5. SITE 329

The Shipboard Party[1]

SITE DATA

Date Occupied: 4-6 May 1974

Time on Site: 47 hours, 12 minutes

Position (Satellite): 50°39.31'S, 46°05.73'W

Number of Holes: 1

Water Depth: 1519 corrected meters (echo sounding)

Bottom Felt at: 1531.5 meters (drill pipe)

Penetration: 464.5 meters

Number of Cores: 33

Total Core Recovered: 215.1 meters (69%)

Age of Oldest Sediment: Late Paleocene

Acoustic Basement: Not reached, but estimated to lie approximately 1.2 km below the sea bed

Summary: Site 329, in 1519 meters of water some 55 km northeast of Site 327 on the Maurice Ewing Bank, was chosen to obtain the shallow-water Neogene biostratigraphic section deliberately avoided at the earlier site. The single hole was cored continuously to 179.5 meters and intermittently to 464.5 meters, yielding 33 cores with 69% recovery and bottoming in Paleocene nanno chalk. It thus provides some stratigraphic overlap with the section cored at Site 327.

Apart from ice-rafted terrigenous debris in the uppermost 4.5 meters of Quaternary diatomaceous ooze, the entire section is biogenic. About 220 meters of upper Miocene nanno and diatom ooze overlies 125 meters of more consolidated middle to upper Miocene ooze and chalk. Beneath this, a Paleocene to lower or middle Miocene nanno chalk, locally silicified, extends to the base of the hole. The sedimentation rate is about five times as high in the uppermost 350 meters of Miocene sediments as in the older sediments beneath. Hiatuses probably span the late Oligocene to early or middle Miocene, and the middle to early Eocene. The former represents an unconformity which reflection profiles show to form the base of a 100-km-long bank of Miocene oozes. This and the presence of reworked Oligocene fossils in the Miocene sediments indicate that strong bottom currents swept the region in the Neogene, possibly as a result of the opening of Drake Passage.

BACKGROUND AND OBJECTIVES

The proposal to drill Site 329 was first made during Leg 36 by the shipboard scientists, after additional time had been made available by the forced abandonment of four more southerly sites. The site lies in 1519 meters of water on the western nose of the isolated eastern part of the Falkland Plateau, about 55 km northeast of Site 327 (Figure 1).

The objectives at this site were essentially an extension of those of Site 327, i.e., to obtain a shallow-water, high-latitude Neogene biostratigraphic section for comparison with the deep-water sections at Site 328 and the more northerly site planned for the Argentine Basin. The Neogene section was missing at Site 327 as expected, but the available reflection profile (RC 16-06; see Figure 2) indicated its likely presence upslope. Site 329 was therefore expected to extend the evolutionary history recorded in Site 327 sediments and thereby throw some light on Neogene events such as the onset of glaciation and development of a circumpolar current system. Acoustic basement at Site 329 was at 1.2 sec two-way time (perhaps 1 km) below the sea bed, but the intention was to sample only the upper half of the sediment pile, until some overlap had been obtained with the section at Site 327, downslope.

SURVEY AND OPERATIONS

On passage between Site 328 and the newly defined Site 329, *Glomar Challenger* was forced northward from the direct track to avoid a dense concentration of icebergs near 50°S, 38°W. This diversion turned the direct approach to Site 329 into a useful traverse of the crest of the elevated eastern block of the Falkland Plateau. Site 329 had been chosen to complement the results obtained at Site 327 (Figure 1) by sampling the thick Neogene section missing there but exposed upslope on the original RC 16-06 reflection profile (Figure 2). The operations plan for Sites 329 and 330, which was nearby, was governed largely by the expected weather; a stationary trough of low pressure at about 80°W was expected ultimately to start moving rapidly eastward and to terminate drilling at Site 329 in about 36 hr. After a day or so of bad weather, the ship could expect to be able to move to Site 330.

The ship approached Site 329 along 260° (Figure 3), slowing at 0010 on 4 May to 5 knots to improve reflection profiler penetration. A 13.5-kHz beacon was dropped at 0120, about 5 km short of the intended site because it was obvious from the reflection profile (Figure 4) that the crest of the bank, with the youngest sediments, had been reached. The underway equipment was recovered without further site survey because time was short. The revised site was at 50°39.31'S, 46°05.73'W in 1519 meters of water.

---

[1] Peter Barker (Co-chief scientist), The University of Birmingham, Birmingham, England; Ian W.D. Dalziel (Co-chief scientist), Lamont-Doherty Geological Observatory, Palisades, New York; Menno G. Dinkelman, The Florida State University, Tallahassee, Florida; David H. Elliot, The Ohio State University, Columbus, Ohio; Andrew M. Gombos, Jr., The Florida State University, Tallahassee, Florida; Alberto Lonardi, CONICET, Buenos Aires, Argentina; George Plafker, U.S. Geological Survey, Menlo Park, California; John Tarney, University of Birmingham, Birmingham, England; Robert W. Thompson, Humboldt State College, Arcata, California; R.C. Tjalsma, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts; Christopher C. von der Borch, The Flinders University, Bedford Park, South Australia; Sherwood W. Wise, Jr., The Florida State University, Tallahassee, Florida.

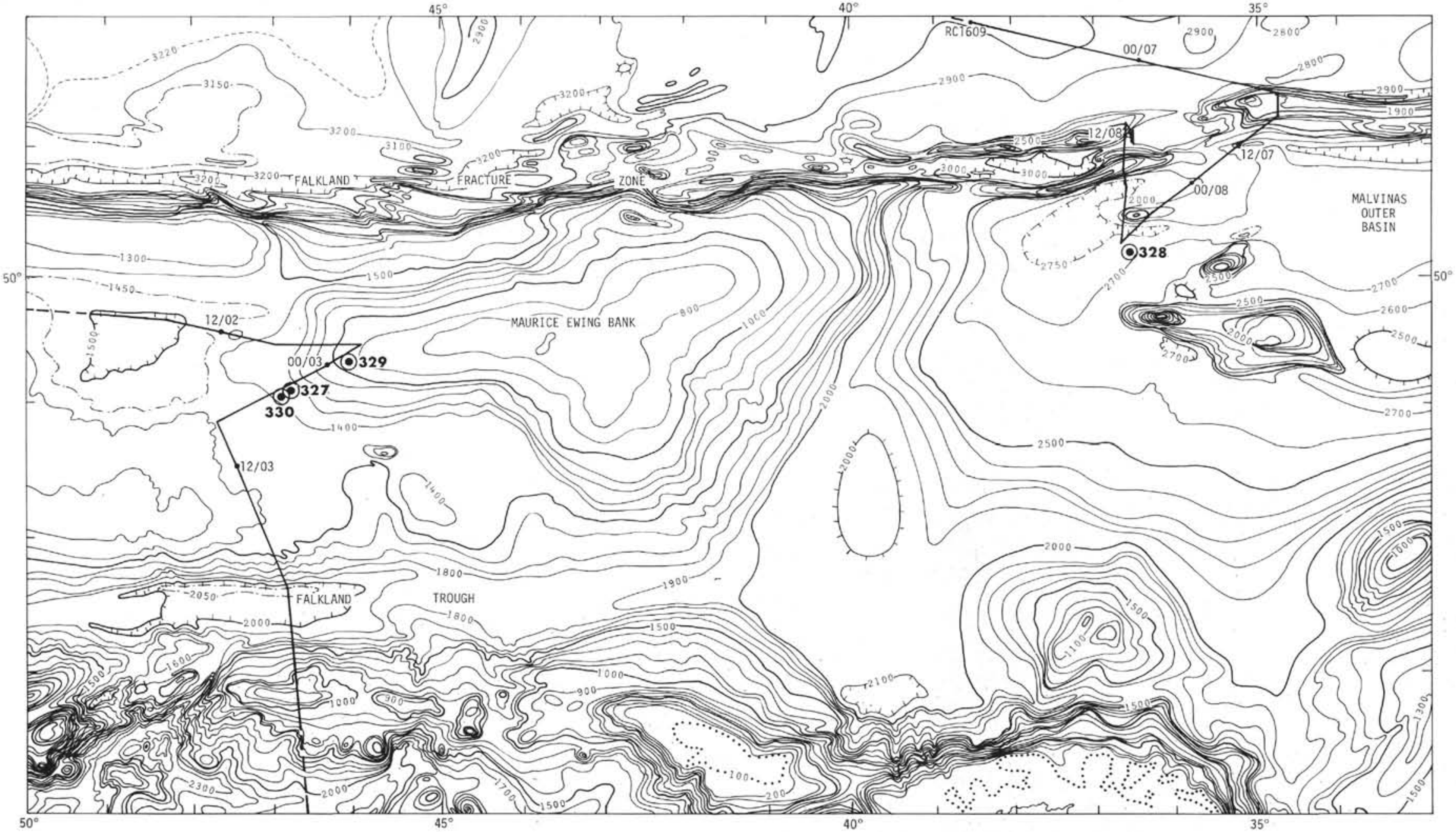


Figure 1. *Bathymetry of the Maurice Ewing Bank in the vicinity of Sites 327 and 329 (after Lonardi and Ewing, 1971), with* Robert D. Conrad *1606 track.*

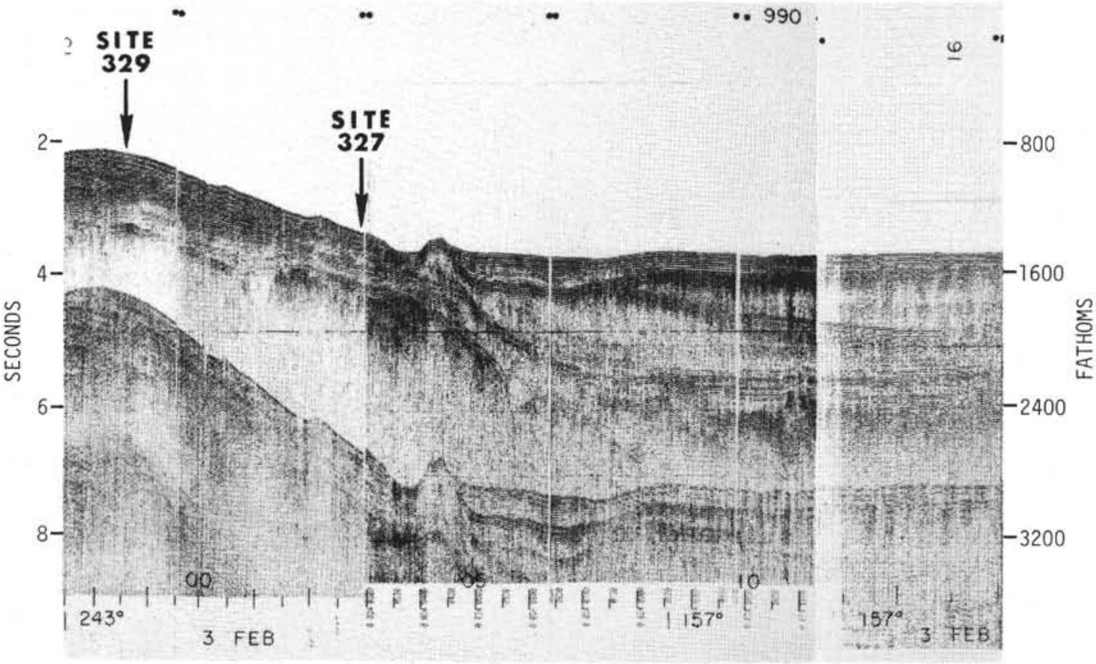


Figure 2. Robert D. Conrad *1606 reflection profile in the vicinity of Sites 327 and 329 (see Figure 1 for track).*

The drill pipe was started down at 0200 on 4 May and spudded in at 0730; the first core was on deck at 0825 (Table 1). The expected time limit on drilling Site 329 meant that the entire hole could not be cored continuously if some overlap with the upper part of the section at Site 327 was to be achieved (the top of the Maestrichtian at Site 327 could be traced upslope to about 570 m at Site 329).

Coring was continuous to 179.5 meters subbottom, then intermittent to 464.5 meters, where the hole was abandoned with some overlap with Site 327 (in the Paleocene). Thirty-three cores were taken with a total recovery of 215.1 meters (69%); lowest recovery occurred in the lower part of the section, where coring was intermittent.

The last core came on deck at 1825 on 5 May and the drill string had been recovered completely by 2310. The ship passed over the beacon heading 244° at 8 knots, bound for Site 330 some 65 km away. Contrary to expectations the weather was holding, and it appeared that the only opportunity to drill Site 330 would now be before the weather broke rather than afterwards.

LITHOLOGICAL SUMMARY

General

The section at Site 329 is summarized in Figure 5; two lithologic units are recognized on the basis of color and degree of induration. The upper one, in shades of green, consists of diatom ooze and nanno ooze which grades downward into chalk; it is divided into three subunits. The lower pale gray to white unit consists almost entirely of nanno chalk.

Unit 1a (0-4.5 m, Core 1)

Unit 1a is a diatom ooze rich in clay, silt, and sand. There is great variability in the proportions of the clastic and biogenic fractions. The lower limit of this unit has been selected, arbitrarily, at the lowest occurrence of pebble-sized clasts at the base of Section 3, Core 1; this gives a thickness of 4.5 meters for Unit 1a. However, sand-sized detritus is present lower in Core 1 and intermittently in trace amounts to Core 6.

The ooze forming Unit 1a is soft and is predominantly grayish-olive-green with mottling in olive-gray and yellowish-green. Diatoms are the principal biogenic component together with lesser to trace amounts of radiolarians, coccoliths (Section 1 only), and foraminifera; one thin layer consists of diatom foram ooze. The sand- and silt-sized clastic fraction is made up largely of quartz and feldspar; phyllosilicates, mainly mica and montmorillonite, are also important constituents, and together with clay form a major part of the sediment in Section 1. Heavy minerals identified in trace amounts in the coarse fraction (62 μm) include garnet, hornblende, and pyroxene. Clasts up to 6.5 cm across occur in the Site 329 cores, but the distribution is partly a function of the drilling operations. Clasts of granite, acid volcanic rocks, and pink sandstone are present in the first three sections of Core 1. Pebbles were also found in Cores 19, 21, 22, and 27 through 30, and because of the Oligocene age of Core 30, which has the greatest abundance of clasts, these pebbles are regarded as surface material that fell to the bottom of the hole as a result of "washing" down under pump water pressure and consequent opening out of the hole. The clasts include metasiltstone, granite, metasandstone, quartzite, graywacke, and chloritized gabbro.

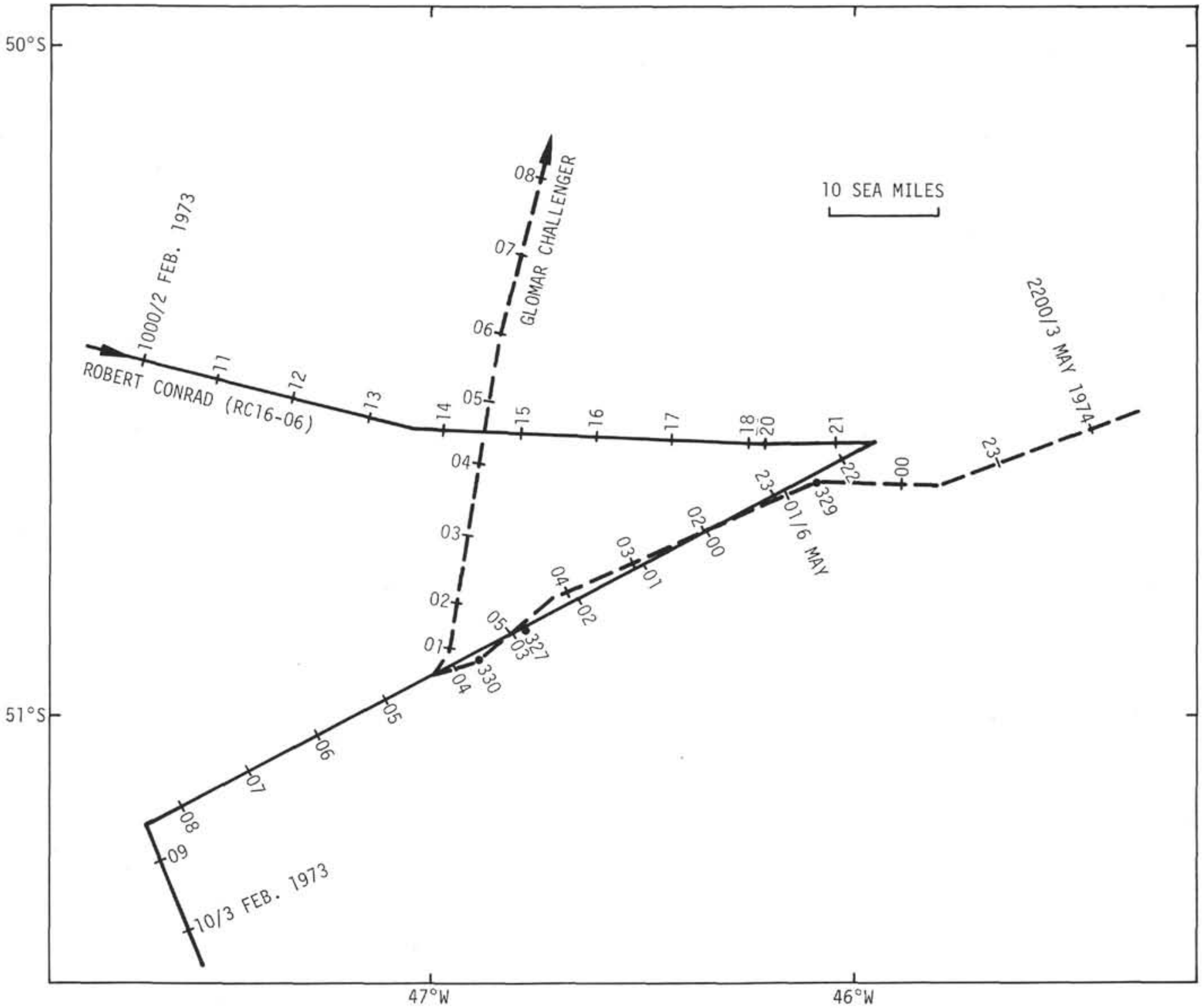


Figure 3. Glomar Challenger *track approaching and leaving Site 329.*

Many of the clasts are angular to subangular; some appear to be faceted and a few show striations, both surface features being indicative of glacial transport.

The base of the unit is arbitrarily placed at the lowest occurrence of a pebble-sized clast in Core 1. Below this level the sand-sized fraction drops markedly and calcareous nannofossils are more abundant, but in other respects, particularly the megascopic characteristics, Unit 1a is gradational into Unit 1b. The upper part of Unit 1a, Section 1 of Core 1, is Pleistocene to Recent; the coccoliths indicate it is younger than 200,000 years old. The lower part of Unit 1a contains a mixed Miocene to Recent diatom flora. A minimum sedimentation rate of 7.5 m/m.y. is indicated for Section 1, Core 1.

Unit 1b (4.5-225 m, Cores 1-21)

This unit consists of about 220 meters of nanno, diatom, and diatom micrite ooze with varying proportions of clastic detritus and biogenic components. Micrite is used here to denote all calcareous components not recognizable as discrete fossils, and thus includes both very fine calcareous nannofossil hash and authigenic carbonate. The calcareous fossil hash is invariably formed of disaggregated coccoliths, and its recrystallization produces the coarser grained authigenic carbonate. Core 22 contains the first chalk and serves to distinguish Unit 1c, but the contact between Units 1b and 1c cannot be defined precisely because it lies in the unsampled interval between Cores 21 and 22.

Colors are predominantly shades of green, gray, and olive. The lighter shades are commonly associated with a higher calcareous component. Diatoms and calcareous nannofossils, much of the latter disaggregated and now forming micrite, form the main biogenic fraction. Radiolarians (up to 15%), silicoflagellates (15%), sponge spicules (5%), and foraminifera (5%) may locally form a significant part of the fossil assemblage, but decrease in abundance down section and in the lower part occur in only trace amounts. The sand- and silt-sized clastic fraction, mainly quartz and subordinate

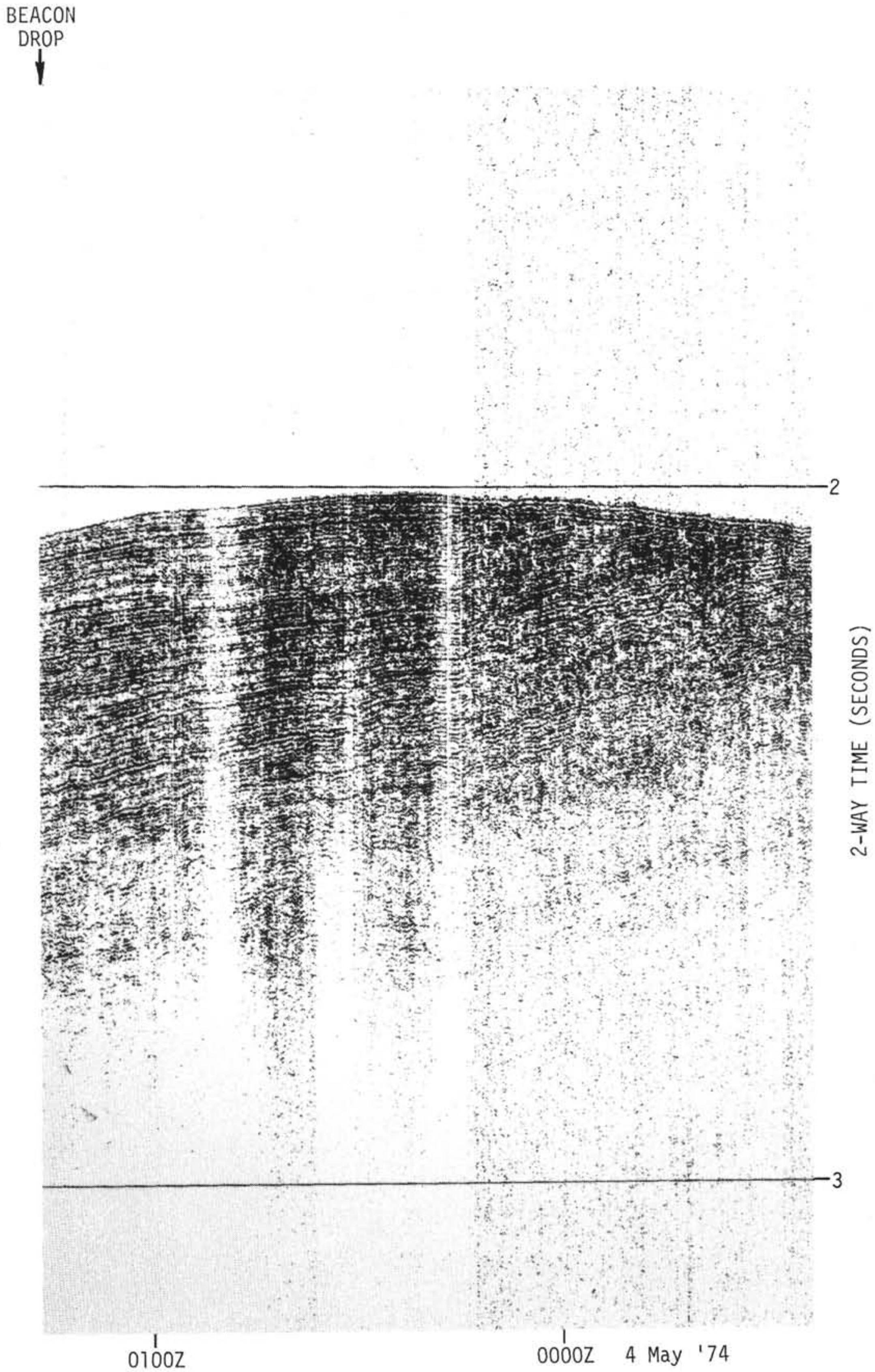


Figure 4. Glomar Challenger *reflection profile approaching Site 329 (see Figure 3 for track).*

TABLE 1
Coring Summary, Site 329

Core	Date (May 1974)	Time (GMT Z)	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	4	0825	1531.5-1540.0	0-8.5	8.5	8.5	100
2	4	0855	1540.0-1549.5	8.5-18.0	9.5	7.8	82
3	4	0935	1549.5-1559.0	18.0-27.5	9.5	9.2	97
4	4	1020	1559.0-1568.5	27.5-37.0	9.5	8.8	93
5	4	1105	1568.5-1578.0	37.0-46.5	9.5	9.4	100
6	4	1150	1578.0-1587.5	46.5-56.0	9.5	8.2	86
7	4	1240	1587.5-1597.0	56.0-65.5	9.5	8.0	84
8	4	1340	1597.0-1606.5	65.5-75.0	9.5	8.0	84
9	4	1415	1606.5-1616.0	75.0-84.5	9.5	8.6	91
10	4	1500	1616.0-1625.5	84.5-94.0	9.5	9.5	100
11	4	1600	1625.5-1635.0	94.0-103.5	9.5	9.0	95
12	4	1645	1635.0-1644.5	103.5-113.0	9.5	9.5	100
13	4	1735	1644.5-1654.0	113.0-122.5	9.5	9.5	100
14	4	1830	1654.0-1663.5	122.5-132.0	9.5	9.6	100
15	4	1915	1663.5-1673.0	132.0-141.5	9.5	9.5	100
16	4	2015	1673.0-1682.5	141.5-151.0	9.5	9.5	100
17	4	2110	1682.5-1692.0	151.0-160.5	9.5	9.5	100
18	4	2205	1692.0-1701.5	160.5-170.0	9.5	9.5	100
19	4	2255	1701.5-1711.0	170.0-179.5	9.5	5.7	60
20	5	0005	1720.5-1730.0	189.0-198.5	9.5	9.5	100
21	5	0105	1739.5-1749.0	208.0-217.5	9.5	5.0	53
22	5	0230	1768.0-1777.5	236.5-246.0	9.5	4.8	51
23	5	0345	1796.5-1806.0	265.0-274.5	9.5	4.0	42
24	5	0435	1815.5-1825.0	284.0-293.5	9.5	3.4	36
25	5	0530	1834.5-1844.0	303.0-312.5	9.5	0.3	3
26	5	0630	1863.0-1872.5	331.5-341.0	9.5	4.2	44
27	5	0755	1891.5-1901.0	360.0-369.5	9.5	1.6	17
28	5	0920	1920.0-1929.5	388.5-398.0	9.5	1.5	16
29	5	1030	1929.5-1939.0	398.0-407.5	9.5	1.2	13
30	5	1225	1939.0-1948.5	407.5-417.0	9.5	4.5	47
31	5	1330	1948.5-1958.0	417.0-426.5	9.5	0.3	3
32	5	1700	1977.0-1986.5	565.5-455.0	9.5	2.4	25
33	5	1825	1986.5-1996.0	455.0-464.5	9.5	5.1	54
Total					312.5	215.1	69

feldspar grains, forms as much as 5% of the sediment in the lower part of Core 1, but decreases downward and occurs only in trace amounts below Core 4. Amphibole occurs sparingly in the coarse fraction. The coarse fraction is a fairly constant 5%-10%. Green phyllosilicates occur in trace amounts except in the upper part of the unit where they may constitute up to 5% of the sediment. Volcanic glass forms about 3% of part of Section 3, Core 4, and has been found in trace amounts elsewhere, particularly in the coarse fractions. Pyrite occurs in the lower half of the unit as dark streaks and disseminations through the sediment; pyrite also replaces some of the siliceous fossils. Pebble-sized clasts occur in Cores 19 and 21, but were emplaced as a result of drilling operations.

The mixed Miocene to Recent diatom flora in Sections 4-6 of Core 1 suggests considerable reworking at this level, partly due to drilling disturbance. Diatoms and radiolarians indicate a late Miocene age for the rest of Unit 1b, except for the lowest core, Core 21, which is possibly middle Miocene on the basis of the diatoms. A minimum average sedimentation rate for Cores 2 to 20, based on the siliceous fossil dating as late Miocene, was 34 m/m.y.

Unit 1c (225-350 m, Cores 22-26)

This unit consists of 125 meters of diatom ooze, diatom-rich nanno chalk, and nanno chalk. The thickness is approximate because the contacts at the top and bottom lie in unsampled intervals between Cores 21 and 22, and Cores 26 and 27, respectively. The unit is distinguished from that above by the replacement of the calcareous ooze by chalk.

Colors are predominantly in shades of green, gray, and olive, with some more calcareous intervals being light gray. Diatoms and calcareous nannofossils are again the dominant biogenic components of the sediment and again the calcareous nannofossils are in part disaggregated and form micrite. Radiolarians may comprise up to 3% of the sediment; other fossils occur in only trace amounts. Clay generally is present only in trace amounts. Traces of pyrite are distributed throughout the unit, locally forming dark streaks, and partially replacing some siliceous fossils. Trace amounts of zeolite, green phyllosilicates, volcanic glass, and quartz, which might be authigenic, have also been observed. Burrow mottling is extensive in the chalky layers. A pebble-sized clast in Core 22 was emplaced by the drilling operation.

A middle Miocene age for Unit 1c is indicated by diatoms and radiolarians; however, the foraminifera suggest a middle to late Miocene age. Sediment accumulated at a minimum average rate of 35 m/m.y., based on the dating by siliceous fossils and including Core 21 (Unit 1b) and Core 27 (Unit 2) both of which are middle Miocene in age.

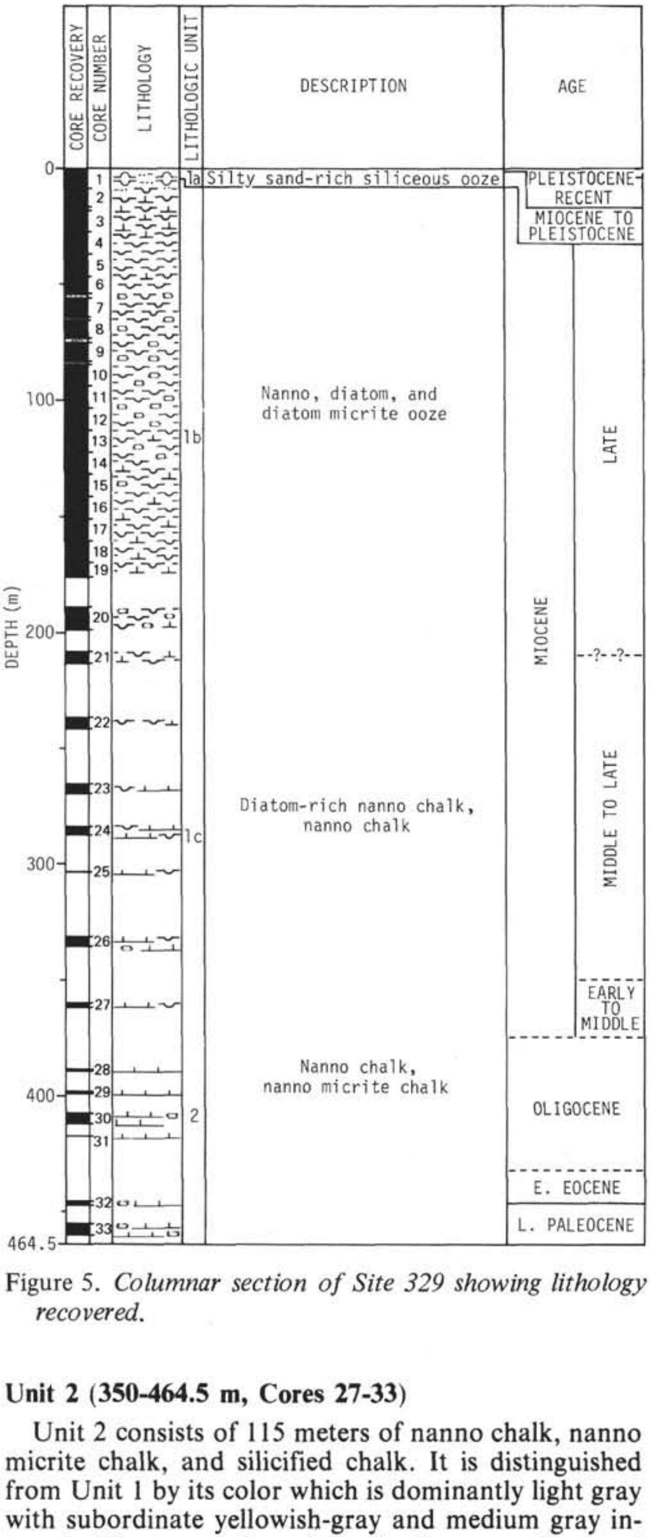


Figure 5. *Columnar section of Site 329 showing lithology recovered.*

Unit 2 (350-464.5 m, Cores 27-33)

Unit 2 consists of 115 meters of nanno chalk, nanno micrite chalk, and silicified chalk. It is distinguished from Unit 1 by its color which is dominantly light gray with subordinate yellowish-gray and medium gray intervals. The top of the unit lies in the uncored interval between Cores 26 and 27, and the unit extends to the base of the hole at 464.5 meters.

Calcareous nannofossils are the principal biogenic components, although disaggregation to micrite and recrystallization to authigenic carbonate is common. Diatoms constitute between 3% and 15% of the sediment, and other siliceous organisms amount to less than 5% of the total. Foraminifera reappear in amounts up to 5%. No clastic sand- or silt-sized grains were observed, but trace amounts of clastic material were detected by X-ray examination. Pebble-sized clasts emplaced as a result of drilling operations occur in Cores 27 to 30. Pyrite is distributed in trace amounts and partially replaces some siliceous fossils. Although zeolite in amounts up to 10% was recorded in smear slides, bulk X-ray examination did not confirm its presence except in trace amounts. Silicification is localized. X-ray data show that cristobalite and subordinate tridymite constitute the silica minerals, so that the silicified layers may be classed as opal-CT. The poor recovery in some cores may result from drilling difficulties associated with the presence of thin hard silicified layers. Bioturbation is widespread and some structures can be identified as *Zoophycos*. Pelecypod shells are sparsely distributed in Core 33.

Core 27, which has a significantly higher proportion of diatoms than deeper cores, is middle Miocene in age.

Cores 28 to 31 are assigned to Oligocene; there is considerable uncertainty as to how much early Oligocene may be present. A minimum sedimentation rate of 7.5 m/m.y. was determined for this interval.

Section 1 of Core 32 is early Eocene, and the remainder (Section 4, Cores 32 and 33) is Paleocene. Sediment accumulated at a rate of 3.3 m/m.y. during this interval from the late Paleocene into the early Eocene, based on the planktonic foraminiferal zones.

PHYSICAL PROPERTIES

Mass physical properties (wet bulk density, porosity, and water content) were determined during the cruise using gravimetric and GRAPE methods. Sonic velocities were measured within a few hours after each core was recovered using the Hamilton frame system. These values are shown in the site summary graphic logs and core summaries. Acoustic impedances were calculated from these measurements.

Thirty-three cores were recovered down to a depth of 464.5 meters, consisting of nanno diatom oozes and nanno chalks ranging in age from Pleistocene to Paleocene. The top 180 meters of the hole were cored continuously, resulting in a detailed, although rather homogeneous profile of physical properties. The first seven cores, from the sea floor down to 65 meters depth, exhibited various degrees of disturbance and sampling was only performed at those places apparently free from deformation (Cores 6 and 7 were not sampled).

Main changes in the relatively uniform character of mass properties are first noticed at 220 meters (where diatom oozes become chalks), and between 350-375 meters and at 430 meters (within nanno chalks and nanno micarb chalks).

Down to 220 meters, typical porosities are relatively high, ranging between 65% and 75% (average 70%), wet bulk densities vary between 1.35 g/cm^3 and 1.60 g/cm^3 (average 1.43 g/cm^3), and water content between 45% and 59% (average 50%).

Eighty-four measurements of sonic velocities performed continuously across the thick sequence of middle to late Miocene oozes mentioned above are consistently low and uniform, averaging 1.53 km/sec.

Consolidation of sediments (consisting of nanno diatom oozes and chalks) increases gradually with depth between 220 meters and 350 meters. Within this interval, sonic velocities are rather uniform, averaging 1.60 km/sec. Other mass physical properties also change with respect to the upper section and exhibit uniform average values within the section (wet bulk density, 1.56 g/cm^3; porosity, 63%; water content, 41%).

Between 350 meters and 420 meters sonic velocities increase apparently linearly with depth to 1.75 km/sec (velocity gradient is about 1.77/sec) across nanno chalks and nanno micrite chalks. The last two cores recovered (445-465 m), consisting of nanno micrite chalks, show a rather abrupt increase in measured velocities (2.06 to 2.25 km/sec).

From 350 meters depth to the bottom of the hole, wet bulk densities increase from 1.60 g/cm^3 to 2.02 g/cm^3, porosities decrease from 60% to 36%, and water content from 40% to 18%.

Average acoustic impedance is uniform across the top 250 meters (average 2.23×10^5 g/cm^{2}sec), increasing to an average of 3.00 at 400 meters depth and 4.41 g/cm^{2}sec at the pair of bottom cores consisting of more indurated micrite chalks. The plotted values are estimated to be accurate to ±7% syringe porosity, ±6% GRAPE porosity, ±0.1 g/cm^3 syringe bulk density, and ±1% velocity.

PALEONTOLOGY

Biostratigraphic Summary

Site 329, located on the western slope of the Maurice Ewing Bank, was chosen to examine the Neogene shallow-water biostratigraphy of the Southern Ocean, specifically that part of the section overlying Eocene and older sediments and sedimentary rocks encountered at nearby Site 327.

A total of 464.5 meters of sediment was penetrated at Site 329. Of this, 312.5 meters of sediment were cored, of which 179.5 meters were cored continuously from the sea floor.

A thin veneer of Pleistocene-Recent (less than 200,000 yr B.P.) sediment was encountered in the first section of Core 1. The remainder of Core 1 contains a mixed assemblage of Miocene, Pliocene, and Quaternary siliceous microfossils. Cores 2 through 27 contain late to middle Miocene, gray-green nanno-diatom ooze rich in radiolarians. Silicoflagellates are common throughout this interval; however, siliceous microfossils decline in abundance beginning in Core 27. Diatoms are absent from the sediment by Core 31. Radiolarians are present through Core 33, but are rare. Calcareous nannofossils are abundant in every core and foraminifera are common throughout, with the exception of Cores 2 to 6.

