8. SITE 18

The Shipboard Scientific Party[1]

SURVEY DATA AND SITE APPROACH

As at Site 17, the area around this site was not surveyed in detail prior to the arrival of the drilling vessel. The general location was selected on the east side of the Mid-Atlantic Ridge, about 150 kilometers west of the previous site, to further test the symmetry of sea-floor spreading.

The drilling vessel crossed the site location (27° 58.72′ S, 8° 00.70′W) only once on a course of 270° before turning around to begin drilling operations. The topography within a few miles of the site (Figure 1) apparently consists of relatively smooth hills 20 to 80 meters (66 to 262 feet) high at an average depth of about 3980 meters (13,054 feet), corrected (2120 fathoms, uncorrected). The depth recorded on the site is 4022 meters (13,192 feet), corrected (2142 fathoms, uncorrected). Underway to the site on course 270°, the vessel crossed a region of unusually large depth (2400 to 2600 fathoms, uncorrected) extending for about 50 to 60 kilometers immediately east of the site. It is possible that the vessel crossed a transverse fracture zone of the Ridge at a low angle. The magnetic anomalies recorded during the crossing of this deep region are of relatively low amplitude.

The air-gun records, approaching the site are of relatively poor quality, but they indicate a sediment thickness equivalent to about 0.15 to 0.20 second reflection time between bottom and "basement" reflector. The record on the site shows a number of possible "basement" reflectors, ranging in depth from about 0.16 to 0.32 second reflection time below bottom. The record may be complicated by side echos from the rough bottom or basement reflectors.

The magnetometer record shows the site to be a few kilometers west of a small positive magnetic anomaly of about 80 gammas amplitude. As at Site 17, the location of this site within the magnetic anomaly pattern is rather uncertain.

[1]A. E. Maxwell and R. P. von Herzen, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts; J. E. Andrews, University of Hawaii, Honolulu, Hawaii; R. E. Boyce and E. D. Milow, Scripps Institution of Oceanography, La Jolla, California; K. J. Hsu, Geologisches Institut, Zurich, Switzerland; S. F. Percival, Princeton University, Princeton, New Jersey; and, T. Saito, Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

OPERATIONS

Positioning

The marker beacon at Site 18 was dropped over the side at 1500 hours on 2 January, 1969. Throughout the 1.5 days on site it was necessary to revert to semi-automatic positioning at some intervals because of erratic large currents (~1 knot) that appeared suddenly and often disappeared as quickly. Aside from these occasions, the ship was held in automatic positioning, seldom deviating more than 15 meters (49 feet) from directly over the beacon.

Drilling

At 178 meters (584 feet), there was a drilling break associated with the bit encountering basalt. The drilling rate was reduced from about 30 m/hr to less than 1. Over three hours of drilling and coring in the basalt were required to recover 0.3 meter (1 foot) of core. It is doubtful that penetration was much greater than this amount. The Christensen diamond bit was thoroughly worn and not useful for further drilling.

Coring

A total of seven cores was collected with a recovery of 52.2 (171 feet) out of 52.9 meters (174 feet), or 98.6 per cent. Only one core at this site had less than 100 per cent recovery.

After a surface core was taken, the pipe was washed in to about 120 meters (394 feet); and, from there to the bottom of the hole, the sediments were cored continuously. On the average this required about 2 hours per core—with the basalt core taking about 5 hours to collect. A summary of the coring is shown in Table 1. Site 18 was planned as a minimum operation in order to conserve time. The total time on site from arrival to departure was 41 hours.

PALEONTOLOGY

Pleistocene, Lower Miocene and Upper Oligocene sediments were recovered from six out of the seven cores. Core 7 recovered basalt. Coring was discontinuous in the upper 130.2 meters (427 feet)—Cores 1 and 2—of the hole; and, it was continuous from 130.2 meters (427 feet) to the top of the basalt at 178.1 meters (584 feet)—Cores 3 through 6. This procedure in coring

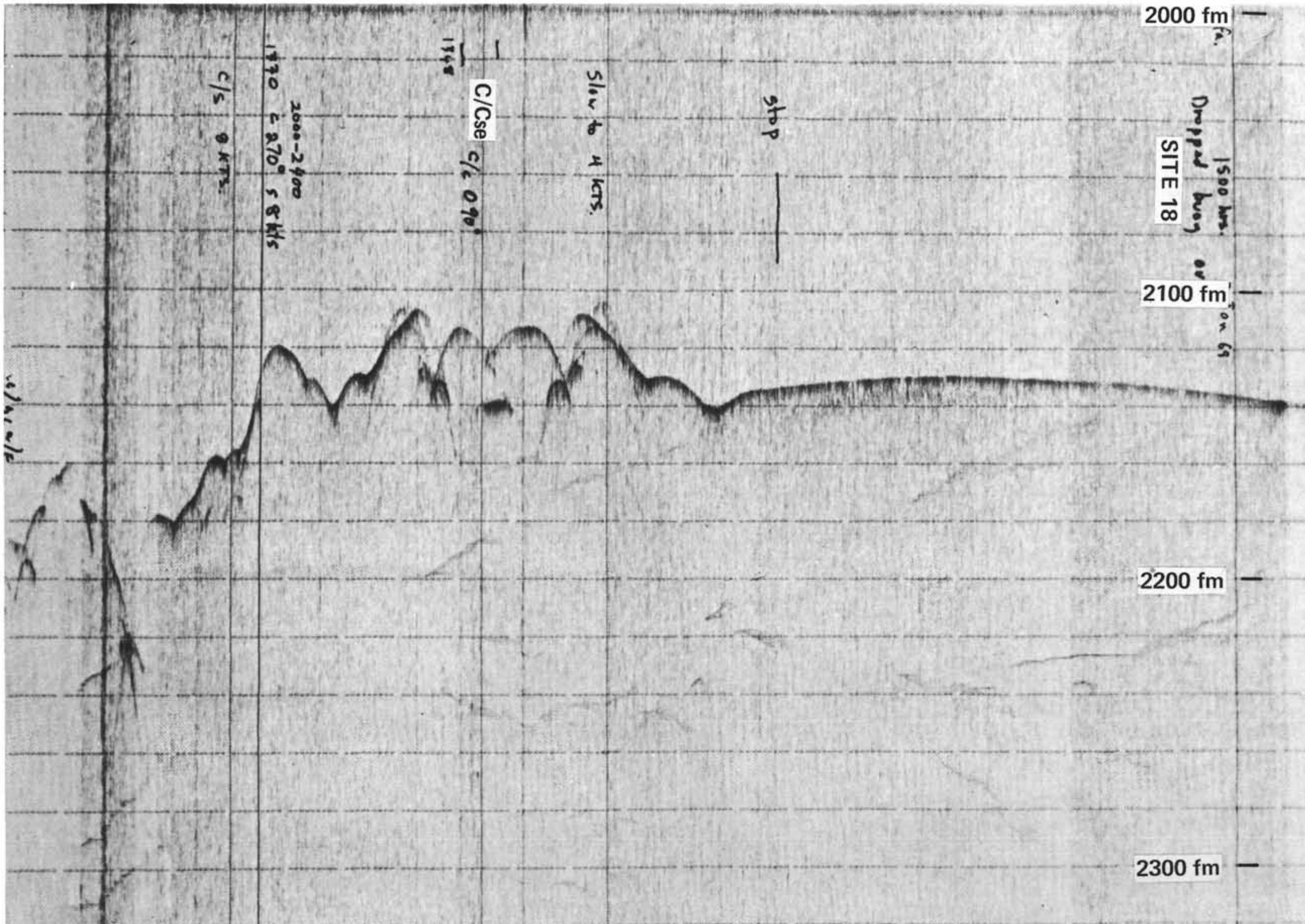


Figure 1. *Precision depth-recording in the vicinity of Site 18.*

TABLE 1
Summary of Coring at Site 18

Core No.	Date/Time	Interval Cored (m below sea floor)	Core Retrieved (m)	Remarks
18-1	1-3-69 0540	0-7.6	7.6	--
18-2	0900	121.0-130.2	9.0	--
18-3	1045	141.2-150.3	9.0	--
18-4	1230	150.3-159.5	8.5	--
18-5	1430	159.8-168.9	9.0	--
18-6	1645	168.9-178.1	9.0	--
18-7	2200	178.1-178.4	0.3	Bit worn out.
	Total		52.4	

was decided upon to establish the age of the sediments immediately above the basalt. The Aquitanian/Burdigalian boundary of the Lower Miocene was drilled in Core 2. The Oligocene/Miocene boundary, although not cored, probably occurs between Cores 5 and 6. Time limitations aboard the ship and the soupy nature of many of the sediments cored resulted in many cores not being slabbed or sampled in detail for geologic and paleontologic studies.

