7. SITE 176

The Shipboard Scientific Party[1]

ABSTRACT

Glomar Challenger's dynamic positioning system was tested in 193 meters of water on the outer continental shelf off Oregon. After 41 meters of continuous coring, the bottom-hole assembly parted when the vessel made a lateral excursion of 15 meters from the hole. Pleistocene greenish gray clayey silt (0-41 m) with abundant coarse detrital debris overlies a Pliocene olive gray fissile shale (recovered only in the core catcher) which has been uplifted at least 500 meters above the original site of deposition. Shallow-water megafossils and the angular unconformity which separates the two lithologic units indicate a time of erosion when the Pliocene unit was near sea level. The outer shelf has since subsided more than 100 meters with subsequent deposition of late Pleistocene sediments.

SITE SUMMARY

Date Occupied: 21-22 June 1971.

Position (Satellite):
Latitude: 45°56.0′N;
Longitude: 124°37.0′W.

Number of Holes: One

Water Depth: 193 meters.

Penetration: 41 meters below sea floor.

Number of Cores: Five

Total Core Recovered: 41 meters, 100%.

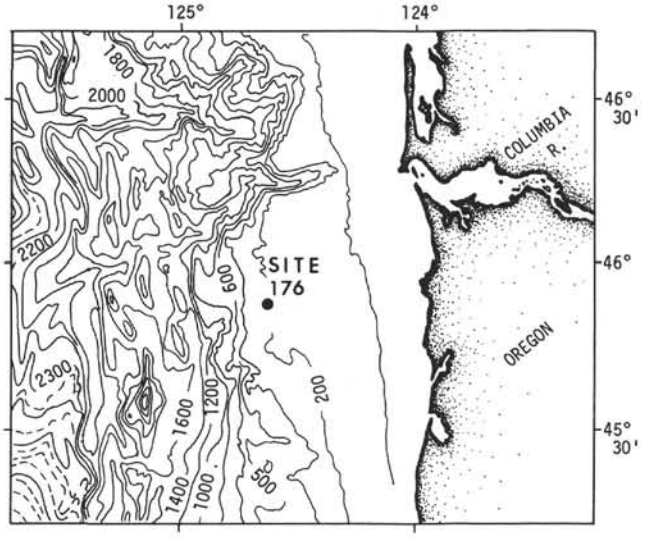
Age of Oldest Sediment: Pliocene.

Acoustic Basement: None.

BACKGROUND AND OBJECTIVES

Site Description

Site 176 was a new site that was selected while *Challenger* was drilling off the Oregon coast. Just prior to the departure on Leg 18 from Honolulu, the Deep Sea Drilling Project expressed interest in drilling a hole in shallow water to test the dynamic positioning system of *Challenger* for future drilling in shallow seas. It was decided that if the weather was good, an attempt should be made to drill a hole on the outer edge of the northern Oregon continental shelf. Continuous seismic records made in this area by Oregon State University (Kulm et al., this volume) were brought aboard *Challenger* during the rendezvous with Oregon State's research vessel, *Yaquina*, on 17 June, 1971.



The location of the site was selected so that penetration of the sedimentary column would not exceed 300 feet, according to the guidelines established by the U. S. Department of Interior for shallow-water drilling, and so that a scientific objective could be accomplished.

Site 176 is located at 45°56.0′N, 124°37.0′W, or about 1 to 2 km immediately west of Nehalem Banks southwest of the Columbia River (Figures 1 and 2). The water depth is 193 meters. The Banks are a series of uplifted anticlinal and synclinal folds that have a surface topographic expression. Reflection profiles show that some folds underlying the Banks have been eroded and are covered unconformably by younger sediments of varying thickness (Figure 3). Faunal studies of dart cores taken in this area (Fowler and Kulm,

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1971; Kulm and Fowler, 1971) show that these younger deposits are Pleistocene in age and that the truncated older deposits may be Pliocene. This is the youngest angular unconformity on the Oregon continental shelf. Dart coring of the exposed Banks in conjunction with reflection profiling indicate such an unconformity exists, but it is impossible to determine a more precise age of the unconformity with this method.

Site Objectives

The prime technical objective of Site 176 was to test the dynamic positioning system of *Challenger* in a water depth of less than 300 meters for future use in shallow seas. In shallow water, the drill string is not as flexible as it is in deeper water due to the short coupling between the bottom and the vessel. If large lateral excursions occur, the drill string will be twisted off at the sea floor.

While testing the system, we wanted to confirm a Plio-Pleistocene date on a widespread angular unconformity on the Oregon continental shelf and relate it to the tectonic framework of the continental shelf and continental slope and adjacent Gorda-Juan de Fuca Plate. For example, it is important to determine if the tectonic events discussed in Sites 174 and 175 are synchronous with those on the continental shelf and therefore linked to a broad regional tectonic scheme. A continuously cored hole through the younger sediments into the older underlying deposits would provide a great deal of information about the regional tectonic picture of the shelf. In addition, the several transgressions and regressions of the sea during the Pleistocene are recorded in the deposits above the unconformity and might be studied in this hole.

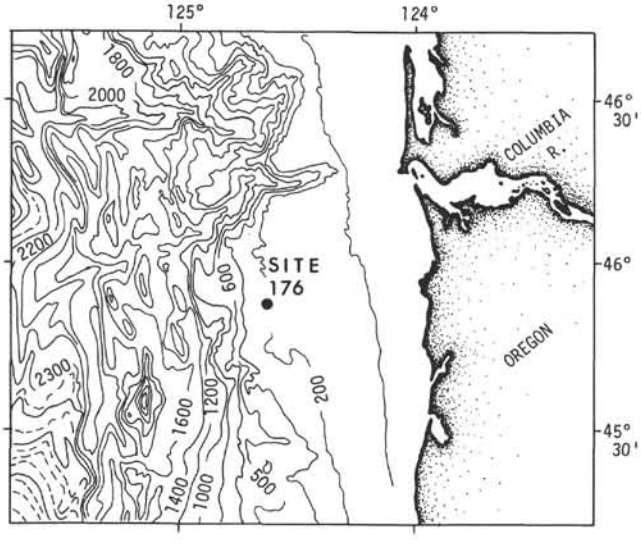


Figure 1. *Bathymetry in the vicinity of Site 176 (Mammerickx and Taylor, 1971). Contours in meters.*

LITHOLOGIC SUMMARY

General Statement

Site 176 was continuously cored to a depth of 41 meters below the sea floor. Cores 1 through 4 were fairly firm but Core 5 may have a considerable amount of downhole debris. The core catcher of Core 5 was plugged by a hard fissile shale of Pliocene age. A hiatus apparently occurs in the depositional record between the late Pleistocene sediments of Unit 1 and the Pliocene shale of Unit 2.

Lithologic Units

Unit 1 (0-41 m; Cores 1-5)

The dominant lithology of this unit is a dark greenish gray soft to firm carbonate-bearing clayey silt. The amount of carbonate varies from a few percent to 10 or 15 percent. A high carbonate content is generally indicated by relatively light shades of greenish gray to olive gray. Smear slides show that the carbonate occurs as angular silt- and clay-sized grains. Biogenous constituents are rare. Only one smear slide had over 2 percent diatoms.

The clayey silt of Cores 2 and 5 contains appreciable amounts of sand-sized material. Remains of glass sponges were found imbedded at 12 meters, a snail at 2 meters, a clam at 28 meters, and numerous mollusk shell fragments and whole shells occur in Core 5. Wood fragments 2 cm long were cored at 5 meters and other bits of plant material were observed in the sediments under the microscope. Angular fragments of hard, dark shale and lumps of sand appear to have been deposited as clastic fragments in the mud along with the shells and wood. Except where included in fragments of hard conglomerate, the shells are scattered vertically through the clayey silt rather than in horizontal shell-rich beds.

Glauconite sands were found at 22 meters, 28 meters, and scattered as inclusions in Core 5 where they are

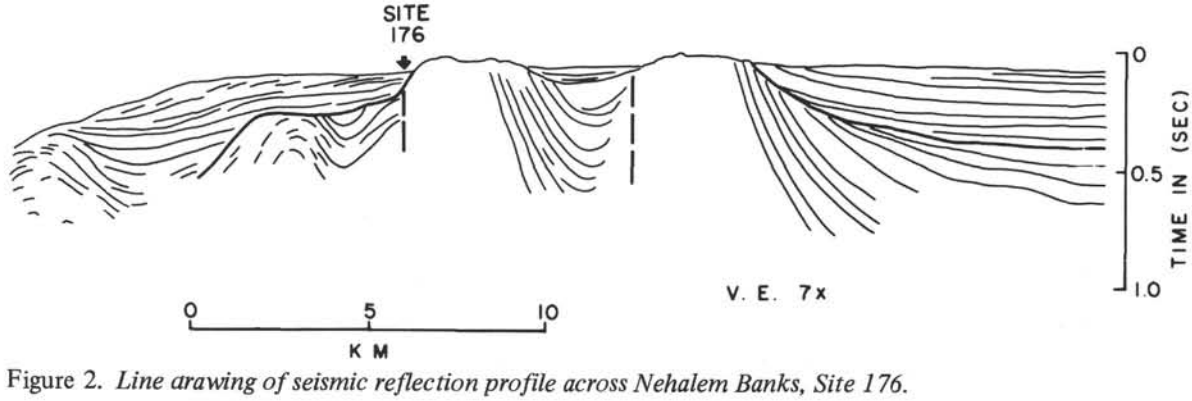


Figure 2. *Line drawing of seismic reflection profile across Nehalem Banks, Site 176.*