The position of the boundary between the late and middle Miocene is dubious in Hole 329. It is placed between Cores 20 and 22 on the basis of diatoms, between Cores 21 and 23 on the basis of radiolarians, and between Core 26, Section 1 and Core 27, Section 1 on the basis of foraminifera.

No solid evidence for the presence of early Miocene sediments at Site 329 was encountered among the calcareous nannofossils or radiolarians. However, foraminifera identified as late middle to early Miocene were encountered in Core 27. Due to the discrepancy in ages indicated by the diatoms, radiolarians, and foraminifera, the interval from Cores 21 through 27 is assigned an age of middle to late Miocene. Both foraminifera and calcareous nannofossils indicate that the Miocene/Oligocene boundary is between Cores 27 and 28.

The discrepancy between the middle and upper Miocene boundaries as determined by diatoms and radiolarians versus foraminifera probably originates in correlation problems still existing between low and temperate high latitude zonations. The foraminiferal boundary is based on the first evolutionary occurrence of *Neogloboquadrina acostaensis* (this event is used in most middle and low latitude biostratigraphic zonations). For the diatoms and radiolarians, high latitude zonations developed from DSDP Leg 28 cores were used to pick the boundary (see Chen, 1975; McCollum, 1975).

Cores 28 through 31 are dated Oligocene by foraminifera and coccoliths. Section 1 of Core 32 contains early Eocene coccoliths assigned to the *Orthostylus tribrachiatus* Zone or below, an assignment in agreement with foraminiferal and radiolarian determinations. The Eocene/Paleocene boundary is placed within a void interval between Sections 1 and 4 of Core 32. Section 4 of that core and Core 33 belong to the coccolith late Paleocene *Discoaster multiradiatus* Zone. Foraminifera in Section 4 of Core 32 indicate a late Paleocene to earliest Eocene age. Core 33 contains late Paleocene foraminifera. Radiolarians are very rare and poorly preserved in Core 33, yielding no diagnostic index species. A considerable amount of section between Cores 31 and 32 was lost due to drilling difficulties encountered in a cherty part of the Oligocene section. Thus, part of the Oligocene and Eocene may have been lost during drilling, or a hiatus may exist there.

The great accumulation of diatoms and calcareous nannofossils during the middle and late Miocene at Site 329 suggests a period of high primary productivity in the vicinity of the East Falkland Plateau during that time, perhaps initiated by upwelling currents which supplied nutrients to the surface waters, thus fostering the prolific growth of the primary producers. The rate of sediment accumulation represented by this section exceeds 30 m/m.y. and was probably enhanced by local accumulation of sediment due to eddying of currents flowing generally northward over the Falkland Plateau. This is also suggested by the consistent occurrence in the Miocene ooze of reworked Paleogene microfossils.

Diatom, radiolarian, nannofossil, and foraminiferal assemblages as well as silicoflagellate ratios all indicate that water temperatures during the late and middle Miocene were generally cool to cold. This is apparently also true of the Oligocene. The Paleocene, and especially the early Eocene, however, were characterized by milder climatic conditions than those which prevailed during the late Paleogene and early Neogene.

Planktonic Foraminifera

Sample 1-1, 38-40 cm contains an assemblage identical to those found in the topmost cores of Sites 326 and 327. It can be correlated with the upper Pleistocene-Recent *Globorotalia truncatulinoides* Zone on the basis of the presence of the zonal marker.

Samples 1-2, 100-102 cm and 1-3, 104-106 cm can probably be assigned to the lower part of the *Globorotalia inflata* Zone based on the co-occurrence of *G. inflata* and *G. puncticulata* (sensu Kennett, not Deshayes) in the absence of *G. truncatulinoides.*

The variable abundance of planktonics in the lower half of the core makes a zone assignment virtually impossible. The core catcher contains a mixed assemblage with *G. puncticulata* and *G. truncatulinoides* co-occurring.

Throughout the entire interval between Cores 1 and 25, planktonic foraminifera are often diluted among the siliceous remains of diatoms and Radiolaria. Characteristic species are virtually lacking, and the extremely low-diversity assemblages mainly consist of *Globigerina bulloides* and *Globorotalia scitula*, the latter only intermittently present. *Globorotalia panda, G. anfracta, Globigerinita glutinata*, and *G. uvula* appear at irregular intervals.

Cores 25 and 26 contain a distinct upper Miocene (N16) assemblage with *Neogloboquadrina acostaensis* and its ancestor *Turborotalia continuosa.* Above Core 25 the morphology of *N. acostaensis* is less characteristic and compact. Four-chambered forms close to *Neogloboquadrina pachyderma* become dominant, replacing *N. acostaensis* above Core 12. At the same interval *T. continuosa* gradually develops into a form with a more umbilical, high-arched aperture.

Only the lower 40 cm of Core 27 was examined; the assemblages here are dominated by primitive members of the *Globorotalia miozea* lineage. Following Walters (1965), the bulk of the population has to be considered transitional between *G. praescitula* and *G. miozea.* Other species present are *Globigerina bulloides* s.l. and *Globigerinita glutinata.* In addition the core catcher contains *Globorotaloides* sp. and rare members of the *Globorotalia zealandica* lineage referable to *G. incognita.* Both the *G. miozea* and *G. zealandica* lineages co-occur in the lower Altonian Stage of New Zealand (sensu Scott, 1972) which is correlated with N6-N7 or upper lower Miocene by Berggren and Van Couvering (1974).

Compared to the Miocene, fairly diverse assemblages are encountered in the Oligocene. The most dominant genera are *Subbotina* and *Globigerina*; less abundant are *Globorotaloides, Turborotalia, Catapsydrax*, and *Chiloguembelina.*

Moderate dissolution in Core 28 and to some degree in Core 29 has affected the species diversity, resulting in the irregular presence of some of the more delicate species like *Turborotalia munda* and *Chiloguembelina cubensis.* The rather uncharacteristic assemblage of Core 28 is dominated by *Globigerina brazieri*; much less abundant are *Catapsydrax unicavus, C. dissimilis*, and *Globorotaloides* sp.

In Cores 29-31, *Subbotina angiporoides* forms 50%-90% of the assemblages. Other species, ranked according to their abundance, are: *C. unicavus, T. munda, C. cubensis, Globorotaloides* sp., *C. dissimilis.* Irregular throughout the section are: *Turborotalia nana* and *Subbotina linaperta.* Forms with bullae are mostly confined to *S. angiporoides, C. unicavus, C. dissimilis*, and *S. linaperta.* Based on the co-occurrence of *S. angiporoides* and *T. munda*, Cores 29-31 can be correlated with the *S. angiporoides* Zone of New Zealand (Jenkins, 1971).

The reduced assemblage of Core 28 cannot be correlated by presence of a zonal marker. *S. angiporoides* appears to be a dissolution resistant species (Jenkins, 1975), so its absence in Core 28 indicates a stratigraphic level above the *S. angiporoides* Zone. In New Zealand both *T. munda* and *C. cubensis* survive *S. angiporoides* for a short time (Jenkins, 1971, 1974), as is the case in other parts of the world (Berggren, 1969; Berggren and Amdurer, 1973).

The latter authors, in an attempt to compare their South Atlantic DSDP Leg 3 sections with the planktonic foraminiferal zonations of both Jenkins and Blow, correlate the *S. angiporoides* Zone with Zone P_{18-20} of Blow. They consider the overlying interval before the extinction of *Chiloguembelina* to be equivalent with the lower part of Zone P_{21}.

Subbotina and *Acarinina* are the dominant genera in Cores 32 and 33. Morozovellids are present only in Core 32. Section 1 of Core 32 is assigned to the early Eocene on the basis of *Acarinina pseudotopilensis* and *Pseudohastigerina wilcoxensis.*

The assemblage includes: *Acarinina mckannai*-group, *A. soldadoensis, A. primitiva, A. esnaensis, A. wilcoxensis, A. aequa, A. apanthesma, Subbotina triangularis/patagonica*-group, *S. velascoensis, S. varianta, Morozovella subbotinae, Planorotalites australiformis, P. planoconica, Turborotalia reissi*, and *Chiloguembelina* spp.

Section 4 of the core contains the same assemblage, but *Acarinina pseudotopilensis* and *Pseudohastigerina wilcoxensis* are lacking; *Acarinina nicoli*, common in Core 33, is found in the lower part of the section. Section 4 is correlated with the topmost Paleocene based on the presence of *Morozovella subbotinae* and *A. wilcoxensis.*

The incoming of *Morozovella subbotinae* practically coincides with a major faunal change among the deep-water benthonics (from a Late Cretaceous-Paleocene fauna to an Eocene fauna), a situation also reported from Site 245 at 30° latitude in the Indian Ocean (Sigal, 1974). Core 33 contains a markedly different assemblage, possibly accentuated by the 1-meter stratigraphic gap between the two cores. Instead of angular Acarininids and Morozovellids, low-conical Acarininids belonging to the *Acarinina tadjikistanensis*-group and *A. convexa* are frequent.

Planorotalites australiformis and *P. planoconica* common in Core 32, continue until Section 3 as does *Subbotina varianta.* In the lower part of Section 4, the more evolved Acarininids like *Acarinina soldadoensis, A. primitiva*, and *A. esnaensis* disappear, leaving a low diversity assemblage with *Subbotina velascoensis, S. triangularis/patagonica*-group, *Acarinina mckannai* and *A. tadjikistanensis*-group (including *A. tadjikistanensis, A.* cf. *praepentacamerata* and *A. nicoli*), *A. convexa*, and *Chiloguembelina.*

The succession of faunas in Core 33 can be compared with that at middle and low latitudes due to the cosmopolitan character of the species. *Planorotalites australiformis* has been reported from New Zealand to replace the low latitude species *P. pseudomenardii* in the late Paleocene. Similarly *Acarinina soldadoensis, A. primitiva*, and *A. esnaensis* suggest a biostratigraphic level just above the *Planorotalites pseudomenardii* Zone.

On the other hand, the assemblage in the lower part of Section 4 is possibly equivalent with the *Planorotalites pseudomenardii* Zone as *Subbotina velascoensis, Acarinina mckannai*, and *A. convexa* are supposed to develop in that zone in the low latitudes.

Benthonic Foraminifera

The upper half of Core 1 contains a low diversity fauna dominated by *Bulimina aculeata* and *Trifarina angulosa.* Present also are *Uvigerina peregrina, Cassidulina crassa, Hoeglandina elegans, Pyrgo* sp., *Karreriella bradyi, Oridorsalis umbonatus*, and *Cibicidoides wuellerstorfi.*

The abundance of benthonic foraminifera is high relative to that of the planktonic foraminifera in the upper Miocene nanno-diatom ooze, often outnumbering the planktonics. The only exception occurs in Cores 2 through 6 where all foraminifera are sparse.

The upper Miocene is characterized by a bathyal-abyssal assemblage in which *Pullenia bulloides* is by far the most dominant species, only at some levels replaced by *Gyroidinoides neosoldanii* or *Eggerella bradyi.* In a number of samples *Oridorsalis umbonatus, Melonis pompilioides*, or *Fursenkoina earlandi* occur in abundance.

Common also are *Cibicidoides grossepunctatus, Pullenia quinqueloba, Melonis barleeanum, Pyrgo murrhina*, and in the upper part *Cibicidoides wuellerstorfi.* Characteristic, but less common, are *Karreriella bradyi, K. novangliae, Martinotiella communis, M. nolulosa, Sphaeroidina bulloides, Valvulineria laevigata*, and *Laticarinina pauperata.* Species irregular in their occurrence are: *Bulimina* aff. *subacuminata, Oridorsalis* cf. *sidebottomi, Trifarina earlandi, Globocassidulina subglobosa, Pyrgo depressa, Plectofrondicularia advena, Lagena elongata*, and *Orthomorphina ambigua.*

In the lower Oligocene nanno-chalk, benthonics are relatively common in Cores 28-29 due to moderate dissolution which affected the relative abundance of planktonic foraminifera. Dominant genera are *Uvigerina, Pullenia*, and *Neoeponides.* In addition *Cibicidoides, Gyroidinoides*, and *Anomalinoides* are common. Some of the characteristic species included in the assemblages are: *Pullenia bulloides, P.* cf. *quinqueloba, Neoeponides* cf. *waltonensis, Gyroidinoides girardana, Cibicidoides trincherasensis, Anomalinoides alazanensis, A. aragonensis, Nonion havanense, Laticarinina bulbrooki, Vulvulina jarvisi, V. spinosa*, and *Bulimina macilenta.*

The Eocene/Paleocene section of Cores 32 to 33 contains two distinct assemblages as is the case with the planktonic foraminifera. The boundary between these assemblages is situated between 32-4 and 32, CC, in fact slightly higher than the one which separates the two main planktonic assemblages. The assemblage in Core 32 is dominated by the genera *Oridorsalis, Cibicidoides, Bulimina*, and *Nuttallides.* Among others *Pullenia quinqueloba, Bulimina jarvisi, Aragonia aragonensis*, and *Gavelinella aragonensis* are characteristic species. In addition some long-ranging species like *Oridorsalis umbonatus, Nuttallides truempyi, Bulimina trinitatensis, Nodosaria velascoensis*, and *Nodosaria monile* are important. Similar faunas are present in the lower Eocene of the Upper Lizard Springs Fm of Trinidad as well as in the lower Eocene of DSDP sites at the Rio Grande Rise and in the Caribbean.

The assemblage in Core 33 and at the base of Core 32 is typical for the Paleocene of the Lower Lizard Spring Fm of Trinidad. The dominant species is *Gavelinella beccariiformis* and at some levels *Pullenia coryelli.* Common are *Oridorsalis umbonatus, Nuttallides truempyi, Tritaxia globulifera*, and various cibicdoidicids and lenticulinids. The assemblage is further characterized by: *Spiroplectammina spectabilis, S. cretosa, Gaudryina pyramidata, G. laevigata, Tritaxia* sp., *Lenticulina* sp., *Nodosaria limbata, N. monile, N. velascoensis, Frondicularia jarvisi, Neoflabellina jarvisi, Tappanina selmensis, Bolivinoides delicatulus, Coryphostoma limonense, Quadrimorphina allomorphinoides, Gyroidinoides globosa, G. girardana, G. quadrata, Gavelinella hyphalus, G. danica, Alabamina* sp., *Nonoinella* sp.

The marked absence of *Aragonia* and the common occurrence of species with outer shelf-middle bathyal depth preference (like *Tritaxia globulifera, Spiroplectammina cretosa, Tappanina selmensis, Neoflabellina jarvisi, Frondiculina jarvisi*, and *Nonionella* spp.) indicates a somewhat shallower depth (probably upper to middle bathyal) for the site during the late Paleocene.

Calcareous Nannofossils

Site 329, drilled about 55 km upslope from Site 327, provides a record of calcareous nannofossil deposition well above the carbonate compensation depth. Recovery of calcareous material was excellent, with abundant coccoliths in every core, most of which consist of carbonate ooze or chalk. Miocene and Oligocene nannofossils are generally well preserved, cold water forms highly restricted in species diversity as is characteristic of high latitudinal sites of deposition in the southern hemisphere. Assemblages are dominated by placoliths, particularly *Reticulofenestra, Coccolithus*, and *Cyclicargolithus.* Forms such as *Chiasmolithus altus* are common only in the high latitudes. Warm water genera such as *Discoaster, Ceratolithus, Triquetrorhabdulus*, and *Sphenolithus* are essentially absent. Low-latitude coccolith zonations based on occurrences of members of these genera are therefore unworkable for this part of the section.

As noted at Site 327, Eocene and Paleocene nannofloras are more diverse and cosmopolitan than those of younger strata, an indication of milder climatic conditions at this locality during the early Tertiary than subsequently. Thus coccolith zonations developed for low- to middle-latitude regions such as California and Europe are applicable to the Paleocene/Eocene part of the section. However, the high-latitude paleosite of deposition for the Paleocene assemblages is clearly indicated by the paucity of warm water forms such as *Discoaster* in comparison to the more abundant cool water *Chiasmolithus*.

Except for a thin veneer of Pleistocene sediment in the top of Core 1, Cores 1 through 26 are late to middle Miocene in age. Species diversity is extremely low, with assemblages composed almost entirely of *Reticulofenestra pseudoumbilica, Coccolithus pelagicus*, and other small placoliths. Reworking of Oligocene forms is noted throughout the section. Although modern *Coccolithus pelagicus* have a temperature preference of about 6°C to 14°C (McIntyre et al., 1970), the highly restricted species diversity at this site suggests surface water temperatures during the late Miocene toward the lower end of this temperature range—slightly warmer conditions are indicated by the presence of common *Cyclococcolithina leptopora* in Cores 15 to 17 (similar evidence is noted in the silicoflagellate floras).

Coccoliths do not provide conclusive evidence of lower Miocene sediment in the section cored. The Miocene/Oligocene boundary is placed between Cores 27 and 28 on the basis of abundant *Chiasmolithus altus* and *Reticulofenestra bisecta* in Core 28. These forms, along with *Cyclicargolithus floridanus*, dominate the low diversity Oligocene assemblages down to Core 31.

A considerable amount of section between Cores 31 and 32 was lost due to drilling difficulties encountered in a cherty part of the Oligocene section. Section 1 of Core 32 contians lower Eocene coccoliths assigned to the *Orthostylus tribrachiatus* Zone or below. The Eocene/Paleocene boundary is placed within a void interval between Sections 1 and 4 of Core 32. Section 4 of that core and Core 33 belong to the uppermost Paleocene *Discoaster multiradiatus* Zone.

Diatoms

Diatoms are abundant at Site 329 in Cores 1 through 28, are present in trace amounts in Cores 29 and 30, and are absent from the remaining cores. Diatoms are generally poor to moderately well preserved in the 30 cores in which they are present. *Thalassiothrix* spp. are the dominant forms through the first 28 cores, often constituting over 50% of the flora.

Core 1, Section 1 is dated as Pleistocene to Recent on the occurrence of *Coscinodiscus lentiginosus* and *Nitzschia kerguelensis*.

Sections 2 to 4 of Core 1 contain a mixed Miocene through Recent diatom assemblage. Diatoms occurring within this interval include: *Coscinodiscus lentiginosus, Coscinodiscus* sp.2 McCollum, *Nitzschia kerguelensis, Nitzschia interfrigidaria, Nitzschia praeinterfrigidaria, Cosmoidiscus insignis, Denticula hustedtii, Denticula antarctica, Denticula dimorpha*, and *Thalassiosira burckliana*.

Samples 2-1, 113-115 cm through 28, CC contain Miocene diatoms. Elements of the following zones of McCollum (1975) were noted in that interval: *Denticula antarctica* Partial Range Zone, *Denticula antarctica/Coscinodiscus lewisianus* Zone, *Denticula lauta/Denticula antarctica* Partial Range Zone, *Denticula hustedtii/Denticula lauta* Partial Range Zone, and the *Denticula hustedtii* Partial Range Zone. Due to extensive reworking in this interval it was not possible to segregate these zones. The early late Miocene boundary is placed between Cores 26 and 27 on the basis of planktonic foraminifera. Cores 29 and 30 are late to middle Oligocene in age. *Pyrgupyxis prolongata, Hemiaulus polymorphus*, and *Stephanopyxis* spp. occur in this interval.

Radiolaria

Radiolaria are commonly encountered in the sediment of Cores 1 through 28 at this site. From the top of Core 29 downward through Core 30 they rapidly decrease in numbers and in Cores 31 to 33 they are rare. Their preservation is generally good, except in the last interval (Cores 29 through 33) where dissolution of the radiolarian assemblages is evident. Diversity, however, is in general rather low except in the interval from Cores 23 through 27. The general appearance is that of a typical cold water assemblage with a reduced number of species but a quite large number of specimens.

A mixed late Miocene to Pleistocene assemblage is found in Core 1 suggesting a thin layer of Pleistocene sediment at the sediment surface. The sediment below this, a radiolarian-diatomaceous ooze, is very soupy in the first few cores and could have been easily disturbed and contaminated in the drilling process. From Core 2 on down through Core 23 the assemblages are of the *Theocalyptra bicornis spongothorax* Zone of the late middle Miocene and the late Miocene.

Theocalyptra bicornis spongothorax is not encountered in the core-catcher sample of Core 23. Instead, a considerably different fauna is present which belongs to the *Antarctissa conradae* Zone. Assemblages of this zone are found in samples from Cores 23 through 26. It is difficult to assign an age to the sediment of Core 27. *Actinomma tanyacantha*, which is never common in the sediment above, seems to be absent, as *Antarctissa conradae* appears to be. Aside from *Theocalyptra bicornis spongothorax*, most of the critical species of Chen's (1975) Miocene zonation are rare. It cannot be ascertained if the middle and early Miocene zones are absent (hiatus) or if biogeographic faunal patterns are responsible.

The sediment from the core catcher of Core 27 contains the last cored sediment of Miocene age. Core 28 can be placed without any doubt in the upper Oligocene. This would mean that a large part of the sedimentary record is missing, i.e., the lowermost part of the middle Miocene and the entire lower Miocene.

The Oligocene assemblages show strong dissolution effects with abundant to common remains of orosphaerid Radiolaria (spines and mesh fragments) and the dominating presence of robust heavy forms. The last two cores retrieved at this site, Cores 32 and 33, are placed in the interval belonging either to the upper Paleocene or lower Eocene. The radiolarians are rare and poorly preserved.

In both core catchers of these cores pieces of silicified limestone as well as zeolitic molds of radiolarians were found. This explains the sudden deterioration in preservation of the siliceous microfossils and their scarcity in the surrounding sediment.

Throughout the entire Miocene sedimentary section small amounts of older reworked fossils were observed. In the upper cores this older admixed fauna is mainly of middle Miocene and Oligocene age. In the lower part of the section, Oligocene and rare cases of Paleocene species are the contaminants. The presence of these older fossils reworked into the younger sediments again underscores the important role which bottom current processes have played in the sedimentary history of this entire area.

Silicoflagellates

A reasonably diverse (over 20 forms and species) silicoflagellate assemblage was recovered from the Miocene cores at Site 329. The upper Miocene sediments of Cores 1 to 15 belong to the *Mesocena circulus* and *Mesocena circulus/Mesocena diodon* Zones (see Busen and Wise, these reports). Exceptionally cold water conditions are indicated by the predominance of *Distephanus* and *Mesocena circulus* throughout this interval. Ciesielski (1975) notes that at DSDP Leg 28 sites in the Pacific sector of the Southern Ocean, strata which contain the *Mesocena circulus* Zone assemblage also provide sedimentologic evidence suggestive of severe glacial climatic conditions during the late Miocene.

Calcareous nannofossil species such as *Cyclococcolithina* in Cores 15 to 17 indicate somewhat warmer conditions for this interval. This suggestion is supported by the sharp increase there in the number of warm water indicating silicoflagellates which belong to the genus *Dictyocha*. The Oligocene Cores 28-29 are assigned to the *Naviculopsis biapiculata* Zone.

CORRELATION OF REFLECTION PROFILE WITH LITHOLOGY

As at the other Leg 36 sites, there was no independent check on the validity of compressional wave velocities measured aboard *Glomar Challenger*; no sonobuoy data were acquired and no distinctive acoustic reflector was cored. The great majority of measurements was made parallel to bedding; values measured perpendicular to bedding were lower by about 2% on the average, the difference being greater in the more consolidated samples from the lowest part of the hole.

The unmodified velocities are plotted against depth in Figure 6, together with a model velocity-depth function. (Velocities greater than 2.4 km/sec are plotted on the depth axis in Figure 6, to save space.) An admixture of ice-rafted terrigenous detritus in the upper 5 meters gives rise to a slightly higher velocity there than in the underlying Miocene siliceous and calcareous oozes of Units 1b and 1c. Continuous coring in the upper part of the hole permitted a dense velocity sampling, but no systematic variations in velocity as large as ±0.02 km/sec are seen. Velocities increase slightly through Unit 1d, which is more consolidated, becoming a nanno chalk near the base. Further, sharper velocity increases occur in the mid-Miocene to Paleocene chalks of Unit 2, and rare cristobalitic porcellanites or cherts within these layers possess even higher velocities.

The section at Site 329 appears to represent increasing compaction with age and depth, with secondary diagenesis, of a fairly consistent initial lithology of calcareous and siliceous biogenic oozes; under these circumstances it is not surprising that velocity and density vary approximately together. Variability and measurement errors are both greater for density than for velocity and, while the measurements are roughly consistent with the nature of the *Glomar Challenger* reflection profile at the site (Figure 4), which is typical for oozes, they cannot be used to account for the character of any particular one of the many reflections seen.

Reflections in the lower part of the profile are less regular and continuous and more diffuse than those above; this could be merely the cumulative effect of heterogeneity within the overlying sediments. On the other hand, diagenetic effects, starting below 320 meters and more common in Unit 2 below about 415 meters at the site, can be expected to produce diachronous acoustic impedance contrasts which will tend to degrade the original sedimentary order.

Two-way travel times to the boundaries between lithologic units can be obtained from the velocity-depth model, and are marked on the reflection profile. The base of the hole lies at 0.57 sec, close to the base of the sequence of reflections. The absence of reflections deeper in the profiler record probably results from a low signal level rather than from any drastic change in lithology, since the RC 16-06 profile (Figure 2) shows other deeper reflections close to the site, and Maestrichtian oozes occur downslope at Site 327.

The hole at Site 329 penetrated to the Paleocene, giving some overlap with Site 327, 55 km to the southwest. Correlation between these sites, using the *Glomar Challenger* and RC 16-06 reflection profiles, is attempted elsewhere (Barker, this volume).

SUMMARY AND CONCLUSIONS

Site 329, at 50°39.31'S, 46°05.73'W in 1519 meters of water on the western end of the Maurice Ewing Bank, was occupied from 0120 on 4 May to 0032 on 6 May 1974. The site lies about 55 km upslope and northeastward from Site 327 (see Figure 1) and was chosen to obtain a shallow-water, southerly, Neogene biostratigraphic section for comparison with the deep-water equivalent at Site 328 and the more northerly section which it was proposed to drill in the Argentine Basin (Site 331). The Neogene section had been avoided deliberately at Site 327 to examine more easily the earlier history of sedimentation on the Falkland Plateau.

A single hole was drilled, penetrating to 464.5 meters and bottoming in Paleocene nanno chalk. The hole was cored continuously to 179.5 and intermittently (mostly one core in three) from there to the base of the hole. A total of 312.5 meters was cored, with a recovery of 215.1 meters (69%). The hole was abandoned when

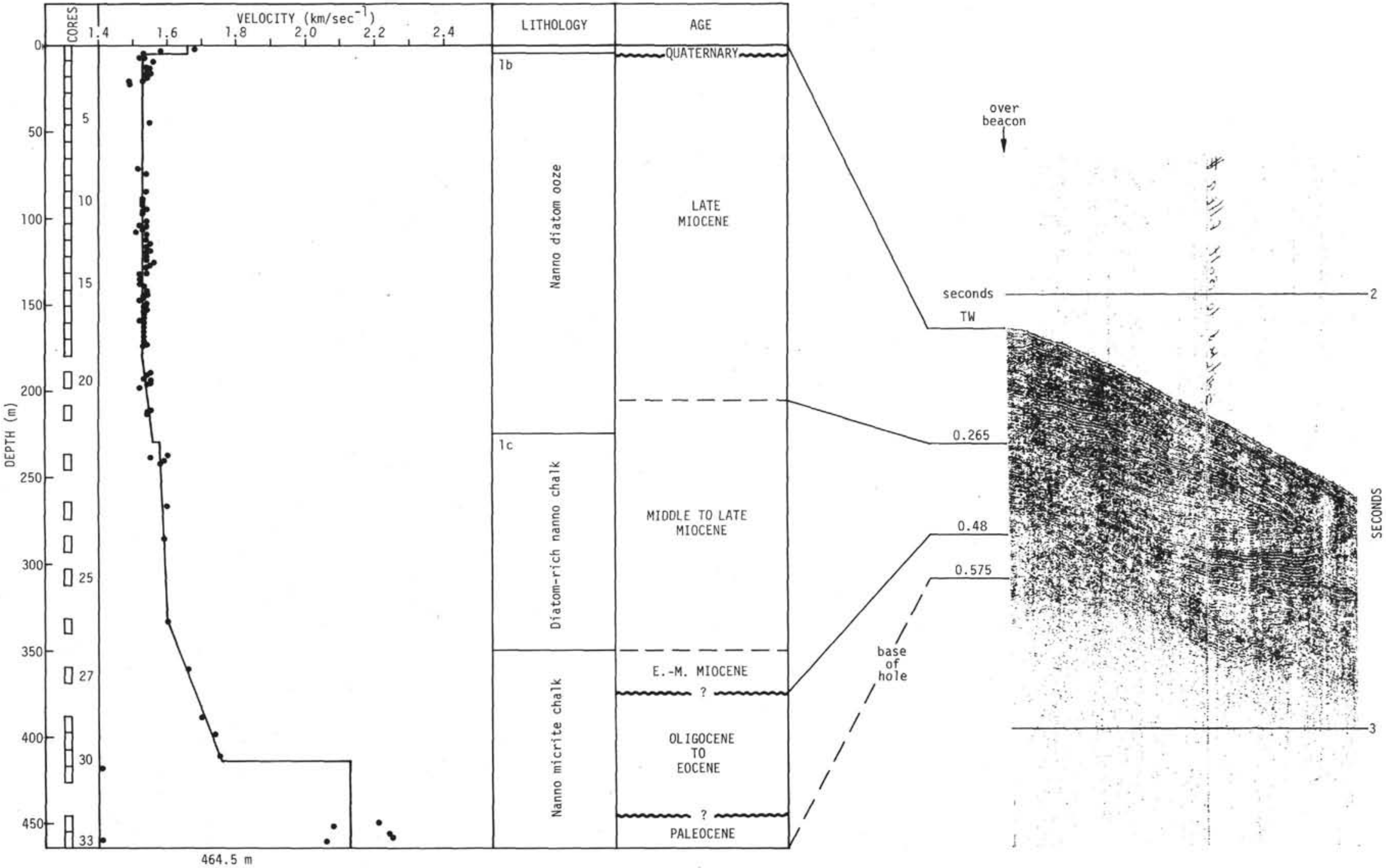


Figure 6. *Correlation between* Glomar Challenger *16-06 profile leaving Site 329 and lithology.*

some biostratigraphic overlap with Site 327 had been achieved.

The entire section at Site 329 is biogenic, and divides into two lithologic units, an upper unit of green ooze and chalk and a lower unit of gray chalk. Unit 1 is further divided into three subunits, the uppermost (1a) extending for only 4.5 meters subbottom. It is composed of sand-, silt-, and clay-rich diatomaceous ooze with ice-rafted terrigenous clasts, and yielded a mixed assemblage of late Miocene to Recent (predominantly Quaternary) fossils. The underlying subunit (1b), extending down to about 225 meters, is an upper Miocene nanno and diatom ooze, containing radiolarians, silicoflagellates, sponge spicules, and foraminifera. The lowest subunit (1c) differs from the overlying material in that the calcareous ooze is replaced by chalk. It is of middle to late Miocene age and approximately 125 meters thick.

Unit 2 is a nanno chalk, locally silicified and containing calcareous and siliceous microfossils of Paleocene to early or middle Miocene age; it extends from 350 meters to the base of the hole. Seismic velocity and density increase steadily down the hole; values in the Paleocene chalk towards the base of Unit 2 are 50% higher than in beds of the same age at Site 327.

The cores recovered at Site 329 reveal a history of sedimentation through the Cenozoic above the carbonate compensation depth in an area remote from sources of terrigenous detritus.

The upper and middle Miocene sediments accumulated at a rate in excess of 33 meters/m.y., an increase at least fivefold over that of the older sediments (see Figure 7). Rates of about 7 m/m.y. through the late Oligocene and about 3 m/m.y. during the Paleocene and early Eocene can be computed provided that hiatuses are inferred between Cores 27 and 28 (late Oligocene to early or middle Miocene) and Cores 31 and 32 (middle Eocene to early Eocene). Hiatuses over these periods occur also at Site 328. Post-middle Miocene sedimentation is restricted to the terrigenous, ice-rafted debris of the top 4.5 meters; an admixture of nannofossil ooze in the uppermost 1.5 meters of this unit can be used to confine its age within the last 0.2 m.y. Reflection profiles through the site (Figure 2) show that the Miocene sediments occur as a restricted bank, only 100 km long on the line of section. This, with the presence of reworked Oligocene fossils throughout the Miocene sediments, indicates that strong bottom currents swept the region and may have contributed to the unusually high local rates of accumulation. The profiles are consistent also with the virtual absence of post-Miocene sediments; Site 329 lies close to the apex of the bank and no obviously younger reflectors can be seen. Between there and Site 327, sediments of all ages between late Miocene and Eocene are exposed and the Oligocene-Miocene boundary (a proposed hiatus at the site) appears to be a more general unconformity. Some pre-middle Miocene erosion is indicated but, given that the Miocene beds contain reworked fossils only of Oligocene age, this may be less important than post-Miocene erosion in shaping the sea bed near the site.

Milder climatic conditions apparently prevailed at Site 329 during the Paleocene than during the later Paleogene and early Neogene. Miocene fossils are cold water forms, although a moderately warm water interval is seen in Cores 14 and 15. Ice-rafted debris is not seen with certainty within the late Miocene sediments, but the very high sedimentation rates make the site less sensitive in this respect than Site 328. A present best estimate of the age of initial opening of Drake Passage is 20 to 30 m.y. (Barker, in press); the consequent completion of a circumpolar current path, combined with an Antarctic continental glaciation starting in the late Oligocene (Hayes and Frakes, 1975) may be expected to produce the strong surface and bottom currents, and zones of high productivity, which appear to have governed Neogene sedimentation on the Falkland Plateau. In particular, the suggested late Oligocene to early or middle Miocene hiatus at Site 329, and the accompanying unconformity, may reflect the initial opening of Drake Passage. More speculatively, it is tempting to associate the older (middle to early Eocene) hiatus with a similar but more distant tectonic event, the separation of Australia from East Antarctica which started 55 m.y. ago (Weissel and Hayes, 1972).

REFERENCES

Barker, P.F., in press. The tectonic framework of Cenozoic volcanism in the Scotia Sea region—a review: Bull. Volc.

Berggren, W.A., 1969. Paleogene biostratigraphy and planktonic foraminifera of northern Europe: Internat. Conf. Plankt. Microfossils, Proc., 1st, Geneva, 1967, Leiden (E.J. Brill), p. 121-160.

Berggren, W.A. and Van Couvering, J.A., 1974. The late Neogene: biostratigraphy, geochronology and paleoclimatology of the last 15 million years in marine and continental sequences: Paleogeogr., Paleoclimat., Paleoecol., v. 16, p. 1-216.

Berggren, W.A. and Amdurer, M., 1973. Late Paleogene (Oligocene) and Neogene planktonic foraminiferal biostratigraphy of the Atlantic Ocean (Lat. 30°N to Lat. 30°S): Riv. Ital. Paleont., v. 79, p. 337-392.

Chen, P., 1975. Antarctic radiolaria, Leg 28, Deep Sea Drilling Project. *In* Hayes, D.E., Frakes, L.A., et al., Initial Reports of the Deep Sea Drilling Project, Volume 28: Washington (U.S. Government Printing Office), p. 437-514.

Ciesielski, P.F., 1975. Biostratigraphy and paleoecology of Neogene and Oligocene silicoflagellates from cores recovered during Antarctic Leg 28, Deep Sea Drilling Project. *In* Hayes, D.E., Frakes, L.A., et al., Initial Reports of the Deep Sea Drilling Project, Volume 28: Washington (U.S. Government Printing Office), p. 625-691.

Hayes, D.E. and Frakes, L.A., 1975. General synthesis, Deep Sea Drilling Project Leg 28. *In* Hayes, D.E., Frakes, L.A., et al., Initial Reports of the Deep Sea Drilling Project, Volume 28: Washington (U.S. Government Printing Office), p. 919-942.

Jenkins, D.G., 1971. New Zealand Cenozoic planktonic foraminifera: New Zealand Geol. Surv. Paleont. Bull. 42, p. 1-278.

———, 1974. Paleogene planktonic foraminifera of New Zealand and the Austral region: J. Foram. Res., v. 4, p. 155-170.

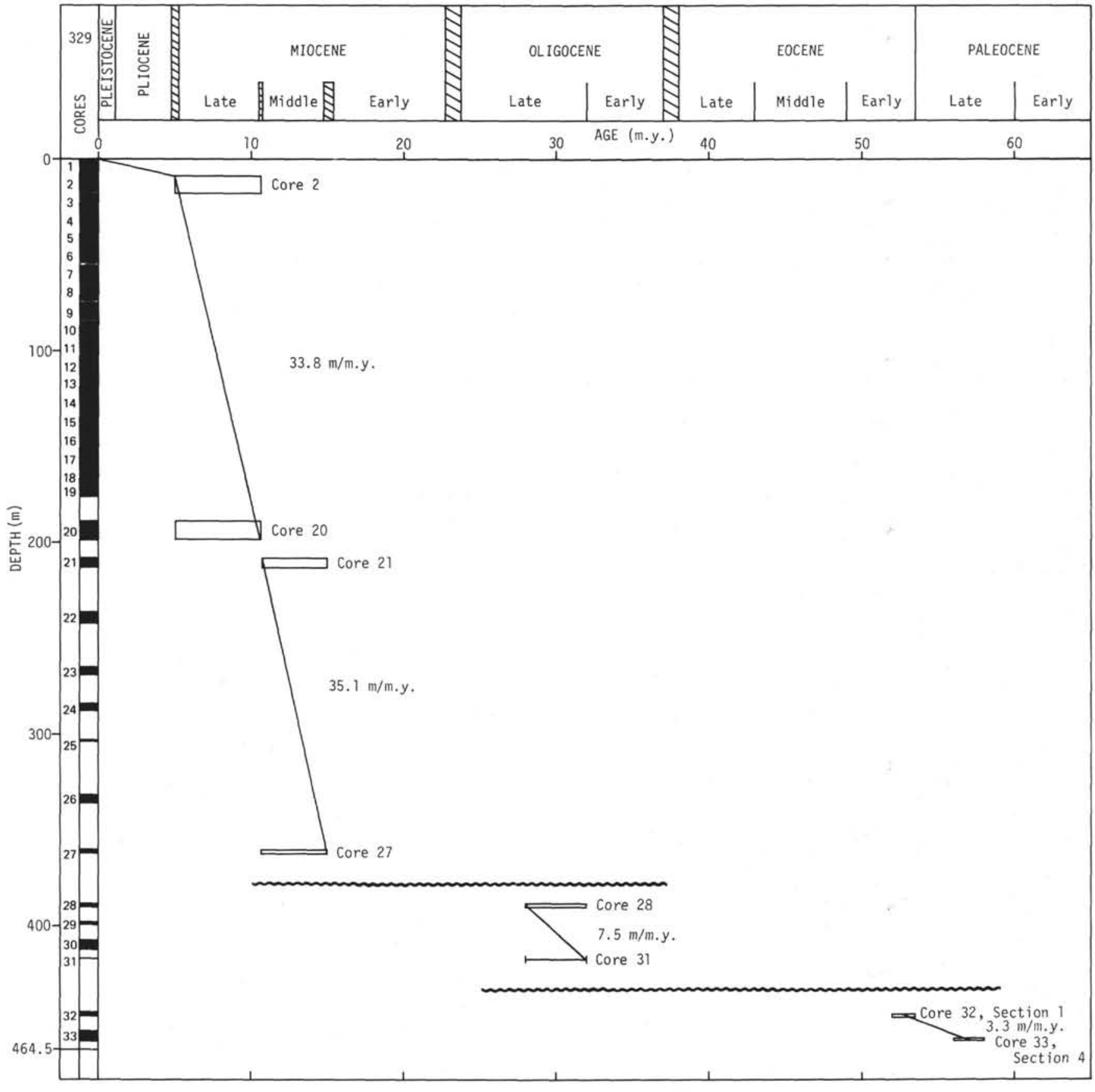


Figure 7. *Sedimentation rates at Site 329.*

———, 1975. Cenozoic planktonic foraminiferal biostratigraphy of the southwestern Pacific and Tasman Sea —DSDP Leg 29. *In* Kennett, J.P., Houtz, R.E., et al., Initial Reports of the Deep Sea Drilling Project, Volume 29: Washington (U.S. Government Printing Office), p. 449-467.