The major purpose in drilling this hole was to test the hypothesis of sea-floor spreading and the interpretation of linear magnetic anomalies. The hole was drilled on a positive anomaly; however, the limited survey data do not permit determination of the Magnetic Anomaly Number in terms of the Heirtzler *et al.* (1968) scheme. The age of the oldest sediments found above the basalt is late Oligocene (Chattian). They represent the lower part of the *Globorotalia kugleri* Zone of Bolli (1957c) and probably the *Sphenolithus ciperoensis* Zone of Bramlette and Wilcoxon (1967). An equivalent radiometric age of approximately 26 million years B. P. is indicated for these zones based upon Chapter 2, Figure 3. An assumed constant rate of spreading of the ocean floor of 2 cm/year over the distance between this site and the axis of the Mid-Atlantic Ridge gives a suggested age of about 25 million years. This computed age is in close agreement with the paleontologic date of 26 million years.

This hole was drilled also to study any floral or faunal changes which took place in southern latitudes. The planktonic foraminifera found in the Pleistocene are not typical of those from tropical latitudes. However, both the planktonic foraminifera found in the older sequence and the calcareous nannoplankton found throughout the section include many species reported by other workers from tropical areas. The calcareous nannoplankton in the Pleistocene are a possible exception, but they were not studied in detail.

The sediments of most of the cores from Hole 18 consist predominantly of plates of the calcareous nannoplankton with minor amounts of planktonic foraminifera. An exception to this is Core 1 where radiolarians and diatoms are present. The variations from lithologic unit to lithologic unit are discussed below under Stratigraphy.

Core 1, from 0 to 7.6 meters (0 to 25 feet), is Pleistocene in age based on all three microfossil groups: planktonic foraminifera, calcareous nannoplankton and Radiolaria. This core was not opened except for Section 5 because of time limitations aboard ship. Though not abundant, a fair amount of radiolarians occur in portions of this core accompanying the diatom, *Ethmodiscus rex* (Rattray). Radiolarian species found are *Dictyophimus crisiae* Ehrenberg, *Penartas tetrathalmus* Haeckle, *Lamprtocycias polypora* Nigrini and *Axoprunum stauraxonium* Haeckle.

The Aquitanian/Burdigalian boundary of the Lower Miocene is found at the bottom of Section 1 of Core 2, from 121 to 130.2 meters (397 to 427 feet), based on the first appearance of *Globigerinita dissimilis* in the sample from 100 to 102 centimeters in Section 2. This is the boundary between the *Globigerinita stainforthi* Zone of Bolli (1957c) and the *Globigerinatella insueta*/*Globigerinoides trilobus* Zone of Blow (1959). Two calcareous nannoplankton zones of Bramlette and Wilcoxon (1967) are present in this core. These are the upper part of the *Triquetrorhabdulus carinatus* and the *Sphenolithus belemnos* Zones. The older zone is found in the sample from 148 to 150 centimeters in Section 5 and below, by the presence of *Sphenolithus belemnos?* associated with *Discoaster druggi, D. deflandrei, Cyclococcolithus neogammation* and *Orthorhabdus serratus.* The younger zone is recognized by the presence of more typical specimens of *Sphenolithus belemnos* in the upper portion of this core. This development of *Sphenolithus belemnos* has been discussed previously for Core 1A of Hole 14.

Core 3, from 141.2 to 150.3 meters (463 to 493 feet), Core 4, from 150.3 to 159.5 meters (493 to 523 feet), and Core 5, from 159.8 to 168.9 meters (524 to 555 feet) are assigned to the Aquitanian based on the planktonic foraminifera. Most of this interval is represented by the *Globorotalia kugleri* Zone of Bolli (1957c). The boundary between this and the overlying *Globigerinita dissimilis* Zone of Bolli (1957c) is found in Core 3 between samples from 148 to 150 centimeters of Section 1 and from 148 to 150 centimeters of Section 3 based on the first appearance of *Globorotalia kugleri* in the lower sample. Cores 3, 4 and 5 represent the lower part of the *Triquetrorhabdulus carinatus* Zone of Bramlette and Wilcoxon (1967), based on the occurrence of *Coccolithus* aff. *bisectus* in association with *Discoaster deflandrei* and *Cyclococcolithus neogammation* throughout this interval.

The Oligocene/Miocene boundary based on the first geologic appearance of the planktonic foraminiferal genus *Globigerinoides* occurs between Core 5, from 159.8 to 168.9 meters (524 to 555 feet) and Core 6, from 168.9 to 178.1 meters (555 to 587 feet), the latter including the lower part of the *Globorotalia kugleri* Zone of Bolli (1957c). The flora from this core is similar to that mentioned above except for the presence of *Coccolithus bisectus* which suggests probably the *Sphenolithus ciperoensis* Zone of Bramlette and Wilcoxon (1967).

STRATIGRAPHY

Hole 18 is the only hole in the Mid-Atlantic Ridge province that was not cored almost continuously, as the primary objective was to sample the sediment directly above the basement. For that reason, only four formations were sampled; they are in descending order:

3-18-1-1	Albatross Ooze	Foraminiferal nannofossil chalk oozes.
3-18-2-1	Endeavor Ooze	Marly nannofossil chalk oozes.
3-18-2-6	Fram Ooze	Nannofossil chalk oozes.
3-18-4-4	Grampus Ooze	Foraminiferal nannofossil chalk oozes.

Correlation with Sites 15 and 17 suggests that other formations such as the Blake and Challenger Oozes and possibly the Discovery Clay are also present, but in the uncored interval. The sediment sequence above the basement, 178 meters (584 feet) here, is thickest among all of the holes of the Mid-Atlantic Ridge province.

The cores from Hole 18 were split only in part because the cores were soupy, the lithology is relatively uniform, and time was short. However, practically all cores were sampled from the ends. Grain-size, carbonate content, clay minerals, and smear-slide data, in addition to the visual description of representative split sections, permit a presentation by the authors of an adequate report on the stratigraphy of the cored intervals.

The Quaternary Unit 3-18-1-1 consists of white foraminiferal nannofossil chalk oozes, readily identified as the Albatross Ooze. The oozes consist of 90 per cent nannofossils and 10 per cent foraminifera.

After a long uncored interval, nannofossil chalk oozes 57 meters (187 feet) thick were penetrated before the basalt basement was reached. These oozes were divided into three units. The top Unit 3-18-2-1 is a yellowish-brown marly chalk ooze, with only traces of foraminifera (sand-fraction 1 to 3 per cent), but appreciable amount of hematitic clays, so that the non-carbonate content ranges from 20 to 25 per cent. This unit can be identified as the Endeavor Ooze, having a lithological character somewhat intermediate between that found at Site 15 and Site 17. The middle Unit 3-18-2-6 is recognized on the basis of a decrease in non-carbonate impurities, which are commonly less than 15 per cent in those sediments. Foraminifera are present, but still rare so that the sand-fraction ranges from 3 to 5 per cent. These oozes are very pale brown to light yellowish-brown in color, somewhat darker than a typical Fram Ooze; otherwise, they are lithologically similar to their correlative at Site 17. The bottom Unit 3-18-4-4 was recognized on the basis of the relatively large foraminifera content. These very pale brown nannofossil chalk oozes are silt-sized sediments with 10 to 15 per cent sand-fraction. The authors correlated this foraminiferal unit with those at Sites 14, 15 and 17 as a part of the Grampus Unit, which represents in those three instances the first sediment above the basalt basement, although the age of this formation ranges from Eocene to Miocene.

A basalt section about 30 centimeters in length was retrieved from Core 3-17-7. The dark gray basalt is weathered a buff brown. A chilled glassy top can be observed. Coarsely crystalline calcareous sediments are enclosed in fractures which may represent recrystallized sediments entrapped in a basalt flow. No obvious contact metamorphic effect is observed, although the Grampus Ooze is very firm at the contact; whereas a meter above, the ooze was sufficiently soft to permit complete penetration by the penetrometer needle (penetrometer reading 25 in contrast to >350).

It is difficult to obtain reliable sedimentation rates for Site 18. On the one hand, neither the bottom contact of the Albatross nor the top contact of the Endeavor Ooze has been cored. On the other hand, the duration of geologic time represented by the Fram and Grampus Oozes could not be accurately estimated. Nevertheless, the average sedimentation rate for Lower Miocene is impressively rapid since more than 57 meters (187 feet) of oozes were deposited during some 7 million years, at a 0.8 cm/t.y. rate.