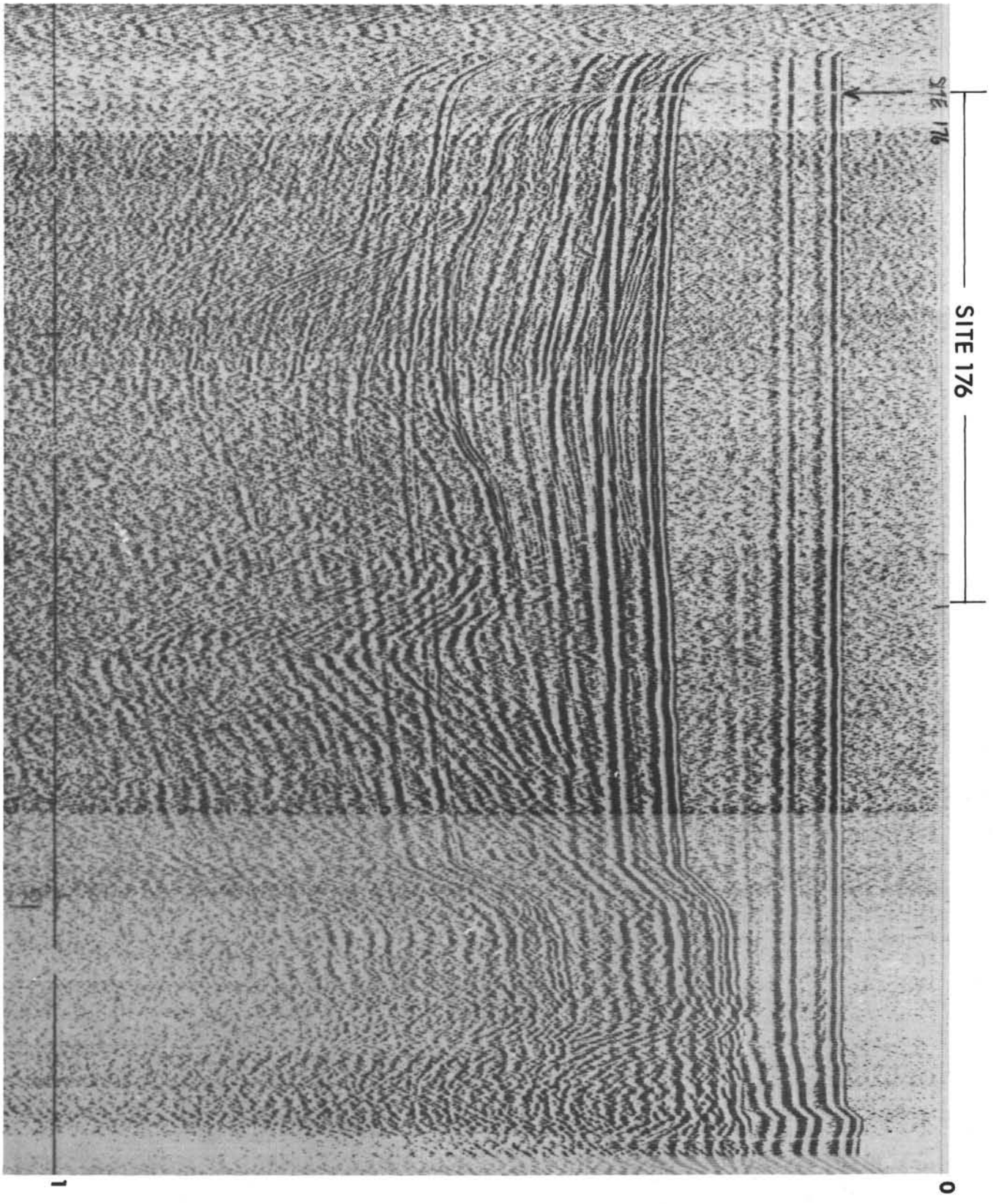


Figure 3. *Seismic reflection profile at Site 176, western flank of Nehalem Banks (from* Glomar Challenger*).*

probably downhole debris resulting from drilling disturbance. The glauconite is a light to medium-dark green and occurs as typical rounded, sand-sized grains in zones a centimeter or two thick; it imparts a greenish cast to the mud where it is smeared out along the core. Another distinct sediment is a 2-cm-thick bed of well-sorted angular coarse silt found near the glauconite at 28 meters and about a meter above the only sharp color and compositional break in the mud.

In Core 5, chips of hard, fine-grained limestone and conglomerate are included in a very disturbed section; they are similar to the occasional 2- to 3-cm, hard carbonate nodules found farther up the hole. The drilling record made at the site does not show any evidence of the thickness of continuity of the hard beds. However, the lithology suggests that some beds are only a lime-cemented phase of the clayey silt sequence and that they are similar to hard, cemented shelf-edge limestone described from other areas. On the basis of very slow penetration at 33 meters and numerous hard conglomerate chips just below, we postulate that there is a relatively thick, hard calcareous bed at 33 meters.

Unit 2 (41 m; Core 5 CC)

A small hard specimen of hard olive gray fissile shale was recovered from the core catcher of Core 5. This is the only sample obtained of Unit 2. This fissile shale is Pliocene in age and is believed to be the older unit below the angular unconformity.

PALEONTOLOGIC SUMMARY

Introduction

A sequence of 41 meters of glauconitic sandy muds and marls, typical of a Pleistocene shelf-edge environment, was continuously cored at Site 176. The core catcher of Core 5 (41 meters) retrieved a piece of hard gray fissile shale representing a Pliocene(?) rock unit underlying the thin blanket of Pleistocene shelf deposits. Abundant and generally well-preserved planktonic and benthonic foraminifera are present throughout these sediments along with common to rare diatoms. Calcareous nannoplankton and radiolaria are generally rare. All microfossils in Cores 1 to 4 (0 to 32 meters) are identified as Pleistocene in age. Foraminifera are common in the hard shale at the base of Core 5 (41 meters) and can be correlated with similar assemblages from adjacent surface sections which in turn are traditionally viewed as Pliocene in age. Pliocene radiolarians and calcareous nannoplankton in the lower portion of Core 5 may represent reworked elements from the underlying Pliocene shale unit. Composition of benthonic foraminiferal assemblages within the Pleistocene shelf sediments reflects several transgressive-regressive events across the shelf during this interval. The benthonic fauna in the Pliocene fissile shale indicates these sediments were originally deposited at bathyal depths and later uplifted to shelf depths during folding.

Calcareous Nannoplankton

Calcareous nannoplankton are sparse or absent in all but Core 5 (32-41 meters) at Site 176. The first and possibly the second core probably belong to the *Emiliania huxleyi* Zone of the Pleistocene. Cores 3 and 4 (15 to 32 meters) are essentially barren. Abundant *Coccolithus pelagicus* dominate the nannoflora of the lower portion of Core 5 (32 to 41 meters) but no *Gephyrocapsa* were observed. Therefore the lower portion of this core may be Pliocene in age. A new coccolith species *Coccolithus pliopelagicus* Wise occurs at 34 and 39 meters in Core 5.

Diatoms

Diatoms are abundant and well preserved in the uppermost portion of Hole 176 (0.6 meters; core 1) but exhibit decreasing abundance and loss of preservation beneath this interval. Samples from the base of Core 5 (41 meters) contain only a few frustules of thick-walled species. All of the floras encountered are classified as Pleistocene. The base of NPD Zone I is placed at 35 meters (176-5-2, 65-66 cm) and is correlated with a radiometric age of 0.26 m.y. (Donahue, 1970). The base of NPD Zone II is placed at 38.6 meters (176-5-5, 66-67 cm) and is tentatively correlated with a radiometric age of 0.92 m.y. (Donahue, 1970). Sediment recovered in the core catcher of Core 5 (41 meters) is assigned to NPD Zone III of the lower Pleistocene.

Planktonic Foraminifera

Abundant and well-preserved Pleistocene planktonic foraminifera are common in Cores 1 through 5 (0-41 meters). However, species diversity is extremely low as is typical of high-latitude shelf deposits in general. These assemblages are dominated by sinistral coiling populations of *Globigerina pachyderma* along with minor percentages of *G. bulloides* and *G. quinqueloba*.

The hard gray fissile shale underlying the thin blanket of relatively unconsolidated shelf deposits contains a planktonic fauna dominated by large dextral coiling specimens of *Globigerina pachyderma* similar to Pliocene populations of this species from many surface sections exposed along the Pacific Coast of North America. Nevertheless, no exclusively Pliocene planktonic species were found and significant dextral populations of *Globigerina pachyderma* do occur in the lower Pleistocene of this region as illustrated at Site 173. Thus, an early Pleistocene age for the fissile shale unit cannot be ruled out on the basis of the planktonic evidence.

Benthonic Foraminifera

Benthonic faunas characterized by abundances of *Cassidulina translucens, C. tortuosa,* and *C. californica,* typical of modern shelf-edge (100-200 meters) biofacies at this latitude, are present in Cores 1 through 5 (0-41 meters) at Site 176. Other significant members of this biofacies present in this interval include several species of *Trifarina* ("*Angulogerina*") and minor percentages of *Uvigerina peregrina* and *Epistominella pacifica*. Mixed elements from inner and outer neritic biofacies including *Nonionella miocenica stella* and *Buccella frigida* also occur within this interval. Indeed, the 41-meter-thick blanket of Pleistocene sediments appears to represent the relict remains from several transgressions and regressions of sea level across this portion of the shelf edge with the marl-rich sediment

containing shallow-water molluscan debris and neritic benthonic foraminifera indicative of low stands of sea level during glacial maxima.