Lonardi, A. and Ewing, M., 1971. Bathymetry chart of the Argentine Basin (Map, no scale). *In* Physics and chemistry of the earth, v. 8: London (Pergamon Press).

McCollum, D.W., 1975. Diatom stratigraphy of the Southern Ocean. *In* Hayes, D.E., Frakes, L.A., et al., Initial Reports of the Deep Sea Drilling Project, Volume 28: Washington (U.S. Government Printing Office), p. 515-571.

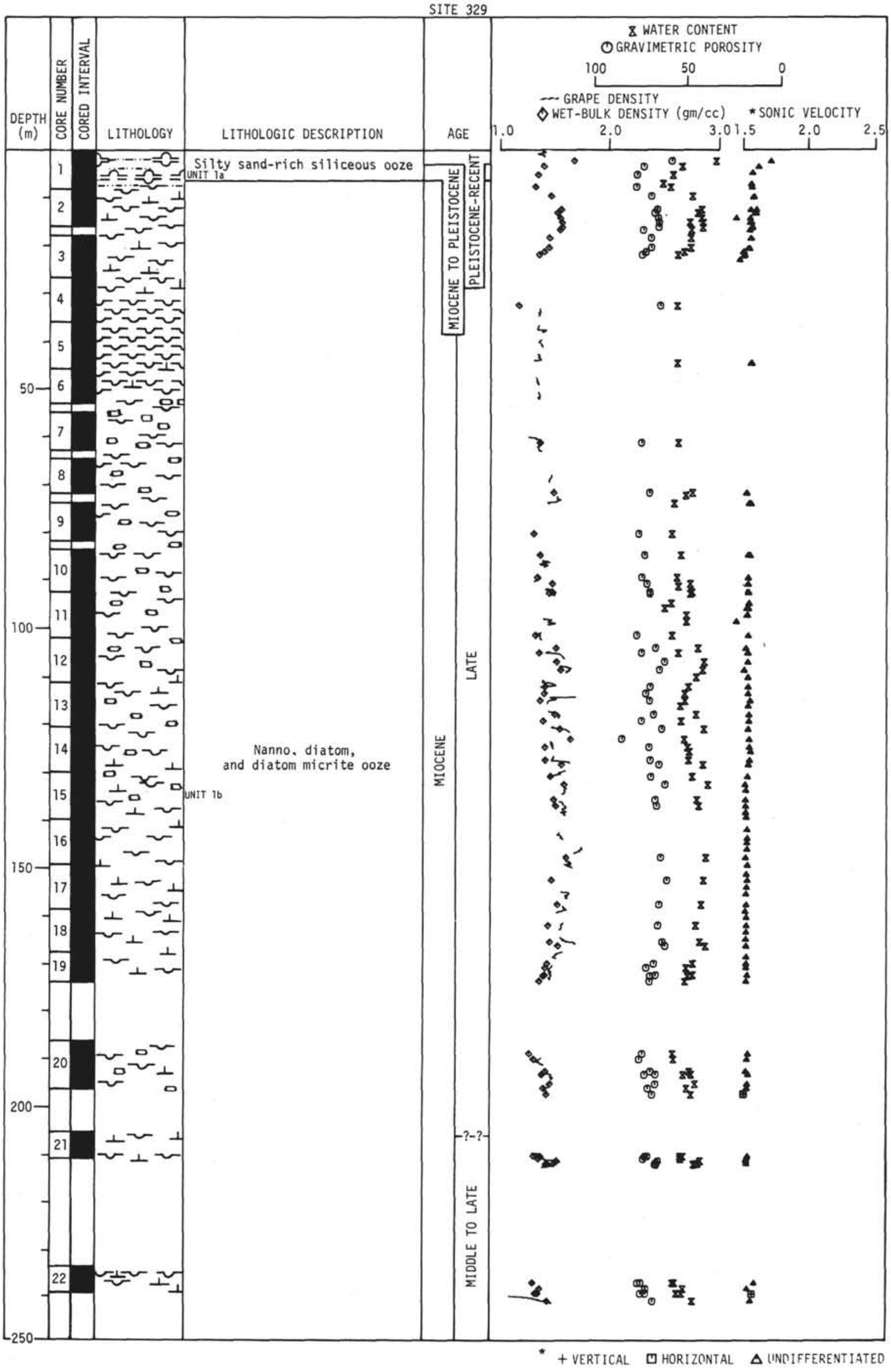
McIntyre, A., Ruddiman, W.F., and Roche, M.B., 1970. Modern Pacific Coccolithophorida: a paleontological thermometer: N.Y. Acad. Sci. Trans., v. 32, p. 720-731.

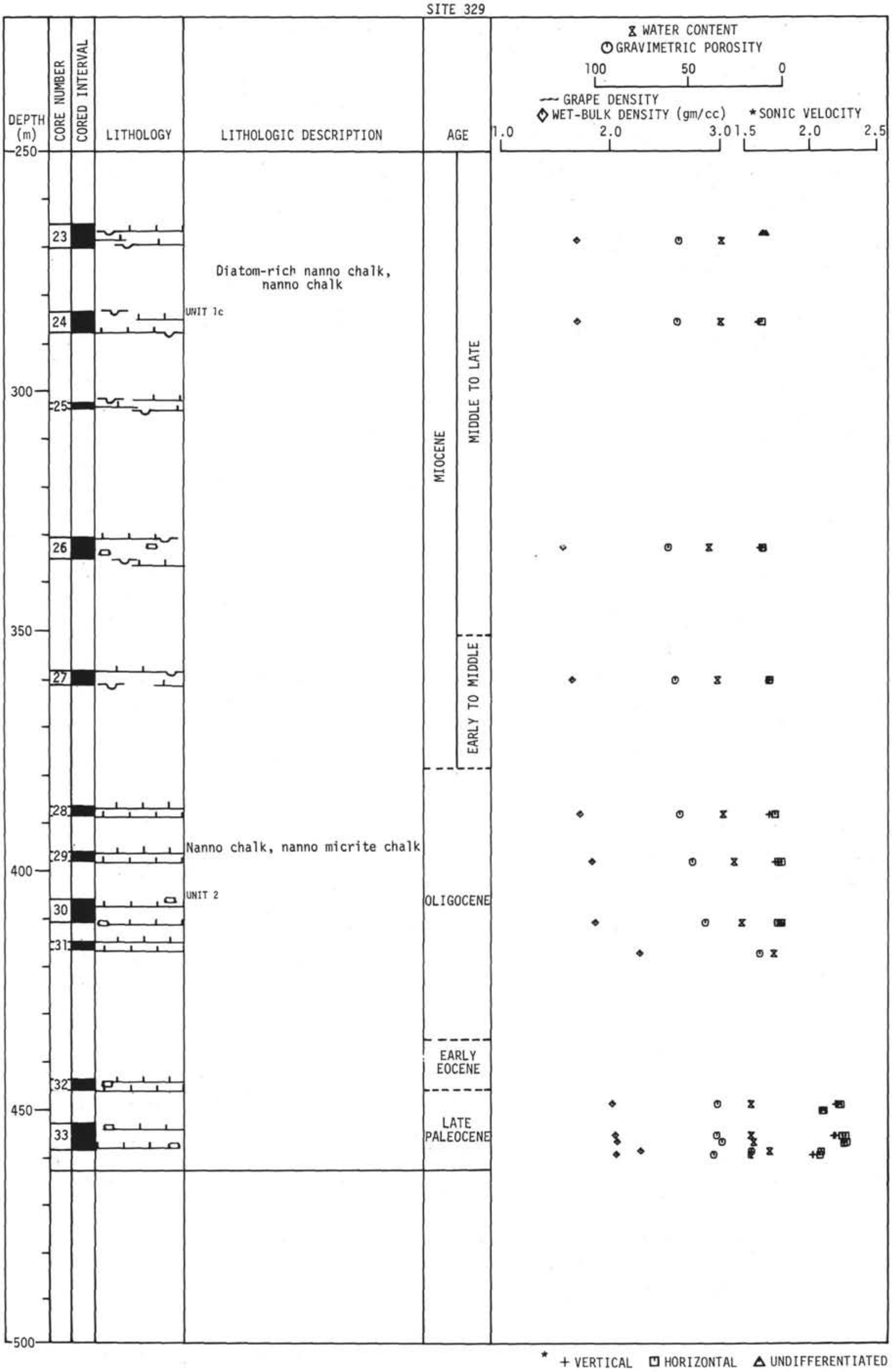
Scott, G.H., 1972. Revision of Hutchinsonian, Awamoan and Altonian Stages (Lower Miocene, New Zealand): New Zealand J. Geol. Geophys., v. 15, p. 49-70.

Sigal, J., 1974. In site report 245: biostratigraphy, Paleogene foraminifera. *In* Simpson, E.S.W., Schlich, R., et al., Initial Reports of the Deep Sea Drilling Project, Volume 25: Washington (U.S. Government Printing Office), p. 199-203.

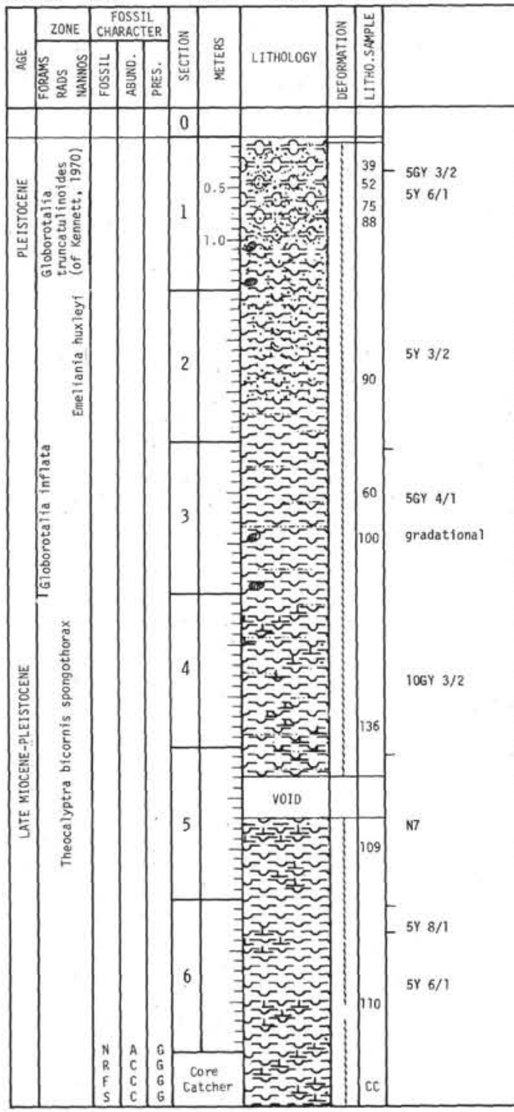
Walters, R., 1965. The *Globorotalia zealandica* and *G. miozea* lineages: New Zealand J. Geol. Geophys., v. 8, p. 109-127.

Weissel, J. and Hayes, D.E., 1972. Magnetic anomalies in the Southeast Indian Ocean. *In* Hayes, D.E. (Ed.), Antarctic Oceanology II: the Australian-New Zealand Sector: Antarctic Res. Ser., 19, Washington (Am. Geophys. Union), p. 165-196.


SITE 329
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
WATER CONTENT
GRAVIMETRIC POROSITY
100
50
0
GRAPE DENSITY
WET-BULK DENSITY (gm/cc)
*SONIC VELOCITY
1.0
2.0
3.0
1.5
2.0
2.5
50
100
150
200
250
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
Silty sand-rich siliceous ooze
UNIT 1a
Nanno, diatom, and diatom micrite ooze
UNIT 1b
MIOCENE TO PLEISTOCENE
PLEISTOCENE-RECENT
MIOCENE
LATE
-?-?-
MIDDLE TO LATE
* + VERTICAL
HORIZONTAL
UNDIFFERENTIATED


SITE 329
DEPTH (m)
CORE NUMBER
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
X WATER CONTENT
O GRAVIMETRIC POROSITY
100
50
0
GRAPE DENSITY
◇ WET-BULK DENSITY (gm/cc)
* SONIC VELOCITY
1.0
2.0
3.0
1.5
2.0
2.5
250
300
350
400
450
500
23
24
25
26
27
28
29
30
31
32
33
Diatom-rich nanno chalk, nanno chalk
UNIT 1c
Nanno chalk, nanno micrite chalk
UNIT 2
MIOCENE
MIDDLE TO LATE
EARLY TO MIDDLE
OLIGOCENE
EARLY EOCENE
LATE PALEOCENE
* + VERTICAL
□ HORIZONTAL
△ UNDIFFERENTIATED

Site 329 Hole Core 1 Cored Interval: 0.0-8.5 m



LITHOLOGIC DESCRIPTION

SILTY CLAY-RICH DIATOM OOZE(major lith)
SILTY SAND-RICH SILICEOUS OOZE (minor lith)
NANNO DIATOM OOZE (minor lith)

Banded grayish olive and light olive gray; grayish olive green, dark greenish gray, dusky yellowish green, light gray, yellowish gray, light olive gray. Silty clay rich diatom ooze is the major sediment type, but top part of core is a silty sand-rich silty siliceous ooze, and the lower part a nanno diatom ooze. Glacially derived clasts occur in the top three sections and sand sized quartz is prominent in these sections. Heavies include garnet, pyroxene, hornblende. Below section three, the sand sized quartz occurs only in trace amounts, although clay sized particles are still prominent. Nannoplankton increases below section three.

Characteristic smear slide

	1-39	3-60	4-136	5-109
diatoms	30	45	60	68
rads	20	5	TR	1
sponge spic.	3	-	-	-
silico.	2	TR	-	-
forams	5	-	-	TR
nannos	15	-	20	30
qtz.	15	15	TR	TR
feld.	5	5	-	-
heavies	TR	-	-	-
clay	5	30	20	1

Carbon-carbonate

	1-120 to 121	5-120 to 121
t. carb	0.5	3.5
o. carb	0.3	0.2
$CaCO_3$	2.0	28.0

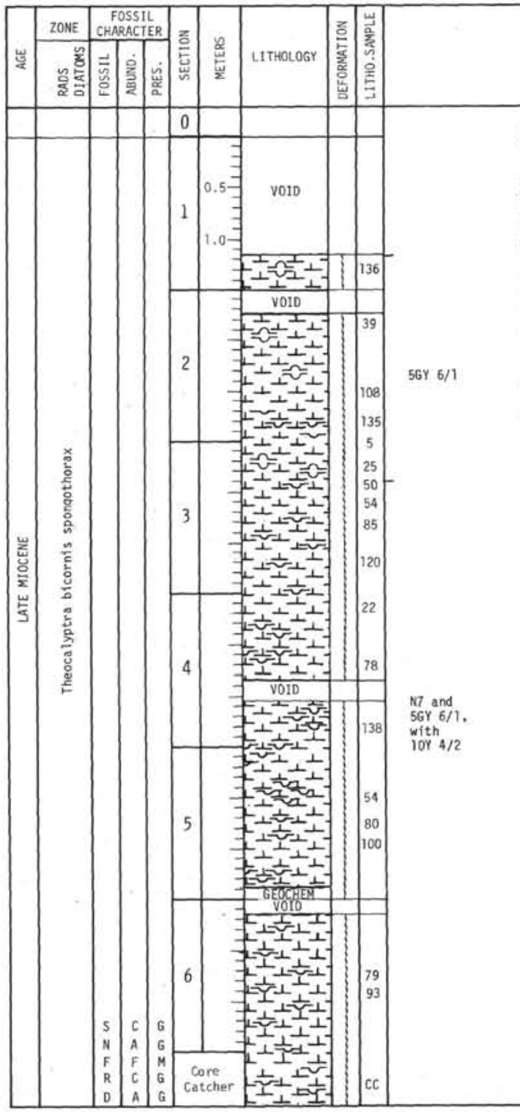
Grain size analysis

	2-100	5-100
sand	63.6	8.3
silt	20.7	35.3
clay	15.7	56.4

Bulk X-ray

	2-10 to 12
amor.	56.2
quar.	51.4
plag.	14.6
K-Fe.	12.9
mica	10.2
mont.	9.0
chlo.	1.9

Site 329 Hole Core 2 Cored Interval: 8.5-19.0 m



LITHOLOGIC DESCRIPTION

DIATOM NANNO OOZE (major lith)
DIATOM OOZE (minor lith)
SILICEOUS FOSSIL NANNO OOZE (minor lith)

Greenish gray, banded light gray and greenish gray and with grayish olive patches. Siliceous fossils, other than diatoms, locally abundant.

Characteristic smear slide

	1-136	2-135	3-120	6-79
nannos	50	25	65	60
diatoms	10	64	35	40
rads	5	3	TR	TR
sponge spic.	15	-	-	TR
qtz.	5	3	TR	TR
feld.	3	-	-	-
clay	10	5	-	-
calcite	2	-	-	-
vol. glass	-	TR	TR	-

Carbon-carbonate

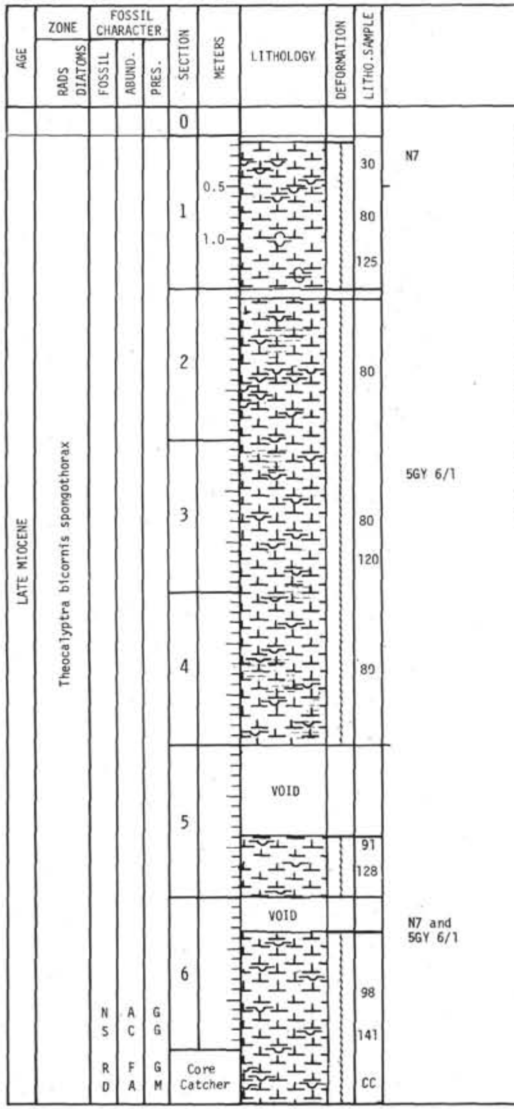
	3-120 to 121
t. carb	7.0
o. carb	0.2
$CaCO_3$	57.0

Grain size analysis

	1-128 to 130	6-128 to 130
sand	21.3	1.0
silt	37.7	39.0
clay	41.0	65.0

Explanatory notes in Chapter 1

Site 329 Hole Core 3 Cored Interval:18.0-27.5 m



LITHOLOGIC DESCRIPTION

DIATOM NANNO OOZE
Light gray, greenish gray, banded in lower part. Section 1 includes a zone with a variety of siliceous fossils.

Characteristic smear slide

	1-80	2-80	6-98
nannos	40	50	60
diatoms	25	60	30
rads	15	TR	TR
sponge spic.	3	-	-
silico.	2	-	-
forams	5	TR	TR
qtz.	2	TR	TR
feld.	1	-	-
clay	-	10	10
vol. glass	-	TR	-
micrite	7	-	-

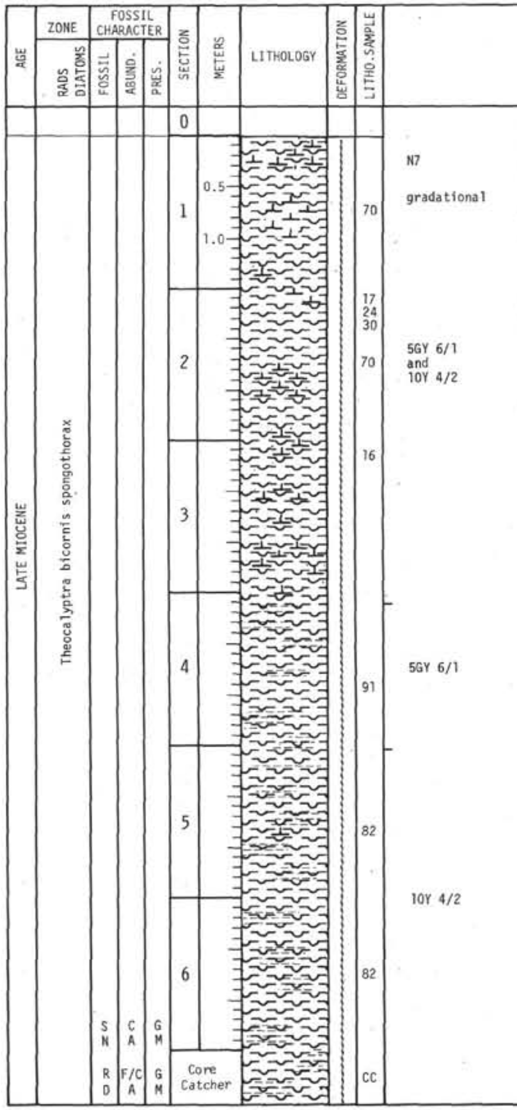
Carbon-carbonate

	4-50 to 51	6-100 to 101
t. carb	4.4	8.5
o. carb	0.3	0.1
$CaCO_3$	34.0	70.0

Grain size

	2-125	6-125
sand	3.0	1.0
silt	40.5	42.1
clay	56.5	56.9

Site 329 Hole Core 4 Cored Interval:27.5-37.0 m



LITHOLOGIC DESCRIPTION

DIATOM NANNO OOZE, DIATOM OOZE
Light gray gradational to greenish gray; greenish gray and grayish olive, banded. Dark pyrite-rich streaks and pockets. Nannos decrease down section.

Characteristic smear slide

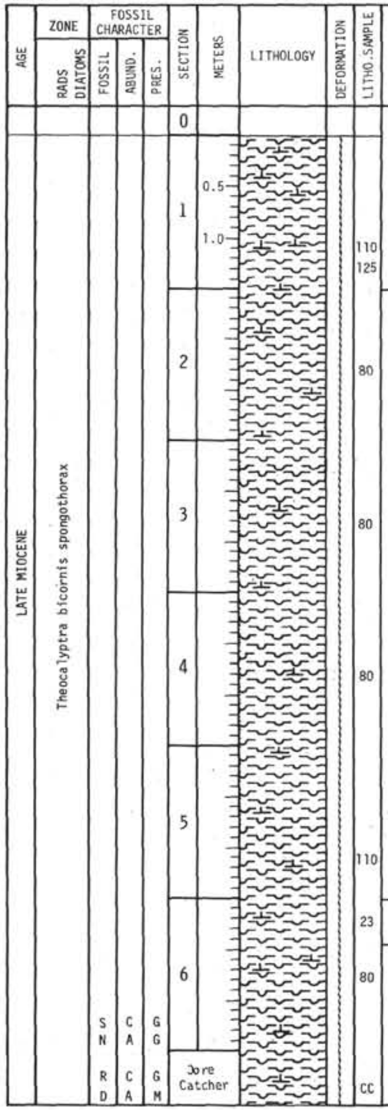
	1-70	3-16	5-82
diatoms	40	60	80
nannos	50	25	5
sponge spic.	5	-	-
silico.	5	-	-
clay	-	5	15
micrite	-	5	-
qtz.	TR	2	TR
heavies	-	-	TR
vol. glass	-	3	TR
forams	-	-	TR
rads	1	1	TR

Carbon-carbonate

	2-120 to 121	5-80 to 81
t. carb	0.4	1.4
o. carb	0.2	0.4
$CaCO_3$	51.0	9.0

Explanatory notes in Chapter 1

Site 329 Hole Core 5 Cored Interval: 37.0-46.5 m



LITHOLOGIC DESCRIPTION

10Y 4/2 and 5GY 6/1

DIATOM OOZE

Banded grayish olive and greenish gray, grayish olive. Micrite consists in part of nanno fragments.

Characteristic smear slide

	1-110	4-80	6-80
diatoms	75	90	77
nannos	15	5	10
micrite	-	-	10
clay	10	5	-
qtz.	TR	TR	-
feld.	-	TR	-
vol. glass	TR	-	-
pyrite	-	TR	1
forams	TR	TR	2
rads	TR	TR	-

Carbon-carbonate

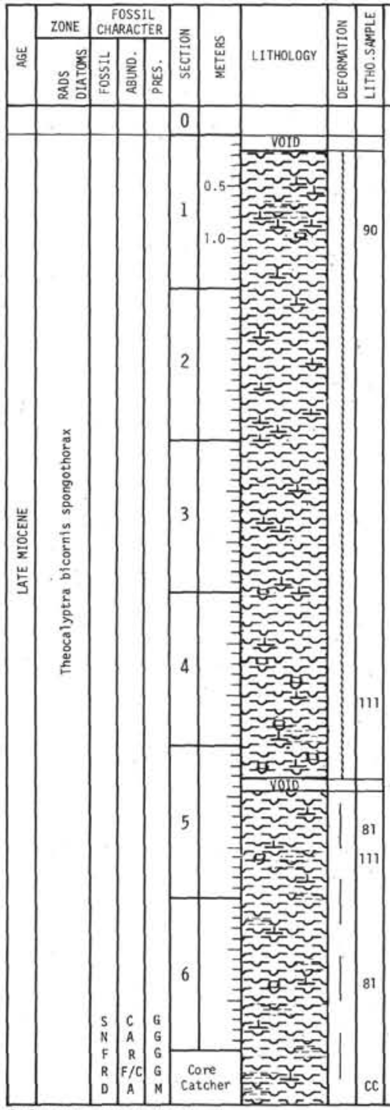
	3-80 to 81
t. carb	1.6
o. carb	0.4
$CaCO_3$	10.0

10Y 4/2

5GY 6/1

10Y 4/2

Site 329 Hole Core 6 Cored Interval: 46.5-56.0 m



LITHOLOGIC DESCRIPTION

NANNO DIATOM OOZE, DIATOM OOZE

Greenish gray in upper part, banded greenish gray and grayish olive in lower part. Micrite consists in part of nanno fragments.

Characteristic smear slide

	1-90	4-111	6-81
diatoms	45	69	65
nannos	42	10	15
micrite	3	15	5
clay	10	5	15
qtz.	TR	TR	-
micronods.	-	TR	-
forams	TR	TR	-
rads	TR	1	-
sponge spic.	-	-	TR
silico.	-	TR	-

5GY 6/1

Carbon-carbonate

	1-100 to 101	4-100 to 101
t. carb	2.8	2.1
o. carb	0.3	0.5
$CaCO_3$	21.0	13.0

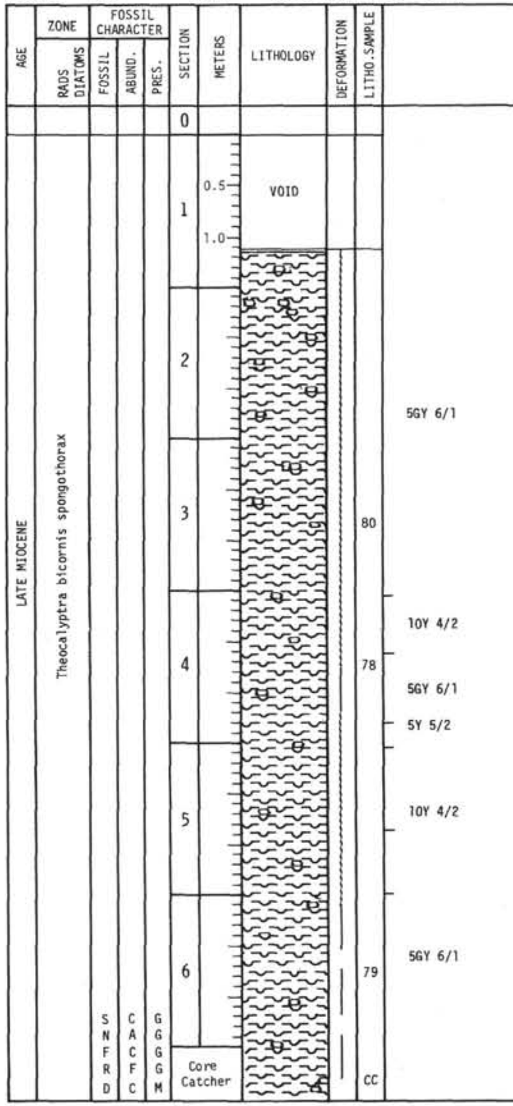
Bulk X-ray

	4-110 to 112
amor.	73.6
calc.	46.8
quar.	14.8
plag.	13.9
mont.	7.2
mica	6.0
K-Fe.	4.6
pyri.	2.3
chlo.	2.2
clin.	1.2

5GY 6/1 and 10Y 4/2

Explanatory notes in Chapter 1

Site 329 Hole Core 7 Cored Interval: 56.0-65.5 m



LITHOLOGIC DESCRIPTION

MICRITE-RICH DIATOM OOZE

Diapiric structures and vertical streaking common. Greenish gray, banded with grayish olive and olive gray in lower part. Micrite consists in part of nanno fragments. Silico. common in lower part.

Characteristic smear slide

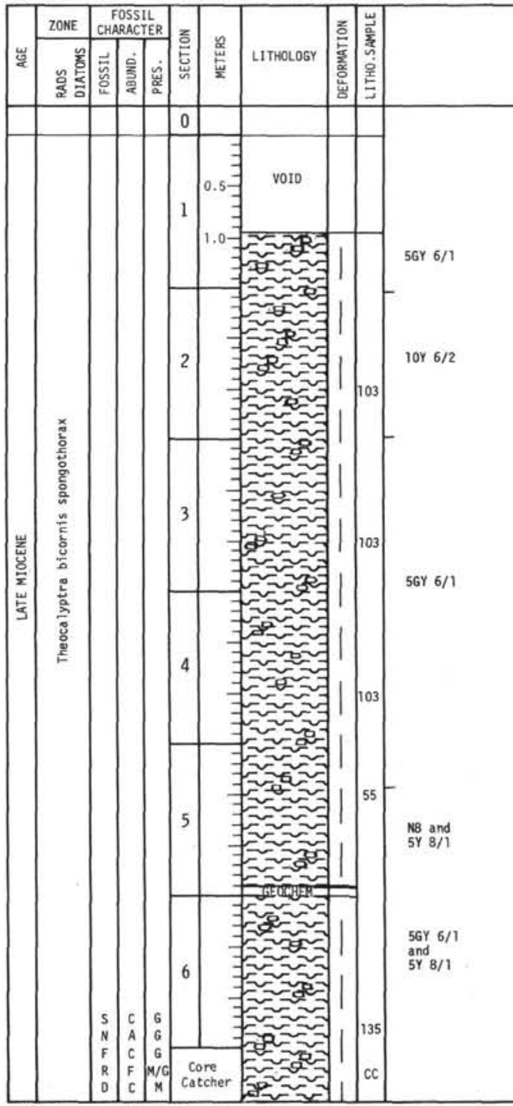
	3-80	4-78	6-79
diatoms	60	40	45
micrite	20	25	25
nannos	5	15	10
silico.	TR	15	15
clay	15	-	5
rads	TR	5	TR
sponge spic.	TR	-	-
forams	-	-	TR

Carbon-carbonate

	4-107 to 108	5-107 to 108
t. carb	4.7	3.5
o. carb	0.2	0.3
$CaCO_3$	37.0	27.0

	6-107 to 108
t. carb	3.7
o. carb	0.3
$CaCO_3$	28.0

Site 329 Hole Core 8 Cored Interval: 65.5-75.0 m



LITHOLOGIC DESCRIPTION

MICRITE DIATOM OOZE

Diapiric structures common. Greenish gray, pale olive, banded very light gray and yellowish gray, banded greenish gray and yellow gray. Greenish gray color associated with higher proportion of siliceous fossils. Micrite consists mainly of nanno fragments.

Characteristic smear slide

	2-103	4-103	6-135
diatoms	45	54	60
micrite	38	25	23
nannos	10	3	10
clay	5	3	5
forams	TR	-	TR
rads	TR	TR	2
sponge spic.	-	-	TR
silico.	2	15	TR

Carbon-carbonate

	2-100 to 101	3-30 to 31
t. carb	5.5	7.7
o. carb	0.3	0.2
$CaCO_3$	43.0	62.0

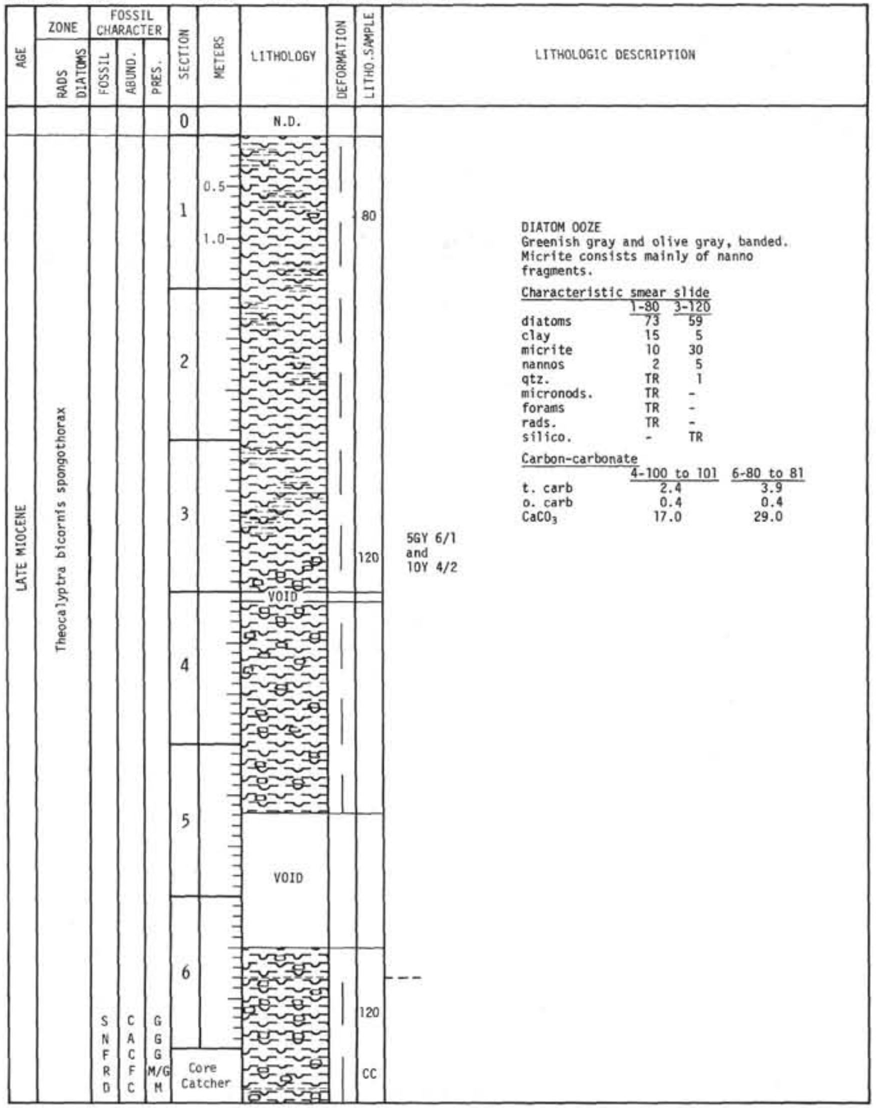
	5-100 to 101
t. carb	7.7
o. carb	0.2
$CaCO_3$	62.0

Bulk X-ray

	6-128 to 130
amor.	68.1
calc.	55.2
plag.	11.8
quar.	10.9
mica	6.8
mont.	6.1
K-Fe.	5.2
pyri.	1.7
chlo.	1.3
kaol.	1.0

Explanatory notes in Chapter 1

Site 329 Hole Core 9 Cored Interval: 75.0-84.5 m



DIATOM OOZE
Greenish gray and olive gray, banded.
Micrite consists mainly of nanno fragments.