The stratigraphy of the cored intervals at Site 18 is summarized in Table 2.

PHYSICAL PROPERTIES

Natural Gamma Radiation

Natural gamma radiation emitted from the Albatross, Endeavor, Fram, and Grampus Oozes, at Site 18 ranged from zero to 700 counts, averaging about 200+ counts/7.6-centimeter core segment/1.25 minutes (Figures 2A and 3A-8A). The highest counts of 700 were obtained from Section 3-18-1-4, within the Albatross Ooze; however, this core section was not split or described. The radiation source is probably clay-type minerals. Intermediate gamma counts of 300 to 400 from Section 3-18-6-6 (Grampus Ooze) are related to a high density, firmer, baked claystone above the basalt. This sediment may contain gamma emitting potassium derived from the basalt.

Porosity, Wet-Bulk Density and Water Content

Porosities, water contents, and wet-bulk densities ranged from 38 per cent to 82(?) per cent, 30 per cent to 47 per cent, and 1.35(?) g/cc to 2.08 g/cc, with averages about 60 per cent, 36 per cent, and 1.70 g/cc, respectively (Figures 2A and 3A-8A). Averaged core porosities decreased (80-55 per cent) with increasing depth through the Albatross Ooze, Endeavor Ooze and Fram Ooze, with the Grampus Ooze having slightly lower porosities. In core Section 3-18-6-6, part of the Grampus Ooze, the firmer baked claystone is depicted in the GRAPE records as being more dense (2.08 g/cc, 38 per cent) than the overlying sediment (2.08 g/cc, 55 to 60 per cent). Porosity correlated inversely with averaged wet-bulk densities and sound velocities. As with all Leg 3 sites, these values may not represent *in situ* values because of coring disturbances.

Sediment Sound Velocity

Limits of the Site 18 sediment sound velocities were 1.49 to 1.64 km/sec, with a norm of about 1.55 km/sec (Figures 2A and 3A-8A). Averaged sound velocities increased with increasing depth through the Albatross Ooze, Endeavor Ooze, Fram Ooze and the Grampus Ooze, and they were inversely correlated to averaged porosities and directly correlated to averaged wet-bulk densities. *In situ* values may not be represented by these measurements, even if corrected for temperature and pressure.

TABLE 2
Stratigraphy Site 18

Age	Cored Interval (m)	Formation Name	Probable Interval (m)	Probable Thickness (m)	Description
Pleistocene	0-9	Albatross Ooze 3-18-1-1	0-?	>9.0	White foraminiferal nannofossil chalk ooze, with 10 per cent foraminifera.
UNCORED INTERVAL OF 112 METERS					
Lower Miocene	121.0-128.5	Endeavor Ooze 3-18-2-1	?-128.5	>7.5	Yellow brown, marly nannofossil chalk oozes.
Lower Miocene	128.5-130.2 141.2-155.0	Fram Ooze 3-18-2-6	128.5-155.0	26.5	Light yellow brown and very pale brown nannofossil chalk oozes. < 2 per cent foraminifera.
Lower Miocene	155-178	Grampus Ooze 3-18-4-4	155-178	23.0	Foraminiferal nannofossil chalk oozes, very pale brown to light yellow brown, 10 per cent foraminifera.
?	178.0-178.4	Basalt 3-18-7-1	178.4-?	?	Basalt–weathered, with coarsely crystalline marble included in veins. Chill margins of dark glassy basalt around the veins.

Penetrometer

Penetrometer measurements at Site 18 extended from 34×10^{-1} millimeters to complete penetration (Figures 2A and 3A-8A). Penetration decreased near the sediment basalt contact in 3-18-6-6 (Grampus Ooze), where an increased wet-bulk density was observed. These data also had a crude inverse correlation with natural gamma radiation.

Interstitial Water Salinity

Interstitial water samples were not collected at Site 18.

Thermal Conductivity

At Site 18, values of thermal conductivity ranged from about 2.5 to 3.1×10^{-3} cal/°C cm sec. The lowest value was measured in a surface core. Low values were measured between the surface core and a depth of about 125 m. in the hole because of a lack of core. Values between 125 and 165 m. were relatively constant at about 3.0×10^{-3} cal/°C cm sec. The highest value was measured at the bottom of the hole at about 173 m. depth.

REFERENCES

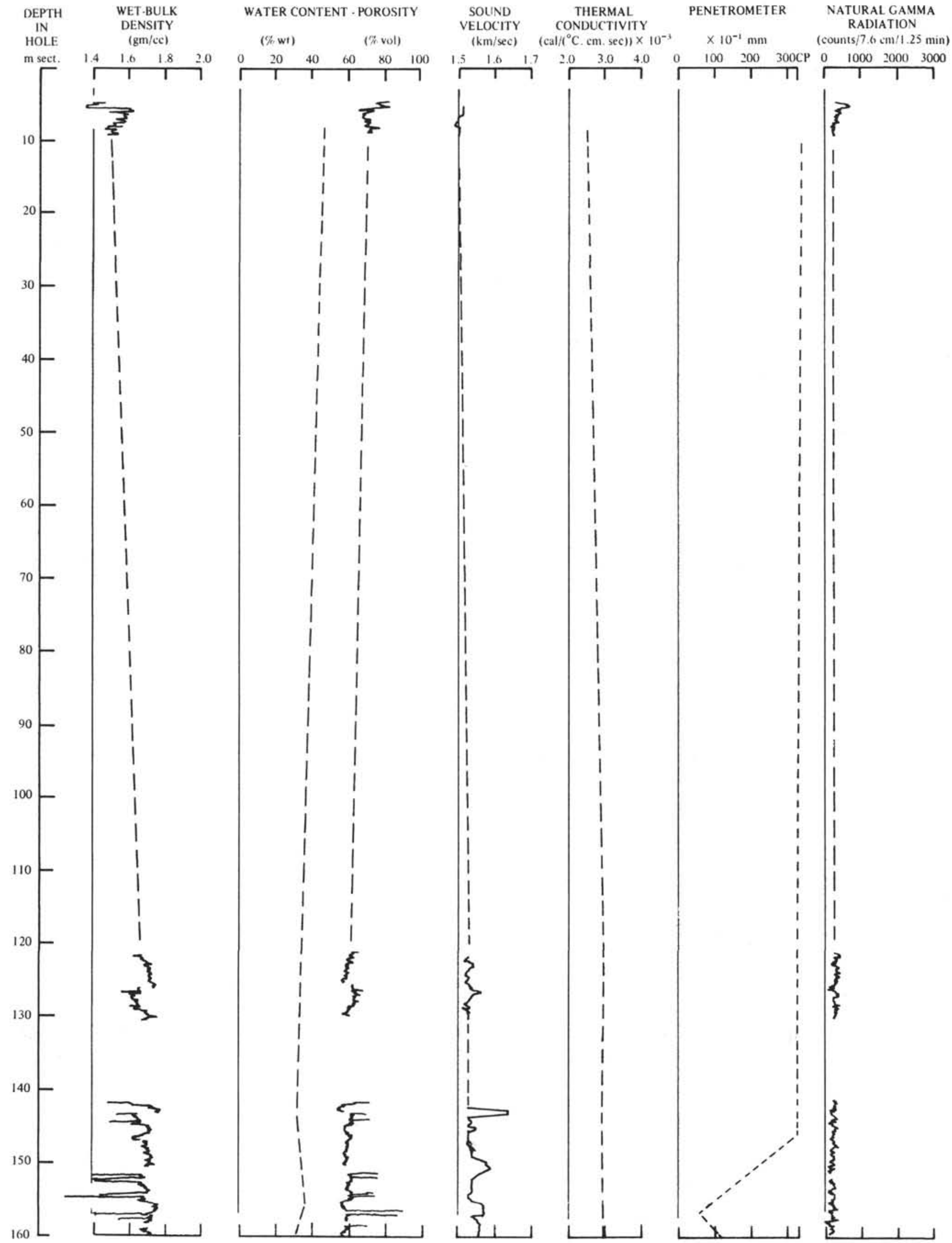
See consolidated list at the end of Chapter 13.

THE CORES RECOVERED FROM SITE 18

The following pages present a graphic summary of the results of drilling and coring at Site 18.

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 18. 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.

