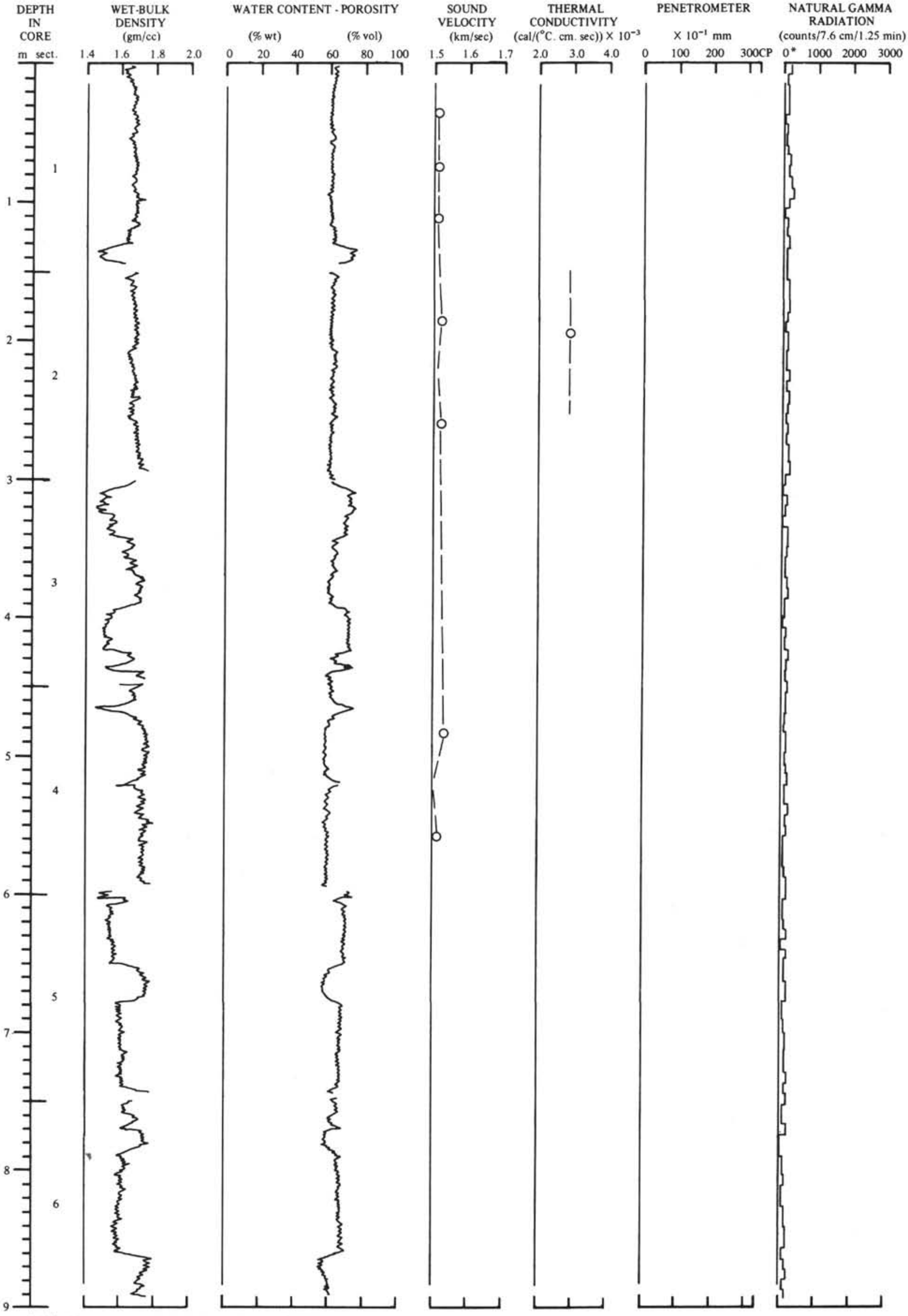


Plate 3. *Core 4, Hole 16.*

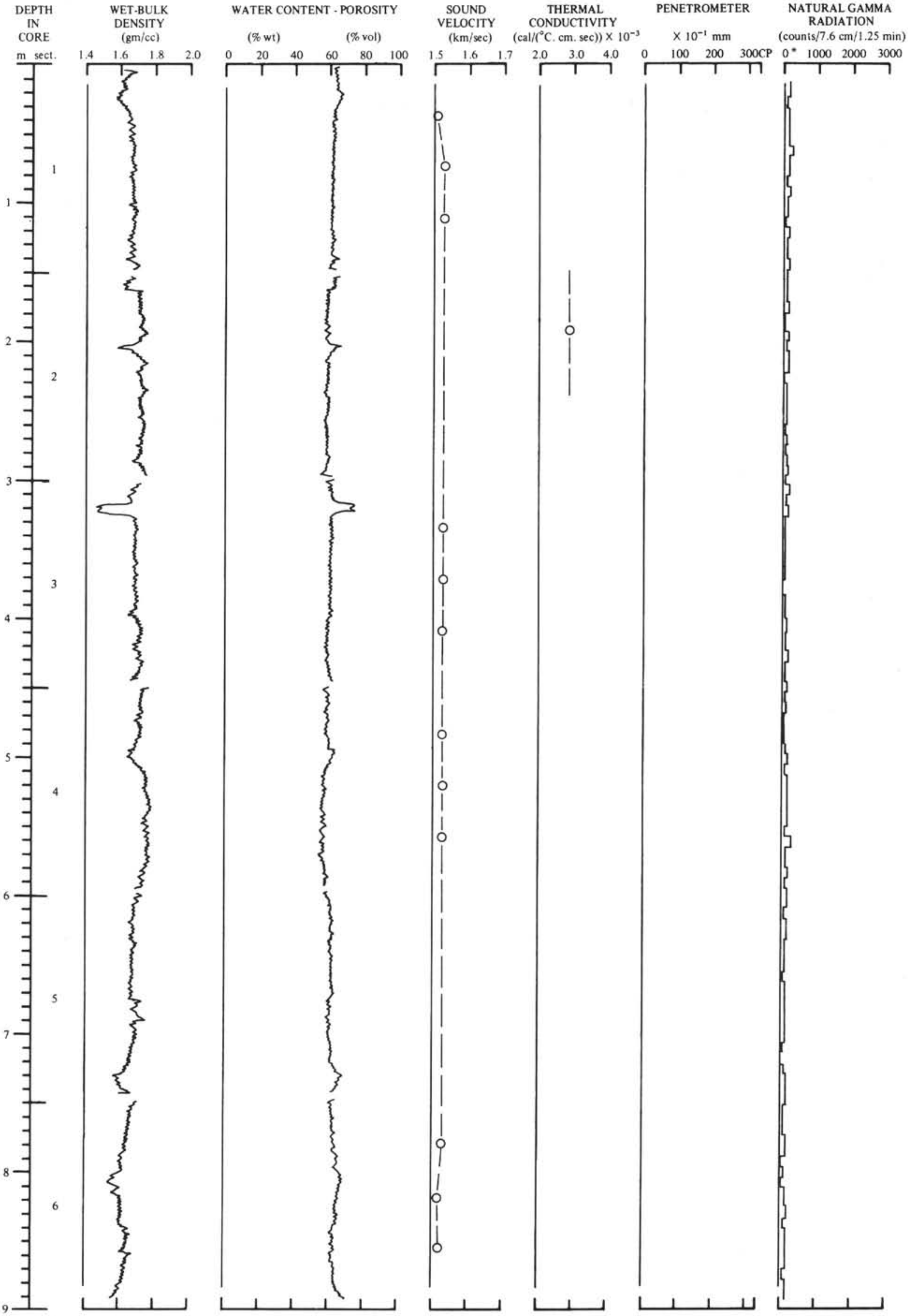


* "0" = laboratory-atmospheric background count of 1550.

Figure 10A. *Physical properties of Core 5, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	MESSINIAN	1	1		OPENED AT END FN		Planktonic foraminifera: *Globigerina nepenthes, Globoquadrina altispira, Globigerinoides obliquus, Globorotalia margaritae, G. inflata, G. conoidea, G. crassaformis oceanica, Sphaeroidinellopsis seminulina.* Calcareous nannoplankton: *Discoaster brouweri, D. surculus, D. pentaradiatus, D. challengeri, Reticulofenestra pseudoumbilica, Ceratolithus tricorniculatus, Cyclococcolithus leptoporus, Coccolithus pelagicus.*
		2	2		OPENED AT END N		Flora similar to above.
		3 4	3		OPENED AT END FN	BLAKE OOZE Very pale brown (10YR8/2.5) to white (10YR8/1.5) nannofossil chalk ooze. Tr-2% foram 5-10% clay minerals	Flora and fauna similar to above.
		5	4		OPENED AT END N		Flora similar to above.
		6 7	5		OPENED AT END FN		Flora and fauna similar to above.
		8	6		OPENED AT END FN		Flora and fauna similar to above. Core catcher: Flora and fauna similar to above.