Evidence of an unconformity at the base of the Pleistocene sequence of relict shelf sediments (base of Core 5) includes pholad-bored rocks and fragments of shallow-water mollusks immediately above the hard fissle shale encountered in the core catcher of Core 5 (41 meters).

A sparse benthonic fauna composed almost exclusively of well-developed *Uvigerina peregrina* and *Epistominella pacifica* and indicative of upper bathyal[2] depths (Bandy 1953;) is present in the hard fissle shale found in the core catcher of Core 5 (41 meters). The presence of this fauna in turn implies folding and uplift of these sediments to shelf depths prior to truncation and ultimate deposition of the Pleistocene shelf sediments. Moreover, the *Epistominella pacifica* biofacies found in this unit can be correlated with a similar biofacies common in portions of the Quinault Formation of Washington (Fowler, 1965; Rau, 1970) and the Wildcat series of northern California (Cushman, Stewart, and Steward 1930; Ogle, 1953) traditionally placed in the Pliocene on the basis of provincial benthonic foraminiferal and molluscan biostratigraphy (Natland, 1957; Faustman, 1963).

Radiolaria

Radiolaria are rare and moderately well preserved in Cores 1 through 5 (0-41 meters). The identified species indicate Quaternary assemblages, but species diagnostic of Pleistocene radiolarian zones are not present. Rare specimens of *Lamprocyclas heteroporos* in Core 5 suggest a Pliocene age for the lower part of this section; however, this species appears to range into the Pleistocene at Site 173.

Spores and Pollen

Palynomorphs occur rarely in cores sampled at Site 176. All pollen found was coniferous. No conclusions concerning climate or stratigraphy can be drawn from the low pollen frequencies and low generic diversity observed.

PHYSICAL PROPERTIES

Routine shipboard measurements were made on cores from Site 176 as in previous sites. Sonic velocities were not measured because of severe time limitations imposed by the half-hour interval between cores.

Two items of significance were noted at this site. First, low porosities and high densities indicate a relatively high percentage of clastic material. Secondly, the great variability in Core 5 reflects a great variability in sedimentary material at the presumed unconformable contact between Pleistocene and Pliocene units.

CORRELATION BETWEEN REFLECTION RECORDS AND THE STRATIGRAPHIC COLUMN

A single 20-in^3 air gun, fired at 2-second intervals, was used to make records at right angles to the strike of structures during the predrilling site survey. The air gun was towed as shallow as the rigging would permit and the ship's speed was kept at 8 knots. Nonetheless, the major objective, a shallow unconformity, was obscured in the strong multiple reflection events of the air gun's outgoing signal (Figure 3). It is difficult to resolve geologic phenomena in the first 100 meters of the records. No attempt was made to reduce the undesirable signal multiplicity on the postdrilling site survey and the unconformity is even more obscure.

The unconformity at the time of beacon drop (time of drop measured on the fathometer record) is estimated between 0.02 and 0.05 second below the sea floor on the predrilling site record. At 1.6 km/sec, this locates the unconformity at 32 to 80 meters, a reasonable depth when compared with the lithologic break at 41 meters. There is good evidence of a sharp unconformity in other parts of the seismic record.

SUMMARY AND CONCLUSIONS

Site 176 was selected to test the stationing capability of *Challenger's* dynamic positioning system in shallow water. The site is located on the outer edge of the northern Oregon continental shelf in 193 meters of water. Forty-one meters of continuous core was obtained before the bottom hole assembly twisted off. This happened when the positioning system allowed a lateral excursion of more than 15 meters from the hole.

The sedimentary section consists of two units separated by a Pliocene-Pleistocene angular unconformity. The upper unit (0-41 m) consists of Pleistocene greenish gray clayey silt which contains detrital carbonate. Thin beds of glauconitic sand and a fine-grained conglomeratic limestone layer also occur within this interval. The sediments in the lower part of this unit include pholad-bored rock fragments and shallow-water mollusk shells. The benthonic foraminiferal fauna is typical of a shelf-edge environment, although elements from the inner shelf are present in minor percentages. These outer shelf deposits may represent materials from the several transgressions and regressions during the Pleistocene, with the marl-rich sediment indicative of low stands of sea level during glacial maxima.

The lower unit (41 m) is a Pliocene olive gray fissile shale. It was recovered in the core catcher of Core 5. This shale unit contains a benthonic assemblage indicative of upper bathyal depths 500 meters or deeper. These paleodepths imply uplift of the shale unit to shelf depths with subsequent truncation by erosion during a former low stand of the sea. This surface has since been covered by a thin blanket of Pleistocene shelf sediments represented by Unit 1.

Based upon sediments and microfossils, there appears to be a hiatus between the depositional records represented by Units 1 and 2. The lithologies of these units are dissimilar and Unit 2 was deposited in deeper water than found over the site today. The diatoms indicate the oldest sediments belong to NPD Zone III (Core 5, Section 6), which has an absolute age range between 0.92 and 1.3 m.y. (Schrader, Chapter 17, this volume). On the other hand, radiolarians suggest a Pliocene age for the lower section of Unit 1 (Kling, Chapter 16, this volume; Core 5, Section 3) and

[2]See Chapter 14 for depth classification of marine environments.

both planktonic and benthonic foraminifera suggest a Pliocene age for Unit 2 (CC of Core 5)(Ingle, Chapter 14, this volume). The unconsolidated sediments of Core 5 may contain reworked material from the underlying Pliocene unit or from slumps of Pliocene shale that originated on the adjacent Nehalem Banks. All of these factors suggest that the angular unconformity occurs between Units 1 and 2 and that it may be Pleistocene in age, possibly one million years or older.

Strong multiple reflection events of the air gun's outgoing signal obscure the unconformity as it surfaces on the western flanks of Nehalem Banks. However, assuming a velocity of 1.6 km/sec, and picking the unconformity at a subbottom depth of 0.02 to 0.05 second, the unconformity is located somewhere between 32 to 80 meters below the sea floor at Site 176.

Assuming that the unconformity was produced by wave action in the nearshore region as the data suggest, this erosional surface presently lies at a depth of 234 meters below sea level at the drill site and much deeper than the late Wisconsin lowering of sea level of approximately 125 meters (Curray, 1965). The unconformity also dips seaward in the subsurface along the western flank of the Nehalem Banks. The outer edge of the shelf must have begun to subside as the blanket of Pleistocene sediments was deposited.

A similar discordance is seen in the seismic reflection profile made across the inner continental shelf syncline that lies to the east of the Nehalem Banks. This rather young unconformity appears to be widespread over the northern Oregon continental shelf.

REFERENCES

Bandy, O. L., 1953. Ecology and paleoecology of some California foraminifera. Part I. The frequency distribution of Recent foraminifera off California. J. Paleo., 27 (2), 161.

Curray, J. R., 1965. Late Quaternary history, continental shelves of the United States. *In* The Quaternary of the United States. H. E. Wright and D. C. Frey (Eds.). Princeton (Princeton University). 723.

Cushman, J. A., Stewart, R. E. and Stewart, K. C., 1930. Tertiary foraminifera from Humboldt County, California. Trans. San Diego Soc. Nat. History. 6 (2), 41.

Donahue, J. G., 1970. Diatoms as Quaternary biostratigraphic and paleoclimatic indicators in high latitudes of the Pacific Ocean. Unpub. Ph.D. thesis, Columbia Univ., New York. 230 p.

Faustman, W. F., 1963. Paleontology of the Wildcat Group at Scotia and Centerville Beach, California. Univ. California, Publ. Geol. Sci. **41** (2), 97.

Fowler, G. A., 1965. The stratigraphy, foraminifera, and paleoecology of the Montesano Formation, Grays Harbor County, Washington. Univ. Southern California. Unpub. Ph.D. Diss. 355 p.

Fowler, G. A. and Kulm, L. D., 1971. Late Cenozoic stratigraphy of the Oregon continental margin in relation to plate tectonics. Geol. Soc. Am. Abst. 3 (7), 570.

Kulm, L. D. and Fowler, G. A., 1971. Shallow structural elements of the Oregon continental margin within a plate tectonic framework. Geol. Soc. Am. Abst. 3(7), 618.

Mammerickx, J. and Taylor, I. L., 1971. Bathymetry of the Pioneer Survey area north of 45°N lat. Scripps Institution of Oceanography, Geological Data Center. (Map)

Natland, M. L., 1957. Paleoecology of West Coast Tertiary sediments. *In* Treatise on Marine Ecology and Paleoecology. Ladd, H. S. (Ed.). Geol. Soc. Am. Mem. 67, 2, 543.

Ogle, B. A., 1953. Geology of the Eel River Valley area, Humboldt County, California. California Div. Mines, Bull. 164. 128 p.

Rau, W. W., 1970. Foraminifera, stratigraphy, and paleoecology of the Quinault Formation, Point Grenville-Raft River coastal area, Washington. Washington Div. Mines and Geology, Bull. 62. 41 p.

APPENDIX A. OPERATIONS

Pre-drilling Survey

A shallow site was selected on the outer edge of the northern Oregon continental shelf southwest of the Columbia River. The water depth at Site 176 was 193 meters. *Challenger* arrived in the area on 21 June and began a seismic reflection survey to delineate the angular unconformity at subbottom depths of less than 100 meters (drilling depths were restricted to 300 feet in this hole in accordance with U. S. Department of Interior regulations for shallow sites).