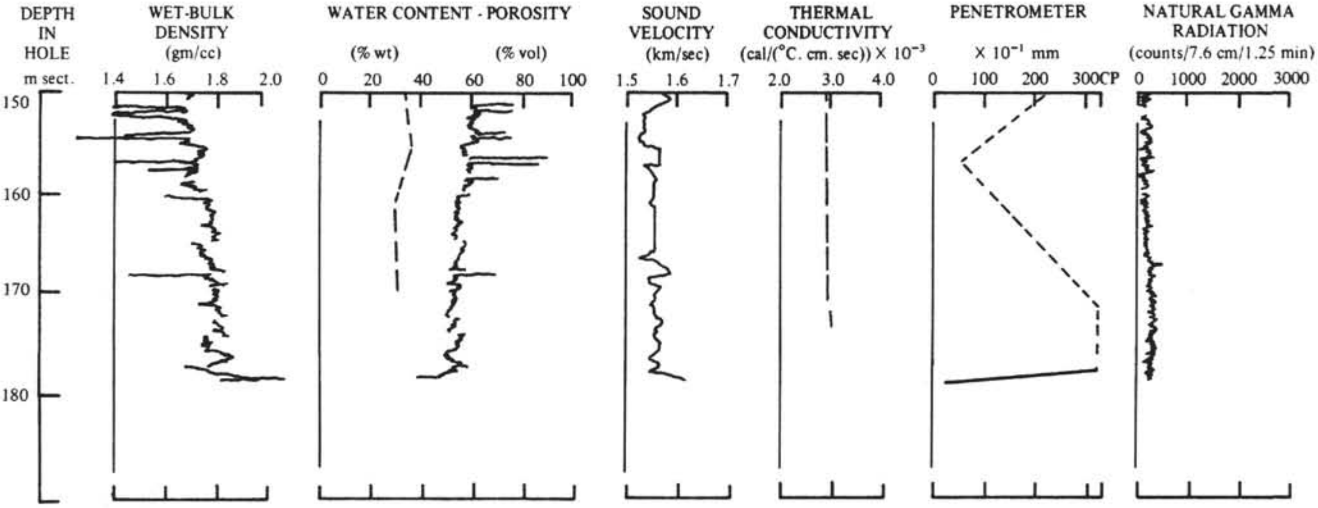


*"0" = laboratory atmospheric background count of 1550.

Figure 2A. *Summary of the Physical Properties of the cores recovered from Hole 18.*

DEPTH	CR.	CI.	FORMATION	LITHOLOGY	AGE
0	1		Albatross Ooze 3-18/1/1	White foraminiferal nannofossil chalk oozes.	PLEISTOCENE
50					
			Long uncored interval (Blake, Challenger, and Discovery formations may be present)		?
100					
	2		Endeavor Ooze 3-18/2/1	Yellow brown, marly nannofossil chalk oozes.	LOWER MIOCENE Burdigalian
	3		Fram Ooze 3-18/2/6	Light yellow and very pale brown nannofossil chalk oozes. Foraminifera <2%.	LOWER MIOCENE Aquitanian
150	4		Grampus Ooze	(see next page)	

Figure 2B. *Summary of the cores from Hole 18. (Depth in meters below sea bed; C.R. = core recovered; C.I. = cored interval.)*



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

Figure 2A. *(Continued)*

DEPTH	CR.	CI.	FORMATION	LITHOLOGY	AGE
150 4					
5 6			Grampus Ooze 3-18/4/4	Foraminiferal nannofossil chalk oozes, very pale brown to light yellow brown. 10% Foraminifera.	LOWER MIOCENE Aquitanian
7			Basement 3-18/7/1	Basalt	

Figure 2B. *(Continued)*

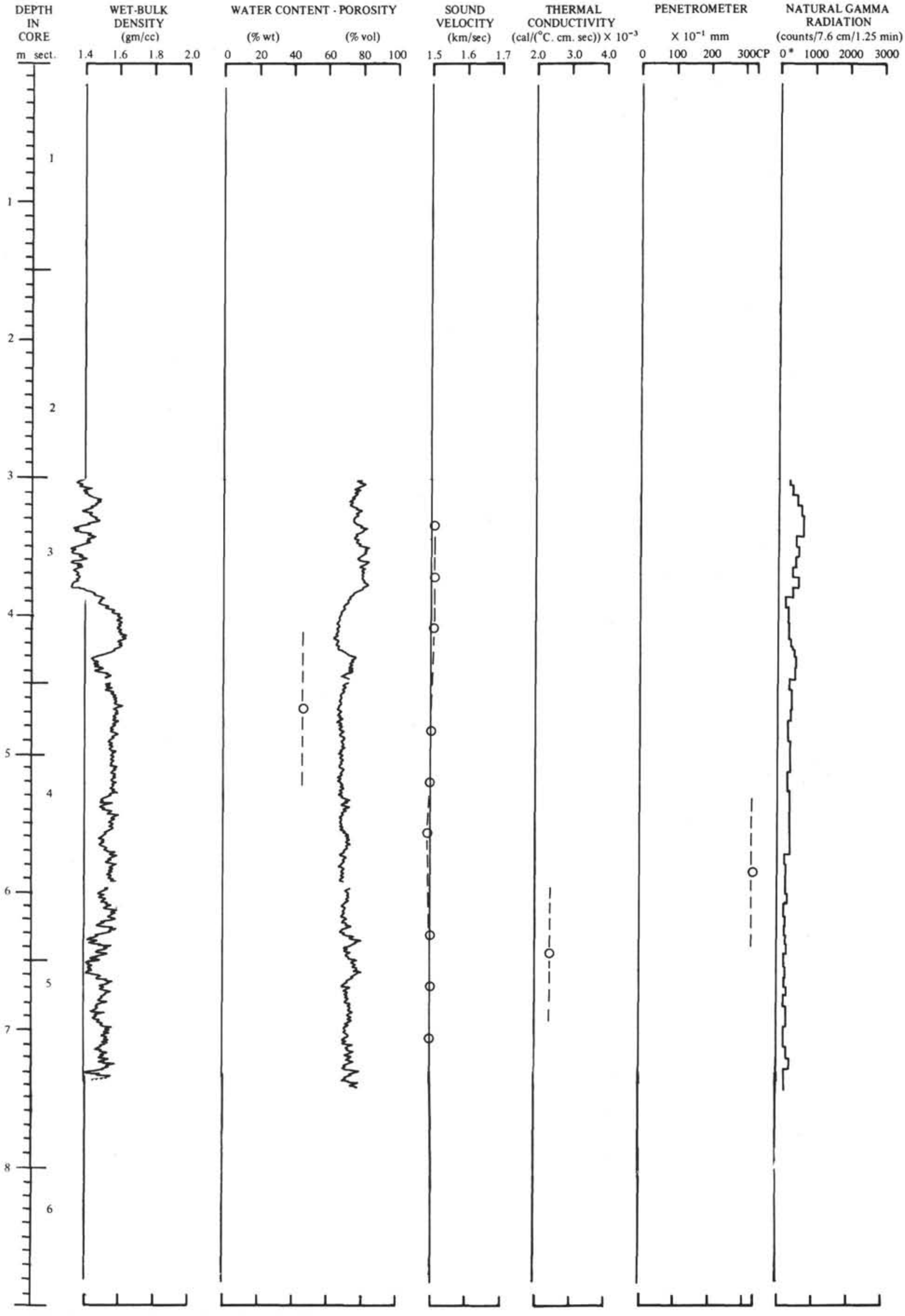
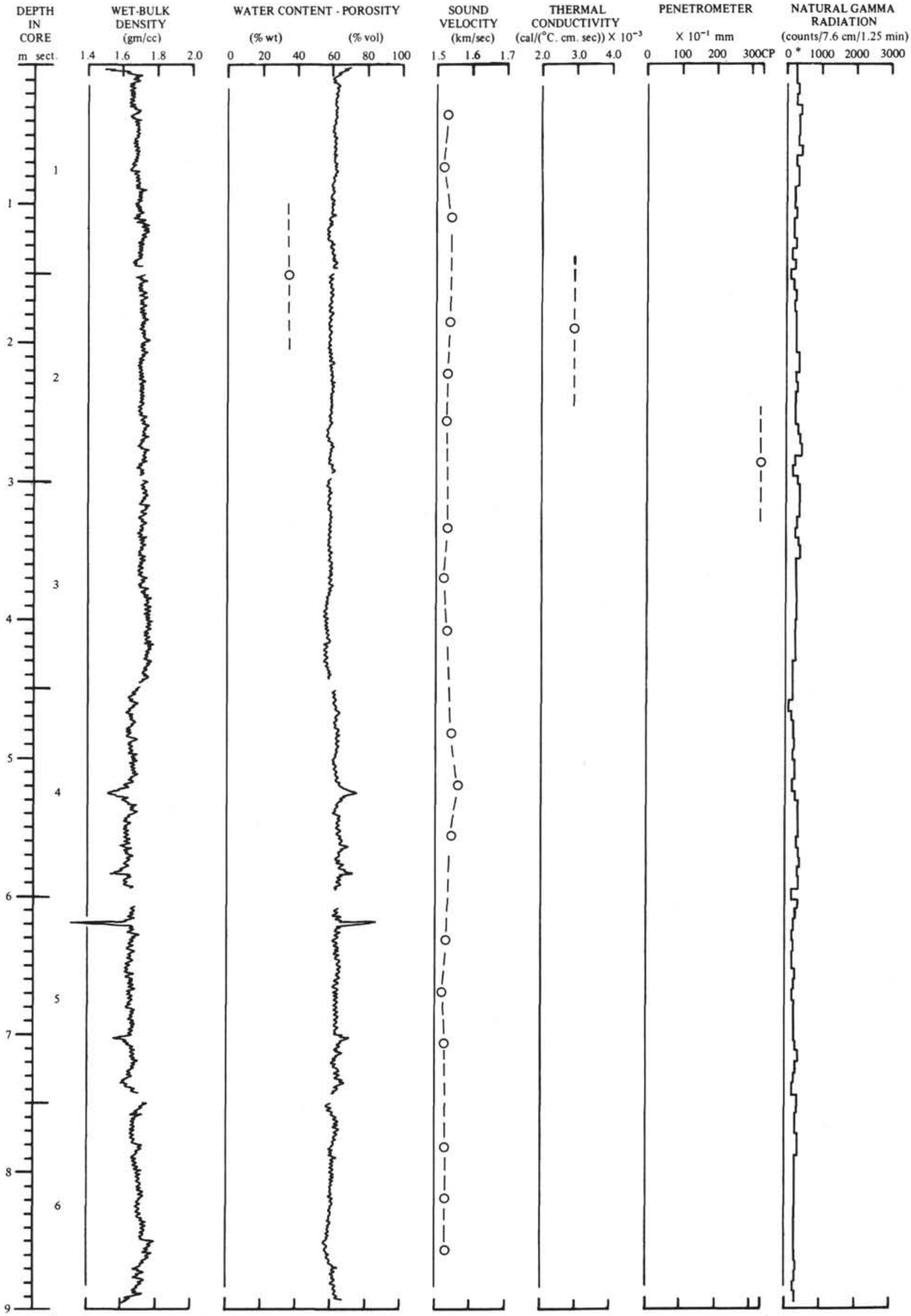