Figure 10B. *Core 5, Hole 16.*

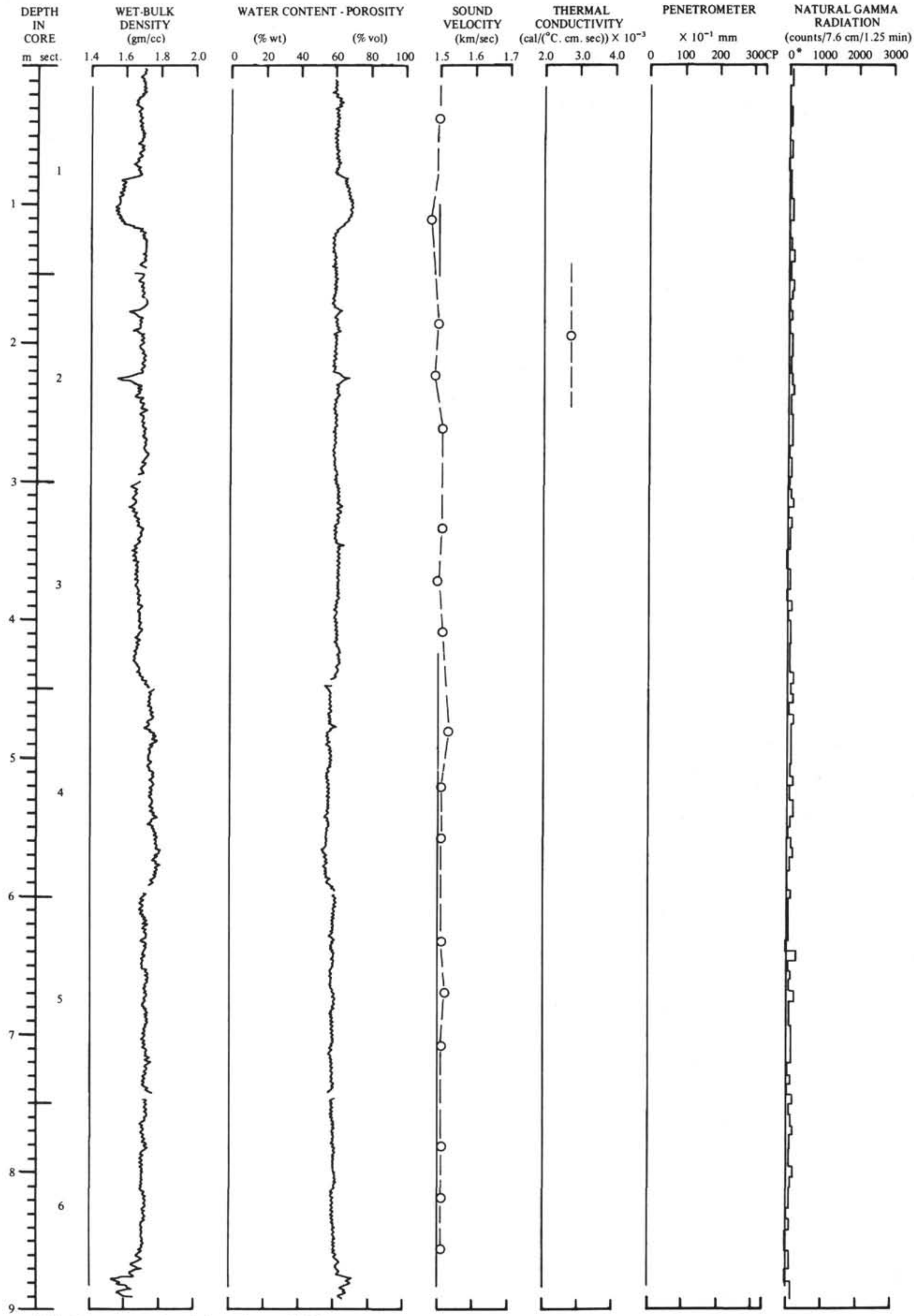


* "0" = laboratory-atmospheric background count of 1550.

Figure 11A. *Physical properties of Core 6, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	MESSINIAN	1	1		OPENED AT END; FN	(Core disturbed, soupy)	Planktonic foraminifera: *Globigerina nepenthes, Globorotalia cibaoensis, G. conoidea, Sphaeroidinellopsis seminulina, Globigerinoides gomitulus.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. challengeri, Ceratolithus tricorniculatus, Reticulofenestra pseudoumbilica, Cyclococcolithus leptoporus, Coccolithus pelagicus.*
		2, 3	2		OPENED AT END; FN		Flora similar to above. Fauna similar to above with *Globorotalia margaritae.*
		4	3		OPENED AT END; N	BLAKE OOZE	Flora similar to above.
		5, 6	4		OPENED AT END	White (2.5Y8/2) nannofossil chalk ooze. Tr-4% foram; 5-10% clay minerals	
		7	5		OPENED AT END; FN		Flora and fauna similar to above.
		8	6		OPENED AT END; FN		Flora and fauna similar to above. Core catcher: Flora and fauna similar to above.