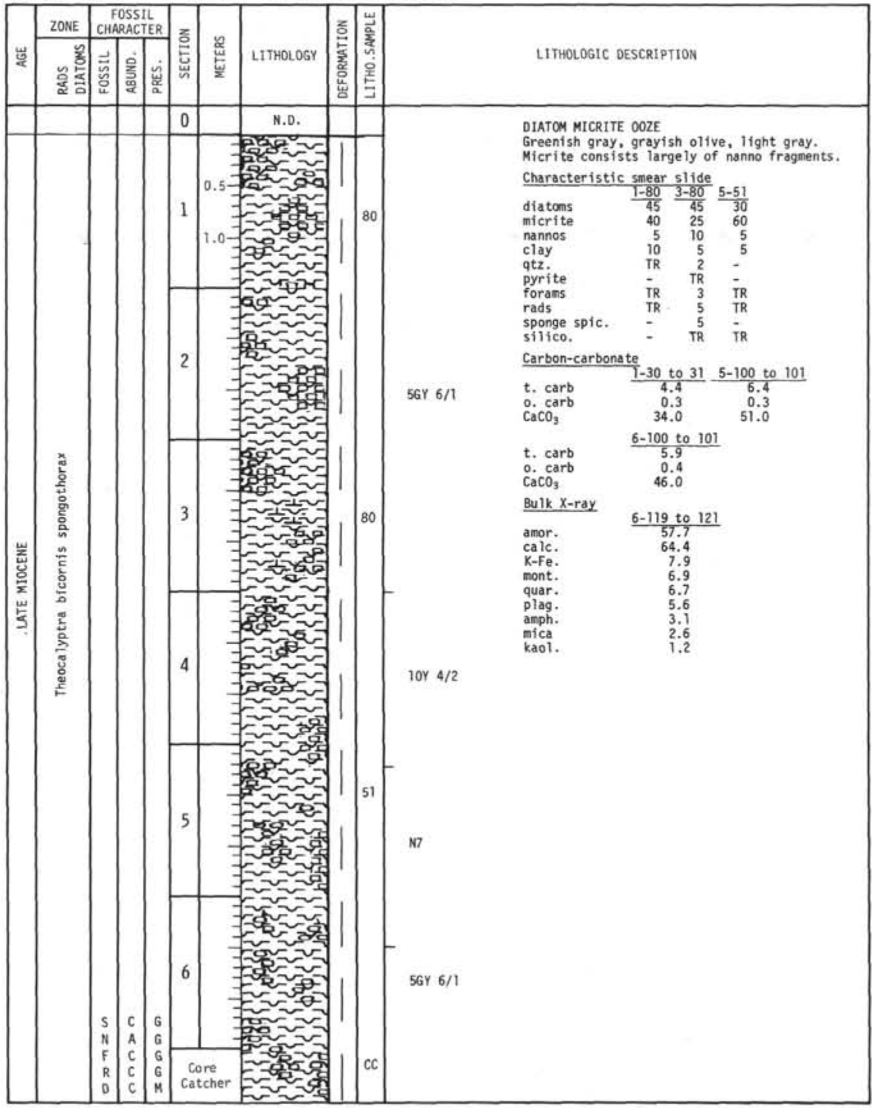
Characteristic smear slide

	1-80	3-120
diatoms	73	59
clay	15	5
micrite	10	30
nannos	2	5
qtz.	TR	1
micronods.	TR	-
forams	TR	-
rads.	TR	-
silico.	-	TR

Carbon-carbonate

	4-100 to 101	6-80 to 81
t. carb	2.4	3.9
o. carb	0.4	0.4
$CaCO_3$	17.0	29.0

Site 329 Hole Core 10 Cored Interval: 84.5-94.0 m



DIATOM MICRITE OOZE
Greenish gray, grayish olive, light gray.
Micrite consists largely of nanno fragments.

Characteristic smear slide

	1-80	3-80	5-51
diatoms	45	45	30
micrite	40	25	60
nannos	5	10	5
clay	10	5	5
qtz.	TR	2	-
pyrite	-	TR	-
forams	TR	3	TR
rads	TR	5	TR
sponge spic.	-	5	-
silico.	-	TR	TR

Carbon-carbonate

	1-30 to 31	5-100 to 101
t. carb	4.4	6.4
o. carb	0.3	0.3
$CaCO_3$	34.0	51.0

	6-100 to 101
t. carb	5.9
o. carb	0.4
$CaCO_3$	46.0

Bulk X-ray

	6-119 to 121
amor.	57.7
calc.	64.4
K-Fe.	7.9
mont.	6.9
quar.	6.7
plag.	5.6
amph.	3.1
mica	2.6
kaol.	1.2

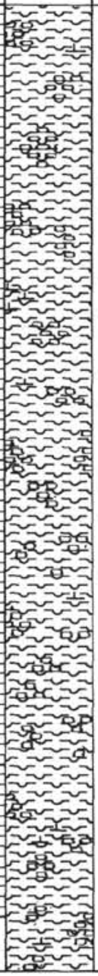
Explanatory notes in Chapter 1

Site 329 Hole Core 11 Cored Interval: 94.0-103.5 m

AGE	ZONE RADS DIATOMS	FOSSIL	ABUND.	PRES.
LATE MIOCENE	Theocalyptra bicornis spongothorax	S	C	G
		N	A	G
		F	C	G
		R	C	G
		D	A	M

SECTION	METERS	LITHO.SAMPLE	
0			
1	0.5 1.0		
2			
3		80	
4			10Y 6/2
5			
6		60	
Core Catcher		CC	

LITHOLOGY



DEFORMATION

LITHOLOGIC DESCRIPTION

MICRITE-RICH DIATOM OOZE
Pale olive with diapirs of light olive. Micrite consists largely of nanno fragments.

Characteristic smear slide

	3-80	6-60
diatoms	45	45
micrite	40	35
nannos	10	10
clay	-	10
rads		TR
sponge spic.	5	TR
silico.		TR
forams	TR	TR
qtz.	TR	-
pyrite	-	TR

Carbon-carbonate

	3-70 to 71	6-70 to 71
t. carb	5.5	3.0
o. carb	0.2	0.4
$CaCO_3$	44.0	22.0

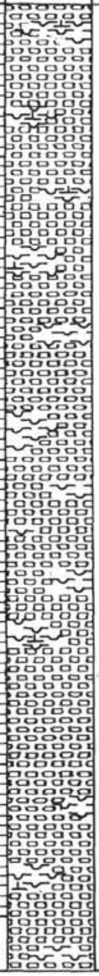
Site 329 Hole Core 12 Cored Interval: 103.5-113.0 m

AGE	ZONE RADS DIATOMS	FOSSIL	ABUND.	PRES.
LATE MIOCENE	Theocalyptra bicornis spongothorax	S	C	G
		N	A	G
		F	F	G
		R	C	G
		D	A	M

SECTION	METERS	LITHO.SAMPLE	
0			
1	0.5 1.0		
2			
3			5B 9/1
4		112	
5		115 10	10Y 6/2 with band of 5G 8/1
6		137	
Core Catcher		CC	

LITHOLOGY

N.D.



DEFORMATION

LITHOLOGIC DESCRIPTION

DIATOM MICRITE OOZE
Bluish white, pale olive with band of light greenish gray in lower part. Sparse dark streaks and mottling. Micrite largely consists of nanno fragments.

Characteristic smear slide

	4-112	6-10
micrite	70	40
diatoms	15	30
nannos	10	5
rads	5	10
sponge spic.	TR	5
silico.	TR	
zeol.	-	TR

Carbon-carbonate

	4-70 to 71	6-70 to 71
t. carb	9.5	3.6
o. carb	0.1	0.4
$CaCO_3$	78.0	27.0

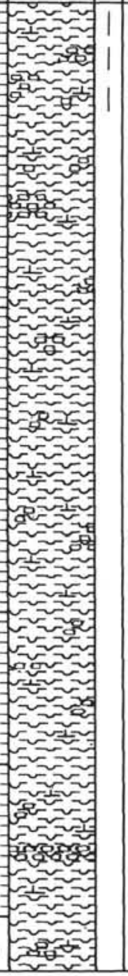
Bulk X-ray

	6-30 to 32
amor.	73.9
calc.	50.5
plag.	12.0
quar.	10.2
K-Fe.	8.1
mont.	7.6
mica	4.3
amph.	2.5
pyri.	1.5
clin.	1.3
chlo.	1.2

Explanatory notes in Chapter 1

Site 329 Hole Core 13 Cored Interval: 113.0-122.5 m

AGE	ZONE RADS DIATOMS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					0		N.D.			
LATE MIOCENE	Theocalyptra bicornis spongothorax				1	0.5 1.0		|	89	
					2					5GY 6/1
					3					
					4				85	5G 8/1 gradational
					5					5GY 6/1
					6				85	5B 9/1
		S N F R D	C A F/C C A	G G G G M	Core Catcher				CC	



NANNO-RICH DIATOM MICRITE OOZE
Greenish gray, light greenish gray, bluish white in bottom section. Proportion of diatoms drops down core, and proportion of preserved nannos increases. Micrite largely nanno fragments.

Characteristic smear slide

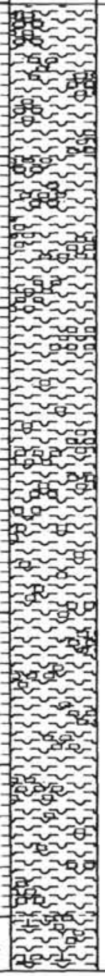
	1-89	4-85	6-85
diatoms	50	30	25
micrite	25	40	50
nannos	15	25	25
rads	5	3	TR
sponge spic.	3	2	TR
silico.	-	-	TR
forams	TR	-	TR
qtz.	TR	-	-
pyrite	TR	-	-
zeol.	2	-	-

Carbon-carbonate

	1-70 to 71	6-70 to 71
t. carb	2.7	8.3
o. carb	0.3	0.1
$CaCO_3$	20.0	68.0

Site 329 Hole Core 14 Cored Interval: 122.5-132.0 m

AGE	ZONE RADS DIATOMS	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					0		N.D.			
LATE MIOCENE	Theocalyptra bicornis spongothorax				1	0.5 1.0			61	5GY 6/1 N8 mottled with 5Y 6/1
					2					gradational to 5GY 6/1
					3					
					4				61 80	
					5				61	5B 9/1
					6					gradational to 10Y 6/2
		S N F R D	C A F/C C A	G G G G M	Core Catcher				CC	5GY 6/1



NANNO-RICH DIATOM MICRITE OOZE
Banded greenish gray, very light gray gradational to light greenish gray, bluish white gradational to pale olive. Sparse dark pyrite-rich streaks. Micrite largely made up of nanno fragments.

Characteristic smear slide

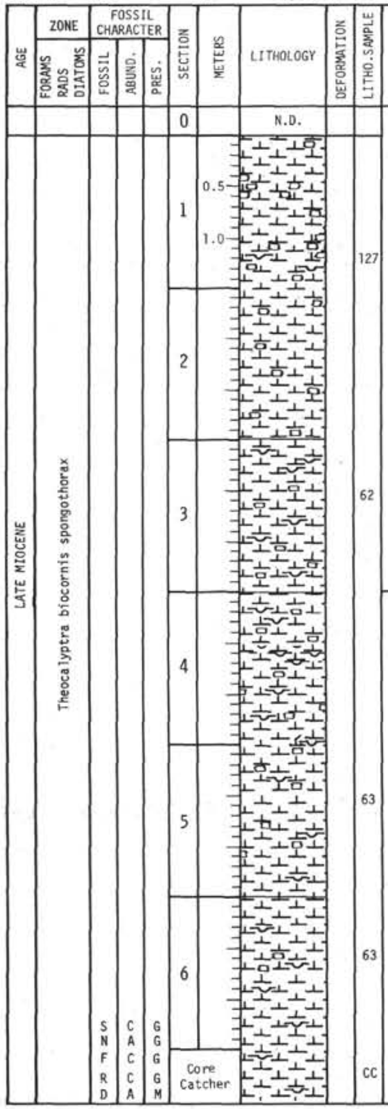
	1-60	4-61	5-61
micrite	40	60	60
diatoms	40	30	20
nannos	20	10	20
qtz.	TR	-	-
vol. glass	TR	-	-
pyrite	-	-	TR
forams	TR	TR	-
rads	TR	TR	TR

Carbon-carbonate

	3-80 to 81	5-80 to 81
t. carb	3.6	9.4
o. carb	0.3	0.1
$CaCO_3$	27.0	78.0

Explanatory notes in Chapter 1

Site 329 Hole Core 15 Cored Interval:132.0-141.5 m



LITHOLOGIC DESCRIPTION

N8

mottled with 5Y 8/1

5GY 6/1

gradational to N7

MICRITE NANNO OOZE (major lith)
DIATOM NANNO OOZE (minor lith)
Very light gray mottled with yellow gray in the upper part; greenish gray gradational to light gray in lower part. Dark pyrite-rich smears and patches. Micrite largely made up of nanno fragments.

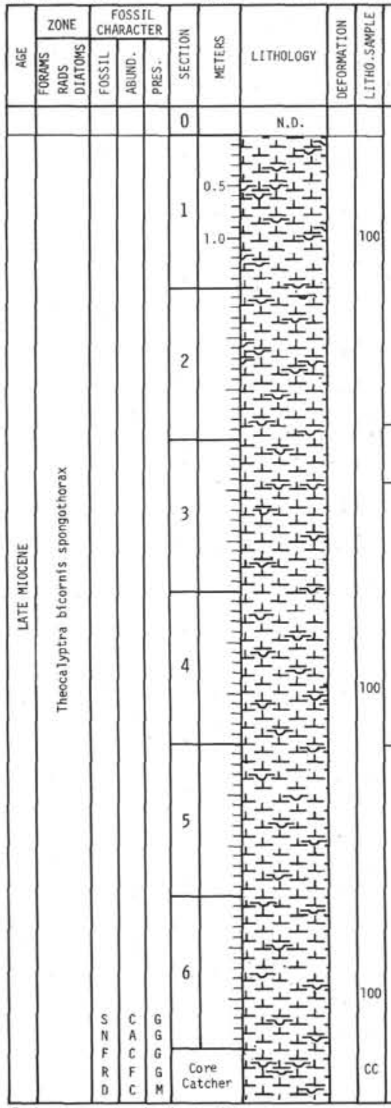
Characteristic smear slide

	1-127	3-62	6-63
nannos	30	30	65
micrite	45	25	15
diatoms	10	43	20
pyrite	15	1	-
rads	-	TR	TR
silico.	-	1	TR

Carbon-carbonate

	6-70 to 71
t. carb	7.9
o. carb	0.1
$CaCO_3$	65.0

Site 329 Hole Core 16 Cored Interval:141.5-151.0 m



LITHOLOGIC DESCRIPTION

5B 9/1
mottled with
5GY 6/1

N8

5B 9/1

N8

DIATOM-RICH NANNO OOZE
Light bluish gray, very light gray. Fine dark pyrite-rich streaks and mottles.

Characteristic smear slide

	1-100	4-100	6-100
nannos	42	75	80
diatoms	30	15	10
micrite	20	10	10
clay	8	-	-
vol. glass	TR	-	-
pyrite	TR	-	TR
forams	-	TR	-
rads	TR	TR	TR

Carbon-carbonate

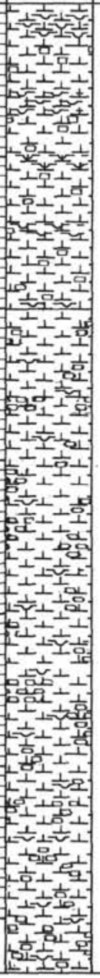
	1-90 to 91	4-90 to 91
t. carb	5.9	9.9
o. carb	0.1	0.1
$CaCO_3$	48.0	82.0

	6-81 to 82
t. carb	9.2
o. carb	0.1
$CaCO_3$	76.0

Explanatory notes in Chapter 1

Site 329 Hole Core 17 Cored Interval: 151.0-160.5 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					0		N.D.			
LATE MIOCENE	Neogloboquadrina acostaensis Theocalyptra bicornis spongothorax				1	0.5 1.0			100	10Y 6/2
					2					5GY 7/2 5Y B/1
					3				35	N9
					4				148	N8
					5					5GY 6/1
					6				100	N8 mottled with 5GY 6/1
		S N F R D	C A A C A	G G G G M	Core Catcher				CC	



DIATOM NANNO OOZE
Pale olive, grayish yellow green, yellow gray, very light gray, banded and locally mottled. Scattered pyritic streaks. Micrite consists largely of nanno fragments.

Characteristic smear slide

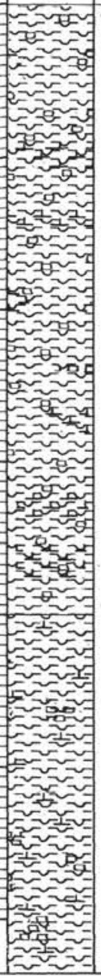
	1-100	6-100
diatoms	40	20
nannos	40	40
micrite	15	40
clay	5	-
qtz.	TR	TR
pyrite	TR	TR
forams	TR	TR
rads	TR	TR
silico.	TR	TR

Carbon-carbonate

	4-90 to 91
t. carb	8.6
o. carb	0.1
$CaCO_3$	71.0

Site 329 Hole Core 18 Cored Interval: 160.5-170.0 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					0		N.D.			
LATE MIOCENE	Neogloboquadrina acostaensis Theocalyptra bicornis spongothorax				1	0.5 1.0				
					2				80	5GY 6/1
					3				138	
					4					N7
					5				80	5GY 6/1
					6				80	
		S N F R D	C A C C C	G G G G P	Core Catcher				CC	



NANNO DIATOM OOZE
Greenish gray with mottling in yellowish gray and olive black. Thin layer of light gray. Sparse dark pyrite-rich streaks. Lower part of core has fewer nannos.

Characteristic smear slide

	3-80	3-138	6-80
diatoms	35	30	50
nannos	35	32	10
micrite	30	27	30
clay	-	-	10
forams	-	-	TR
rads	TR	1	TR
sponge spic.	-	-	TR
silico.	TR	-	-
qtz.	-	-	TR
pyrite	-	TR	-

Carbon-carbonate

	2-30 to 31	4-100 to 101
t. carb	6.9	7.7
o. carb	0.2	0.1
$CaCO_3$	56.0	63.0

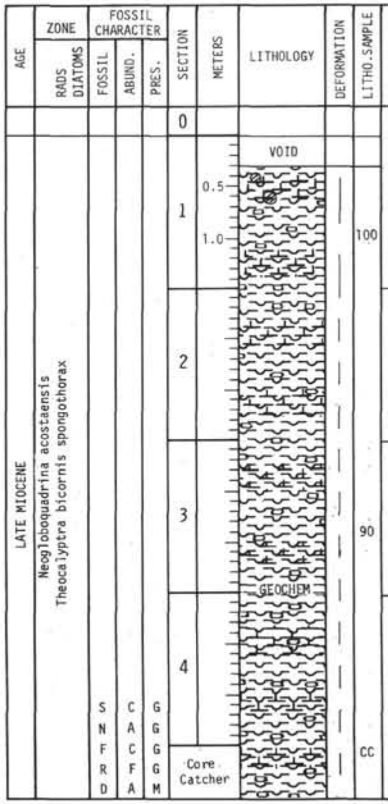
	6-100 to 101
t. carb	4.3
o. carb	0.3
$CaCO_3$	33.0

Bulk X-ray

	6-86 to 90
amor.	64.4
calc.	59.0
mont.	8.6
quar.	7.7
K-Fe.	7.3
plag.	7.3
mica	4.8
amph.	2.9
kaol.	1.1
pyri	0.8

Explanatory notes in Chapter 1

Site 329 Hole Core 19 Cored Interval: 170.0-179.5 m



N7
mottled with
10Y 6/2

5GY 6/1

N7

5GY 6/1

LITHOLOGIC DESCRIPTION

NANNO DIATOM OOZE
Alternating light gray and greenish gray ooze. Lithic clasts are regarded as downhole contaminants.

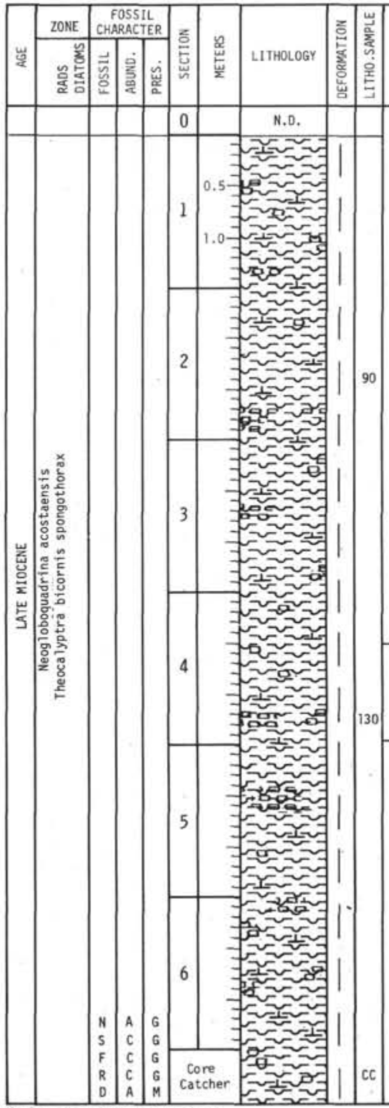
Characteristic smear slide

	1-100	3-90
diatoms	50	39
nannos	20	30
micrite	20	30
clay	10	-
qtz.	TR	TR
pyrite	TR	1
forams	-	TR
rads	-	TR
sponge spic.	-	TR
silico.	TR	TR

Carbon-carbonate

	3-65 to 66	4-65 to 66
t. carb	4.1	4.5
o. carb	0.2	0.3
$CaCO_3$	33.0	35.0

Site 329 Hole Core 20 Cored Interval: 189.0-198.5 m



5GY 6/1
mottled with
10Y 4/2
5Y 2/1

N7

5Y 6/1
mottled with
5Y 2/1
10Y 6/2

LITHOLOGIC DESCRIPTION

NANNO-RICH MICRITE DIATOM OOZE
Greenish gray mottled with grayish olive and olive black, gradational to light gray and then gradational to light olive gray, mottled with olive black. Olive black mottling due to pyrite concentration. Micrite includes disaggregated nannos.

Characteristic smear slide

	2-90	4-130
diatoms	45	30
micrite	30	43
nannos	15	25
clay	10	-
forams	TR	1
rads	TR	1
sponge spic.	TR	TR
qtz.	TR	-
vol. glass	-	TR
pyrite	TR	-

Carbon-carbonate

	2-100 to 101	4-100 to 101
t. carb	2.9	6.2
o. carb	0.4	0.2
$CaCO_3$	21.0	50.0

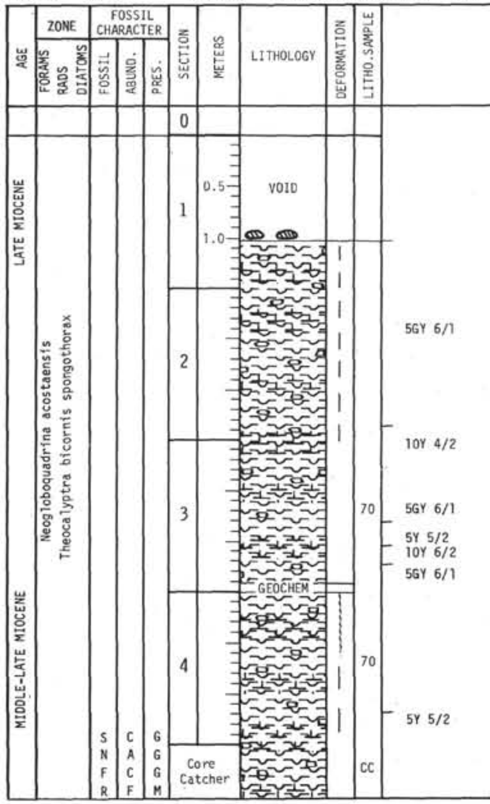
	6-100 to 101
t. carb	4.4
o. carb	0.2
$CaCO_3$	35.0

Bulk X-ray

	2-101 to 105
amor.	75.0
calc.	58.5
plag.	9.6
quar.	9.1
mica	7.4
mont.	6.6
K-Fe.	3.8
pyri.	2.7
chlo.	1.4
kaol.	1.1

Explanatory notes in Chapter 1

Site 329 Hole Core 21 Cored Interval: 208.0-217.5 m



LITHOLOGIC DESCRIPTION

NANNO-RICH DIATOM OOZE
Greenish gray with layers of grayish olive, light olive gray, pale olive. Pyrite-rich streaks. Micrite includes disaggregated nannos. Lithic clasts are regarded as downhole contaminants.

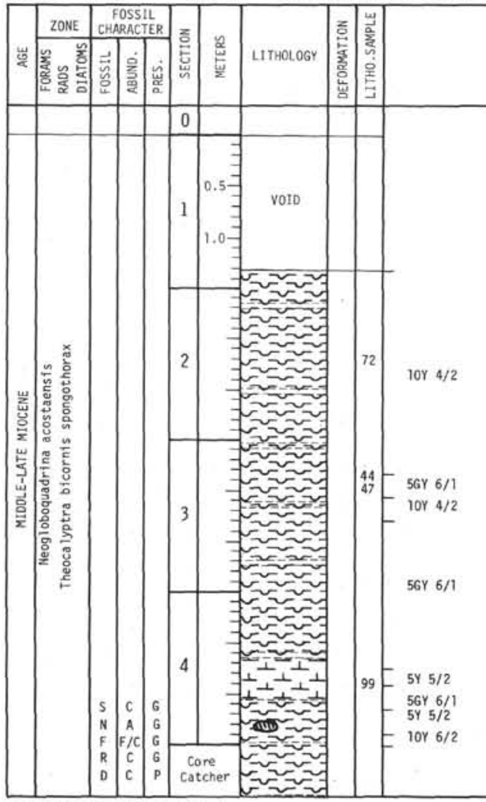
Characteristic smear slide

	3-70	4-70	CC
diatoms	55	30	35
micrite	14	30	37
nannos	20	39	25
clay	10	-	-
qtz.	TR	TR	2
pyrite	TR	-	1
micronods.	-	TR	-
forams	-	TR	-
rads	1	1	TR
sponge spic.	TR	-	TR
silico.	TR	TR	-

Carbon-carbonate

	3-85 to 86	4-86 to 87
t. carb	2.9	6.2
o. carb	0.4	0.2
$CaCO_3$	21.0	50.0

Site 329 Hole Core 22 Cored Interval: 236.5-246.0 m



LITHOLOGIC DESCRIPTION

DIATOM OOZE (major lith)
NANNO CHALK (minor lith)
Core is partly ooze and partly lithified due to silicification. Grayish olive and greenish gray; light olive gray and pale olive bands near base. Firmer parts of core show burrow mottling. Firmer parts include ?authigenic silica minerals. Lithic clast is regarded as a downhole contaminant.

Characteristic smear slide

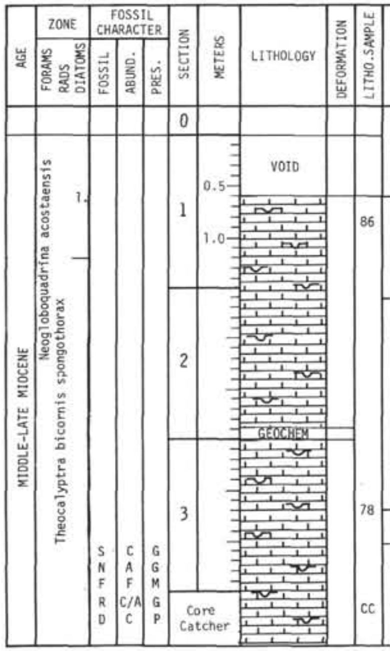
	2-72	3-47	4-99
diatoms	70	69	20
micrite	7	12	5
clay	22	-	4
nannos	TR	10	70
qtz.	TR	5	TR
rads	1	3	1
sponge spic.	TR	TR	TR
silico.	TR	-	TR
pyrite	1	-	TR

Carbon-carbonate

	2-68 to 70	4-124 to 126
t. carb	0.9	3.2
o. carb	0.5	0.7
$CaCO_3$	3.0	21.0

Explanatory notes in Chapter 1

Site 329 Hole Core 23 Cored Interval: 265.0-274.5 m



LITHOLOGIC DESCRIPTION

10Y 6/2

5GY 6/1

N8

5GY 6/1

NANNO CHALK
Pale olive, greenish gray and very light gray. Abundant burrow mottling; some dark pyritic streaks. Very light gray interval is a nearly pure nanno chalk.

Characteristic smear slide

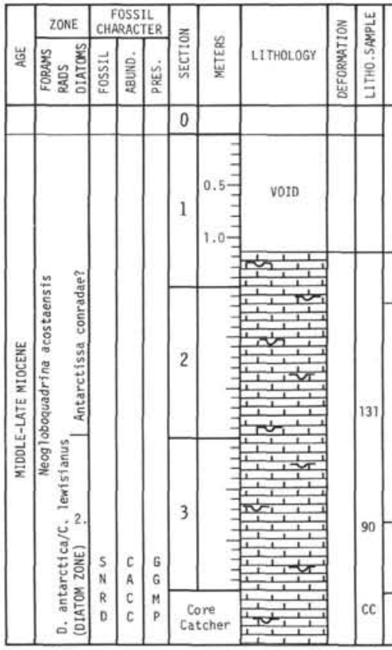
	1-86	3-78
nannos	47	80
micrite	22	15
diatoms	30	5
rads	TR	TR
sponge spic.	TR	-
forams	TR	TR
qtz.	TR	TR
heavies	-	TR
pyrite	1	TR

Carbon-carbonate

	3-104 to 105
t. carb	7.9
o. carb	0.2
$CaCO_3$	64.0

1. Denticula hustedtii

Site 329 Hole Core 24 Cored Interval: 284.0-293.5 m



LITHOLOGIC DESCRIPTION

5GY 6/1

5Y 8/1

10Y 6/2

5GY 6/1

N7

10Y 6/2

10Y 4/2

DIATOM-RICH NANNO CHALK
Greenish gray; yellowish gray gradational through pale olive to greenish gray; light gray gradational to pale olive. Extensive burrow mottling. Dark pyrite-rich streaks and pockets.

Characteristic smear slide

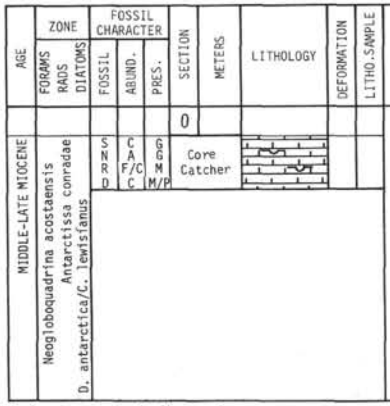
	2-131	3-90
nannos	55	58
diatoms	25	25
micrite	20	14
rads	TR	3
sponge spic.	-	TR
silico.	TR	TR
forams	TR	-
qtz.	TR	TR
vol. glass	TR	-
pyrite	TR	-

Carbon-carbonate

	2-69 to 70
t. carb	8.1
o. carb	0.2
$CaCO_3$	66.0

2. Denticula lauta/Denticula antarctica

Site 329 Hole Core 25 Cored Interval: 303-312.5m



LITHOLOGIC DESCRIPTION

5Y 5/2

DIATOM NANNO CHALK
Light olive gray.

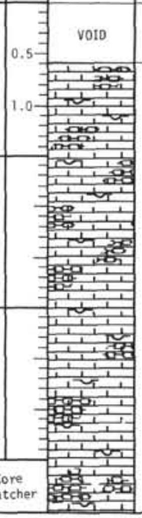
Smear slide

	CC
nannos	45
diatoms	35
micrite	20
forams	TR
rads	TR
silico.	TR
qtz.	TR
vol. glass	TR
pyrite	TR

Explanatory notes in Chapter 1

Site 329 Hole Core 26 Cored Interval: 331.5-341.0 m

AGE	ZONE FORAMS RADS DIATOMS	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	LITHO.SAMPLE
MIDDLE-LATE MIOCENE	Neogloboquadrina Antarctissa conradae acostaensis D. antarctica/C. lewisianus	S N R D	C A C A	G G M/G M	0 1 2 3 Core Catcher	120 120 120 CC



10Y 6/2

5GY 6/1

gradational

10Y 4/2

gradational

5Y 5/2

5GY 3/2

LITHOLOGIC DESCRIPTION

DIATOM-RICH, MICRITE NANNO CHALK
Pale olive, greenish gray grading into gray olive. Abundant burrow mottling, some Zoophygus-like structures. Some pyrite-rich layers.

Characteristic smear slide

	1-120	2-120
nannos	50	30
micrite	35	35
diatoms	15	32
rads	TR	2
forams	TR	-
pyrite	TR	-
qtz.	TR	1

Carbon-carbonate

	2-85 to 86
t. carb	5.0
o. carb	0.4
$CaCO_3$	38.0

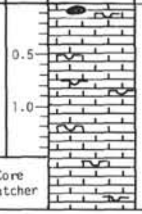
DIATOM OOZE
Core broken into very small pieces and is "soupy". Light olive gray; CC is grayish olive green. CC sample in particular suggests the sediment is winnowed, removing nannos and concentrating quartz and feldspar.

Characteristic smear slide

	3-120	CC
diatoms	95	53
qtz.	2	15
feld.	-	
clay	3	25
rads	TR	5
nannos	TR	1
sponge spic.	TR	TR
micrite	TR	1
pyrite	TR	TR

Site 329 Hole Core 27 Cored Interval: 360.0-369.5 m

AGE	ZONE RADS DIATOMS	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	LITHO.SAMPLE
EARLY/MIDDLE MIOCENE	Actinomma tanyacantha? Denticula antarctica/Coscinodiscus lewisianus	S N F R D	C A F C C	G M P M/G M/P	0 1 Core Catcher	81 CC



N7

N6

N7

LITHOLOGIC DESCRIPTION

SILICEOUS FOSSIL-RICH NANNO CHALK
Light gray and an interval of medium light gray with dark streaks. Extensive burrow mottling.

Characteristic smear slide

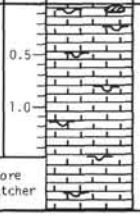
	1-81	CC
nannos	50	70
diatoms	25	5
rads	3	15
micrite	20	2
sponge spic.	-	2
forams	TR	1
vol. glass	-	5
silico.	TR	-

Carbon-carbonate

	1-113 to 114
t. carb	8.4
o. carb	0.1
$CaCO_3$	69.0

Site 329 Hole Core 28 Cored Interval: 388.5-398.0 m

AGE	ZONE FORAMS	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	LITHO.SAMPLE
OLIGOCENE		S N F R D	C A C F/C R	G M M M P	0 1 Core Catcher	110 CC



N7

LITHOLOGIC DESCRIPTION

DIATOM-RICH NANNO CHALK
Light gray. Extensive burrow mottling.

Characteristic smear slide

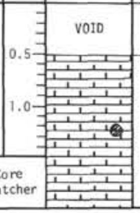
	1-110	CC
nannos	79	88
diatoms	15	10
micrite	5	-
forams	TR	2
pyrite	1	TR
rads	TR	TR
qtz.	TR	-

Carbon-carbonate

	1-64 to 65
t. carb	8.0
o. carb	0.1
$CaCO_3$	66.0

Site 329 Hole Core 29 Cored Interval: 398.0-407.5 m

AGE	ZONE FORAMS	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	LITHO.SAMPLE
OLIGOCENE	Actinomma tanyacantha?	S N F R D	C A C F/C R	G A M/G M/P P	0 1 Core Catcher	92 CC



N7

LITHOLOGIC DESCRIPTION

NANNO CHALK
Light gray. Burrow mottling. Lithic clast is regarded as a downhole contaminant.

Characteristic smear slide

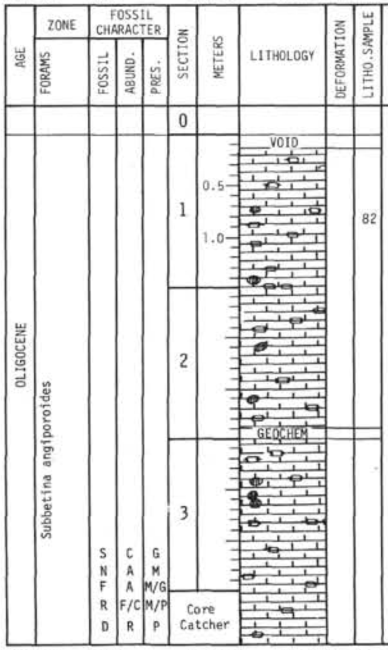
	1-92	CC
nannos	91	84
micrite	3	10
rads	3	3
diatoms	3	-
silico.	-	2
pyrite	TR	1
forams	TR	TR

Carbon-carbonate

	1-60 to 61
t. carb	10.4
o. carb	0.1
$CaCO_3$	86.0

Explanatory notes in Chapter 1

Site 329 Hole Core 30 Cored Interval: 407.5-417.0 m



LITHOLOGIC DESCRIPTION

N7

MICRITE NANNO CHALK
Light gray. Extensive burrow mottling. Lithic clasts are regarded as downhole contaminants.

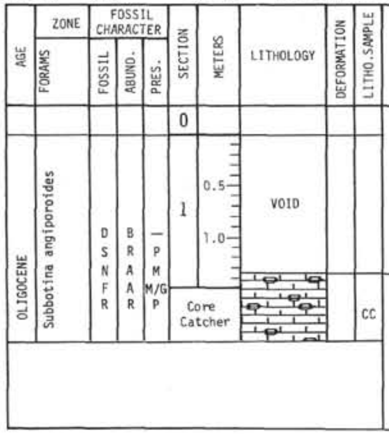
Characteristic smear slide

	1-82	CC
nannos	42	47
micrite	40	45
diatoms	10	-
rads	5	5
sponge spic.	3	TR
forams	-	3
dolom.	-	TR
qtz.	-	TR

Carbon-carbonate

	2-30 to 31
t. carb	8.0
o. carb	0.1
$CaCO_3$	65.0

Site 329 Hole Core 31 Cored Interval: 417.0-426.5 m



LITHOLOGIC DESCRIPTION

N5

NANNO MICRITE CHALK
Medium gray. Silicified. Extensively burrowed.