Figure 3A. *Physical properties of Core 1, Hole 18.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
PLEISTOCENE		1	1		N	Core disturbed	Calcareous nannoplankton: *Gephyrocapsa oceanica, Ceratolithus cristatus, Helicopontosphaera kamptneri, Cyclococcolithus leptoporus, Coccolithus pelagicus.*
		2	2		OPENED		
		3, 4	3		NOT	ALBATROSS OOZE White (10YR8/2), foram-nannofossil chalk ooze. 10% foram	
		5	4		CORE		
		6, 7	5		R FN		Flora similar to above. Radiolaria: *Dictyophimus crisiae* Ehrenberg, *Penartus tetrathalamus* Haeckel, *Lamprocyclas maritalis polypora* Nigrini, *Axoprunum stauraxonium* Haeckel. Planktonic foraminifera: *Globorotalia inflata, G. truncatulinoides, G. crassaformis, G. tumida* (L), *G. menardii* (L), ***Pulleniatina obliquiloculata*** (L), *Candeina nitida, Globigerinoides conglobatus, G. ruber, G. gomitulus.* Core catcher: Flora and fauna similar to above.
		8	6				

Figure 3B. *Core 1, Hole 18.*



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

Figure 4A. *Physical properties of Core 2, Hole 18.*

AGE (STAGE)	ZONE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER MIOCENE (BURDIGALIAN)	* ; *Sphenolithus belemnos* Zone	0–1	1		FN; OPENED AT END	(Core disturbed) ENDEAVOR OOZE Yellow brown 10YR5.5/6 nannofossil chalk ooze. 3% foram 3% hematite	Planktonic foraminifera: *Globoquadrina altispira, G. dehiscens G. obesa, Globorotalia mayeri, G. peripheroronda, G. zealandica, Globigerinita stainforthi.* Calcareous nannoplankton: *Cyclococcolithus neogammation, Sphenolithus belmnos, Orthorhadus serratus, Discoaster deflandrei.*
LOWER MIOCENE (AQUITANIAN)	*Globigerinita stainforthi* Zone; *Sphenolithus belemnos* Zone	2	2		N; FN		Sample 3-5 cm: Flora similar to above. Sample 100-102 cm: Flora similar to above with *Discoaster druggi.* Planktonic foraminifera: *Globigerinita dissimilis, G, stainforthi, Globoquadrina obesa, Globorotalia mayeri, G. peripheroronda, Sphaeroidinellopsis seminulina.*
		3–4	3		OPENED AT END; FN		Flora and fauna similar to above.
		5	4		OPENED AT END; FN		Flora similar to above.
		6–7	5		OPENED AT END; FN		Flora similar to above with *Sphenolithus belemnos?* Fauna similar to above with *Globigerinita unicava.*
	**	8	6		OPENED AT END	FRAM OOZE Light yellow brown (10YR6/4). 1% foram 3% hematite	Core catcher: Planktonic foraminifera: *Globigerinita dissimilis, G. stainforthi, Globoquadrina dehiscens, Globorotalia mayeri, G. siakensis, Globigerinoides subquadratus.*

* This interval represents the *Globigerinitella insueta/ Globigerinoides trilobus* Zone.