Figure 11B. *Core 6, Hole 16.*



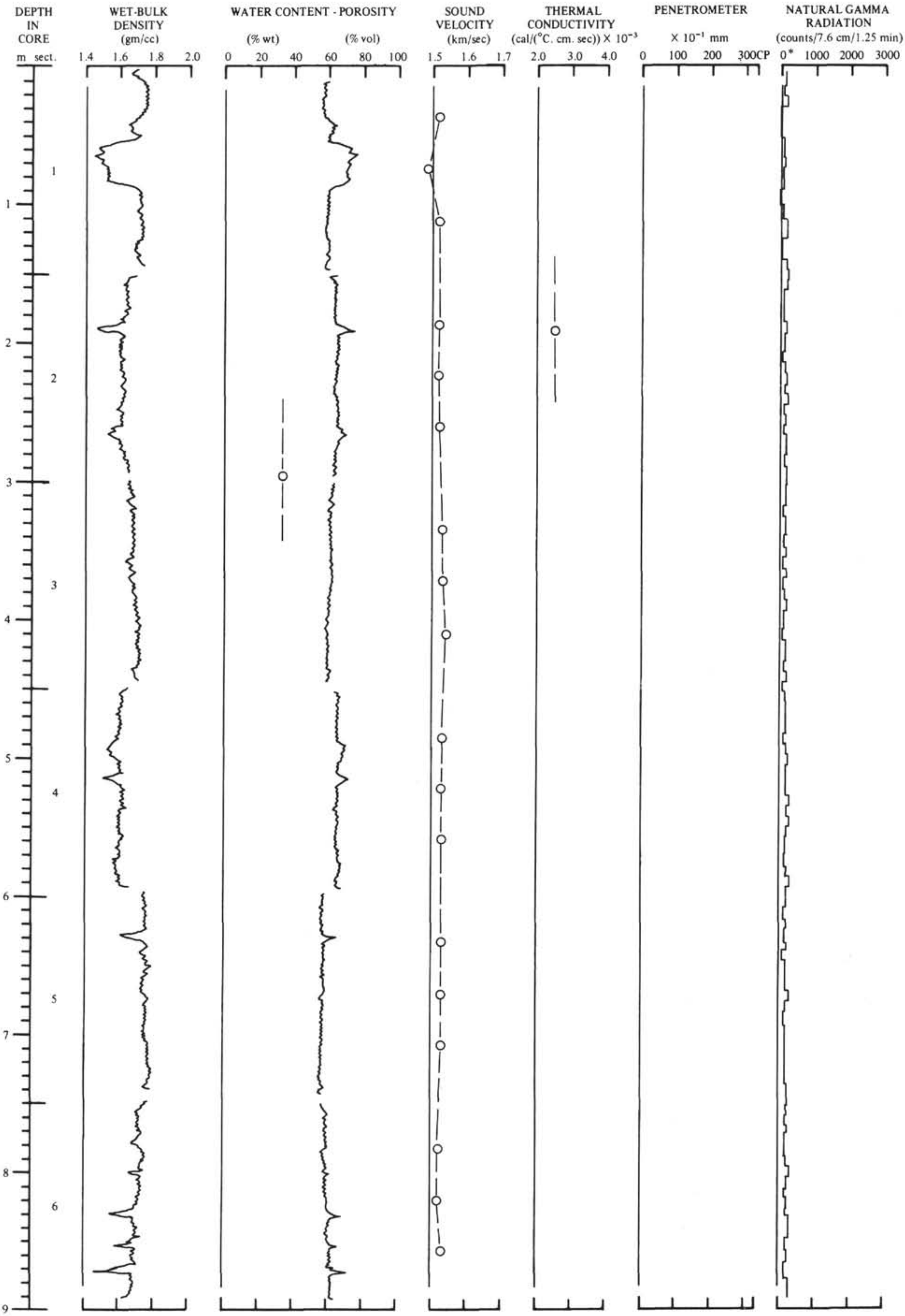
* "0" = laboratory-atmospheric background count of 1550.