Challenger approached the site on course 090° T commencing on the upper continental slope and profiling up to the Nehalem Banks, which are located just to the east of the proposed site (Figure 4). At 1358, a broad turn was made to the south coming eventually to course 270°. At 1445, a broad turn was made to the north eventually steadying on 090°. A spar buoy was dropped at 1456, but it drifted out of the area before the seismic gear could be retrieved.

A second survey commenced at 1555 on course 270° at 6 knots. At 1614, a broad turn was made to the north coming around to 090° at 1622 at 8 knots. The speed was reduced to 5 knots at 1630 and and the beacon was dropped on the run at 1632.

The unconformity surfaced on the flank of the bank very rapidly as the beacon was dropped so the vessel came on station at a point 62 meters to the west of the beacon to avoid the rocky terrain of Nehalem Banks. Several tests of the positioning system were made at this time to determine what the extent of the lateral excursions would be in the calm seas. Excursions of less than 7.5 meters were recorded during the tests.

Drilling Program

Site 176 was continuously cored to a total depth of 41 meters. The hole was spudded into soft mud derived from the Columbia River. Water depth at the site was 193 meters. Prior to Leg 18, positioning had not been attempted in water depths of less than 850 meters.

Two punch cores were taken before partially indurated layers were encountered. Rotation and circulation were necessary on Cores 3, 4, and 5. During the cutting of Cores 1 to 5, the dynamic positioning system of *Challenger* allowed excursions of up to 14 meters from the beacon. During the first 30 minutes of coring, *Challenger* stayed

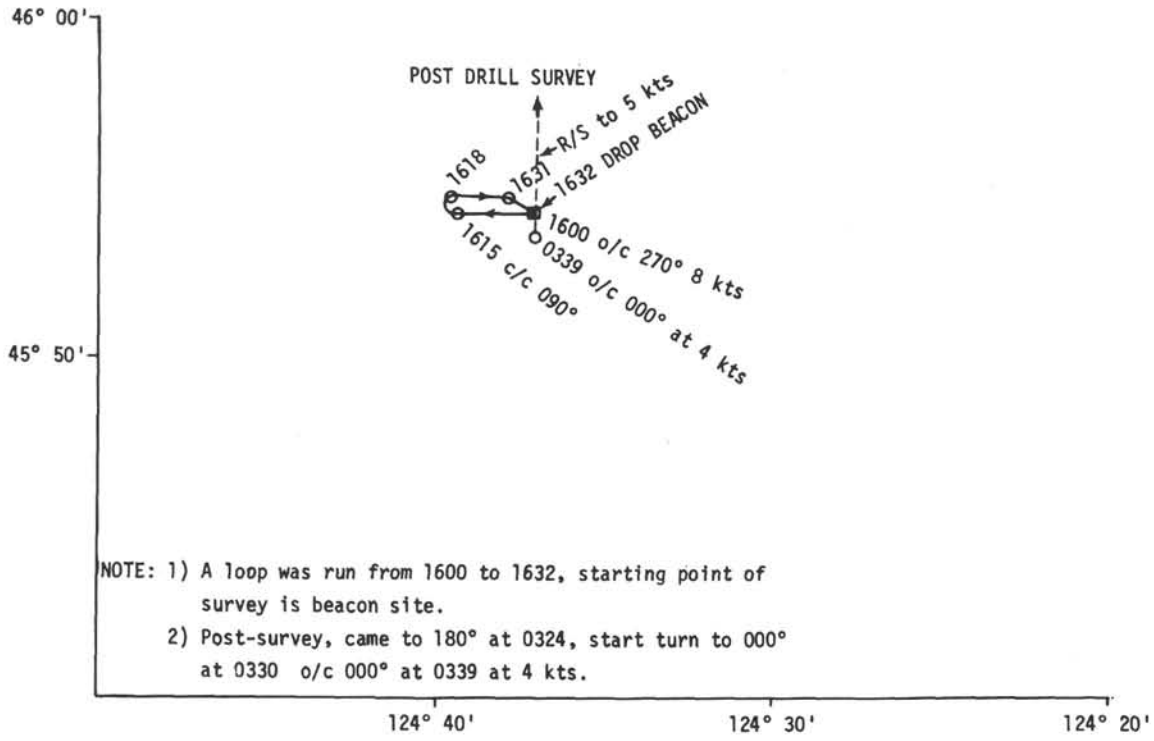


Figure 4. Glomar Challenger *presite survey of Site 176.*

within 7.5 meters (4 percent of water depth) of the hole, for the next 1 hour and 15 minutes within 3 meters (1.6 percent), and the next 45 minutes within 7.5 meters (4 percent); however, during the last hour of coring, there were three excursions: one of 12.5 meters (7 percent), one of 8 meters (4 percent), and one of 14.5 meters (7.5 percent)—the drilling assembly parted on the third. A hard sand was being cored just as the two bumper subs were at the mudline, placing the weakest part of the drilling assembly in a severe bending area during the maximum excursion. This resulted in a "twist off" at a service break on the lower bumper sub and terminated operations. An excursion up to 30 meters was recorded shortly thereafter. Because of the short coupling between the vessel and the bottom (<200 meters), it appears that excursions of more than 14.5 meters will result in mechanical failure at the mud line, especially when the drilling string is being rotated and the bottom-hole assembly is not completely buried. In addition, we had just penetrated several hard layers which most likely held the pipe in a rigid upright or inflexible position. If the hole had consisted of soft muds, the entire string might have dug into the walls before breaking. Positioning would have been considered excellent in greater water depths; however, with a water depth of only 193 meters positioning is extremely critical, and the positioning response, particularly in the Y axis, was too slow to keep the ship within 9 meters or 5 percent of water depth of the hole.

The weather conditions were excellent during the drilling operations with swell and sea conditions being less than 2 feet and the winds slight. The positioning hardware also was in excellent operating condition. A fairly strong current was noted, flowing to the south, but it was compensated for by the positioning system. The unfortunate failure of the dynamic positioning system at Site 176 could not be attributed to the sea conditions.

A total of 41 meters of core were recovered, which gives a 100 percent recovery for this site (see Table 1 for the coring summary). The scientific objective was reached just prior to the mechanical failure.

TABLE 1
DSDP Site 176 Coring Summary

Core	Cored Interval Below: Derrick Floor (m)	Cored Interval Below: Bottom (m)	Cored (m)	Recovered (m)	Recovered (%)
1	201-207	0-6	6.0	6.0	100.0
2	207-216	6-15	9.0	9.0	100.0
3	216-225	15-24	9.0	9.0	100.0
4	225-233	24-32	8.0	8.0	100.0
5	233-242	32-41	9.0	9.0	100.0
		Total	41.0	41.0	100.0

Drilling Specifications

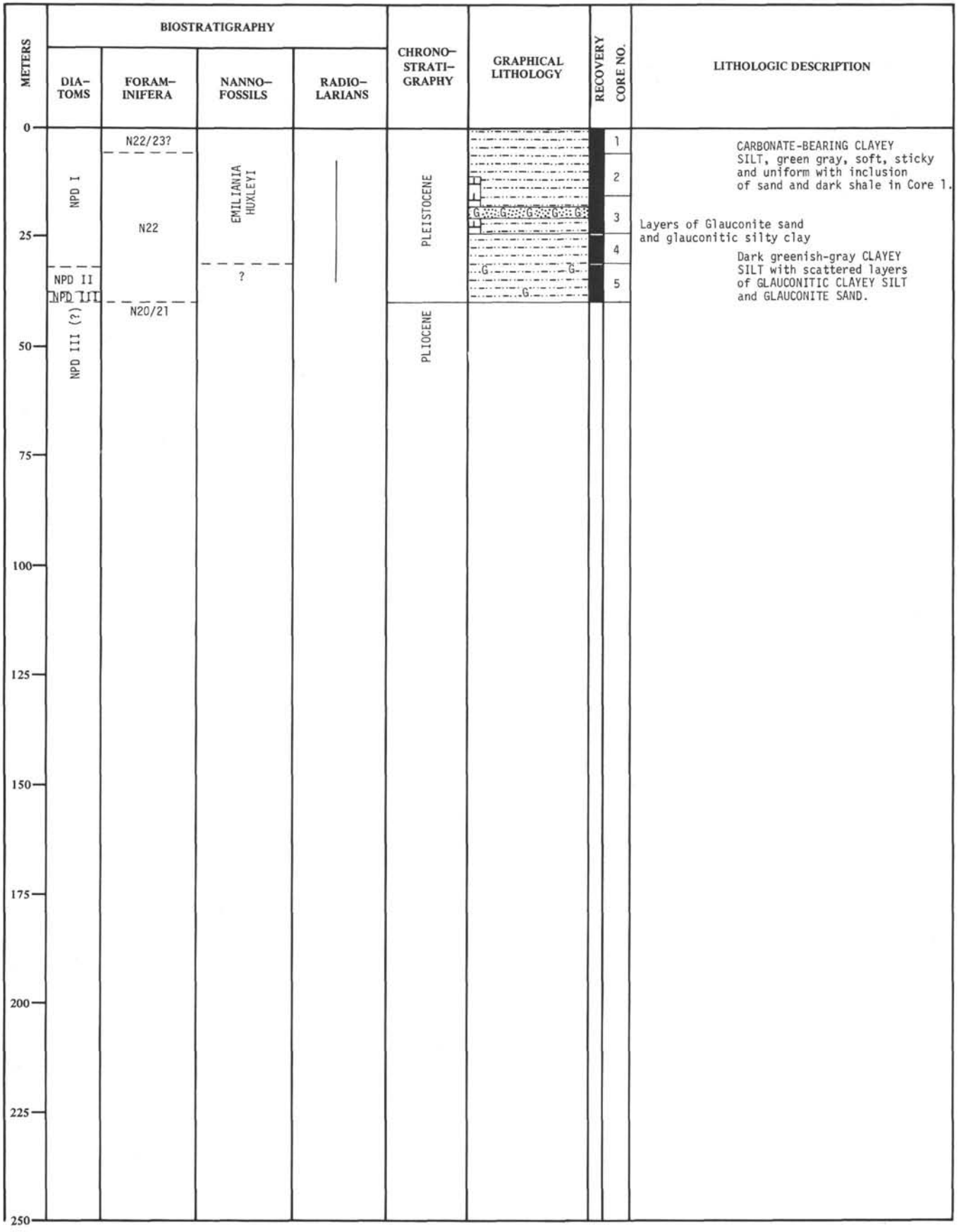
This hole was cored from 201 meters to 242 meters for a subbottom penetration of 41 meters with 100 percent recovery. Total time on site was 12 hours of which 4½ hours were spent coring.