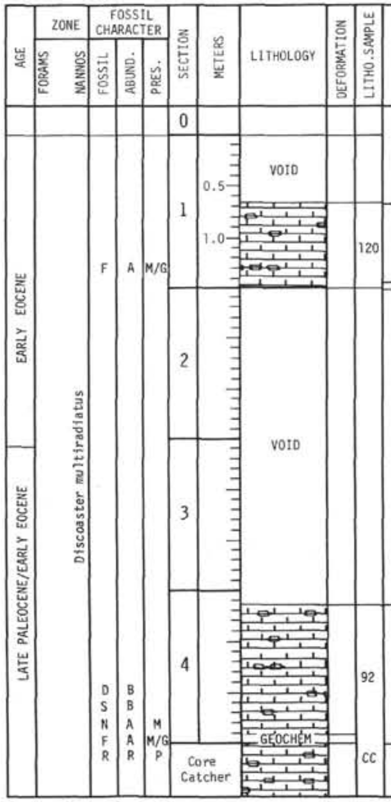
Characteristic smear slide

	CC
micrite	50
nannos	45
forams	5
pyrite	TR
zeolite	TR

Bulk X-ray

	1-145 to 147
amor.	19.8
cris.	47.8
calc.	25.5
trid.	19.8
quar.	2.8
mica	2.1
plag.	0.9
K-Fe.	0.8
chlo.	0.3

Site 329 Hole Core 32 Cored Interval: 445.5-455.0 m



LITHOLOGIC DESCRIPTION

N8

5Y 8/1

5Y 8/1

N8

NANNO-RICH MICRITE CHALK
Very light gray and yellowish gray. Bioturbation common. Lower part of Section 4 is silicified. Lithic clast is regarded as a downhole contaminant.

Characteristic smear slide

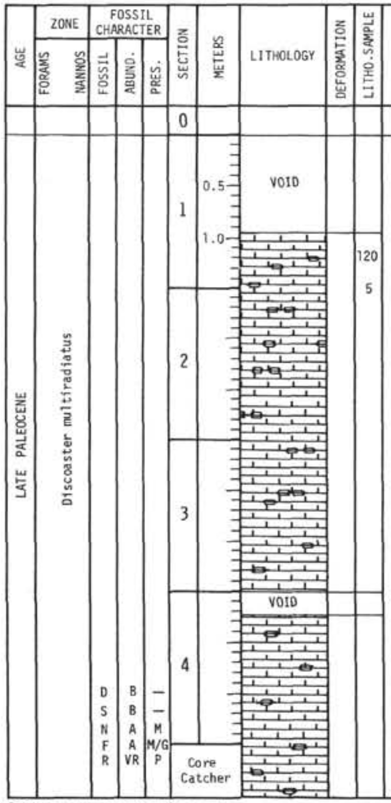
	1-120	4-92
micrite	74	60
nannos	20	25
diatoms	-	5
forams	1	-
zeol.	5	10

Carbon-carbonate

	4-120 to 121
t. carb	9.4
o. carb	0.1
$CaCO_3$	78.0

Explanatory notes in Chapter 1

Site 329 Hole Core 33 Cored Interval: 455.0-464.5 m



LITHOLOGIC DESCRIPTION

5Y 8/1

NANNO MICRITE CHALK
Yellowish gray. Extensive bioturbation.
Pelecypod fragments sparsely distributed.
Locally silicified.

Characteristic smear slide

	1-120	2-5
micrite	55	83
nannos	35	15
zeol.	7	2
apatite	3	-

Bulk X-ray

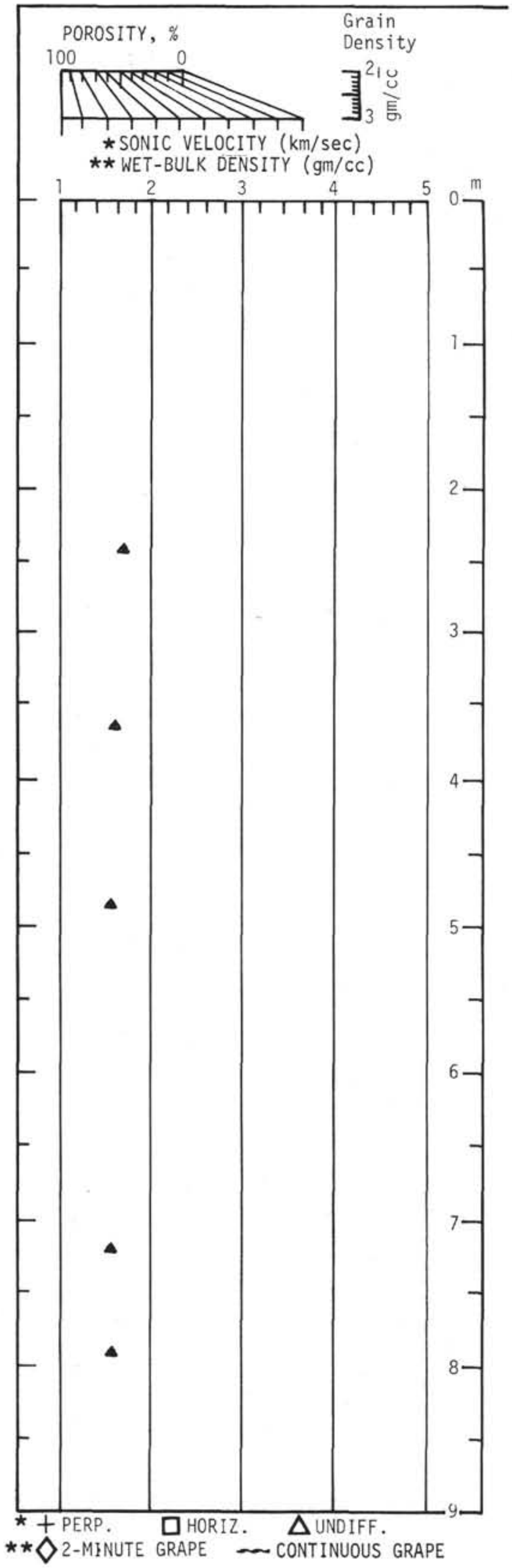
	2-10 to 12	3-6 to 8
amor.	-	13.6
calc.	38.0	78.7
cris.	40.9	14.8
trid.	19.2	-
quar.	1.9	1.0
mont.	-	5.5

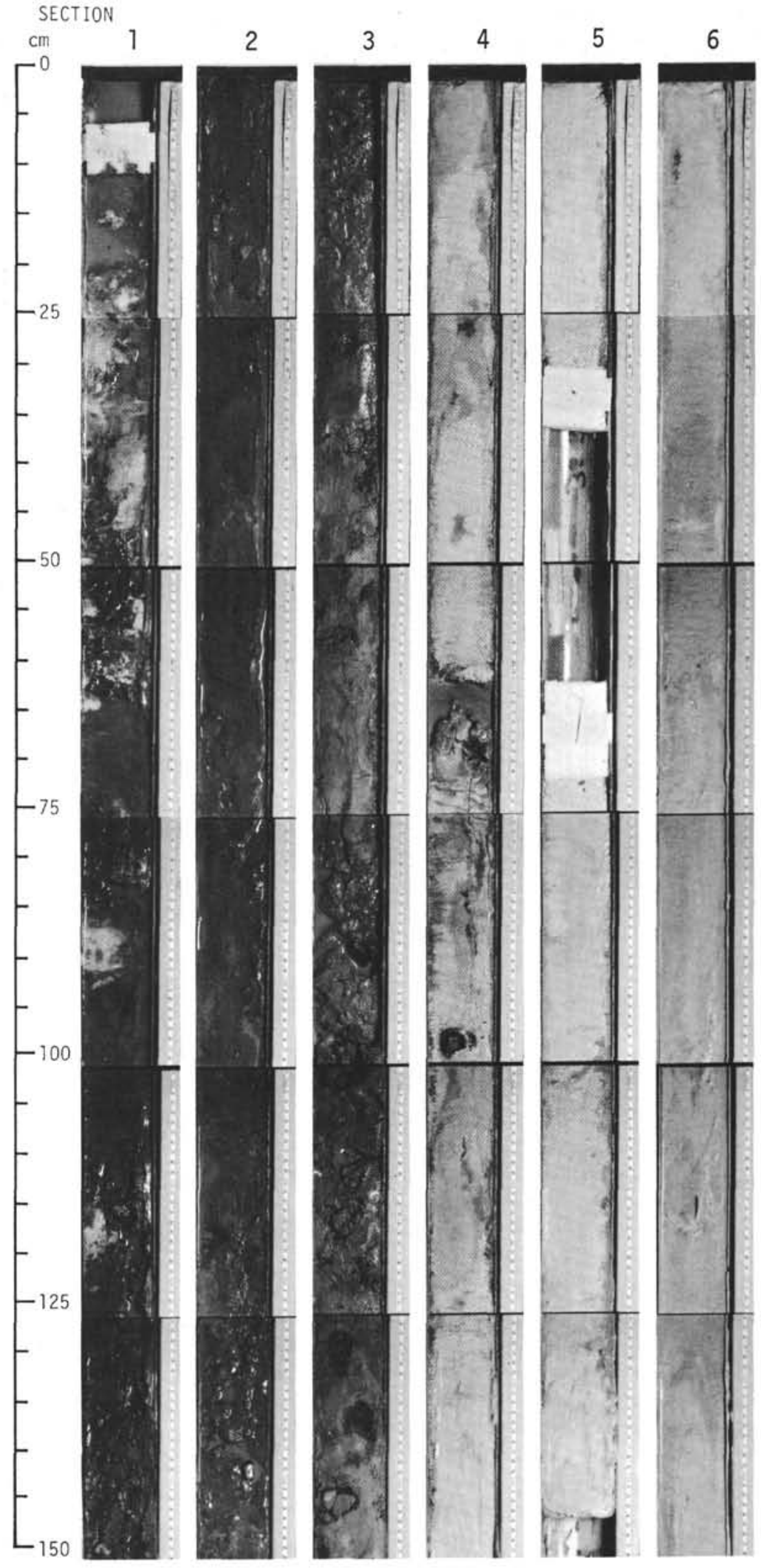
	4-33 to 35	4-48 to 50
amor.	-	1.4
calc.	53.1	50.3
cris.	29.9	34.7
trid.	16.6	12.6
quar.	0.3	0.6
mont.	-	1.8

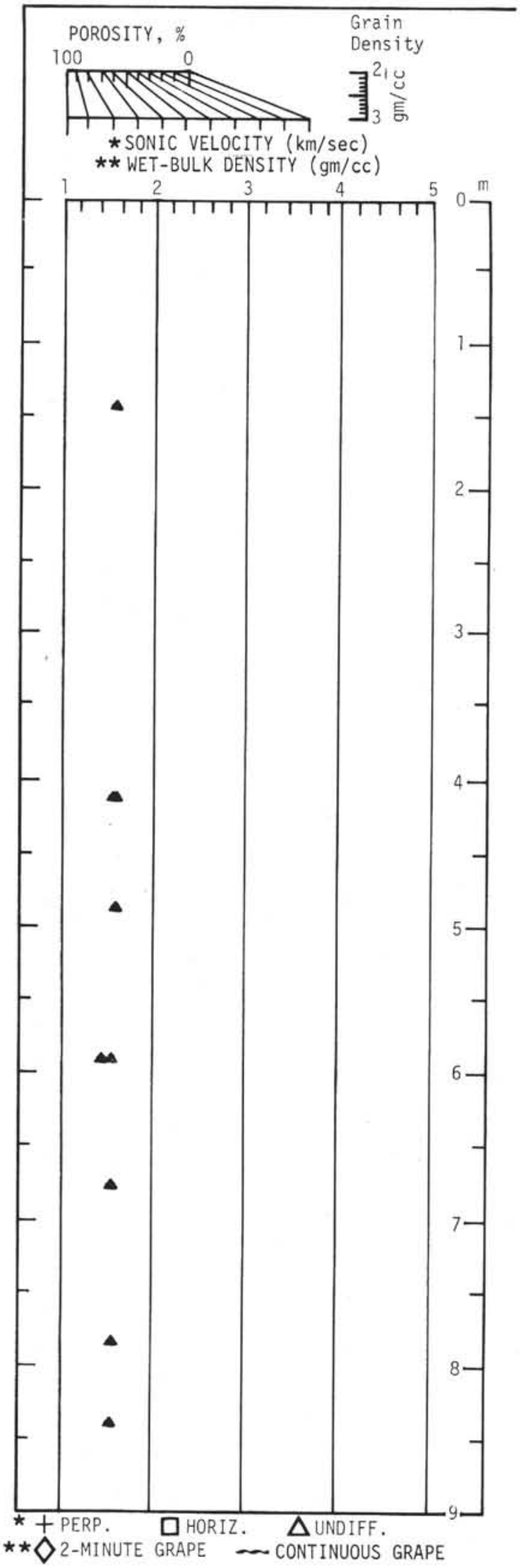
	4-122 to 124
amor.	17.9
calc.	89.6
cris.	-
trid.	-
quar.	1.1
mont.	9.3

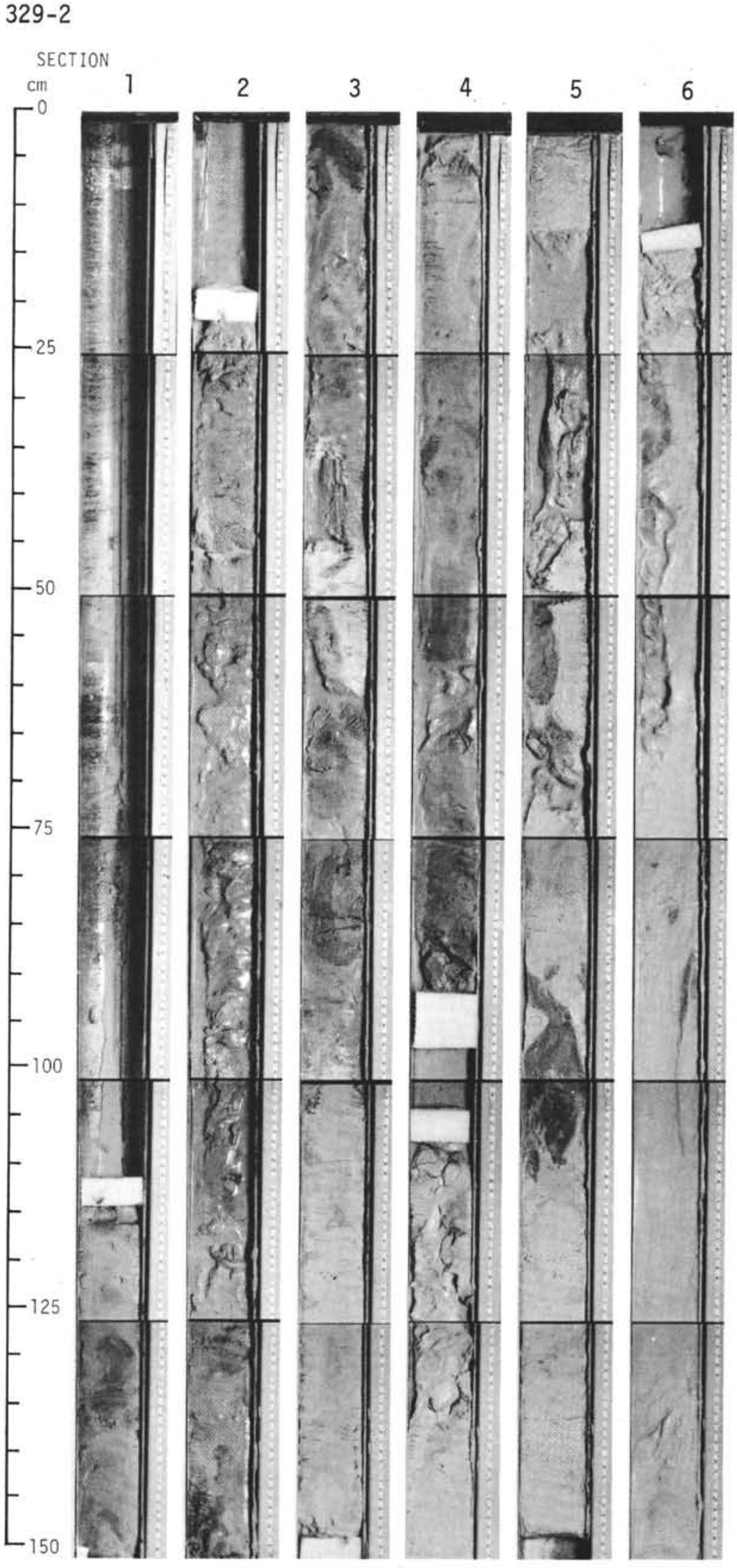
Explanatory notes in Chapter 1

329-1

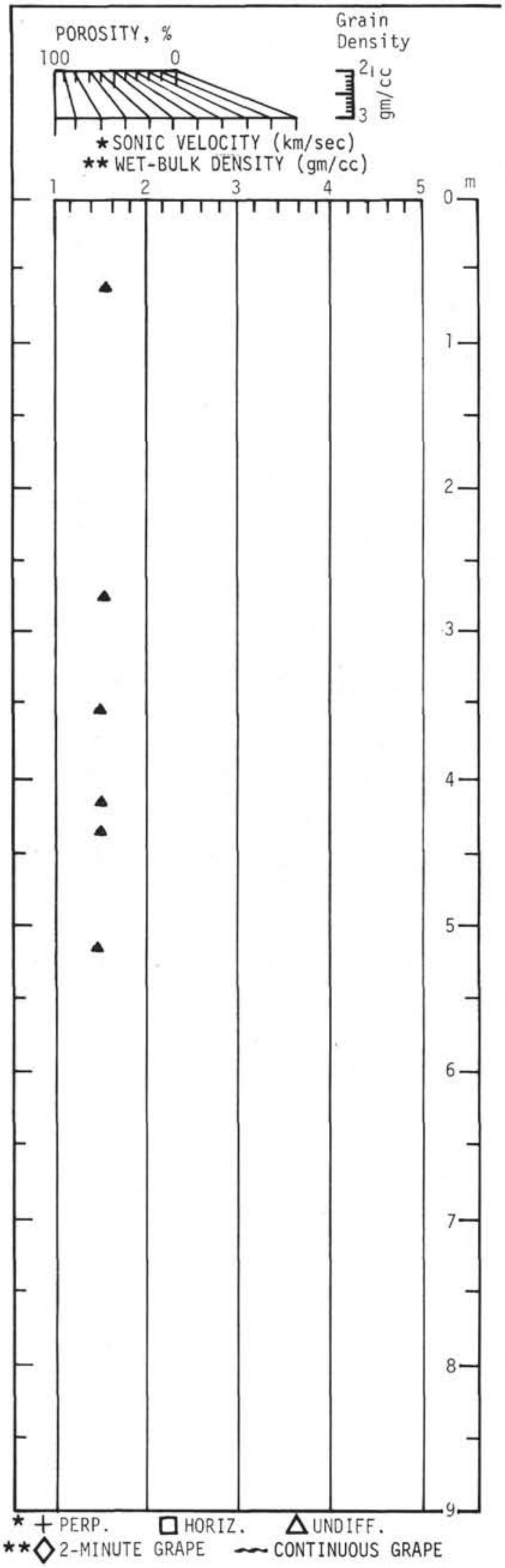

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
**◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