Figure 12A. *Physical properties of Core 7, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	MESSINIAN	1	1		OPENED AT END; FN	(Core disturbed, soupy; not split)	Planktonic foraminifera:* *Globigerina nepenthes, Globigerinoides obliquus, Globorotalia conoidea, Sphaeroidinellopsis seminulina, Orbulina universa.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. challengeri, Ceratolithus tricorniculatus, Reticulofenestra pseudoumbilica, Coccolithus pelagicus, Cyclococcolithus leptoporus.*
		2	2		OPENED AT END; N		Flora similar to above.
		3, 4	3		OPENED AT END; FN	BLAKE OOZE White 2.5Y8/2) nannofossil chalk ooze. Tr-5% foram 5-12% clay minerals	Flora and fauna similar to above.*
		5	4		OPENED AT END; N		Flora similar to above.
		6, 7	5		OPENED AT END; N		Flora similar to above.
		8	6		OPENED AT END; N		Flora and fauna similar to above. Core catcher: Flora and fauna similar to above.

* Most of planktonic foraminifera tests are broken in these samples.

Figure 12B. *Core 7, Hole 16.*



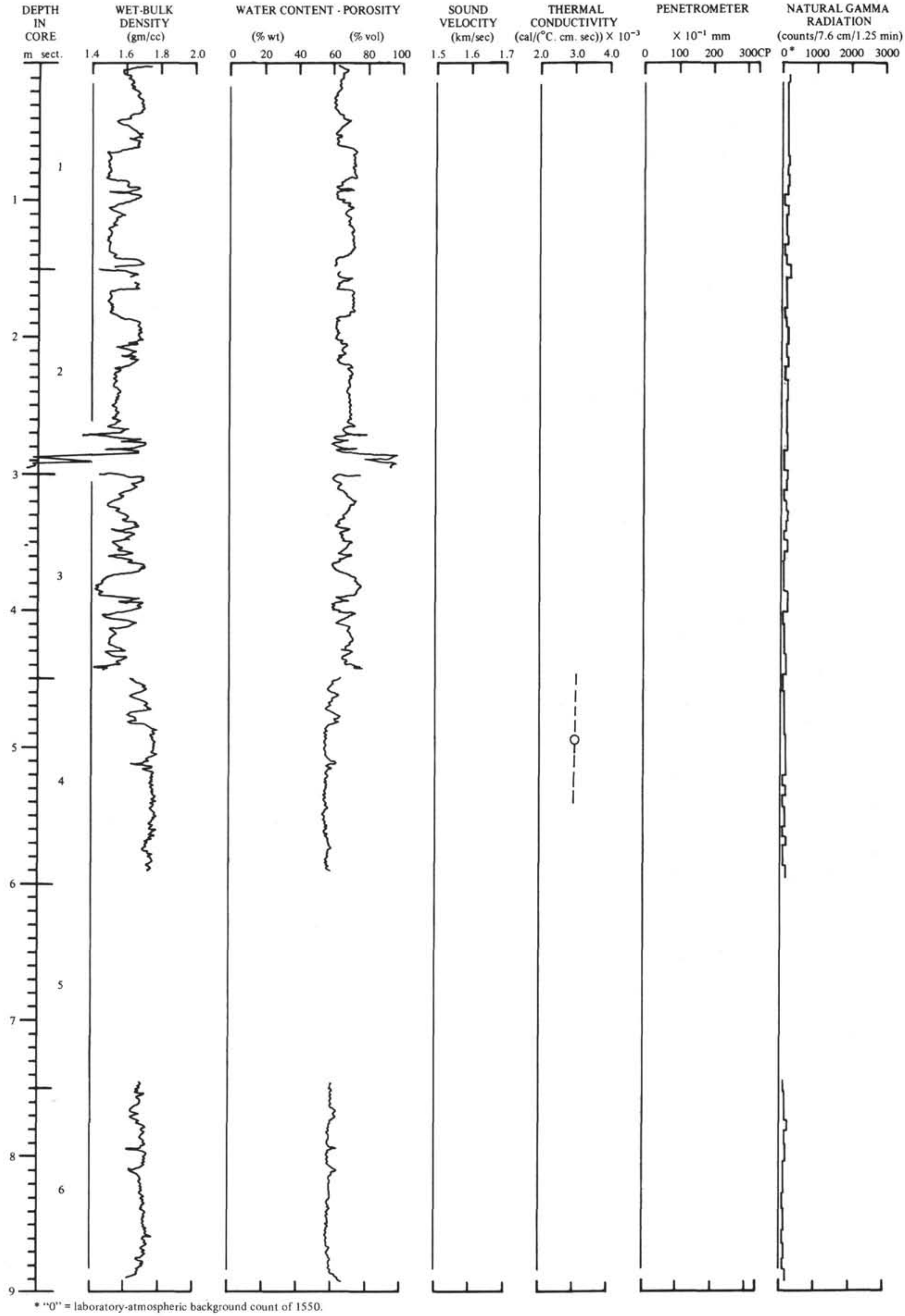
* "0" = laboratory-atmospheric background count of 1550.