From the bit upward, the bottom hole assembly consisted of the outer barrel, three 8¼-inch drill collars, two bumper subs, two 8¼-inch drill collars, one 7¼-inch drill collar, and one joint of "Hevi-Wate" drill pipe.

Site 176 was an experimental hole. The main objectives were to dynamically position the ship in only 193 meters of water and continuously core to 90 meters below the mudline.

Post-drilling Survey

The post-drilling survey was made parallel to the strike of the structural elements on the outer shelf. *Challenger* came to course 180° at 0324 hours at a speed of 4 knots. At 0330, a reciprocal course of 000° was executed and the survey made along the outer edge of the shelf just west of Nehalem Banks.


METERS
BIOSTRATIGRAPHY
DIA-TOMS
FORAM-INIFERA
NANNO-FOSSILS
RADIO-LARIANS
CHRONO-STRATI-GRAPHY
GRAPHICAL LITHOLOGY
RECOVERY
CORE NO.
LITHOLOGIC DESCRIPTION
0
25
50
75
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175
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225
250
NPD I
NPD II
NPD III
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N22
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EMILIANIA HUXLEYI
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1
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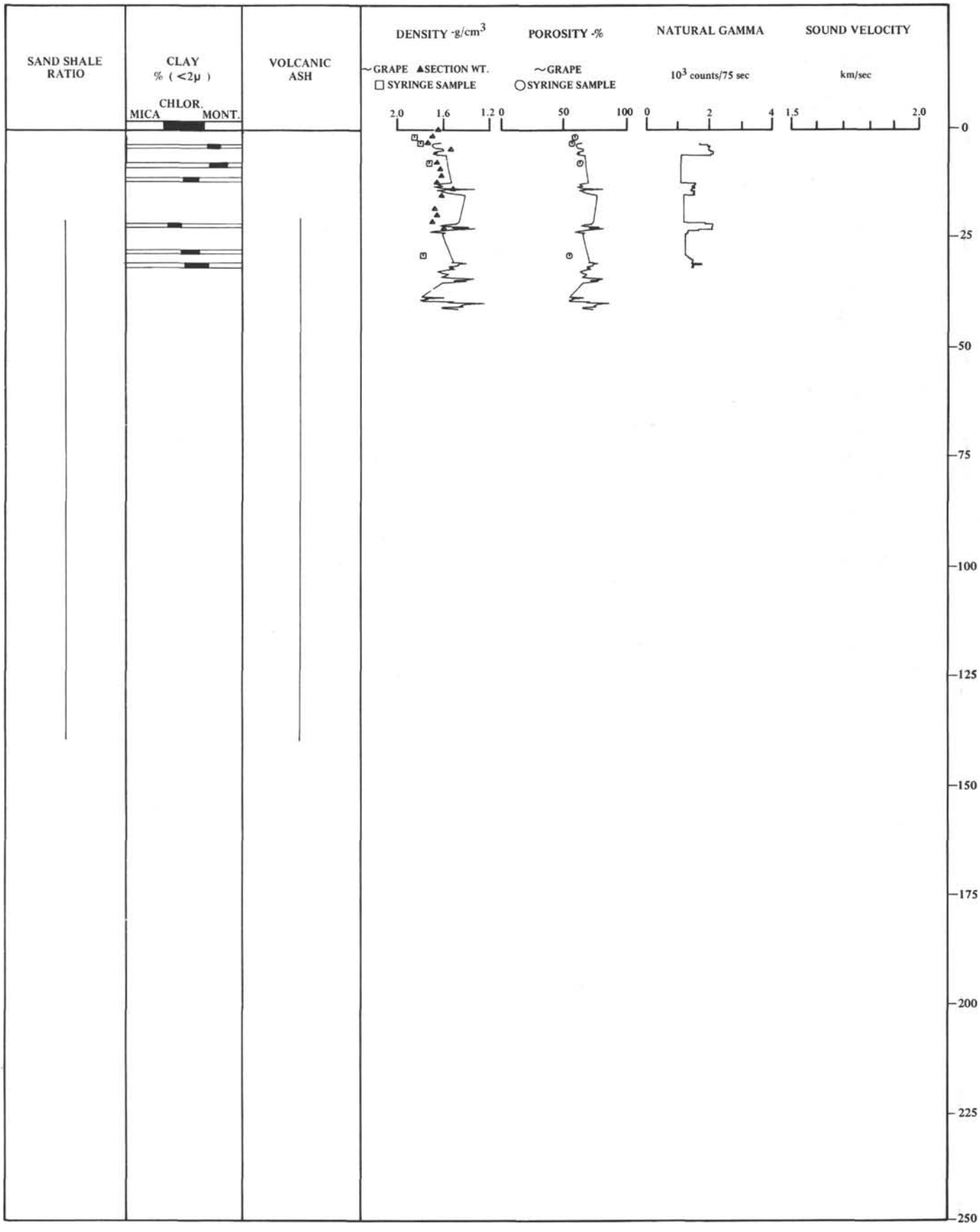
CARBONATE-BEARING CLAYEY SILT, green gray, soft, sticky and uniform with inclusion of sand and dark shale in Core 1.
Layers of Glauconite sand and glauconitic silty clay
Dark greenish-gray CLAYEY SILT with scattered layers of GLAUCONITIC CLAYEY SILT and GLAUCONITE SAND.


SAND SHALE RATIO
CLAY % (<2μ)
CHLOR.
MICA
MONT.
VOLCANIC ASH
DENSITY -g/cm3
~GRAPE ▲SECTION WT.
□ SYRINGE SAMPLE
2.0
1.6
1.2
POROSITY -%
~GRAPE
○SYRINGE SAMPLE
0
50
100
NATURAL GAMMA
10^3 counts/75 sec
0
2
4
SOUND VELOCITY
km/sec
1.5
2.0
0
25
50
75
100
125
150
175
200
225
250

Site 176 Hole Core 1 Cored Interval: 0-6.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM*	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
PLEISTOCENE	N22/23(?) Emiliania huxleyi NPDZ 1	C/G	B		A/G	1	0.5 1.0				Green gray, CARBONATE-BEARING CLAYEY SILT, soft, sticky, and uniform. Numerous inclusions of SAND and dark SHALE. Sponges
		R/G	B		C/G	2					Gastropod shell sec. 2, 50 cm.
		C/G	R/M		B	3					Wood fragments at base of section 3.
		R/M	R/M R/M		B	4					
		C/G	R/M	R/M	C/M	Core Catcher					

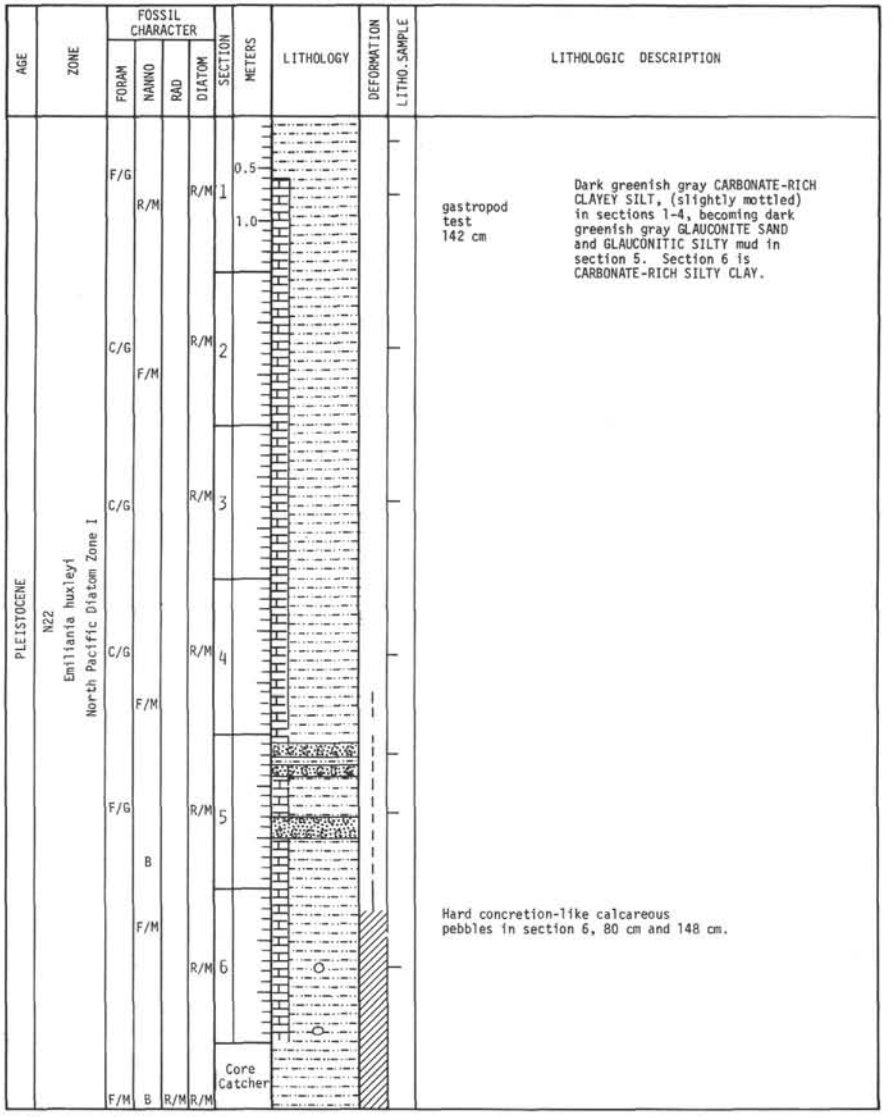
Explanatory notes in chapter 1
*PLANKTONIC FORAMINIFERA