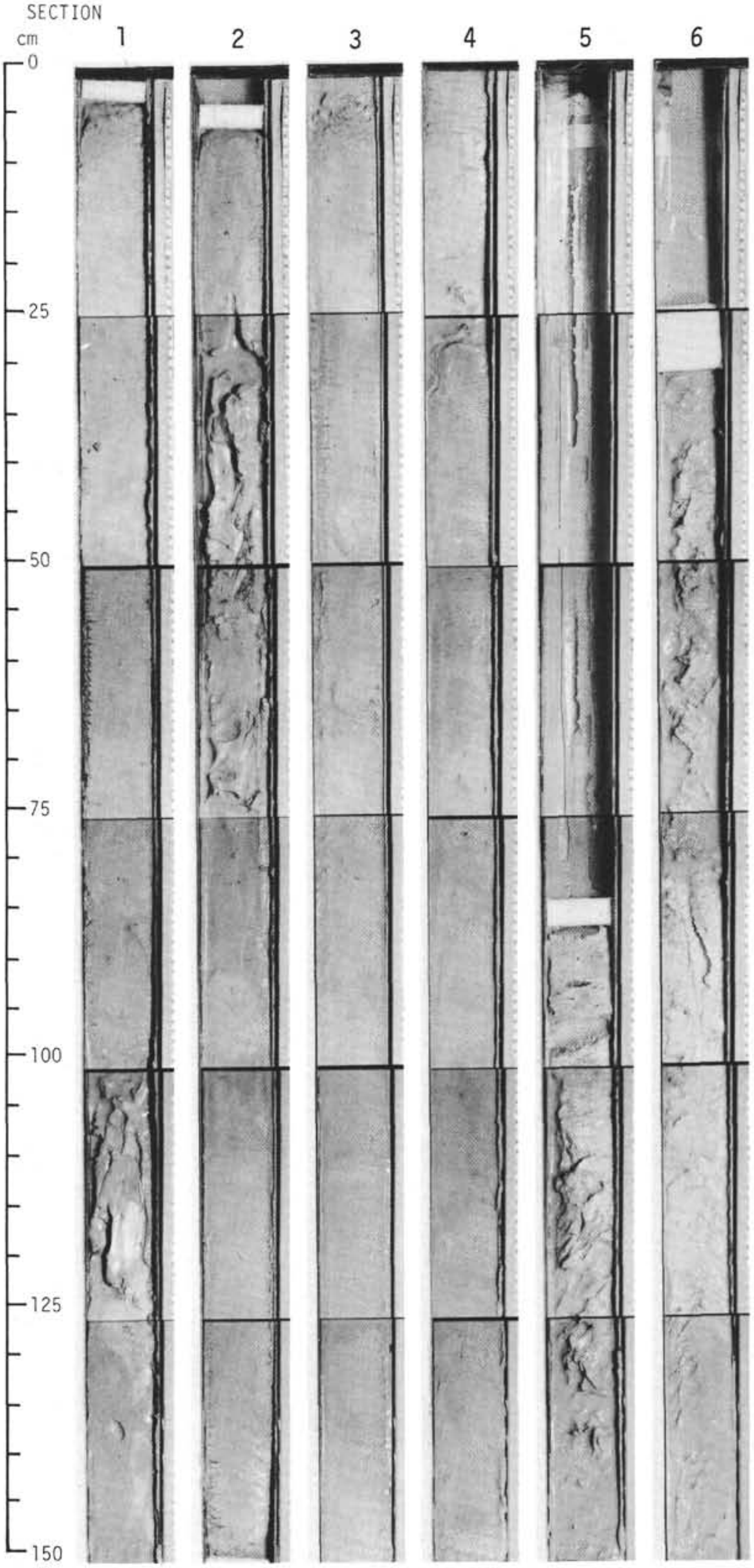

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

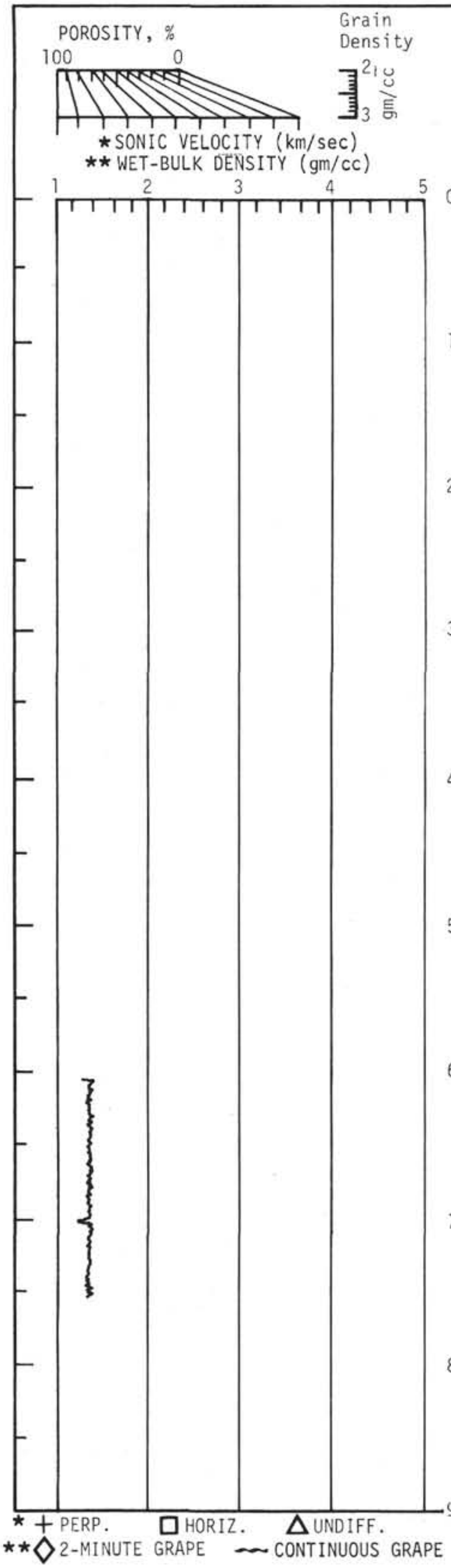

329-2
SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

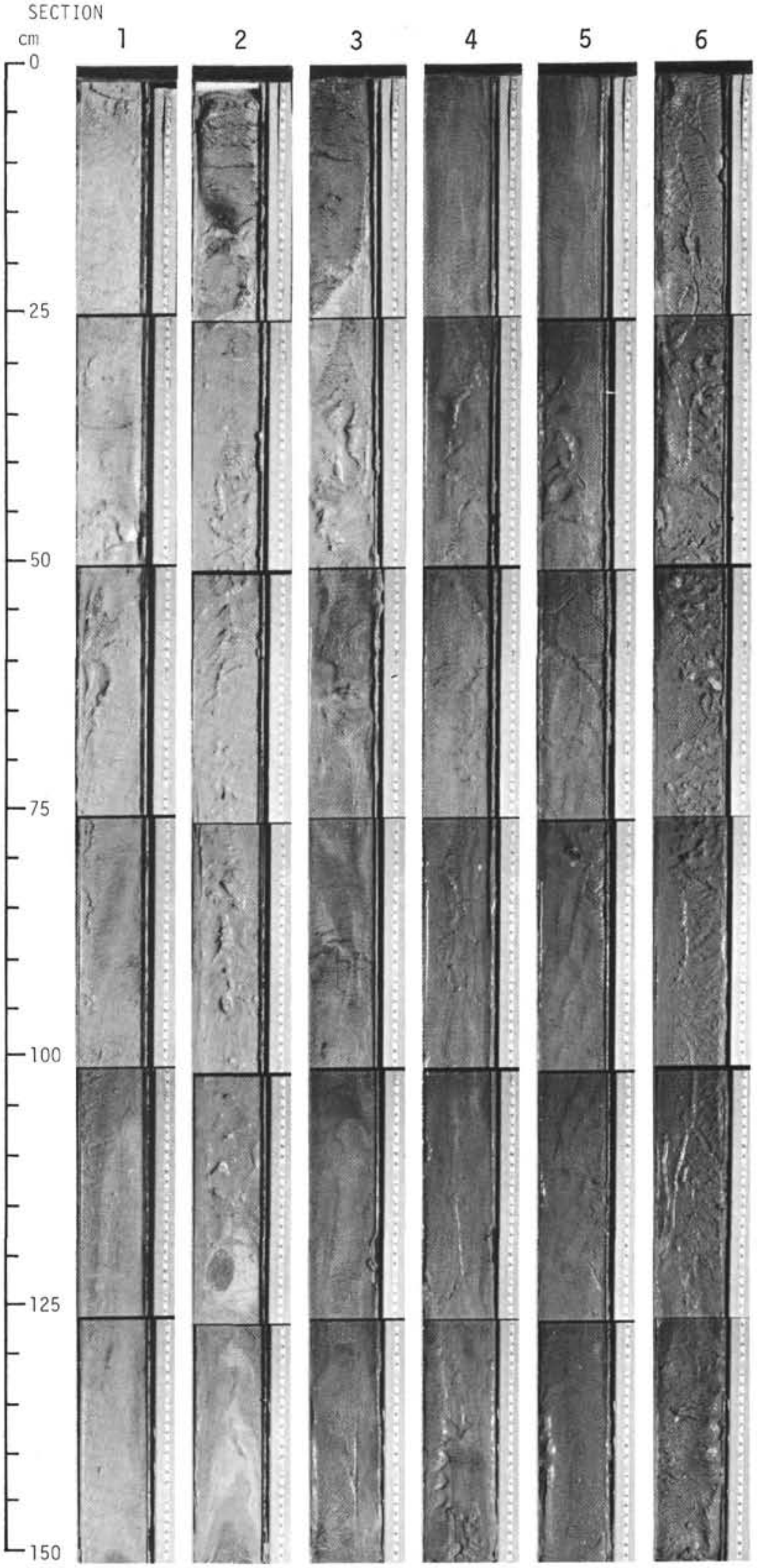
329-3


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
〰 CONTINUOUS GRAPE

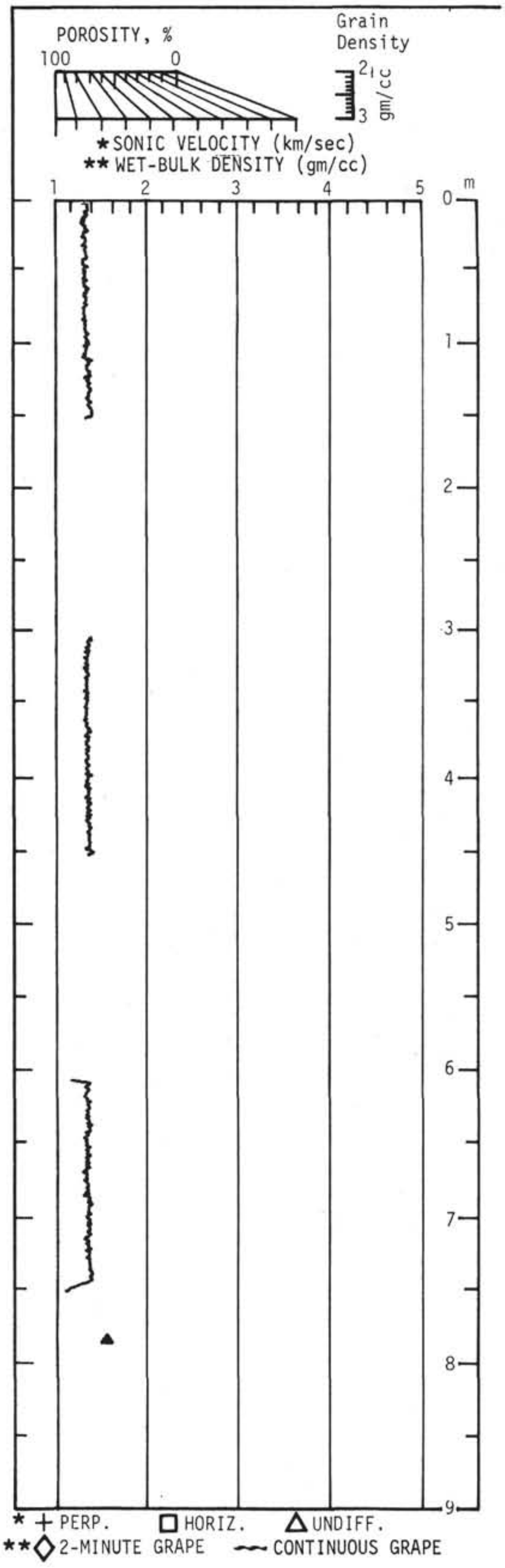

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

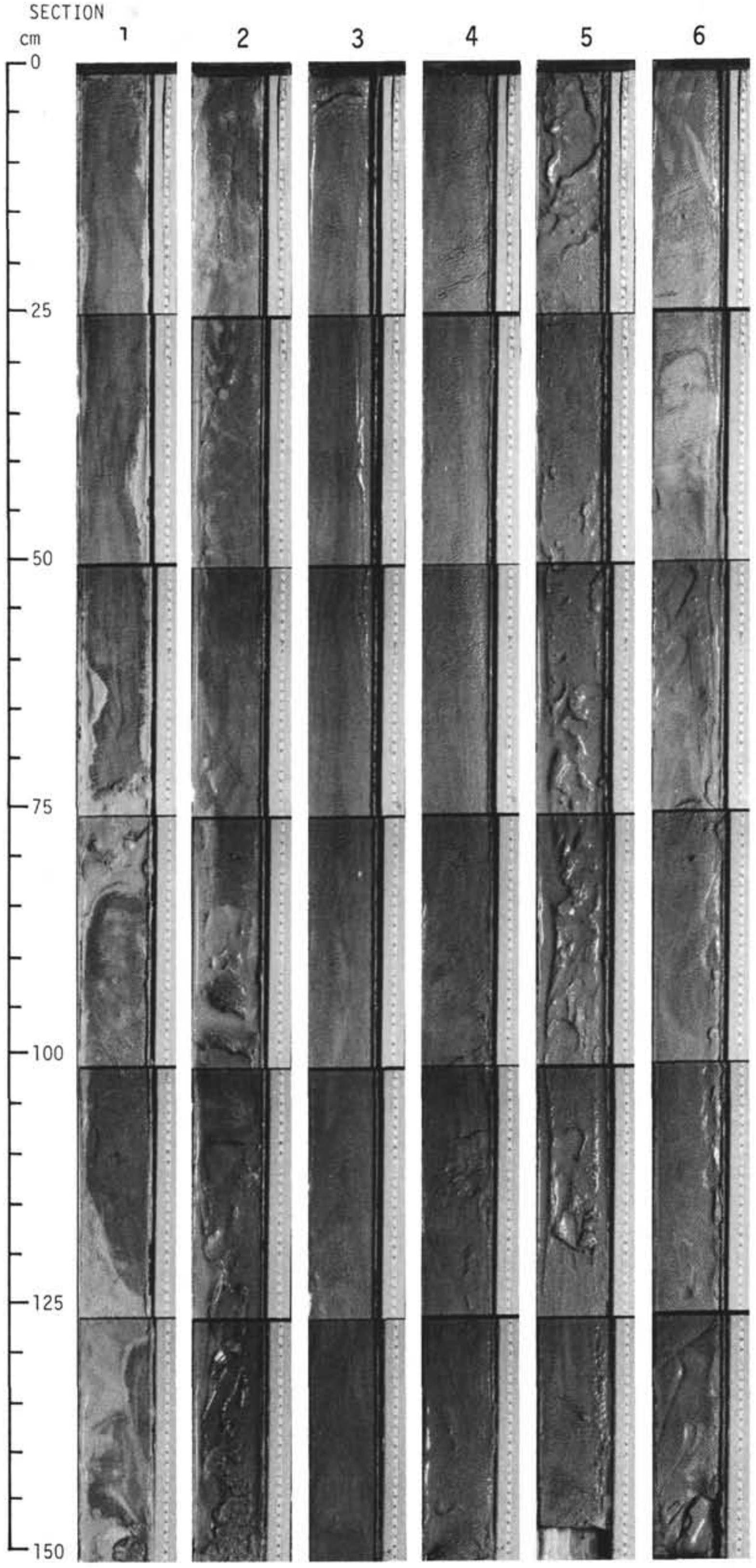
329-4

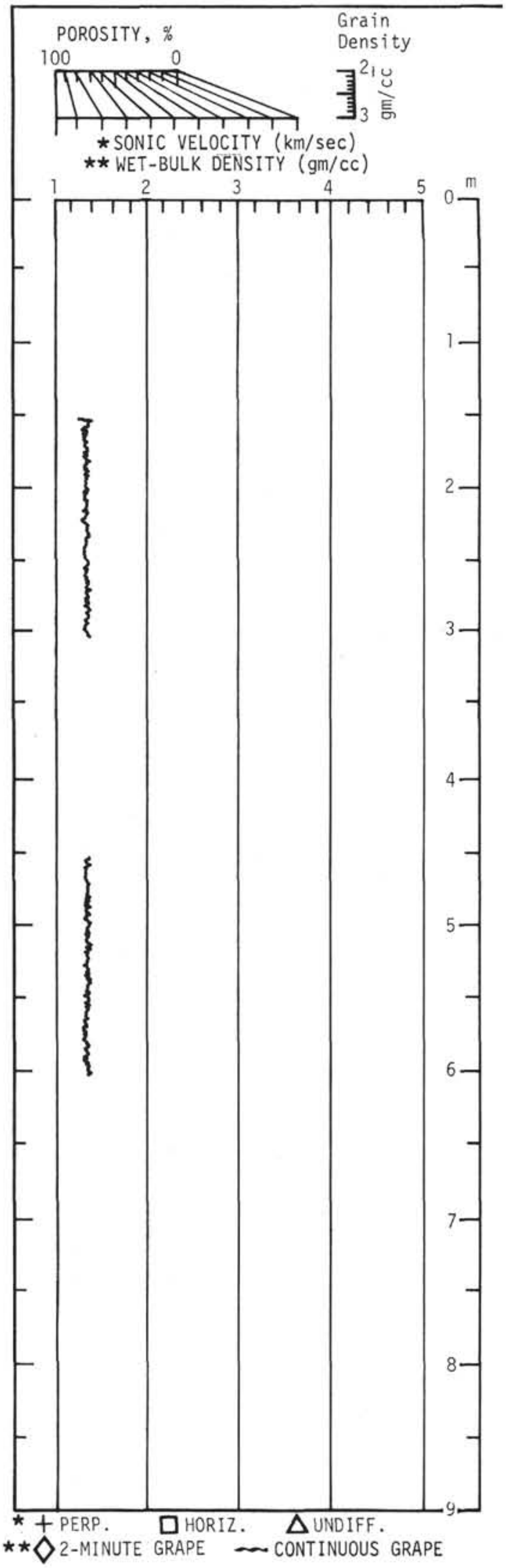

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

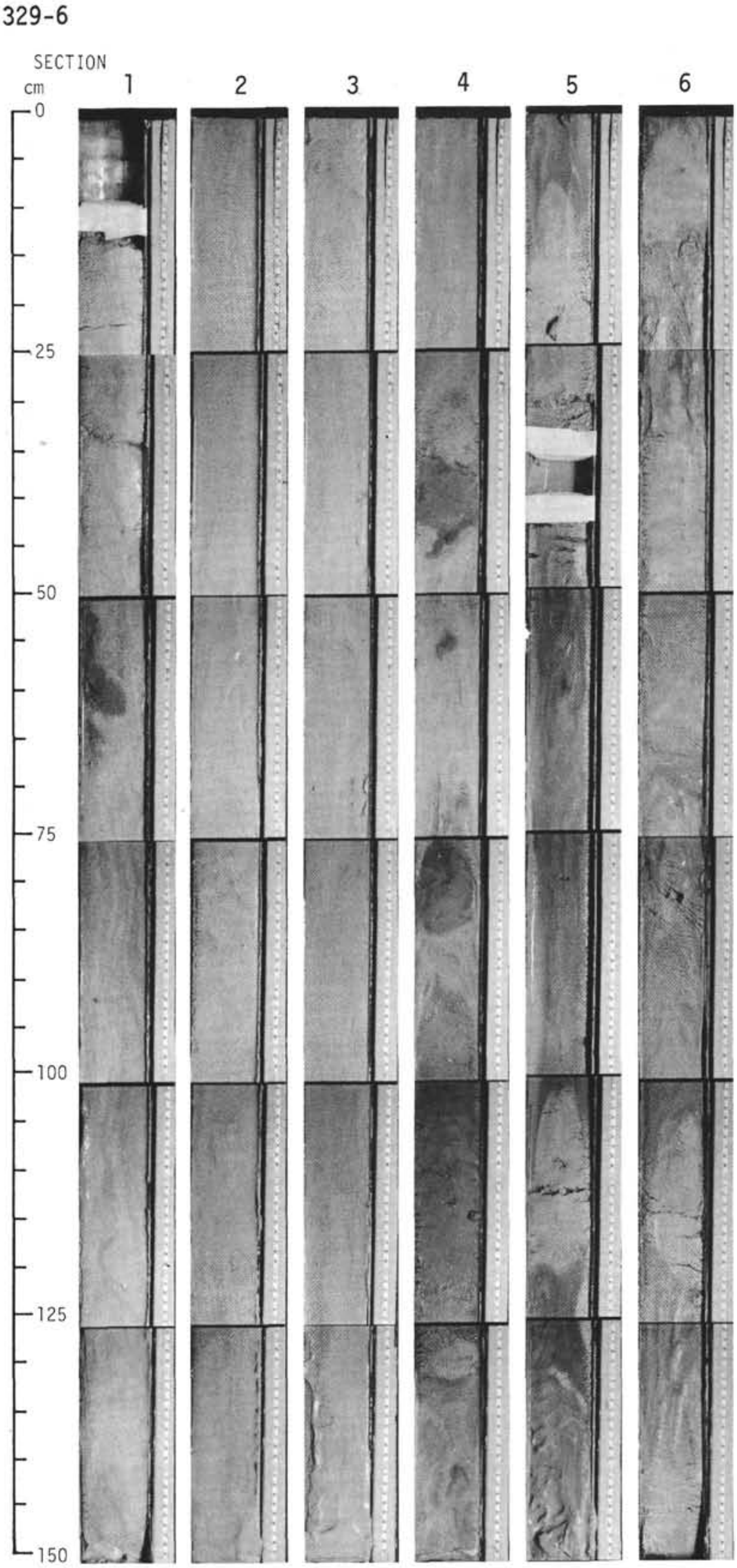

SECTION
1
2
3
4
5
6
cm
0
25
50
75
100
125
150

329-5

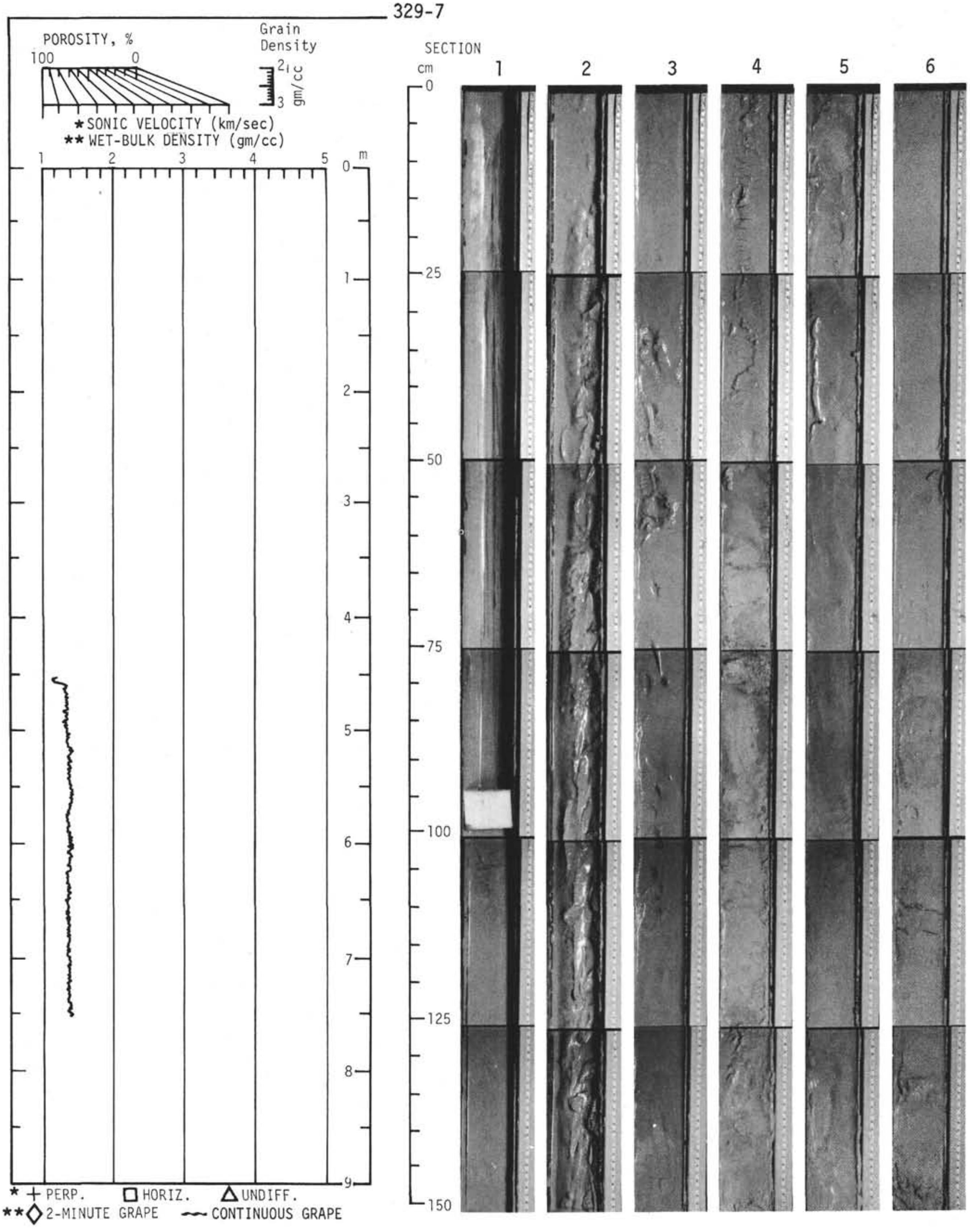

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
〰 CONTINUOUS GRAPE

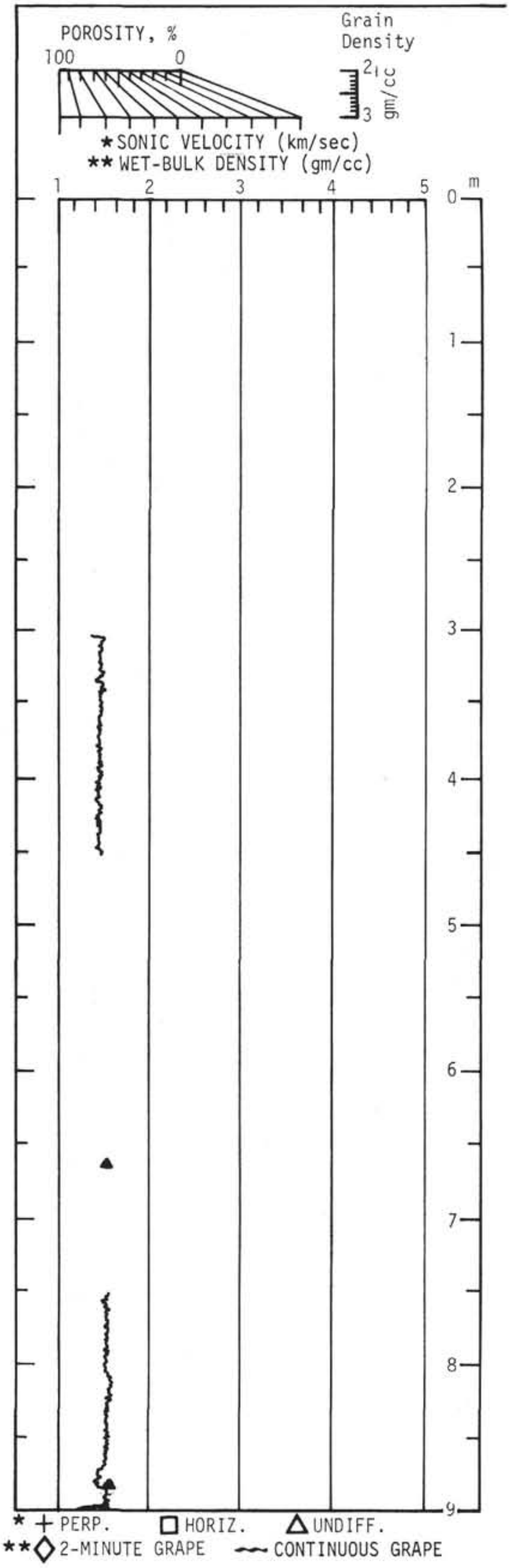

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
**◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

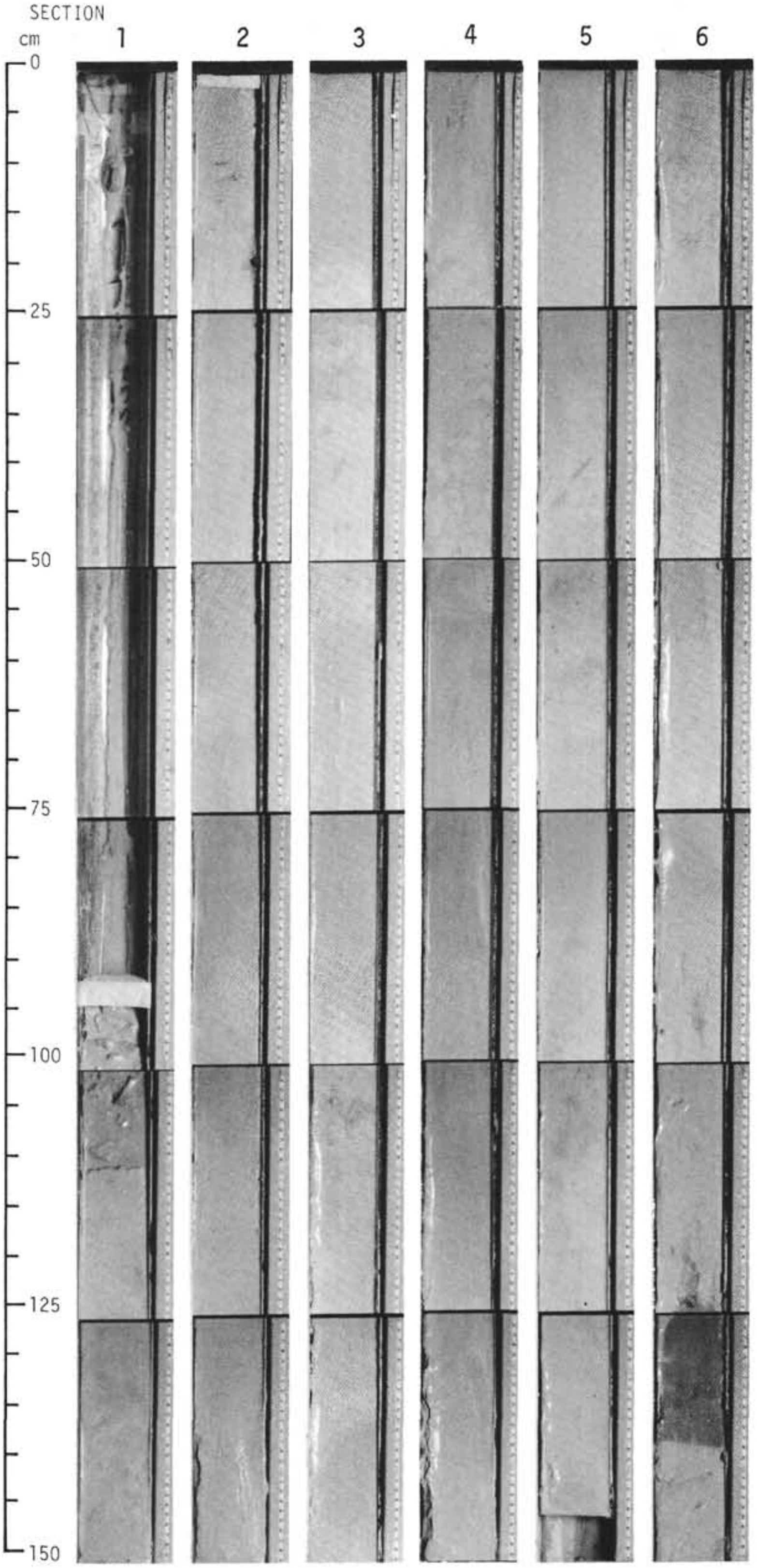

329-6
SECTION
1
2
3
4
5
6
cm
0
25
50
75
100
125
150

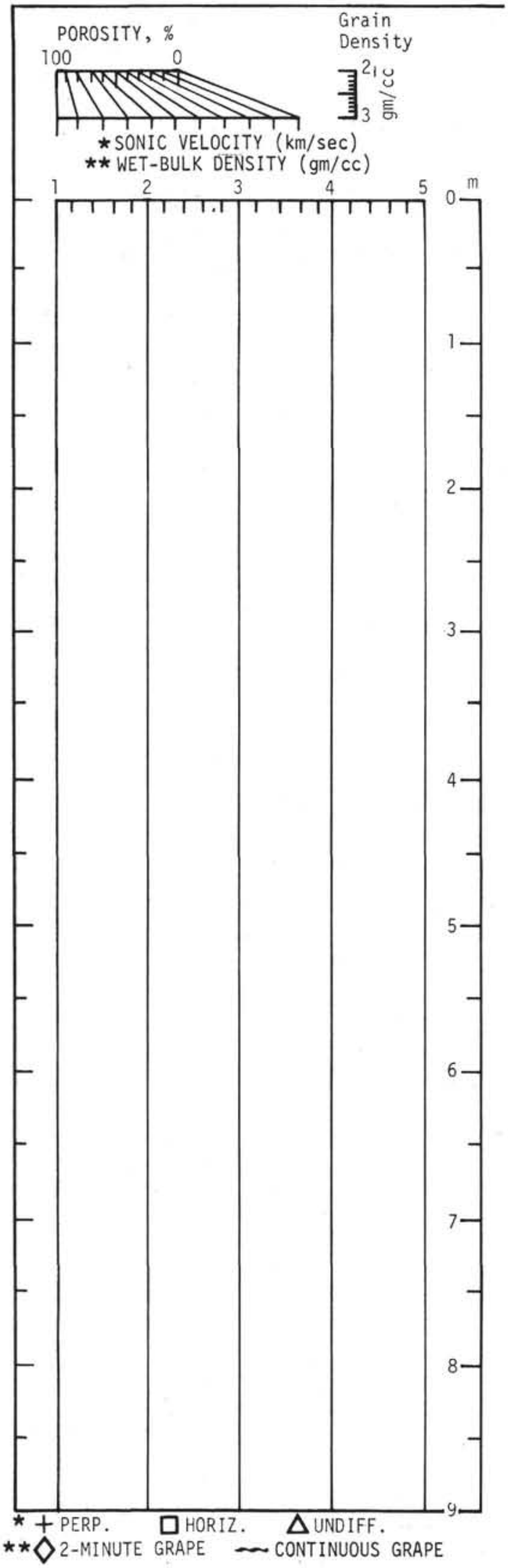
329-7


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE
SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

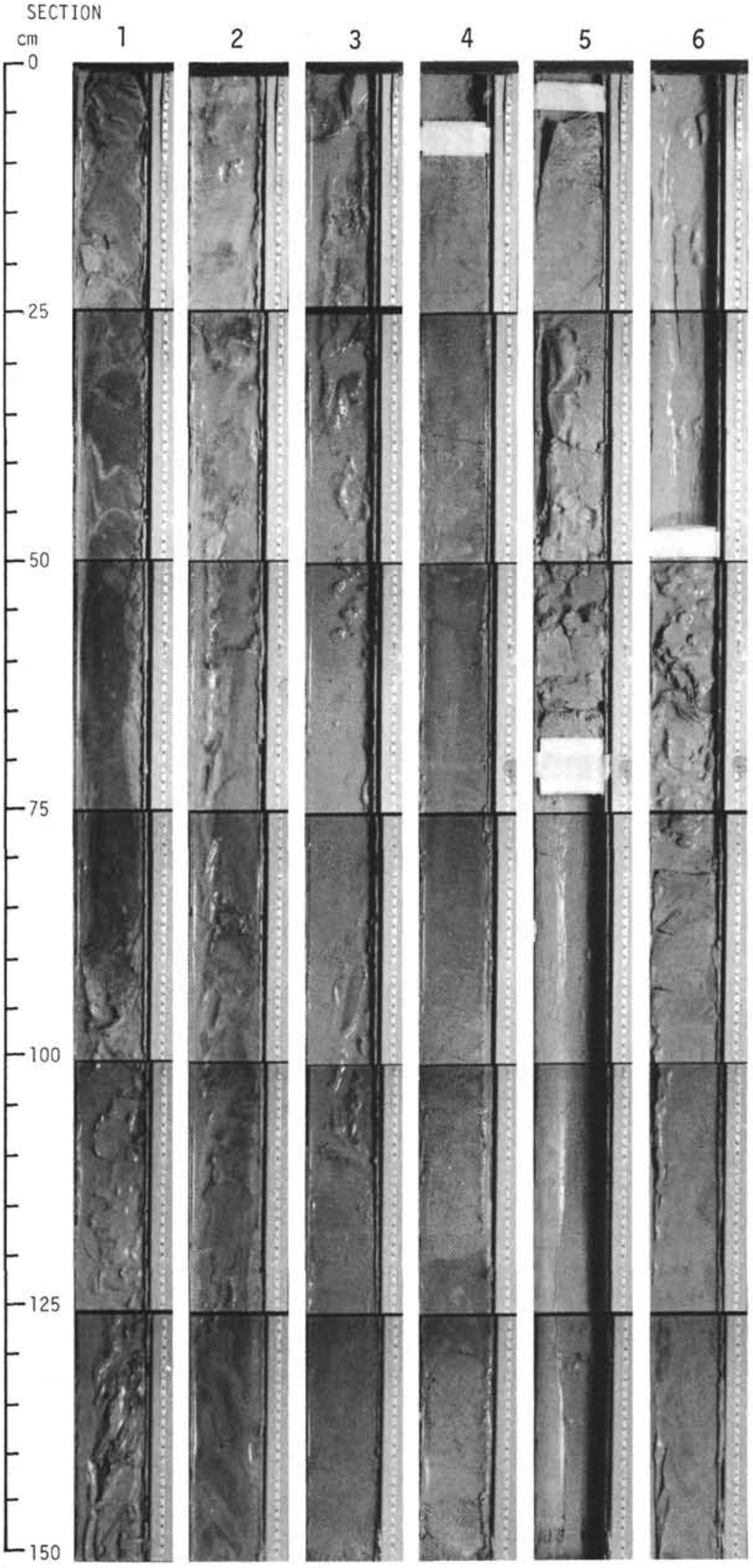

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

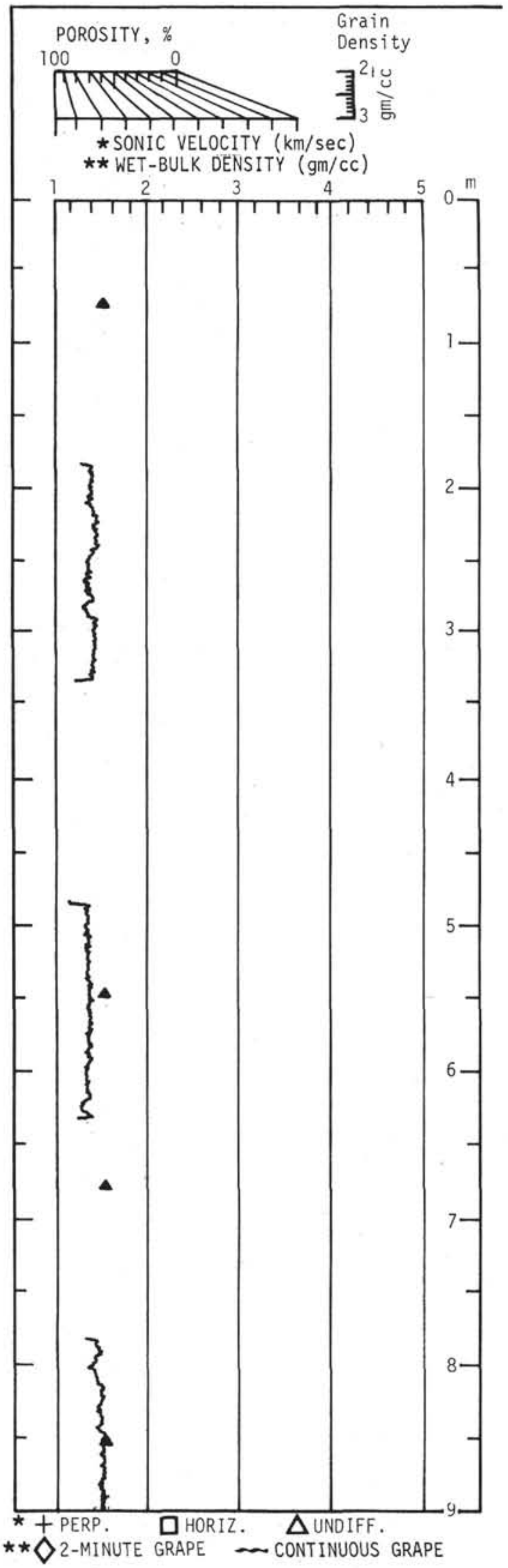
329-8


SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

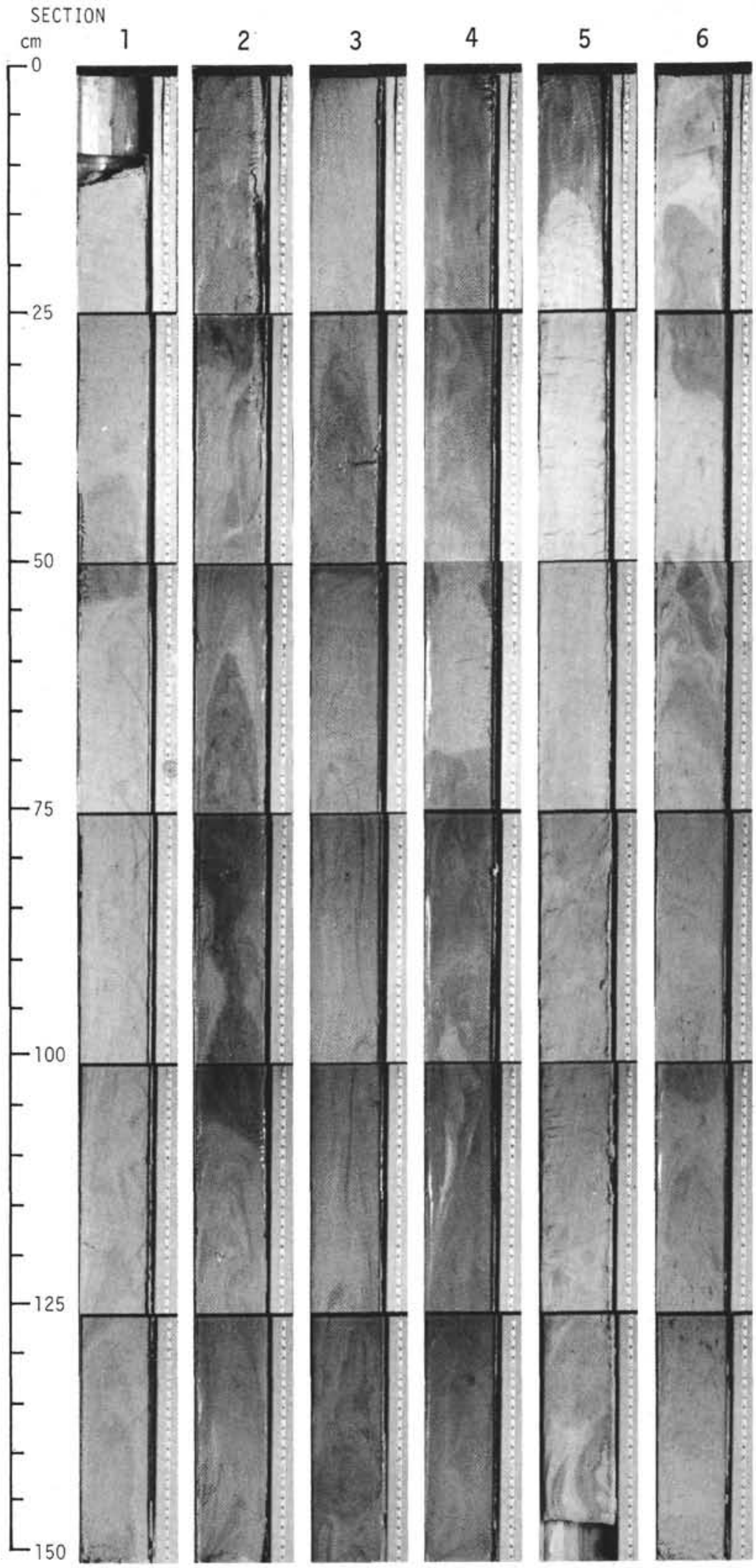

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP. □ HORIZ. △ UNDIFF.
**◇ 2-MINUTE GRAPE ~ CONTINUOUS GRAPE

329-9

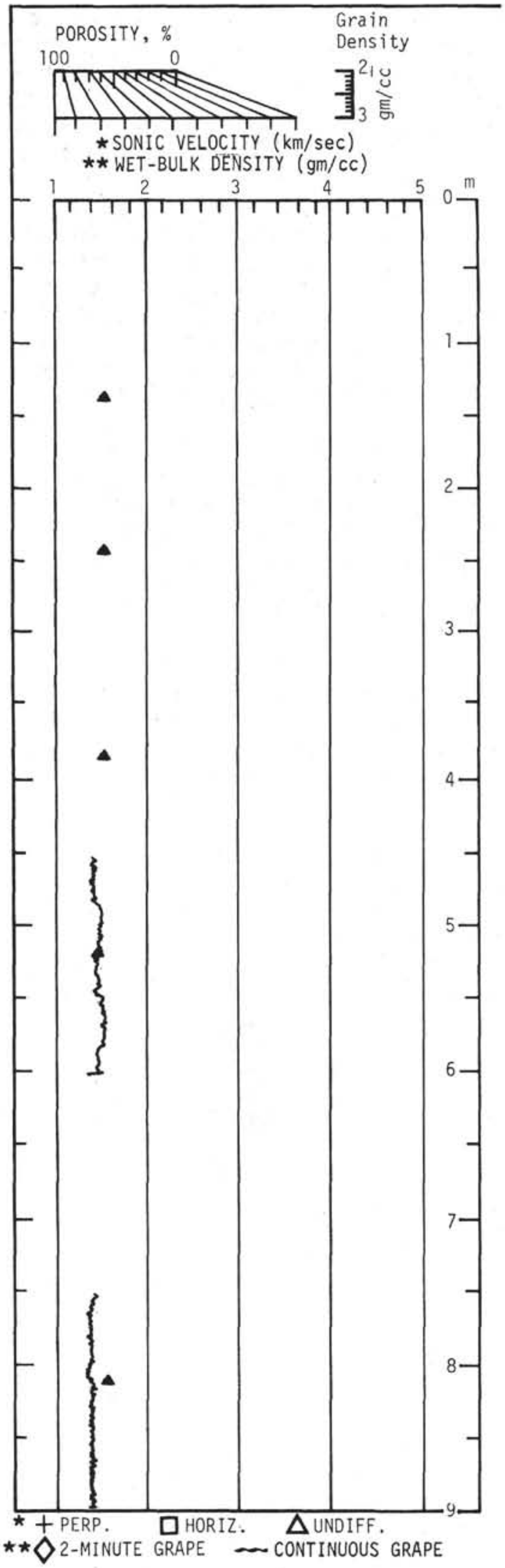

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

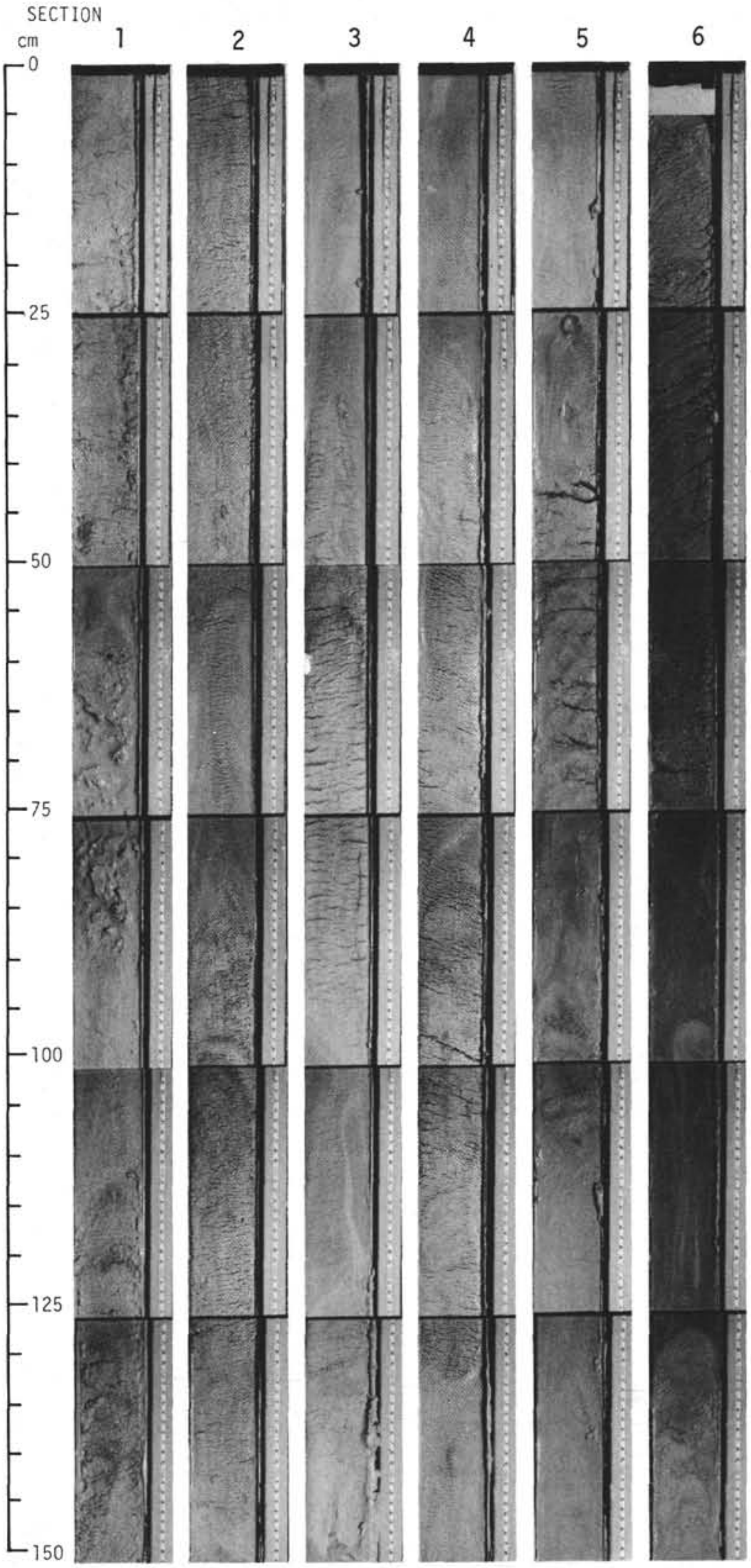

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

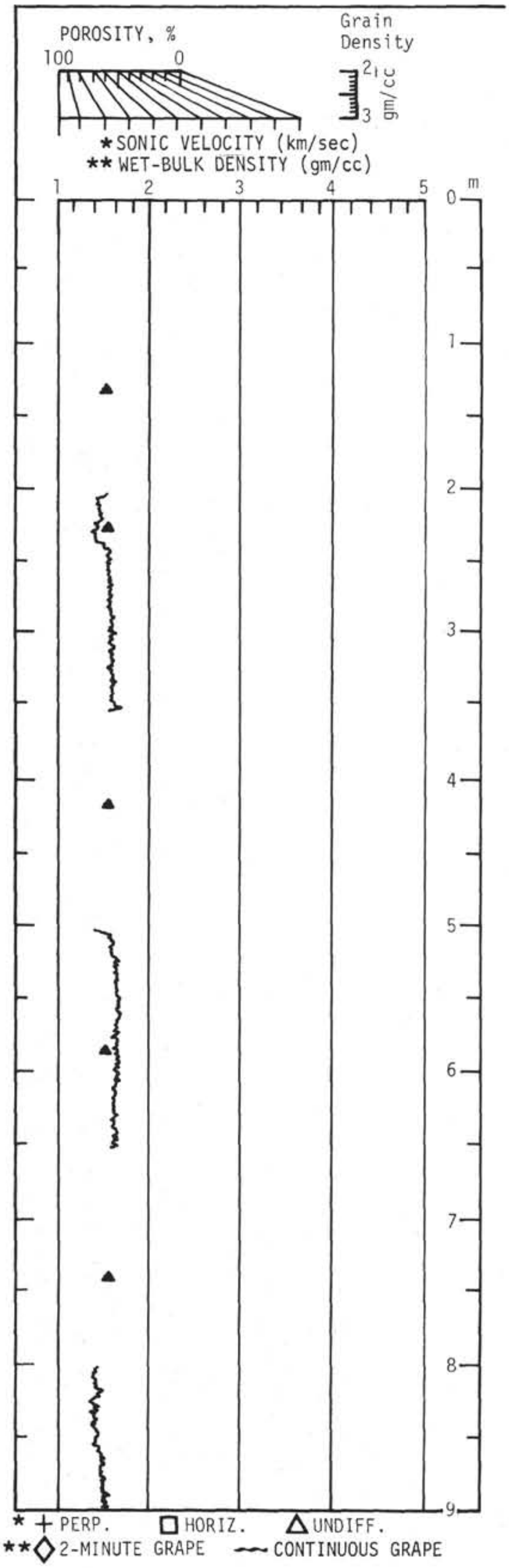
329-10


SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

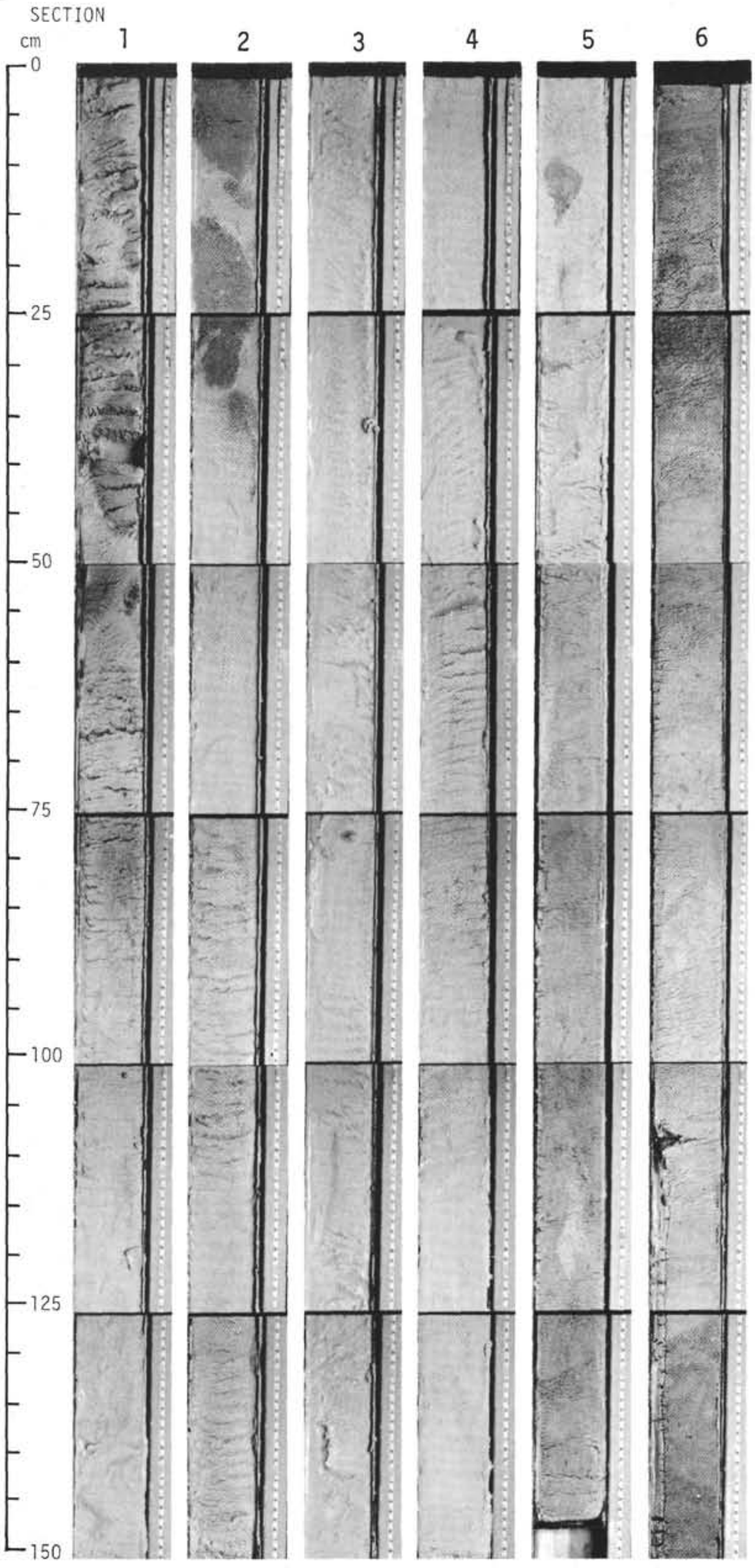
329-11


POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
**◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