Figure 13A. *Physical properties of Core 8, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	MESSINIAN	1	1		OPENED AT END; FN	(Core disturbed, soupy)	Planktonic foraminifera: *Globigerina nepenthes, Globorotalia conoidea, G. lenguaensis, G. scitula, Sphaeroidinellopsis seminulina.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. challengeri, Ceratolithus tricorniculatus* (rare), *Reticulofenestra pseudoumbilica, Coccolithus pelagicus, Cyclococcolithus leptoporus.*
		2, 3	2		OPENED AT END; N		Flora similar to above.
		4	3		OPENED AT END; N	BLAKE OOZE	Flora similar to above.
		5, 6	4		OPENED AT END; N	White (2.5Y8/2) nannofossil chalk ooze. Tr-2% foram	Flora similar to above.
		7	5		OPENED AT END; N		Flora similar to above.
		8	6		OPENED AT END; FN		Flora and fauna similar to above. Core catcher: Planktonic foraminifera: *Globorotalia conomiozea, G. miotumida, Globigerina nepenthes, Globigerinoides bollii, Sphaeroidinellopsis seminulina, S. subdehiscens.* Calcareous nannoplankton:* Flora similar to above without *Ceratolithus tricorniculatus.*

* The core catcher sample is probably Upper Miocene, Tortonian.

Figure 13B. *Core 8, Hole 16.*



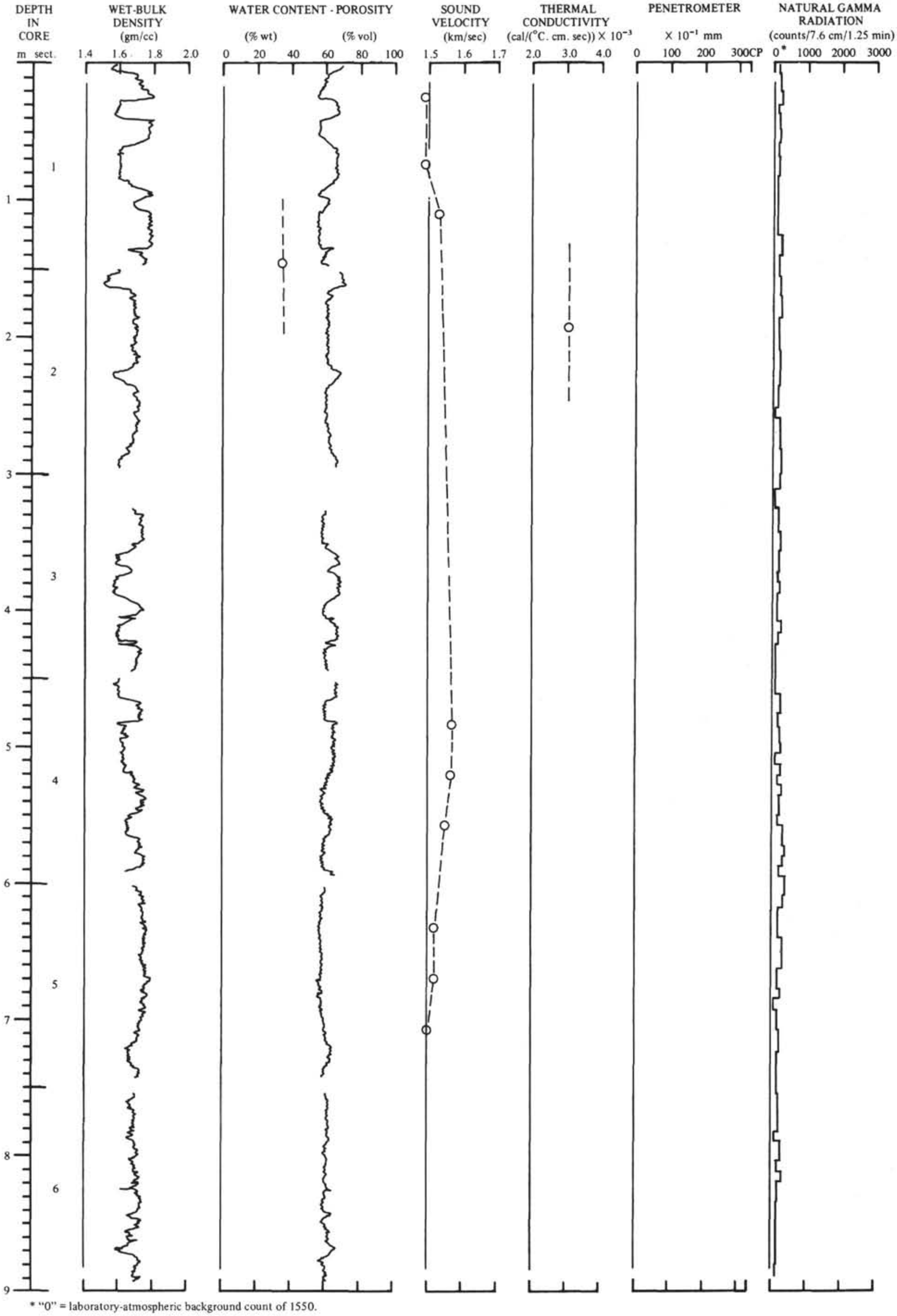
* "0" = laboratory-atmospheric background count of 1550.