Site 176 Hole Core 2 Cored Interval: 6.0-15.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
PLEISTOCENE N22 Emiliania huxleyi North Pacific Diatom Zone 1		C/M	R/M		B	1	0.5 1.0				Green gray CARBONATE-BEARING clayey silt and medium gray silty clay (slightly mottled).
		F/G	R/M		B	2					
		F/G	R/M		B	3					
		R/M			C/M	4					
		R/M	B		C/M	5					Sponges
				R/M	C/M	6					CARBONATE CONCRETIONARY PEBBLES, section 6, 20 and 45 cm.
		C/G	R/M	R/M	R/M	Core Catcher					

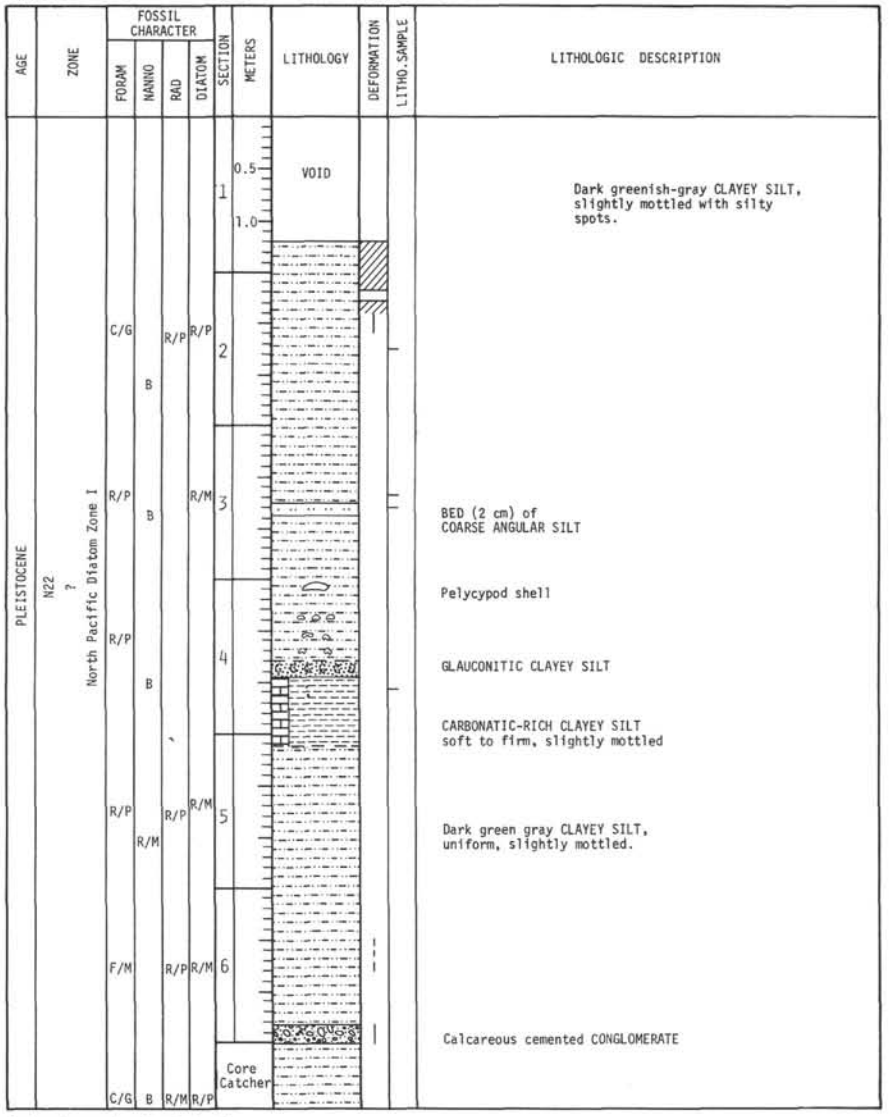
Explanatory notes in chapter 1

Site 176 Hole Core 3 Cored Interval: 15-24 m



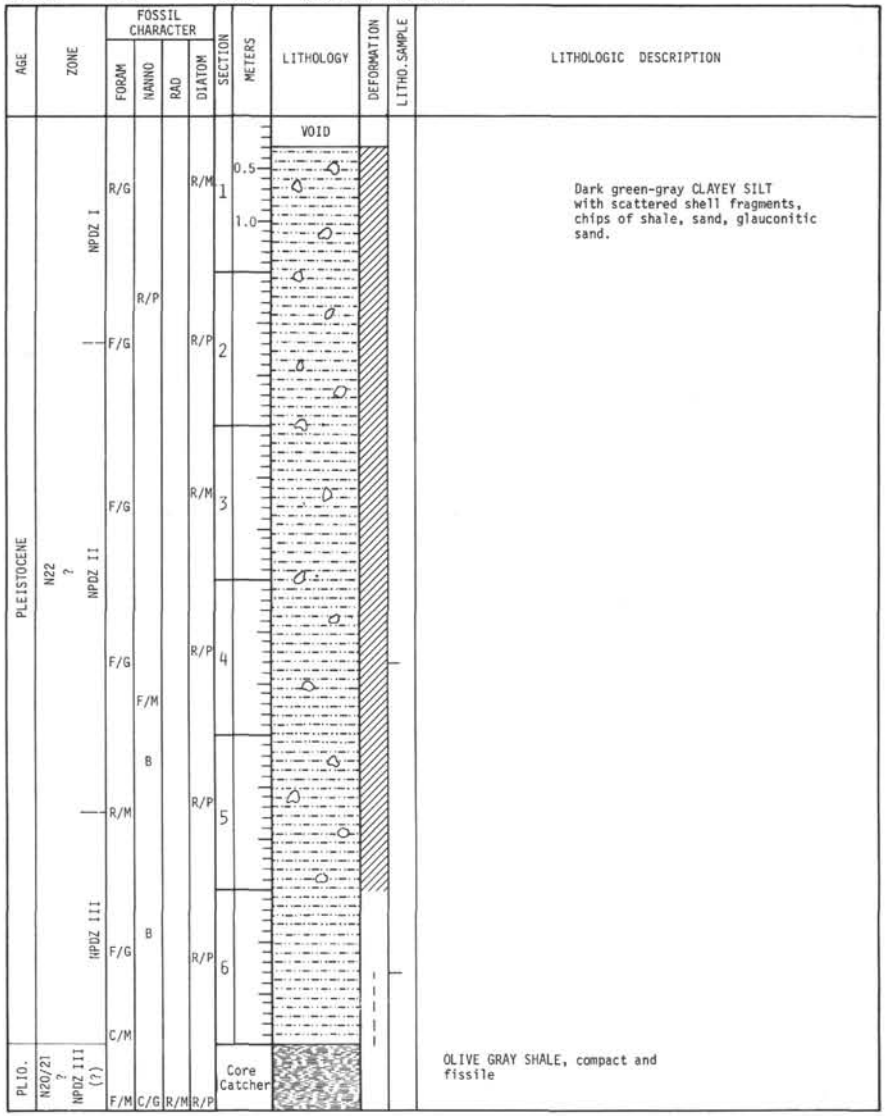
Explanatory notes in chapter 1

Site 176 Hole Core 4 Cored Interval: 24-32 m

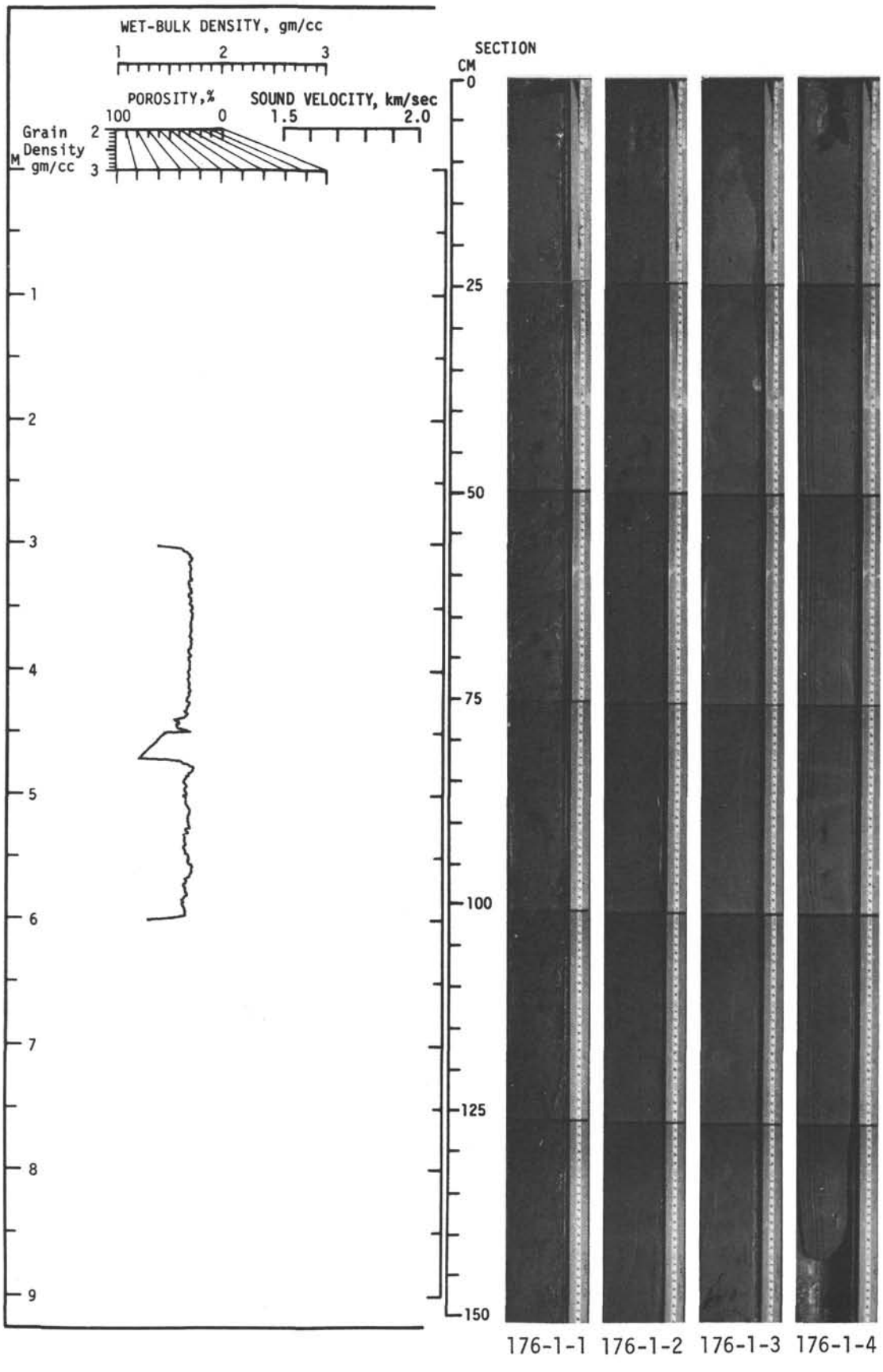


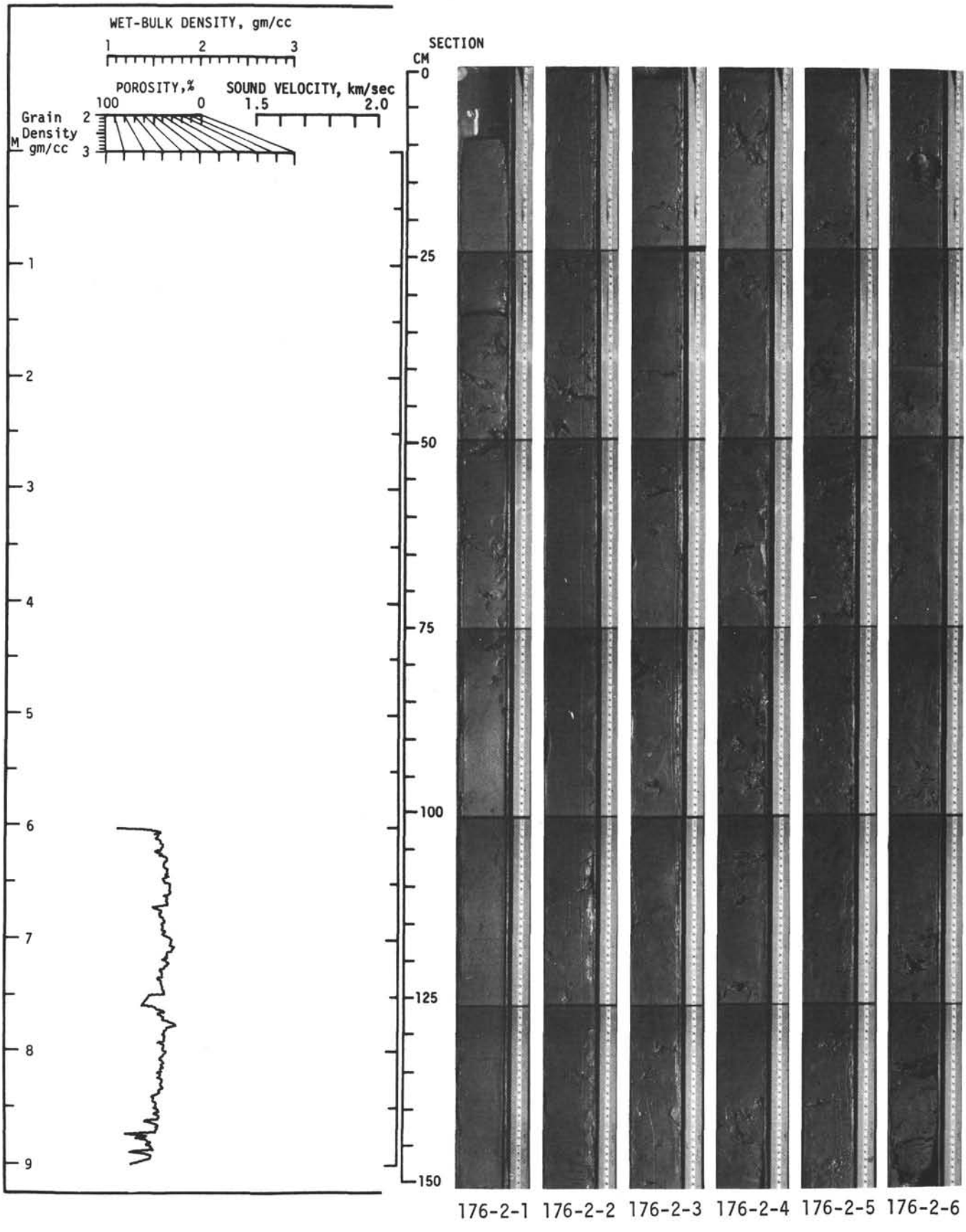
Explanatory notes in chapter 1

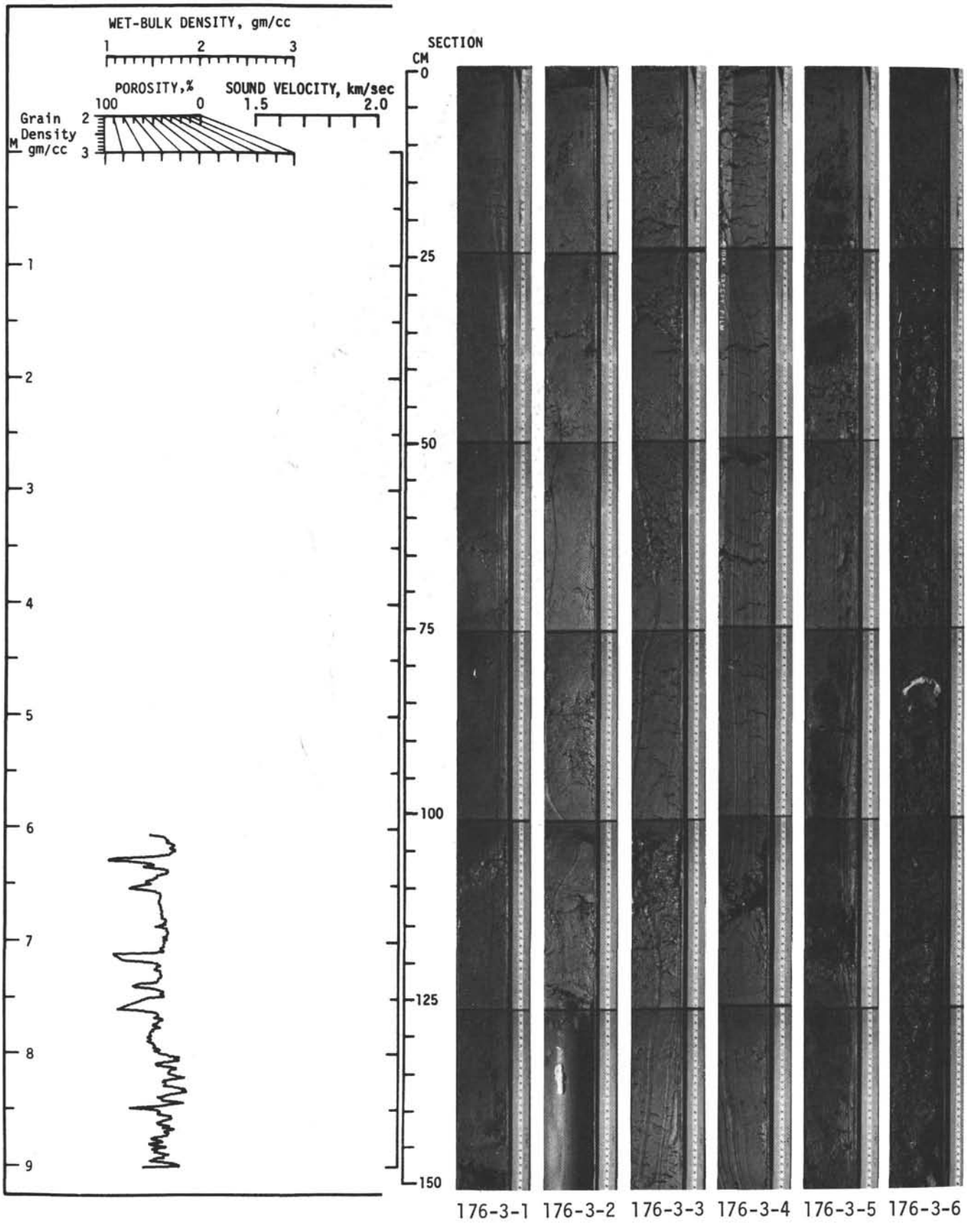
Site 176 Hole Core 5 Cored Interval: 32-41 m