**This interval represents the *Triquetrorhabdulus carinatus* Zone.

Figure 4B. *Core 2, Hole 18.*

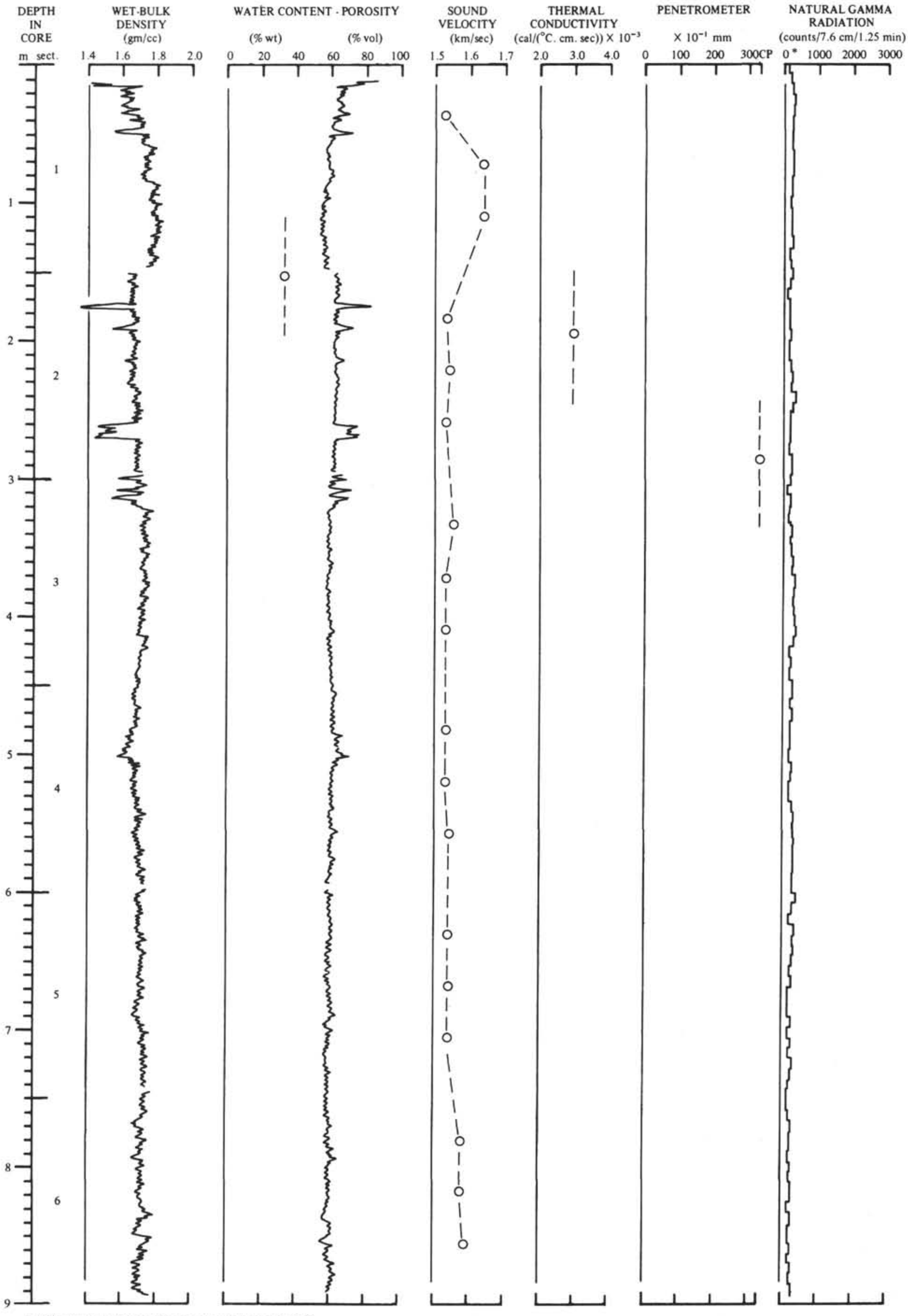
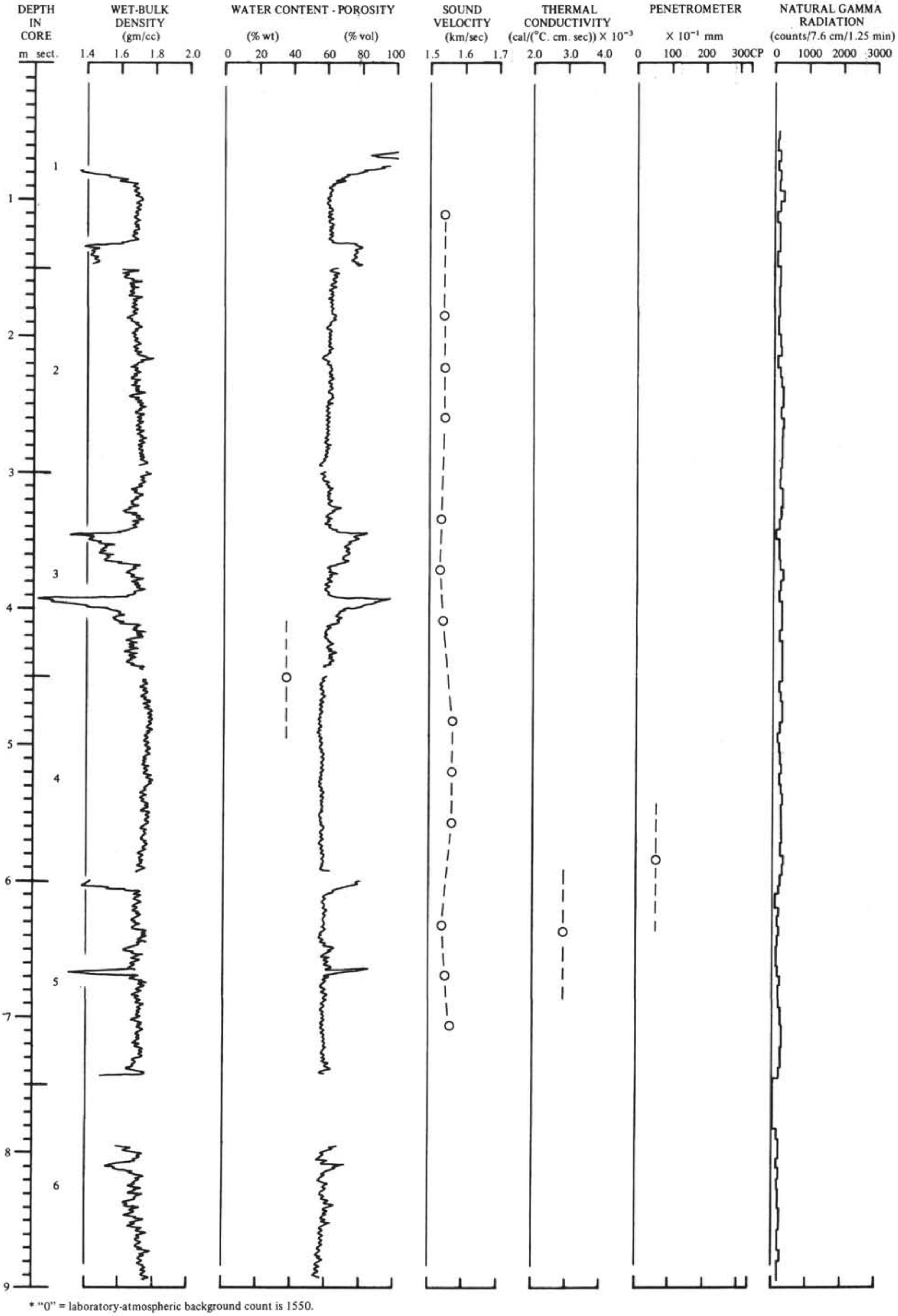


Figure 5A. *Physical properties of Core 3, Hole 18.*

AGE (STAGE)	ZONE		DEPTH (METERS)	SECTION NO.	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER MIOCENE (AQUITANIAN)	*Globigerinita dissimilis* Zone	*Triquetrorhabdulus carinatus* Zone	1	1	N		Planktonic foraminifera: *Globigerinita unicava*, *G. dissimilis*, *G. stainforthi*, *Globoquadrina dehiscens*, *Sphaeroidinellopsis seminulina*, *Cassigerinella chipolensis* (Rare). Calcareous nannoplankton: *Coccolithus* aff. *bisectus*, *C. pelagicus*, *Sphenolithus belemnos?*, *Cyclococcolithus neogammation*, *Discoaster deflandrei*.
			2	2	FN		
	Globorotalia kugleri Zone		3, 4	3		FRAM OOZE Light yellow brown (10YR6/4) nannofossil chalk ooze. 3% hematite 1% foram	Flora similar to above. Fauna similar to above. First appearance of *Globorotalia kugleri* (Very rare).
			5	4	FN		Flora and fauna similar to above.
			6, 7	5	FN		
			8	6	FN		Flora similar to above. Planktonic foraminifera: *Globorotalia kugleri*, *G. opima nana*, *G. nana pseudocontinuosa*, *G. siakensis*, *G. postcretacea*, *Globigerinita dissimilis*, *G. stainforthi*, *Globigerina sellii*, *Globoquadrina dehiscens*. Core catcher: Flora and fauna similar to above.