Figure 14A. *Physical properties of Core 9, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	TORTONIAN	1	1		OPENED AT END; FN		Planktonic foraminifera:* *Globigerina nepenthes*, ***Globigerina** conglomerata*, *Globorotalia conoidea*, *G. miotumida*, *Globigerinoides ruber*, *Sphaeroidinellopsis seminulina*, *Orbulina universa*. Calcareous nannoplankton: *Discoaster brouweri*, *D. pentaradiatus*, *D. challengeri*, *Reticulofenestra pseudoumbilica*, *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*.
		2	2		OPENED AT END; N		Flora similar to above.
		3, 4	3		OPENED AT END; FN	CHALLENGER OOZE Very pale brown (10YR7/4) to light yellow brown, marly nannofossil chalk ooze. 15-30% clay minerals 0-3% foram .	Flora and fauna similar to above.
		5	4		OPENED AT END		
		6, 7	5		OPENED AT END; N		Flora similar to above.
		8	6		OPENED AT END		Flora similar to above. Core catcher: Planktonic foraminifera: *Globorotalia conomiozea*, *G. menardii* (L), *Globigerina nepenthes*, *Globigerinoides bollii*, *sphaeroidinellopsis seminulina*. Calcareous nannoplankton: Flora similar to above.

* This sample contains younger Neogene planktonic foraminifera contaminants from uphole.