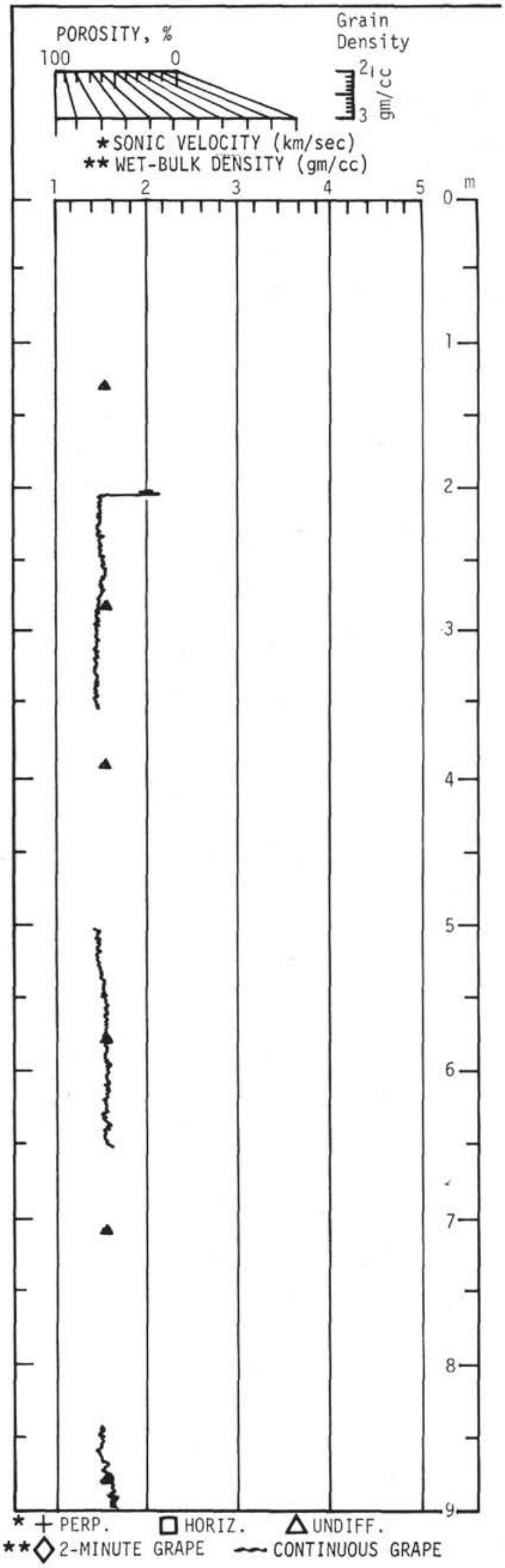

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

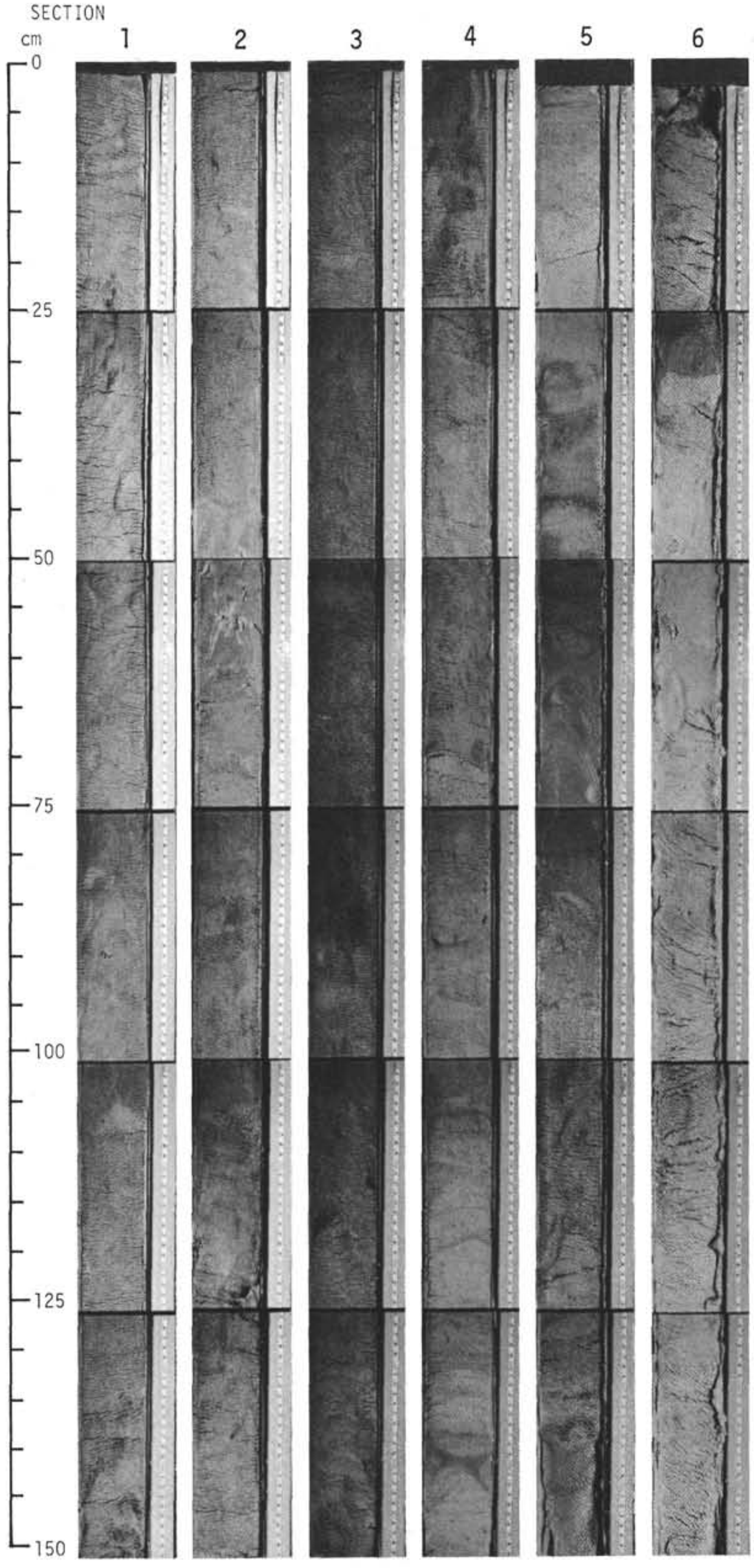

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

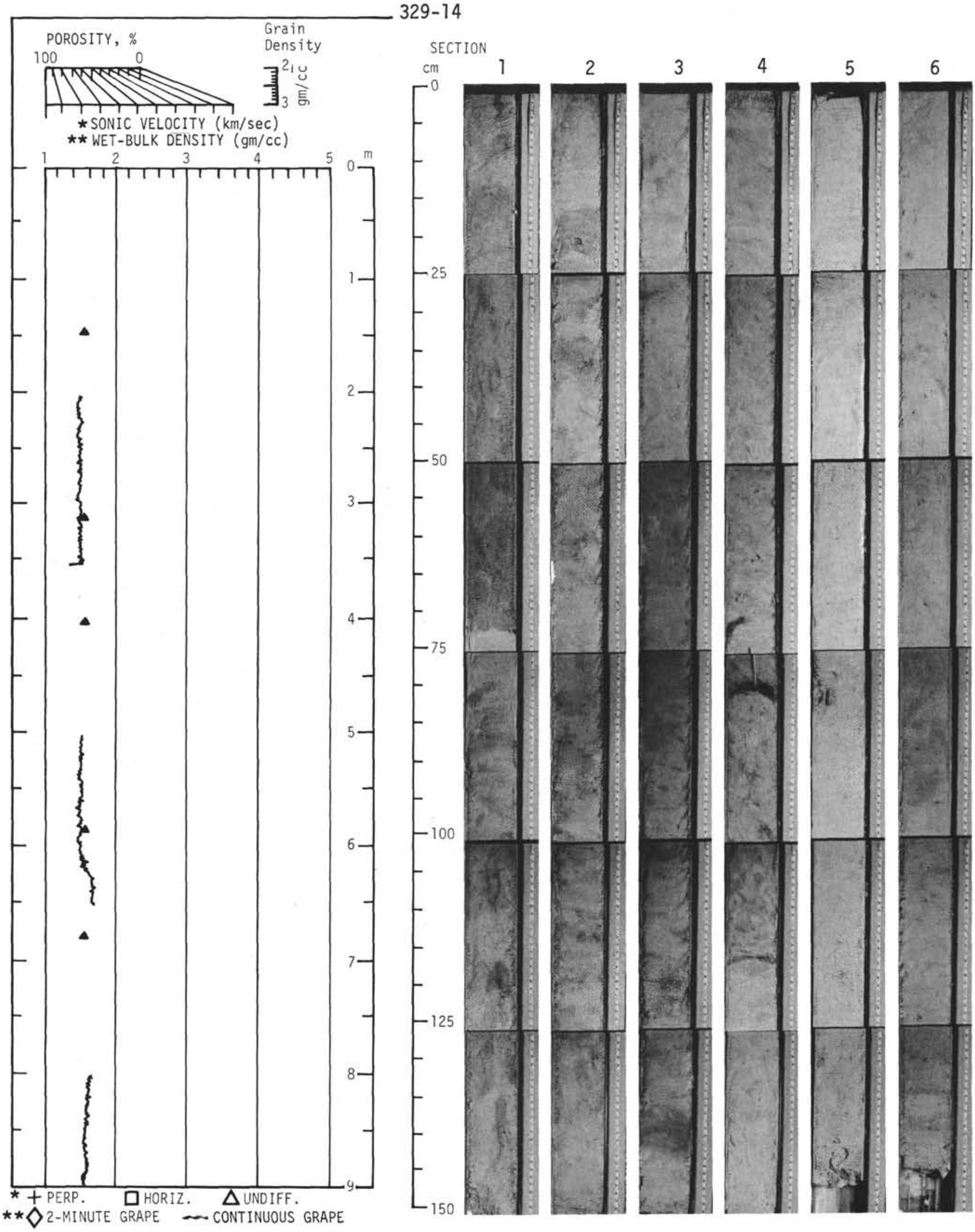
329-12

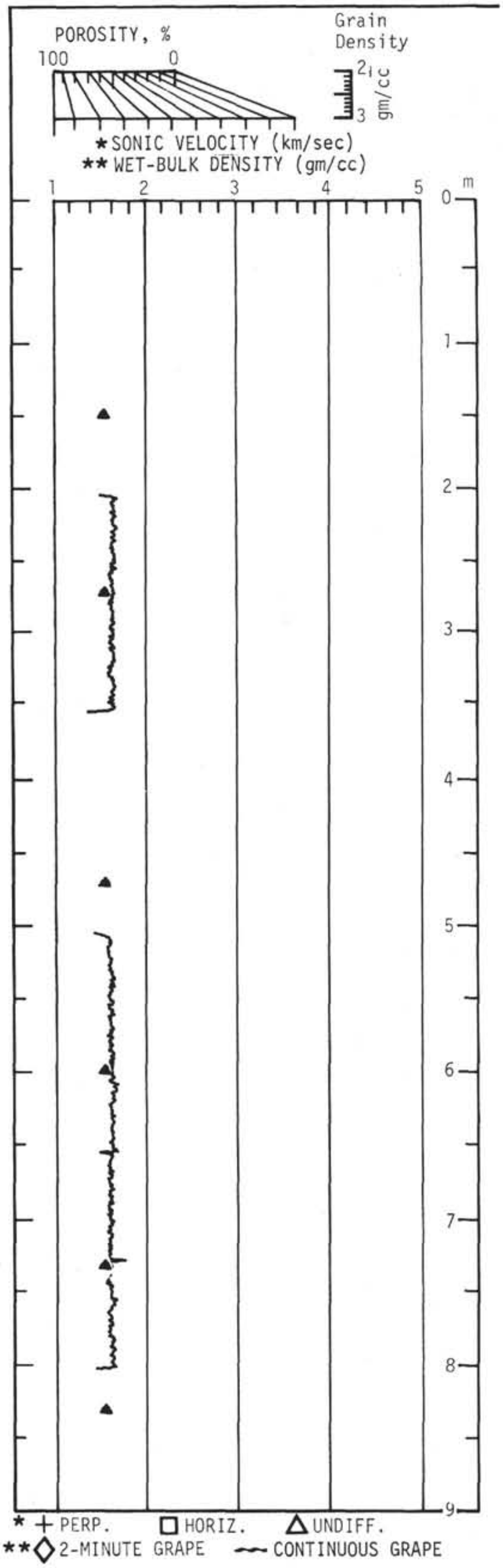

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

329-13

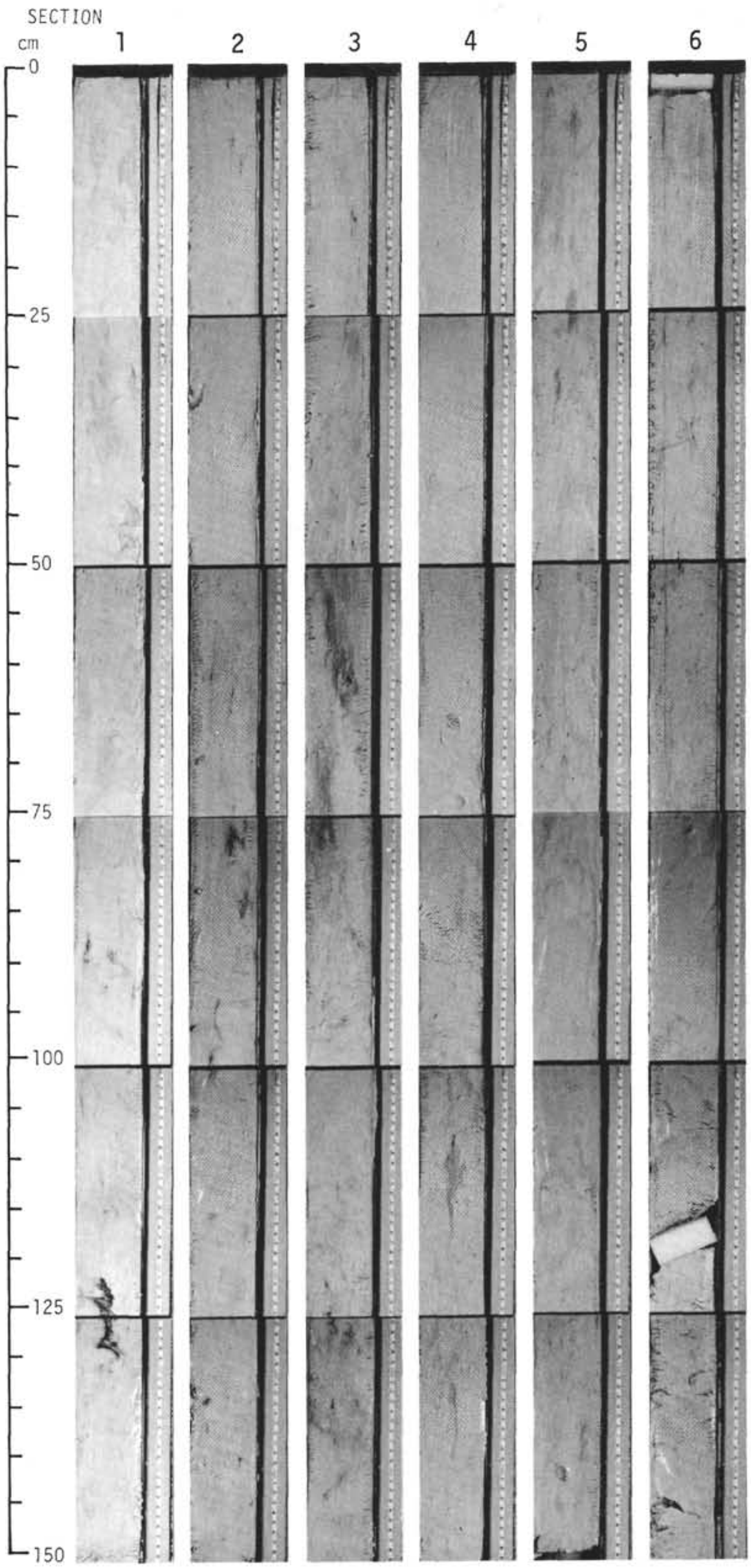

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE


SECTION
1
2
3
4
5
6
cm
0
25
50
75
100
125
150

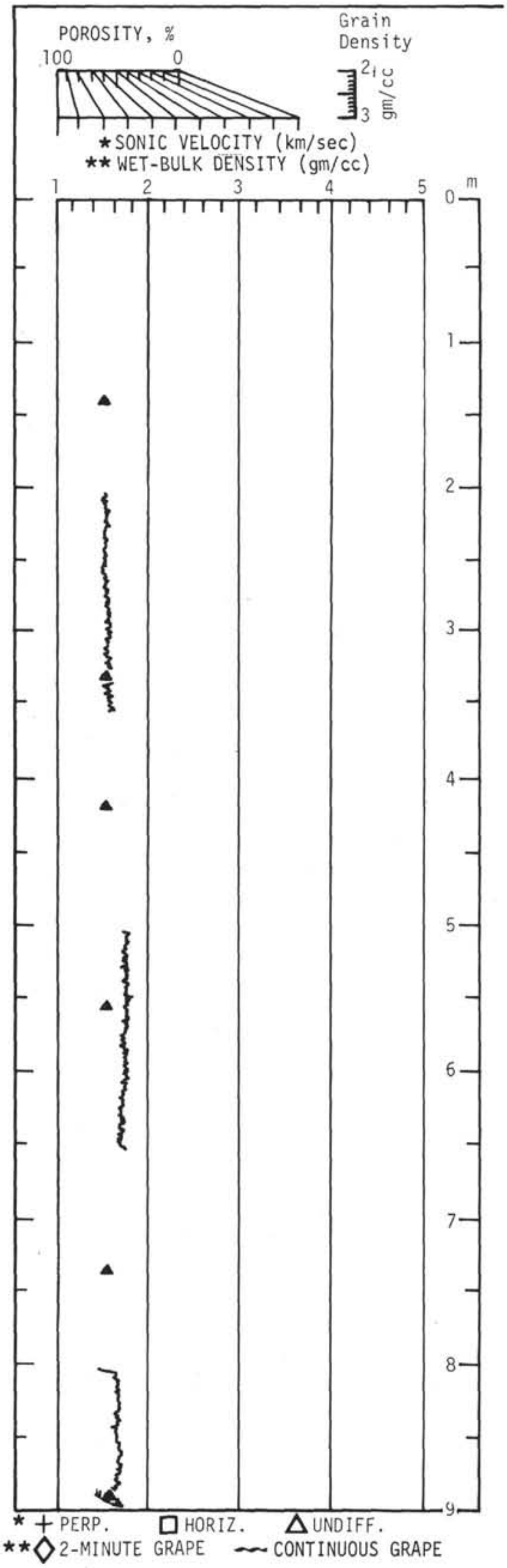

329-14
POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE
SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