Figure 5B. *Core 3, Hole 18.*

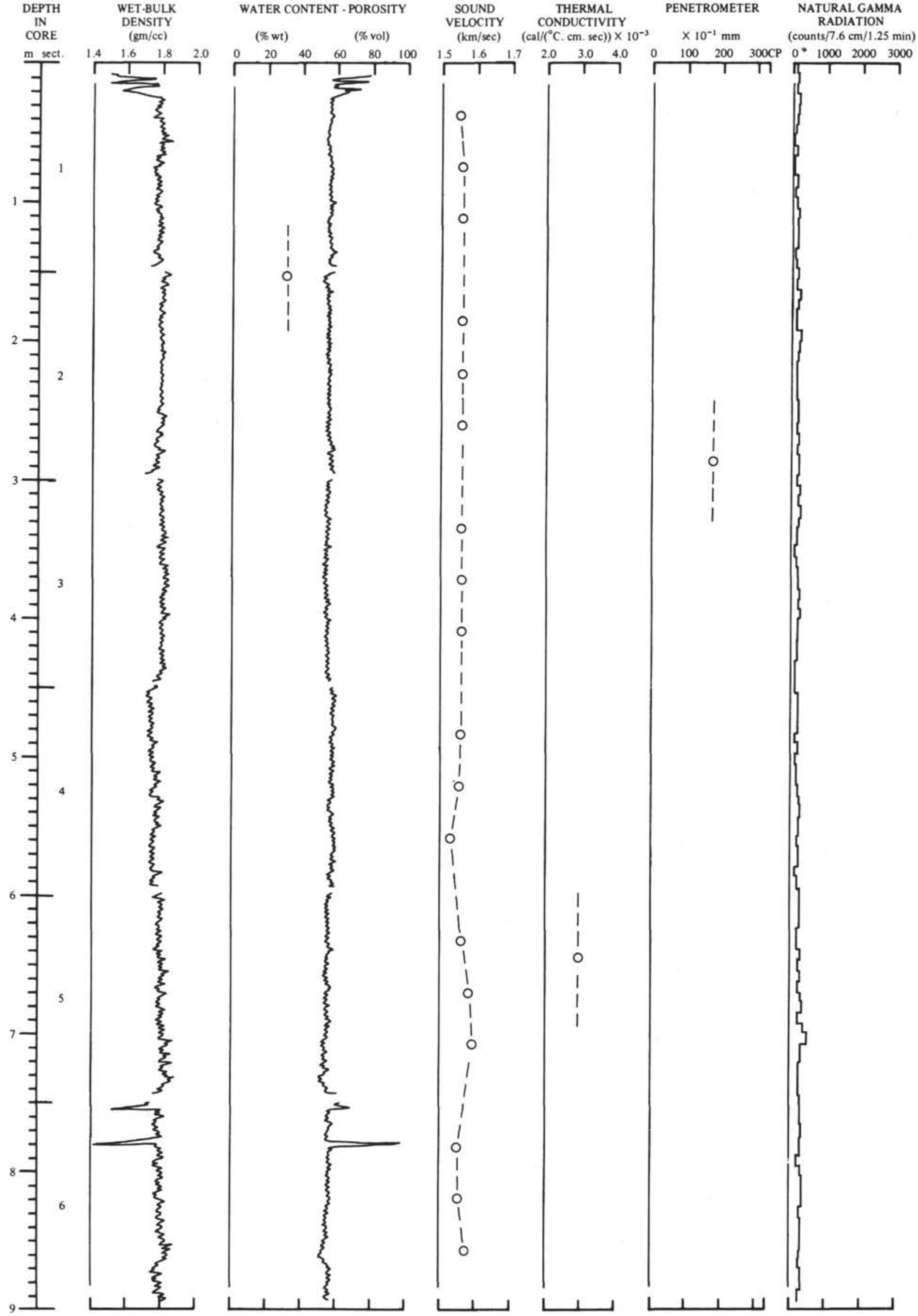


* "0" = laboratory-atmospheric background count is 1550.

Figure 6A. *Physical properties of Core 4, Hole 18.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER MIOCENE (AQUITANIAN)	*Globorotalia kugleri* Zone; *Triquetrorhabdulus carinatus* Zone	1	1	OPENED AT END		
		2	2	FN; OPENED AT END		Planktonic foraminifera: *Globorotalia kugleri, Globorotalia opima nana, G. nana pseudocontinuosa, G. siakensis, G. postcretacea, Globigerinita dissimilis, G. stainforthi, Globigerina sellii, Globoquadrina dehiscens.* Calcareous nannoplankton: *Cyclococcolithus neogammation, Coccolithus* aff. *bisectus, C. pelagicus, Sphenolithus belemnos?, Discoaster deflandrei.*
		3, 4	3	N; OPENED AT END		Flora similar to above.
		5	4	FN	FRAM OOZE Very pale brown, (10YR7/3) nannofossil chalk ooze. Tr. foram	Planktonic foraminifera: *Globorotalia kugleri, Globigerinoides altiapertura, Globigerina praebulloides G. woodi, Globigerinita dissimilis, G. stainforthi, Globoquadrina dehiscens.* Calcareous nannoplankton: *Cyclococcolithus neogammation, Coccolithus* aff. *bisectus, C. pelagicus, Discoaster deflandrei.*
		6, 7	5	OPENED AT END; N		Flora similar to above. Core catcher: Flora similar to above. Planktonic foraminifera: *Globorotalia kugleri, Globigerina woodi, Globigerinoides primordius, Globigerinita dissimilis, G. unicava.*
		8	6			

Figure 6B. *Core 4, Hole 18.*

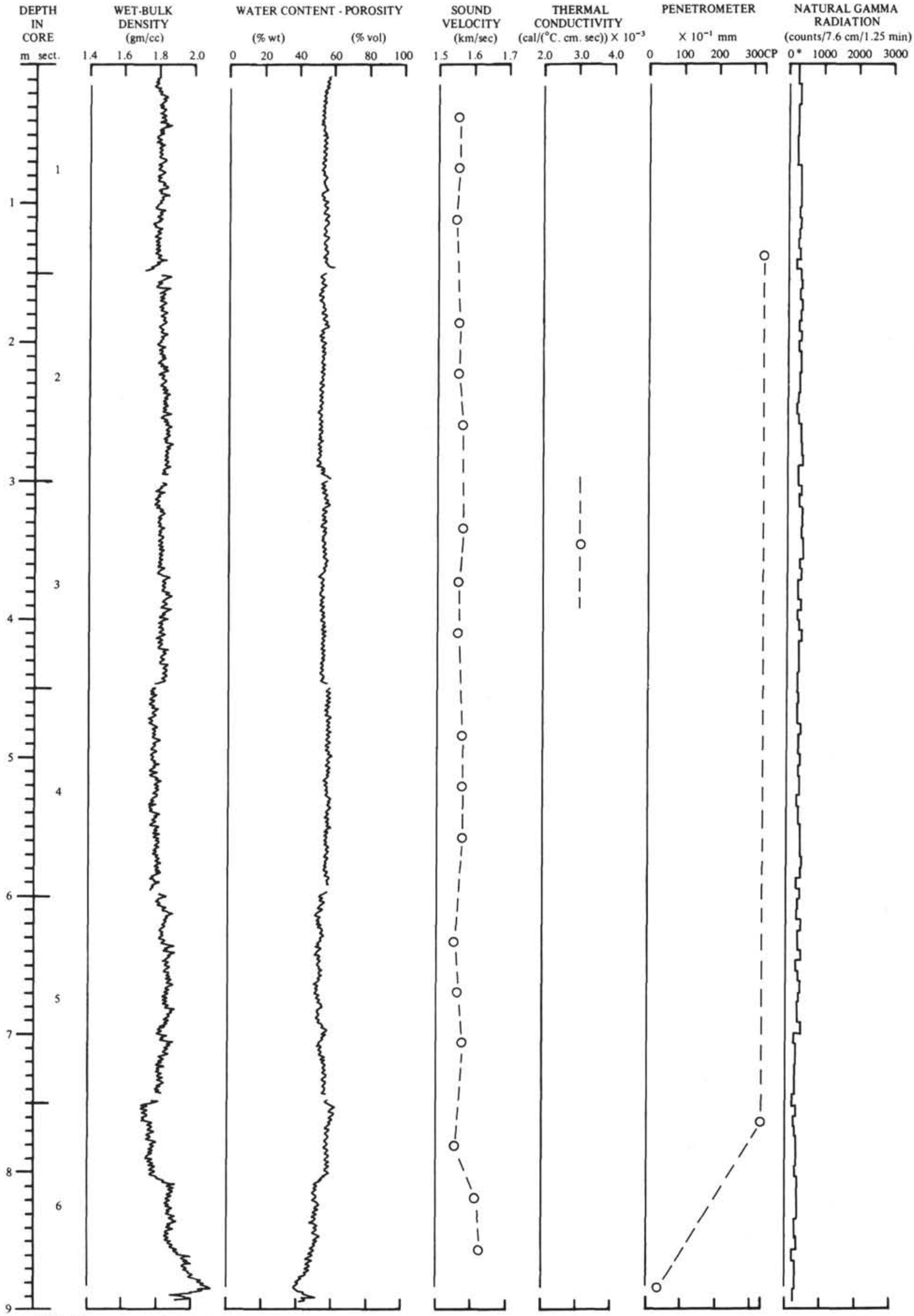


* "0" = laboratory-atmospheric background count is 1550.

Figure 7A. *Physical properties of Core 5, Hole 18.*

AGE (STAGE)	ZONE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
LOWER MIOCENE (AQUITANIAN)	*Globorotalia kugleri* Zone; *Triquetrorhabdulus carinatus* Zone	1	1		OPENED AT END; FN	FRAM OOZE Very pale brown,(10YR7/3), nannofossil chalk ooze. Tr. foram	Planktonic foraminifera: *Globigerinoides primordius, Globoquadrina dehiscens, Globorotalia opima nana, G. kugleri, Globigerinita stainforthi, G. dissimilis.* Calcareous nannoplankton: *Cyclococcolithus neogammation, Coccolithus* aff. *bisectus, C. pelagicus, C. eopelagicus, Discoaster deflandrei.*
		2, 3	2				
		4	3		OPENED AT END; FN		Flora and fauna similar to above.
		5, 6	4				
		7	5		OPENED AT END; N		Flora similar to above.
		8	6		OPENED AT END; F		Fauna similar to above. Core catcher: Flora similar to above. Planktonic foraminifera: *Globorotalia kugleri, Globoquadrina dehiscens, G. rohri, G. venezuelana, Globigerina woodi, Globigerinoides primordius, Globigerinita dissimilis, G. unicava.*