Figure 14B. *Core 9, Hole 16.*

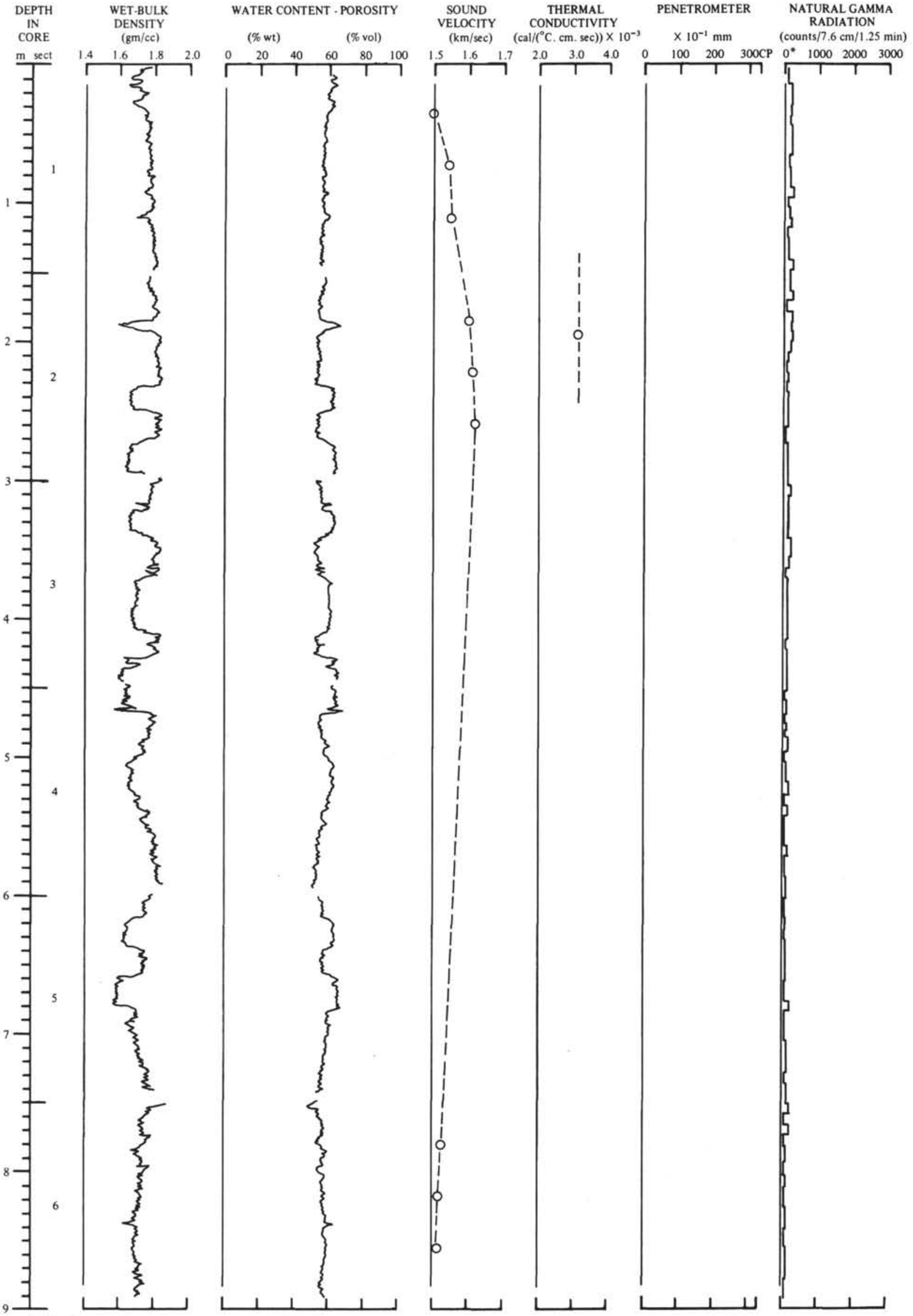


* "0" = laboratory-atmospheric background count of 1550.

Figure 15A. *Physical properties of Core 10, Hole 16.*

AGE	STAGE	SECTION NO.	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	TORTONIAN	1	FN	(Core disturbed)	Planktonic foraminifera:* *Globigerina nepenthes*, ***Globoquadrina** conglomerate*, *Globorotalia conomiozea*, *G. conoidea*, *G. miotumida*, *Orbulina universa*. Calcareous nannoplankton: *Discoaster brouweri*, *D. pentaradiatus*, *D. challengeri*, ***Reticulofenestra** pseudoumbilica*, *Cyclococcolithus leptoporus*, *Coccolithus pelagicus*.
		2	FN		Flora and fauna similar to above.*
		3	N	CHALLENGER OOZE Light yellow brown (10YR6.5/4), marly nannofossil chalk ooze. 20-25% clay minerals 1-5% foram Tr. phosphate.	Flora similar to above.
		4	N		Flora similar to above.
		5			Flora similar to above.
		5	N		Planktonic foraminifera: Fauna similar to above with *Globorotalia menardii* (R), *G. miocenica*, *G. tumida*, and *G. lenguaensis*. Calcareous nannoplankton: Flora similar to above. Core catcher: Planktonic foraminifera: *Globigerina nepenthes*, *Globigerinoides bollii*, *G. ruber*, *Globorotalia conomiozea*, *G. menardii* (L), *Sphaeroidinellopsis seminulina*.
		6	FN		* These samples contain younger Neogene planktonic foraminifera contaminants from uphole.

Figure 15B. *Core 10, Hole 16.*



* "0" = laboratory-atmospheric background count of 1550.

Figure 16A. *Physical properties of Core 11, Hole 16.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER MIOCENE	TORTONIAN	1	1		OPENED AT END; FN	(Core disturbed, soupy)	Planktonic foraminifera: *Globorotalia conomiozea, G. conoidea, G. menardii* (L), *G. scitula Globigerina nepenthes, Globigerinoides bollii, G. ruber, Orbulina universa, Sphaeroidinellopsis seminulina.* Calcareous nannoplankton: *Discoaster brouweri, D. pentaradiatus, D. challengeri, Cyclococcolithus leptoporus, Coccolithus pelagicus, Reticulofenestra pseudoumbilica.*
		2, 3	2		OPENED AT END; N		Flora similar to above.
		4	3		OPENED AT END; FN	CHALLENGER OOZE Pale yellow (2.5Y7/4) to very pale brown (10YR7/4), marly nannofossil chalk ooze. 22-25% clay minerals 5% foram.	Flora and fauna similar to above.*
		5, 6	4		OPENED AT END; N		Flora and fauna similar to above.
		7	5		OPENED AT END; N		Flora similar to above.
		8	6		OPENED AT END; FN		Flora and fauna similar to above. Core catcher: Flora and fauna similar to above.

* This sample contains younger Neogene floral and faunal contaminants from uphole.

Figure 16B. *Core 11, Hole 16.*