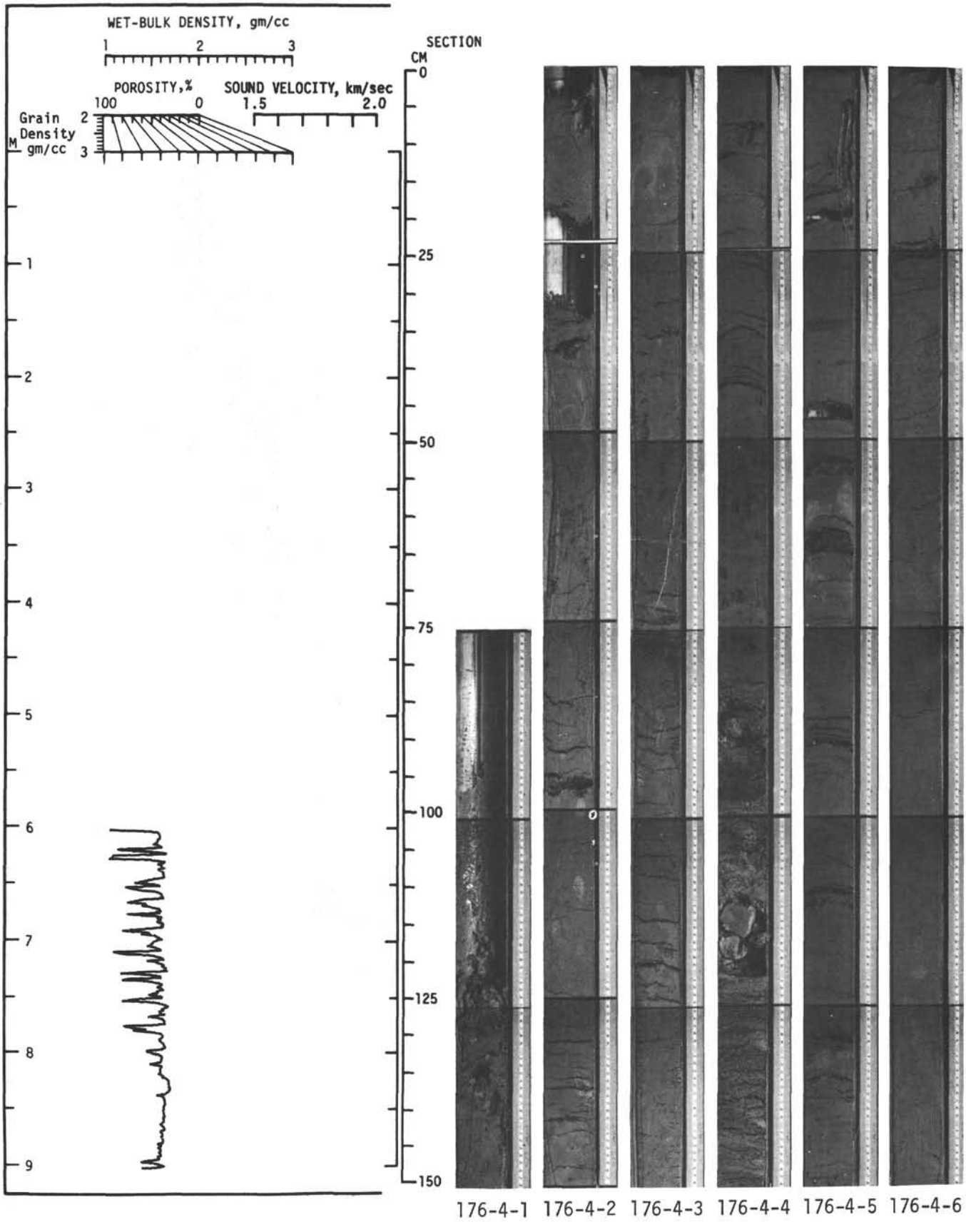


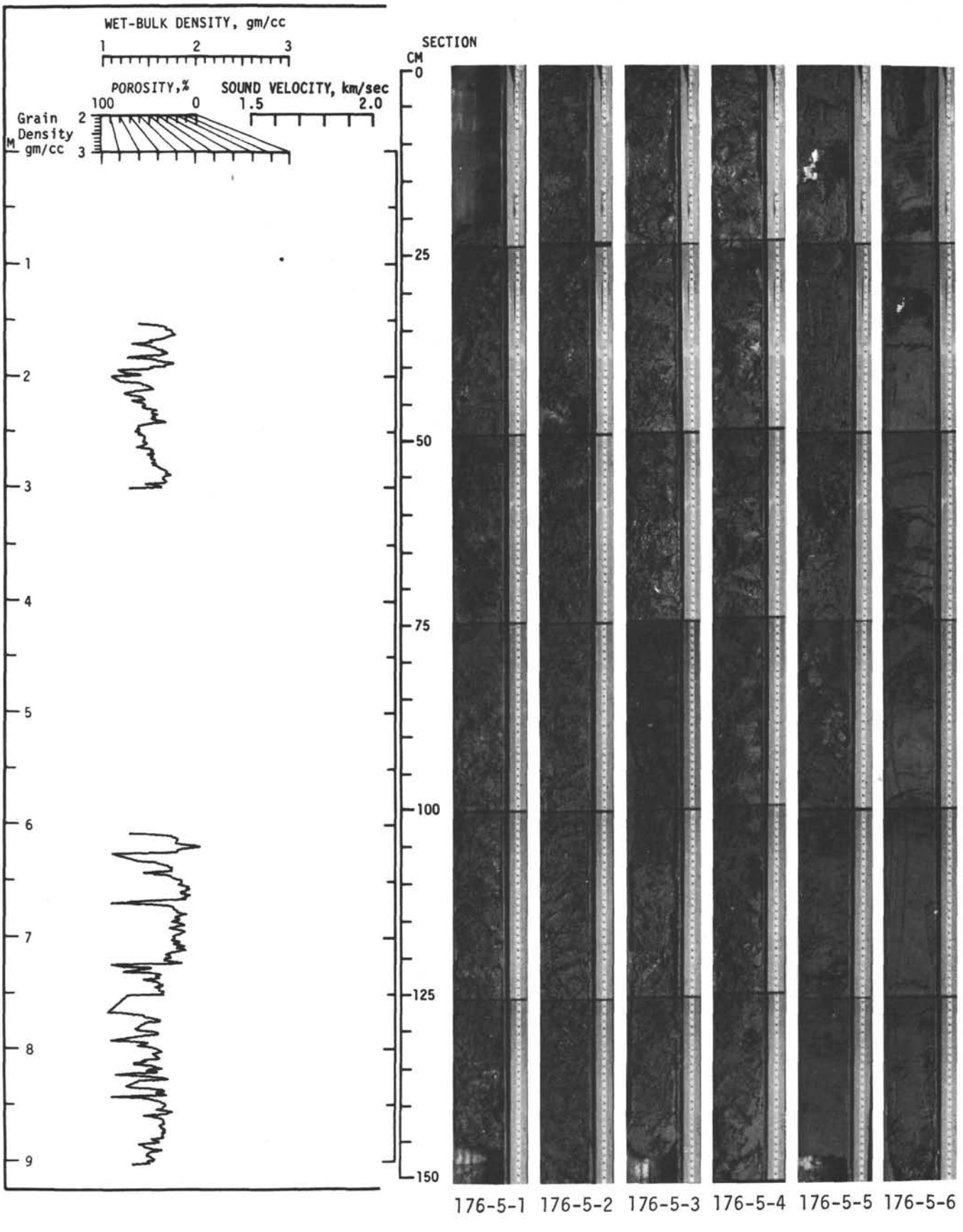
Explanatory notes in chapter 1


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
176-1-1
176-1-2
176-1-3
176-1-4


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
176-2-1
176-2-2
176-2-3
176-2-4
176-2-5
176-2-6


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
176-3-1
176-3-2
176-3-3
176-3-4
176-3-5
176-3-6


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
SECTION
CM
0
25
50
75
100
125
150
1
2
3
4
5
6
7
8
9
176-4-1
176-4-2
176-4-3
176-4-4
176-4-5
176-4-6


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
176-5-1
176-5-2
176-5-3
176-5-4
176-5-5
176-5-6