Figure 7B. *Core 5, Hole 18.*



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

Figure 8A. *Physical properties of Core 6, Hole 18.*

AGE (STAGE)	ZONE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
UPPER OLIGOCENE (CHATTIAN-BORMIDIAN)	*Globorotalia kugleri* Zone; Probably *Sphenolithus ciperoensis* Zone	1	1		N; F		Calcareous nannoplankton: *Coccolithus bisectus, C.* aff. *bisectus, C. pelagicus, C. eopelagicus, Cyclococcolithus neogammation, Discoaster deflandrei* Planktonic foraminifera: *Globorotalia kugleri, G. peripheroronda, G. mayeri, Globoquadrina rohri, G. praedehiscens, Globigerina praebulloides, G. occlusa, Globigerinita dissimilis.*
		2	2		OPENED AT END; FN		Flora and fauna similar to above.
		3, 4	3		OPENED AT END; N	FRAM OOZE Very pale brown (10YR7/3) nannofossil chalk ooze. Tr. foram	Flora similar to above. Planktonic foraminifera: *Globorotalia kugleri, G. opima nana, G. postcretacea, Globigerinita dissimilis, Globigerinia corpulenta, G. sellii, Globoquadrina rohri, G. venezuelana.*
		5	4		OPENED AT END; N		Flora and fauna similar to above.
		6, 7	5				
		8	6		OPENED AT END; FN	Bottom of Section 6 is much firmer than top - may be related to emplacement of basalt immediatly below.	Flora similar to above. Planktonic foraminifera: *Globortalia kugleri, G. opima nana, G. postcretacea, Globigerina occlusa, G. yeguaensis, Globoquadrina dehiscens, Globigerinita dissimilis.* Core catcher: Flora and fauna similar to above.

Figure 8B. *Core 6, Hole 18.*

AGE	STAGE	DEPTH (METERS)	SECTION NO.	LITHOLOGY	SAMPLE INTERVAL	LITHOLOGY	DIAGNOSTIC FOSSILS
		1	1	EMPTY		Basement Weathered, pale olive (5Y6/3) aphanitic basalt with fractures filled by metamorphosed calcareous sediments (marble). Black, glassy, chilled margins around these zones.	
		2	2				
		3 4	3				
		5	4				
		6 7	5				
		8	6				

Figure 9. *Core 7, Hole 18.*

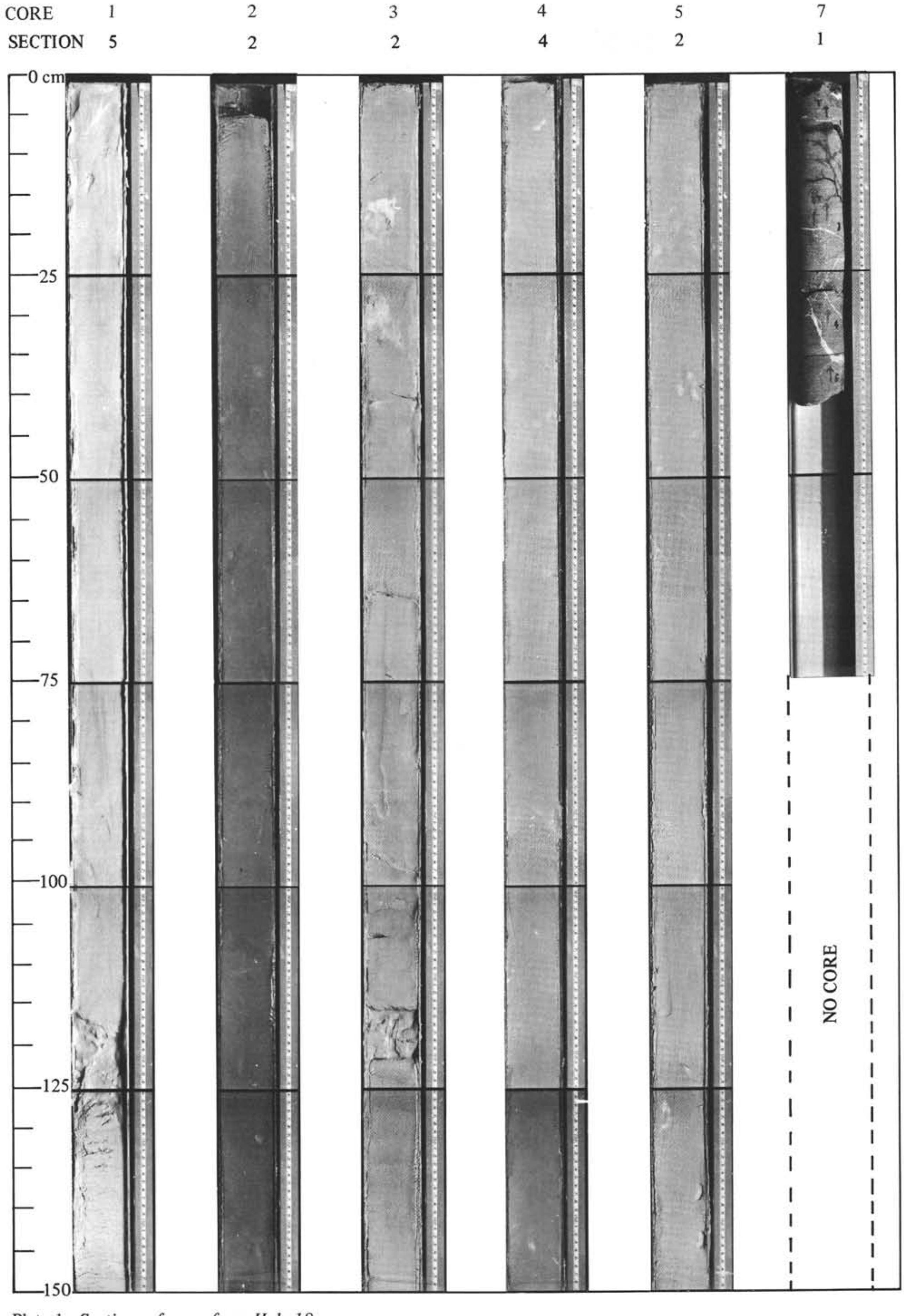


Plate 1. *Sections of cores from Hole 18.*

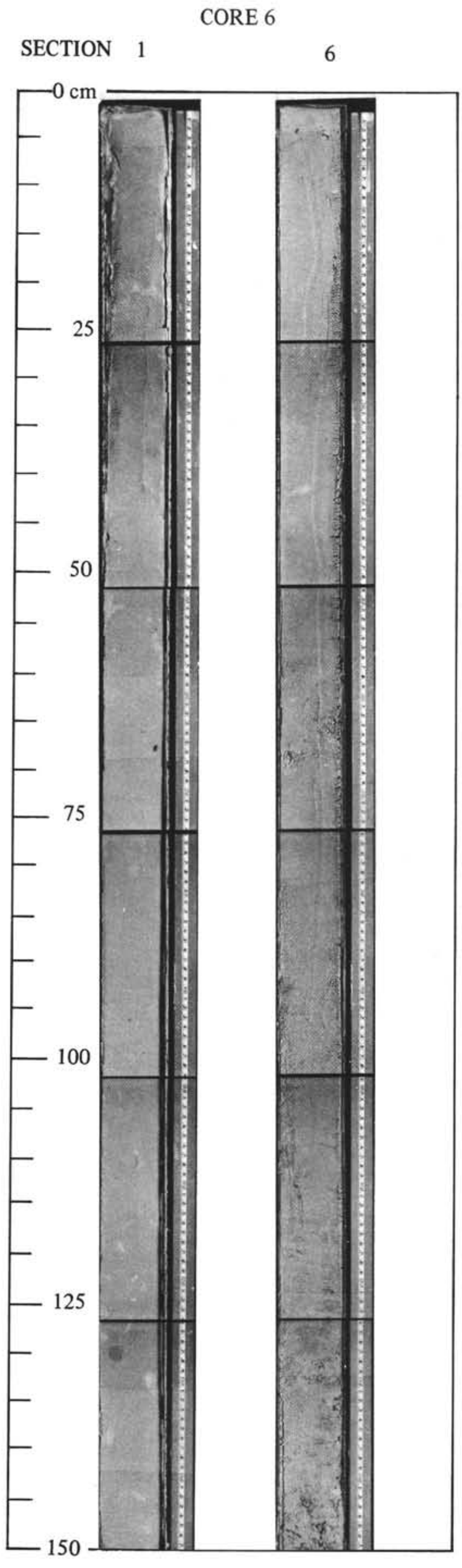


Plate 2. *Sections of cores from Hole 18.*