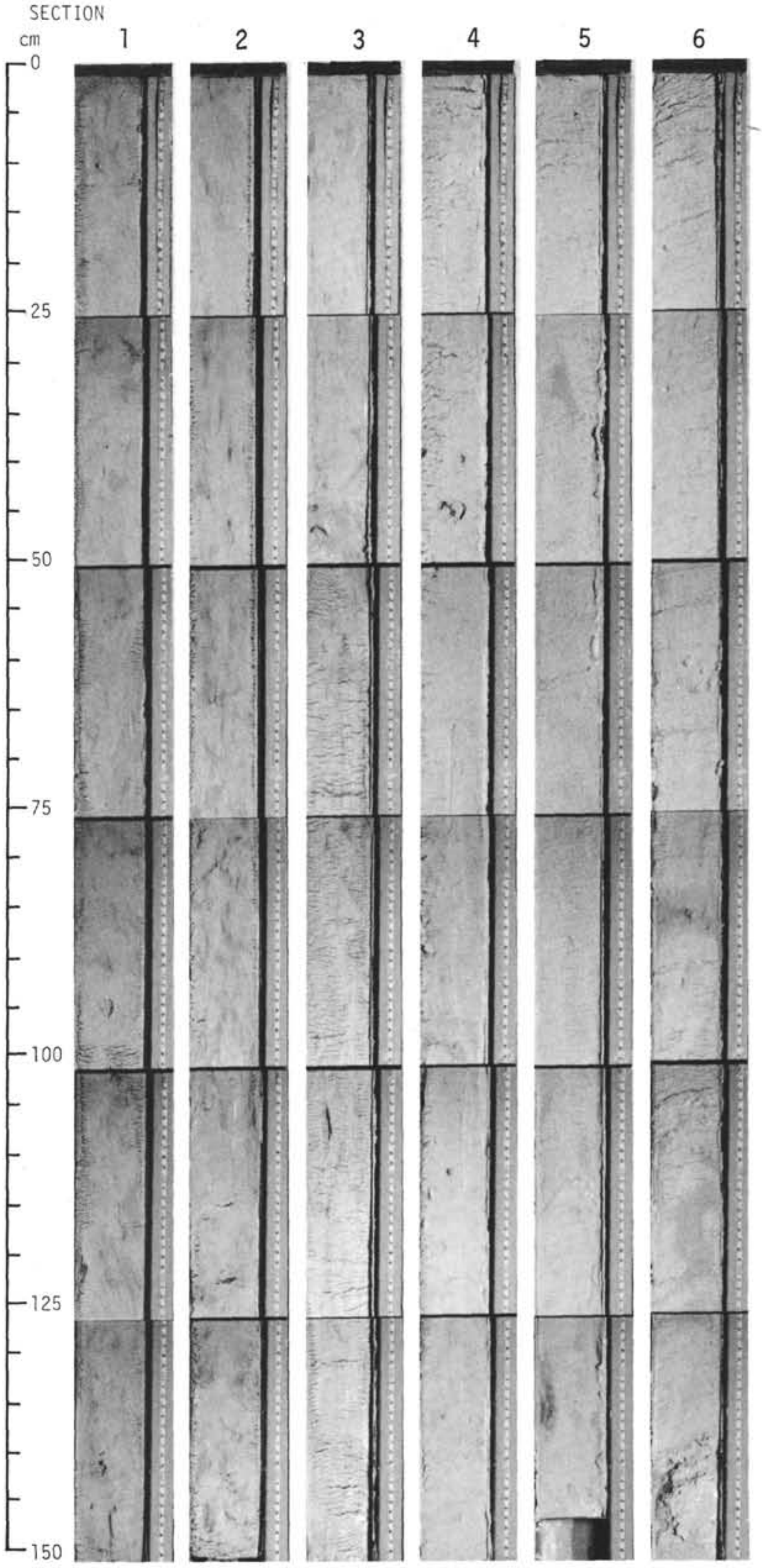

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

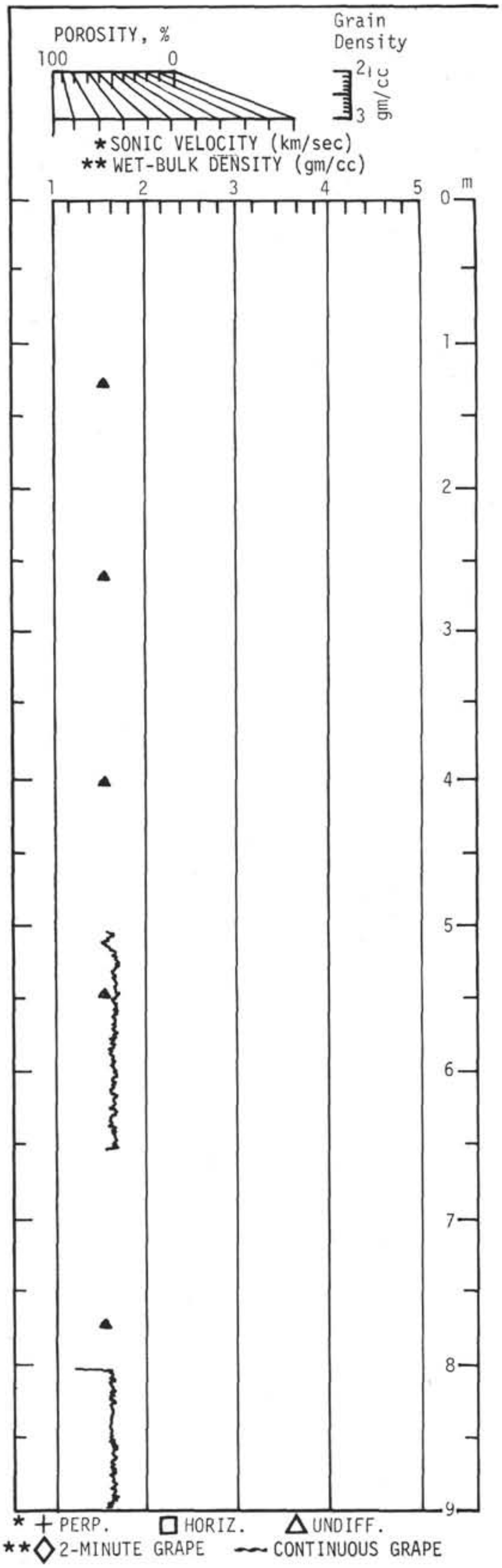
329-15


SECTION
1
2
3
4
5
6
cm
0
25
50
75
100
125
150

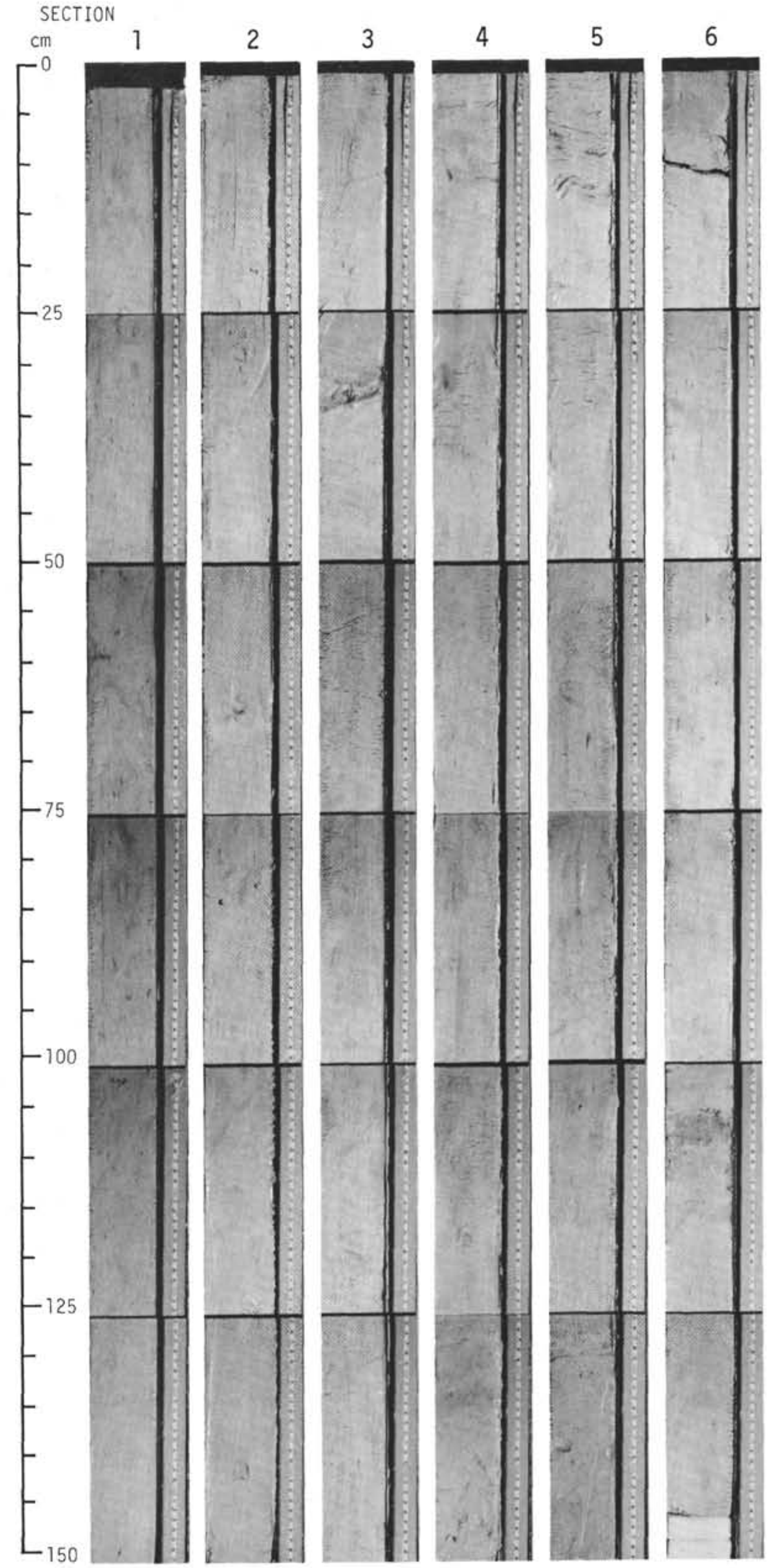
329-16

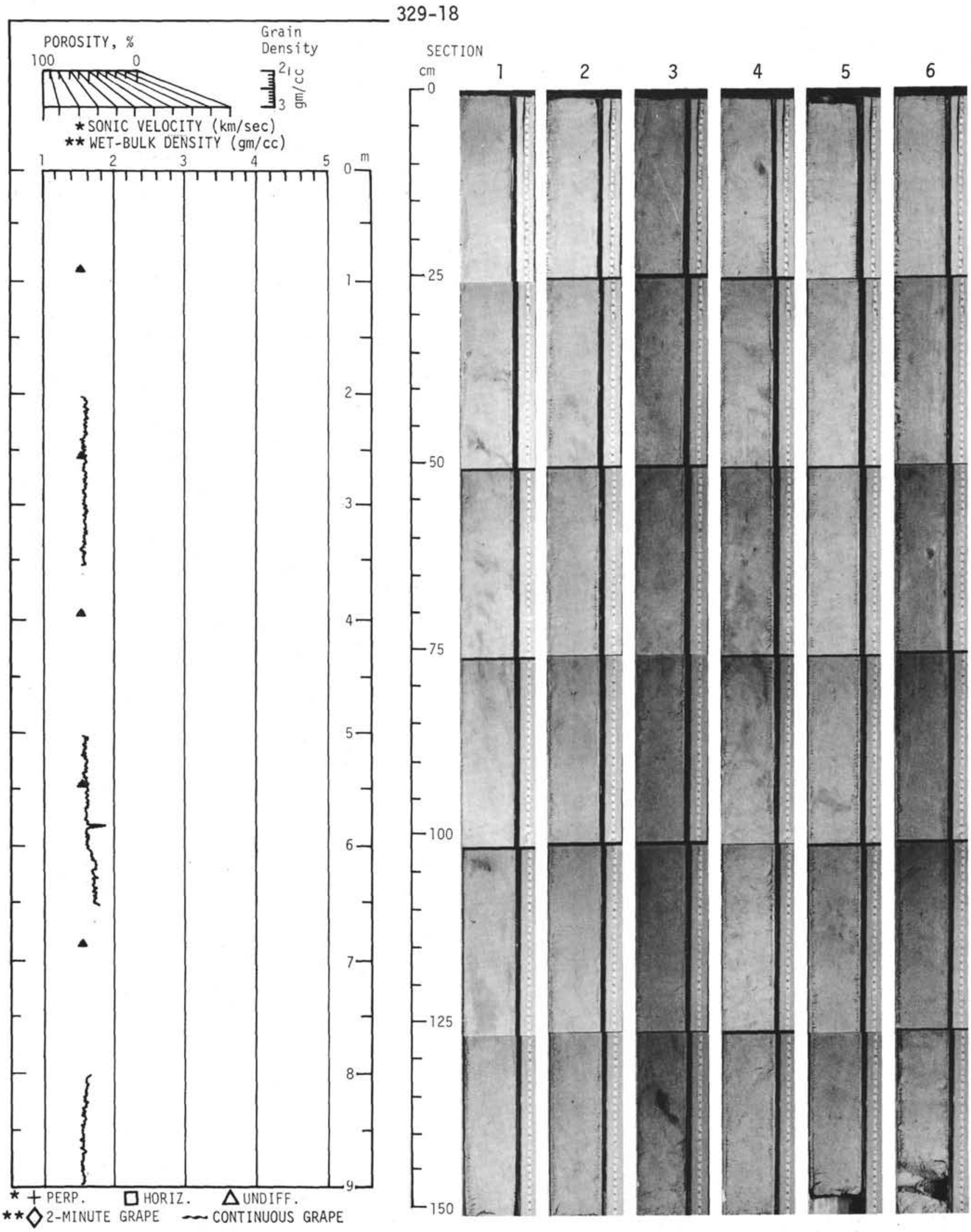

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE


SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

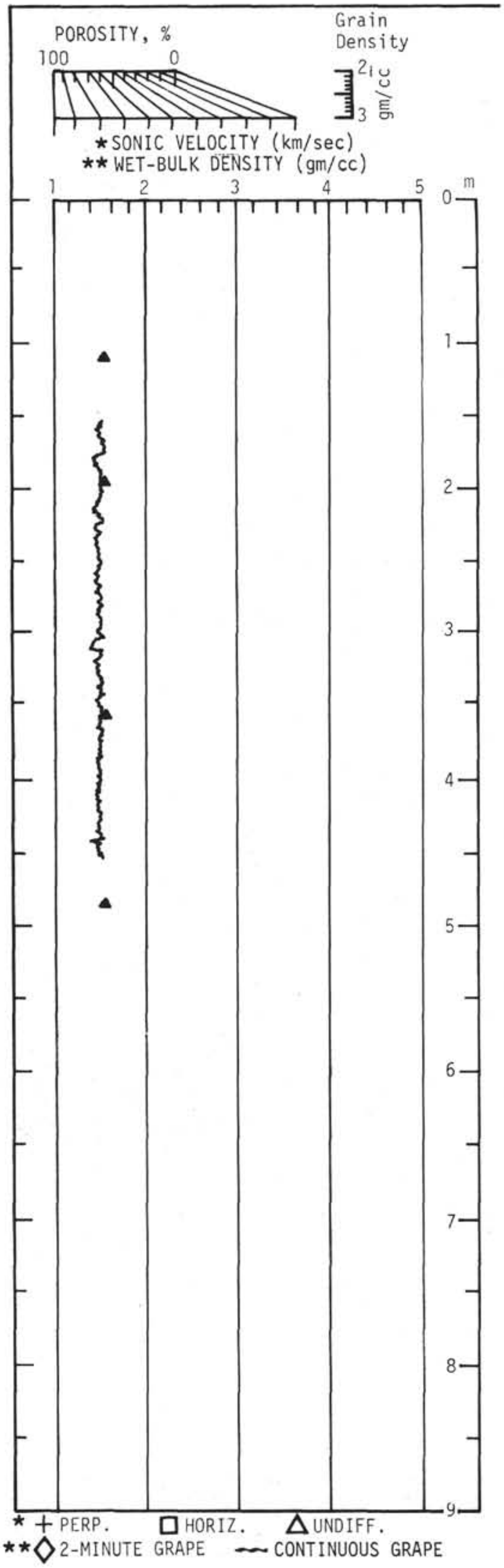

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

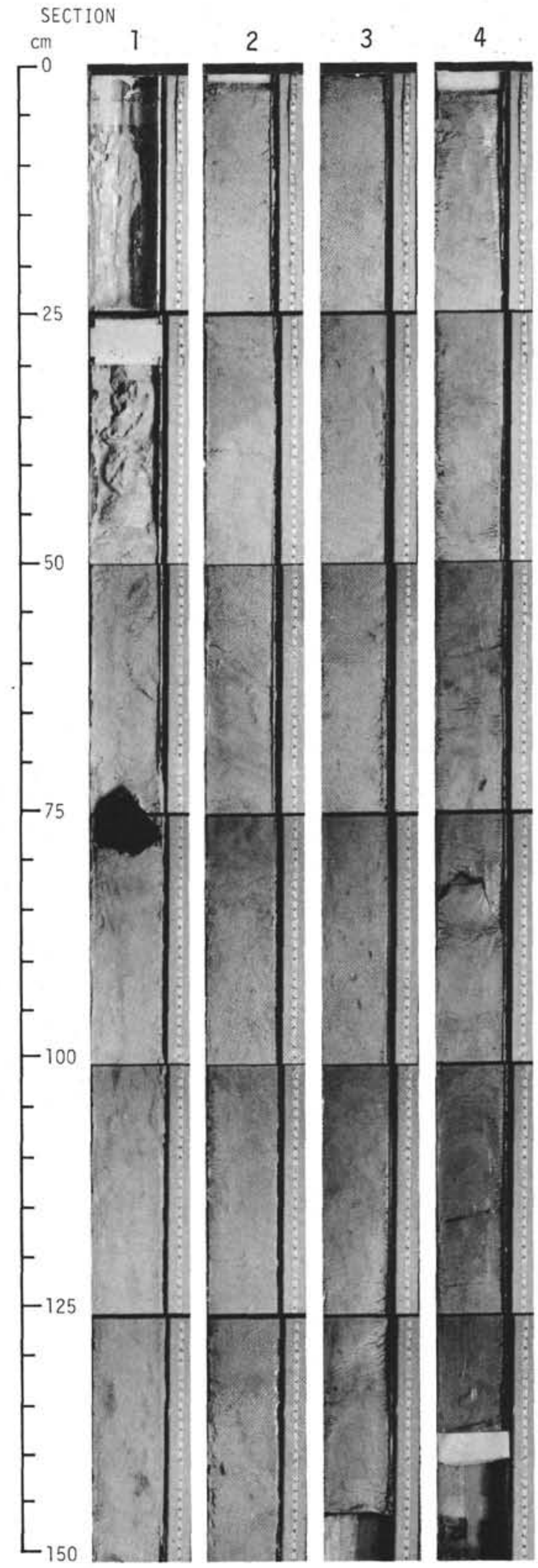
329-17

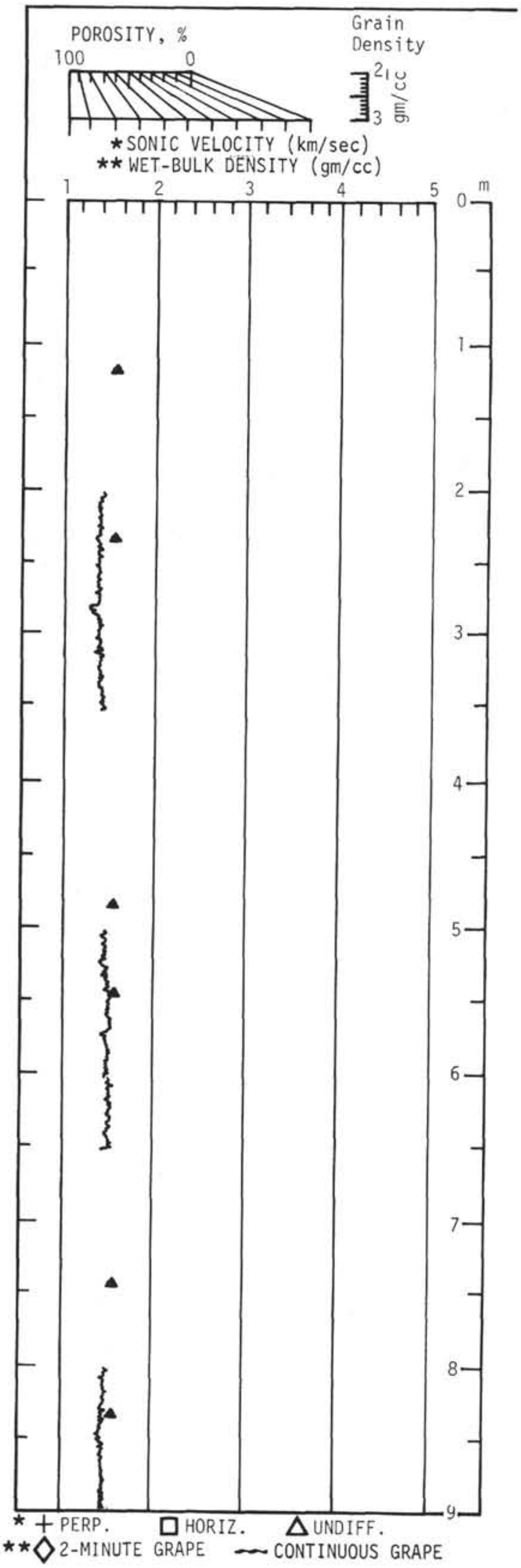

SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

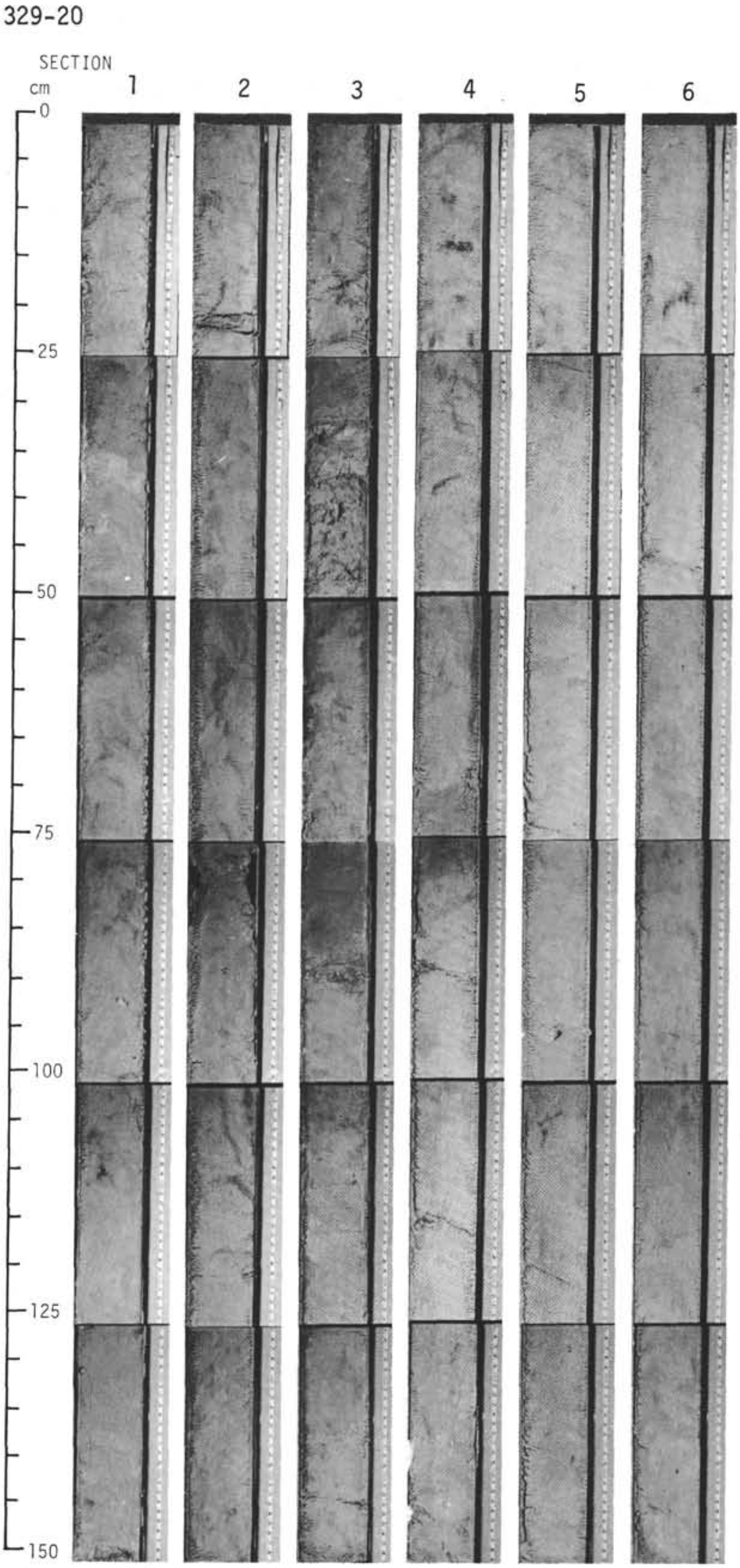

329-18
POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE
SECTION
cm
1
2
3
4
5
6
0
25
50
75
100
125
150

329-19

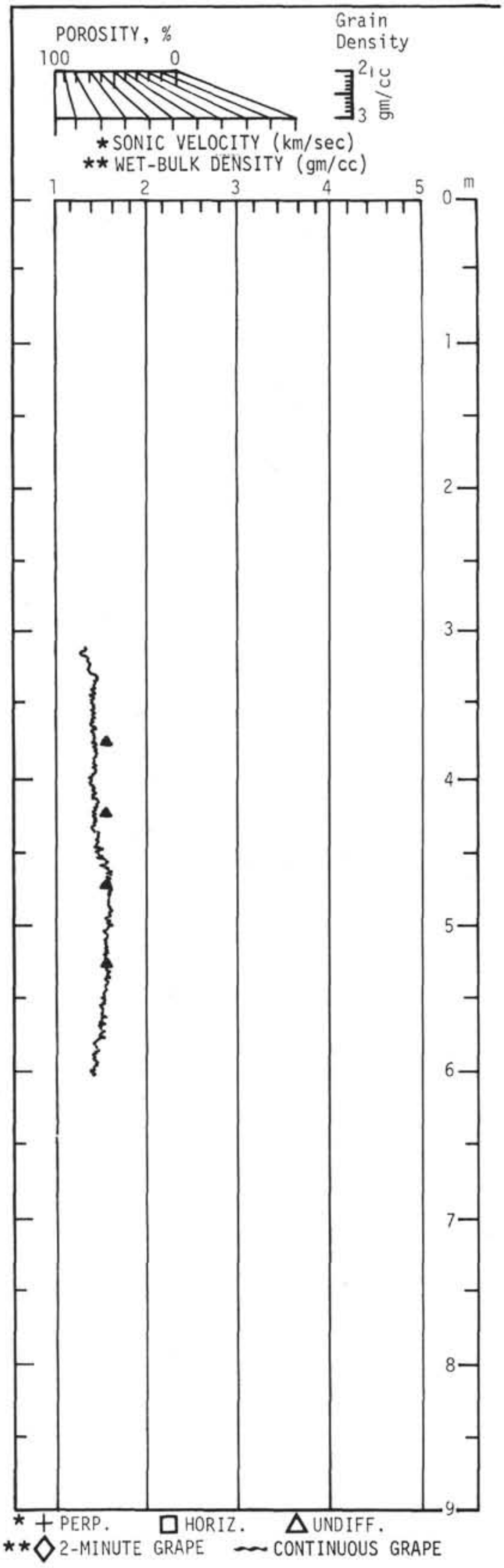

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

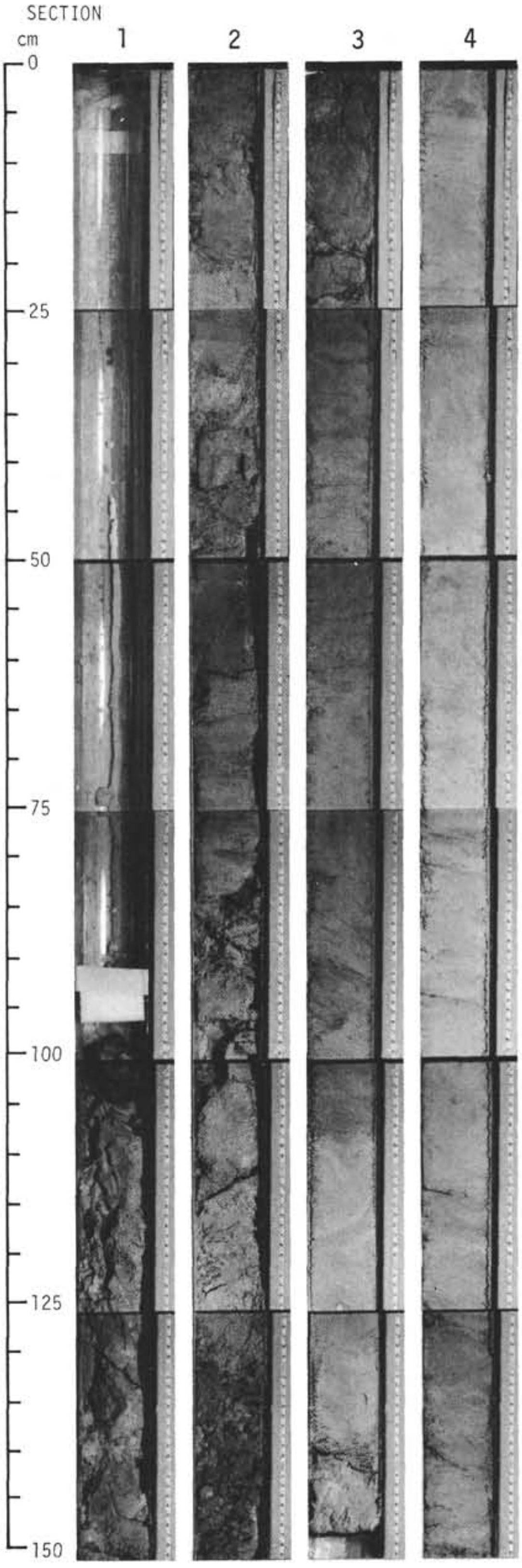

SECTION
cm
1
2
3
4
0
25
50
75
100
125
150

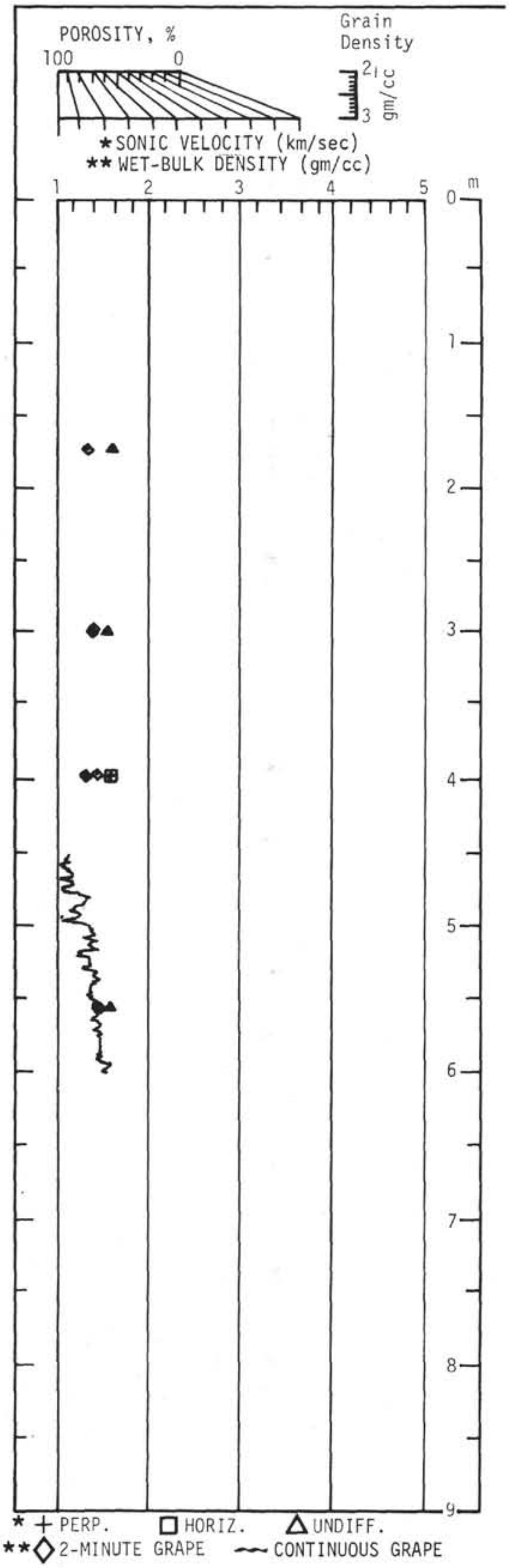

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE


329-20
SECTION
1
2
3
4
5
6
cm
0
25
50
75
100
125
150

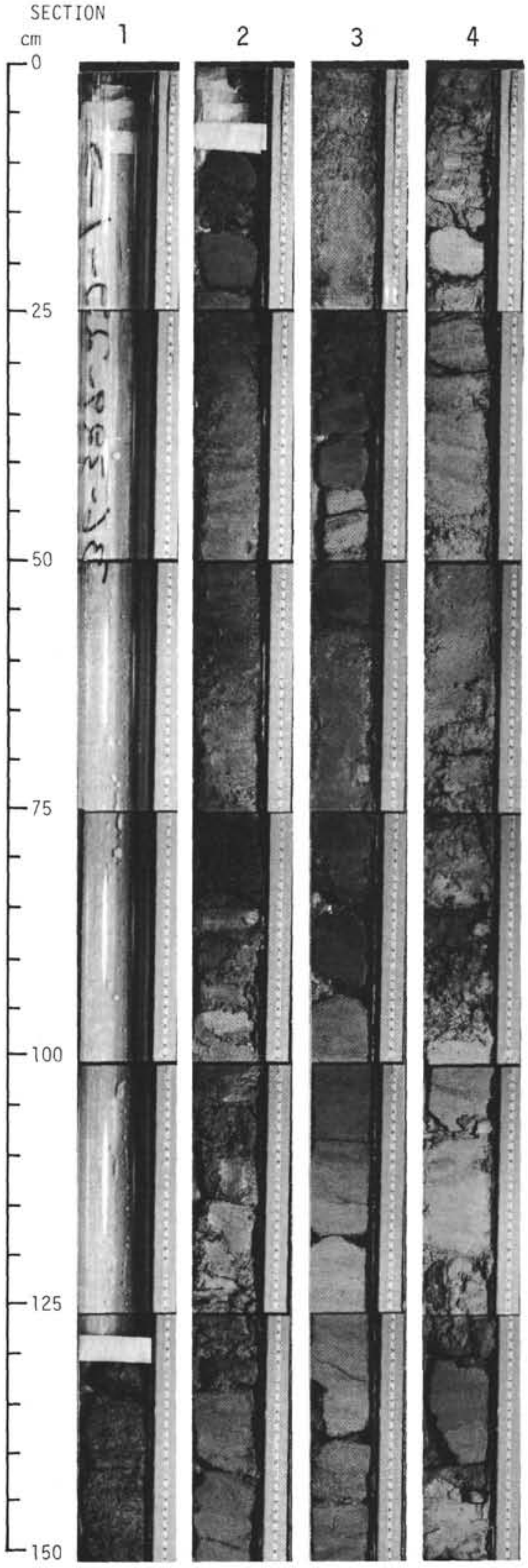
329-21

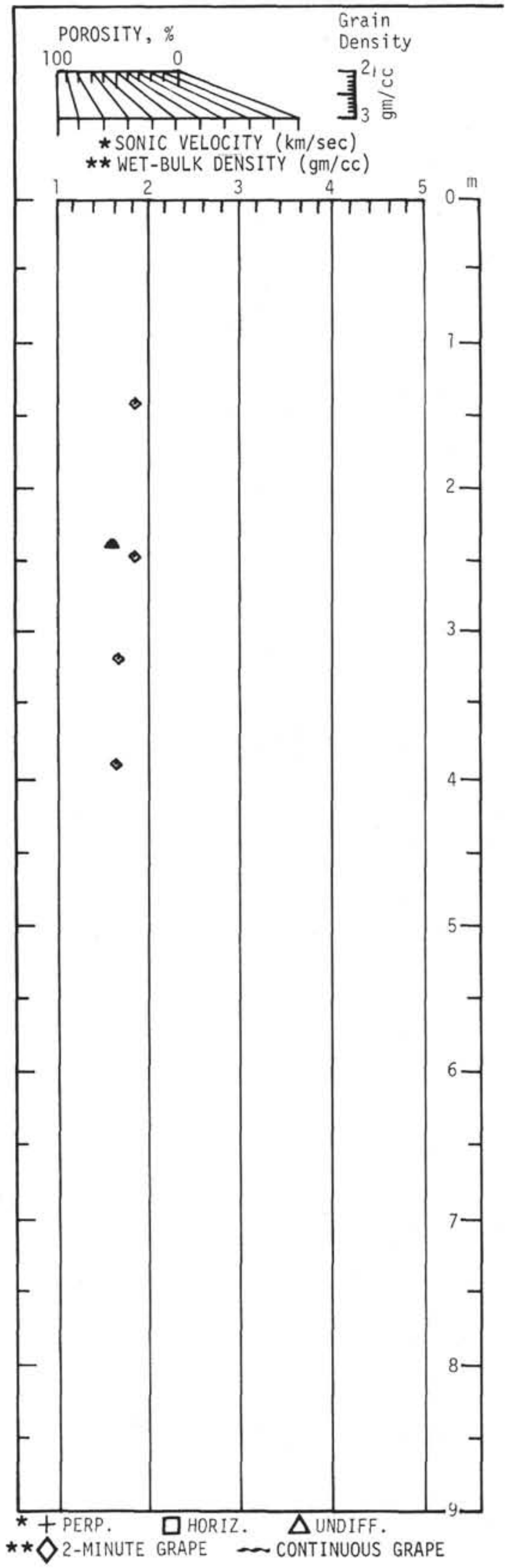

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE


SECTION
cm
1
2
3
4
0
25
50
75
100
125
150

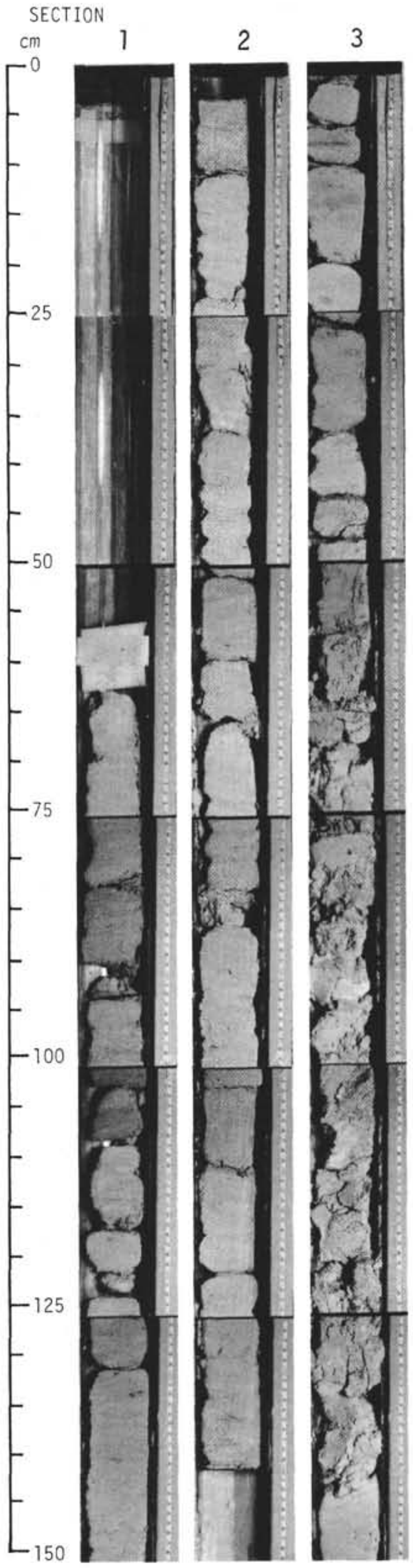

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

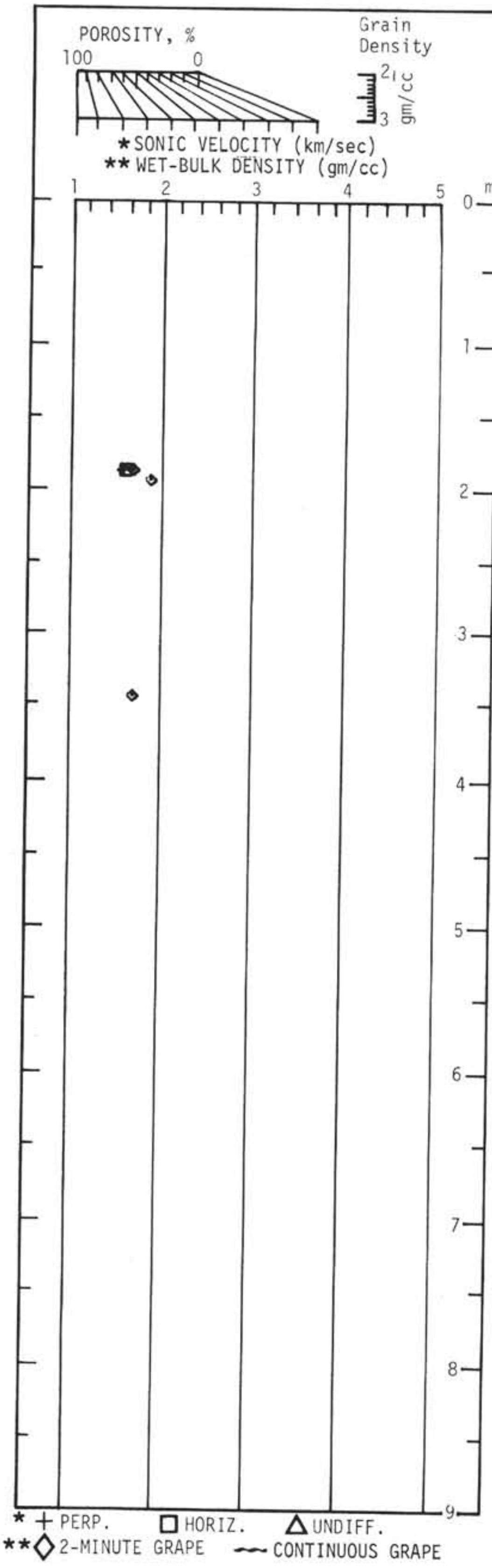
329-22


SECTION
cm
1
2
3
4
0
25
50
75
100
125
150

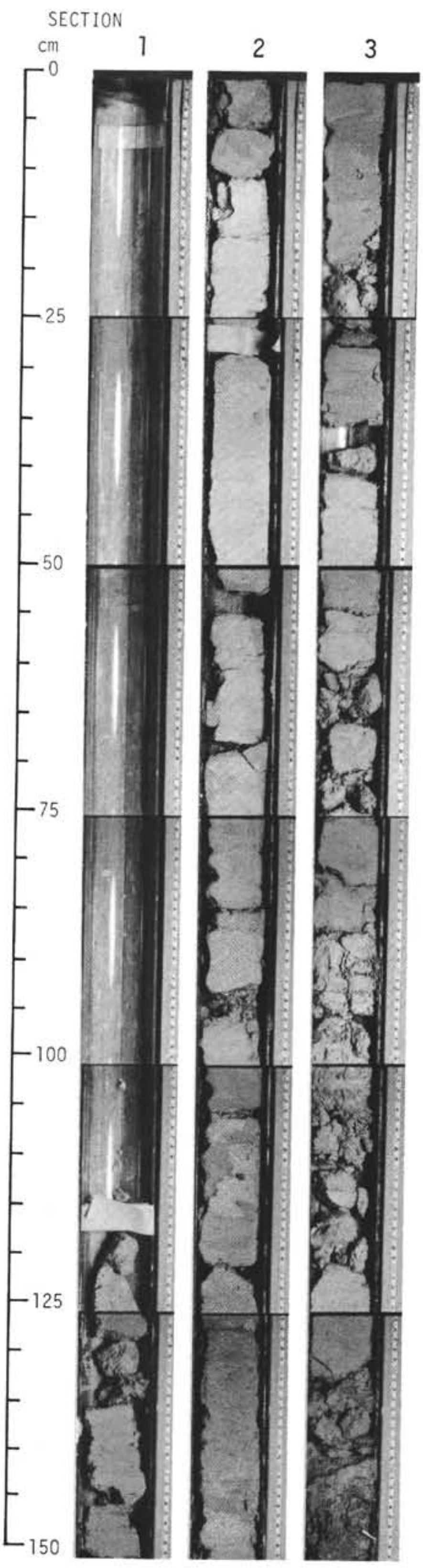

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

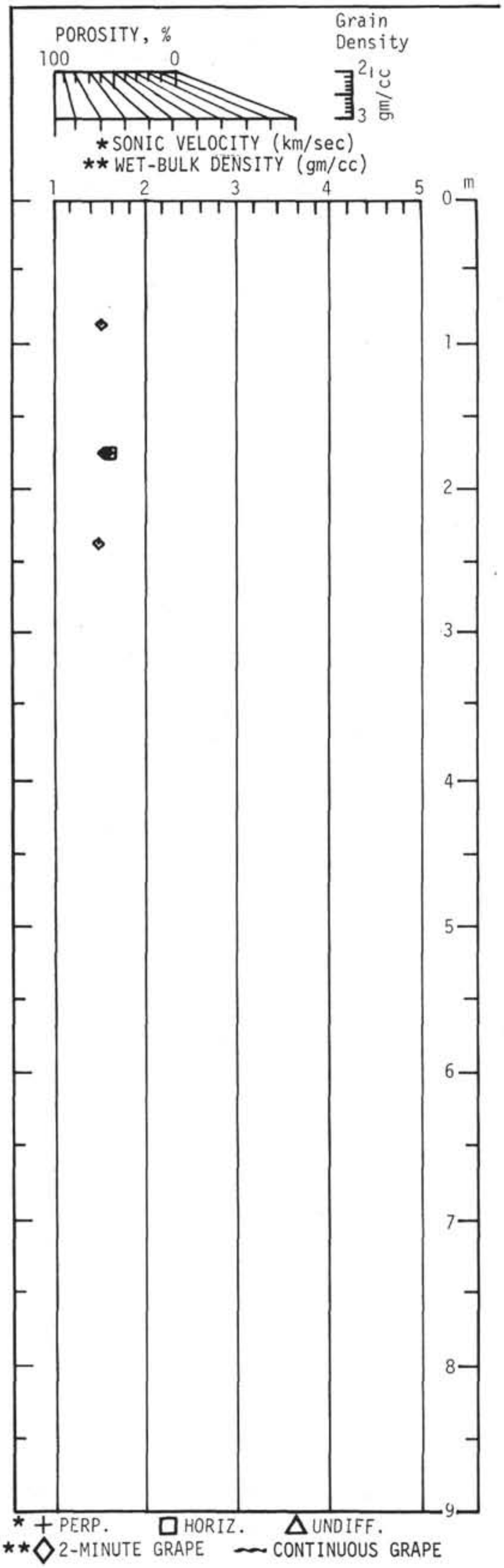
329-23


SECTION
cm
1
2
3
0
25
50
75
100
125
150

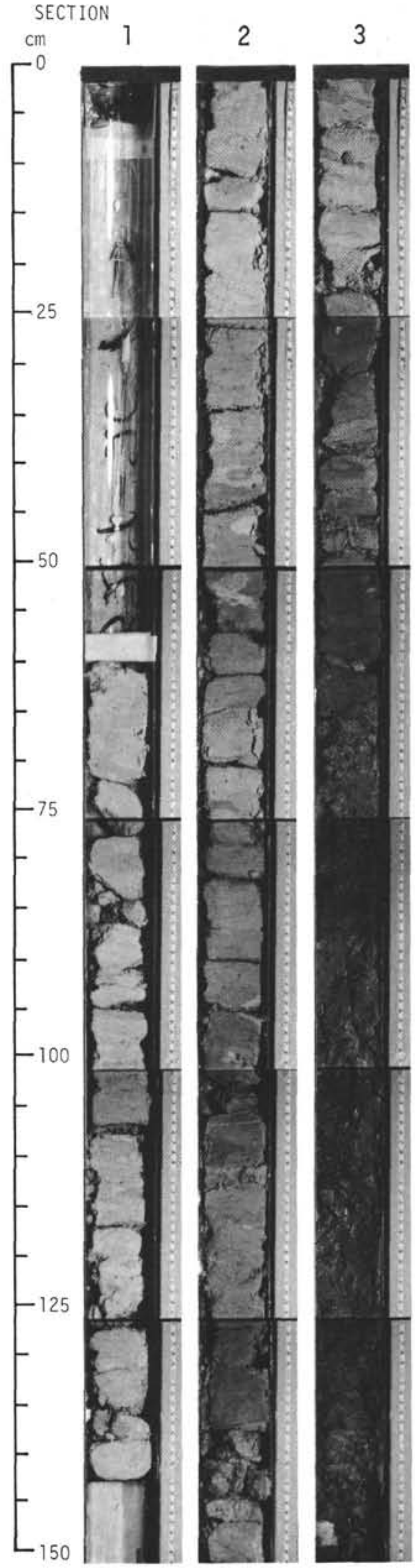

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE

329-24

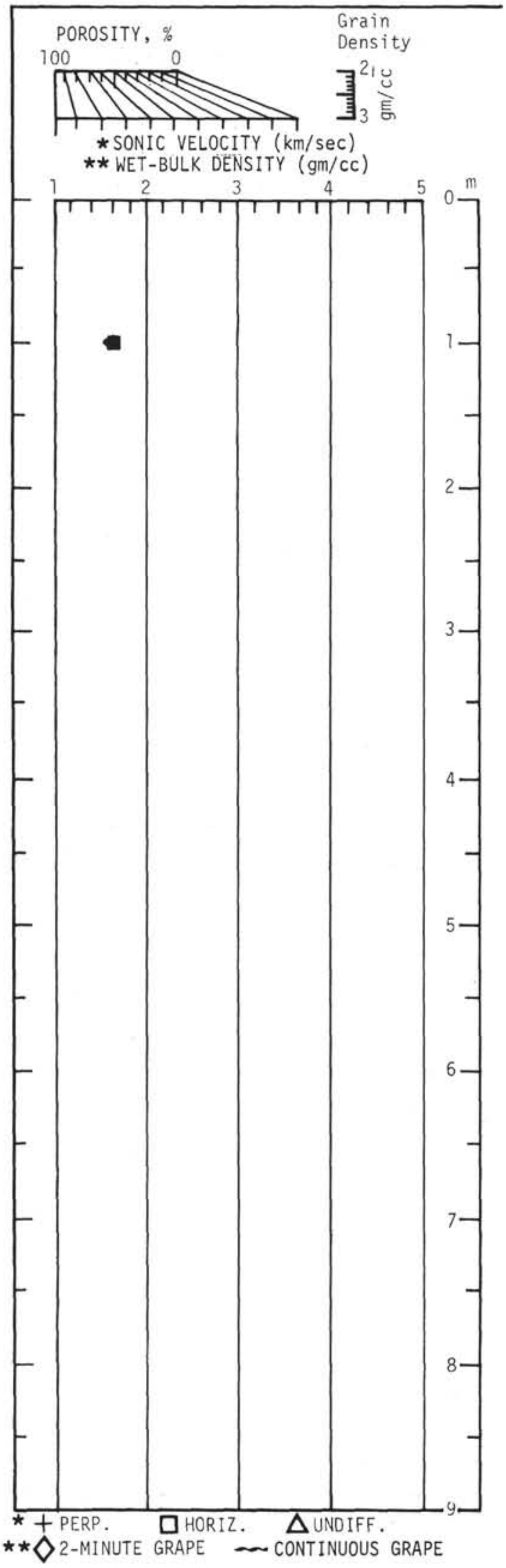

SECTION
cm
1
2
3
0
25
50
75
100
125
150

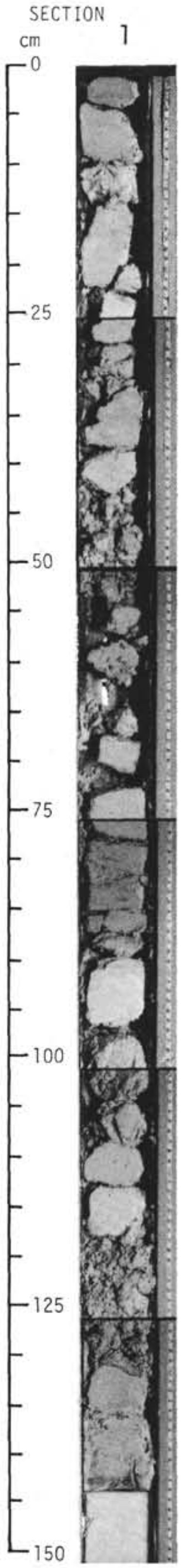

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

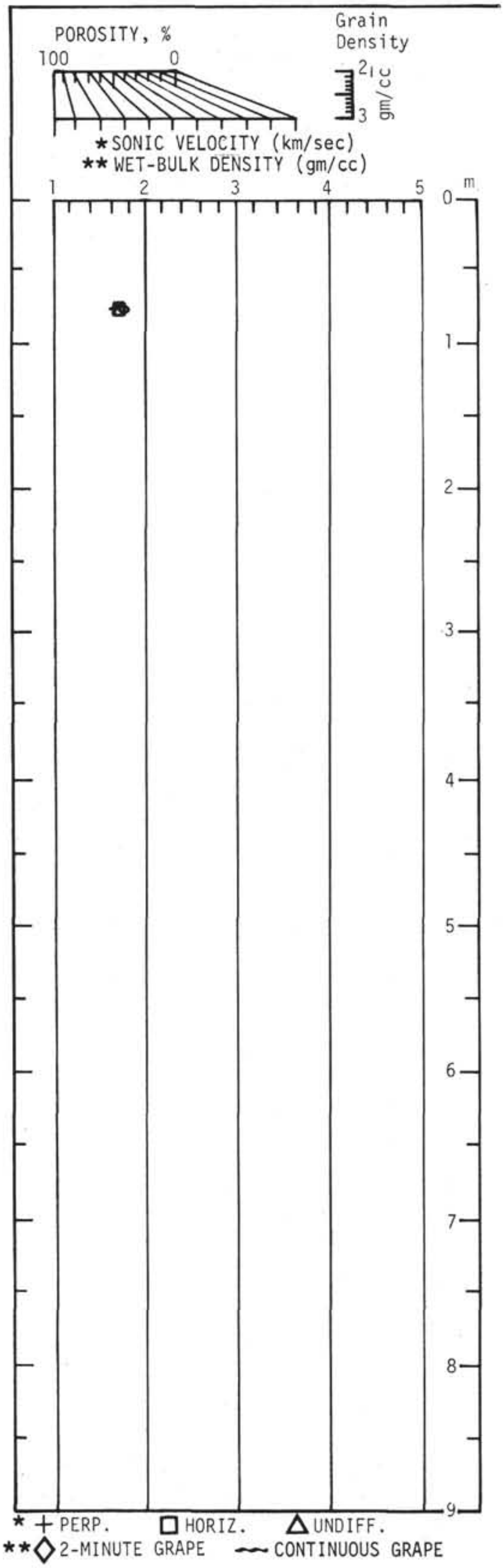
329-26


SECTION
cm
1
2
3
0
25
50
75
100
125
150

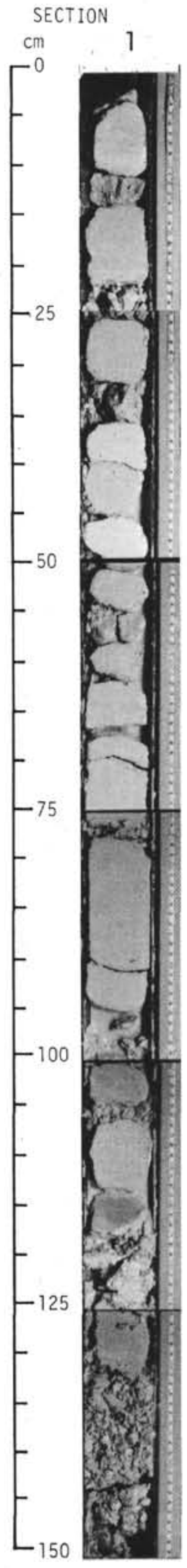
329-27

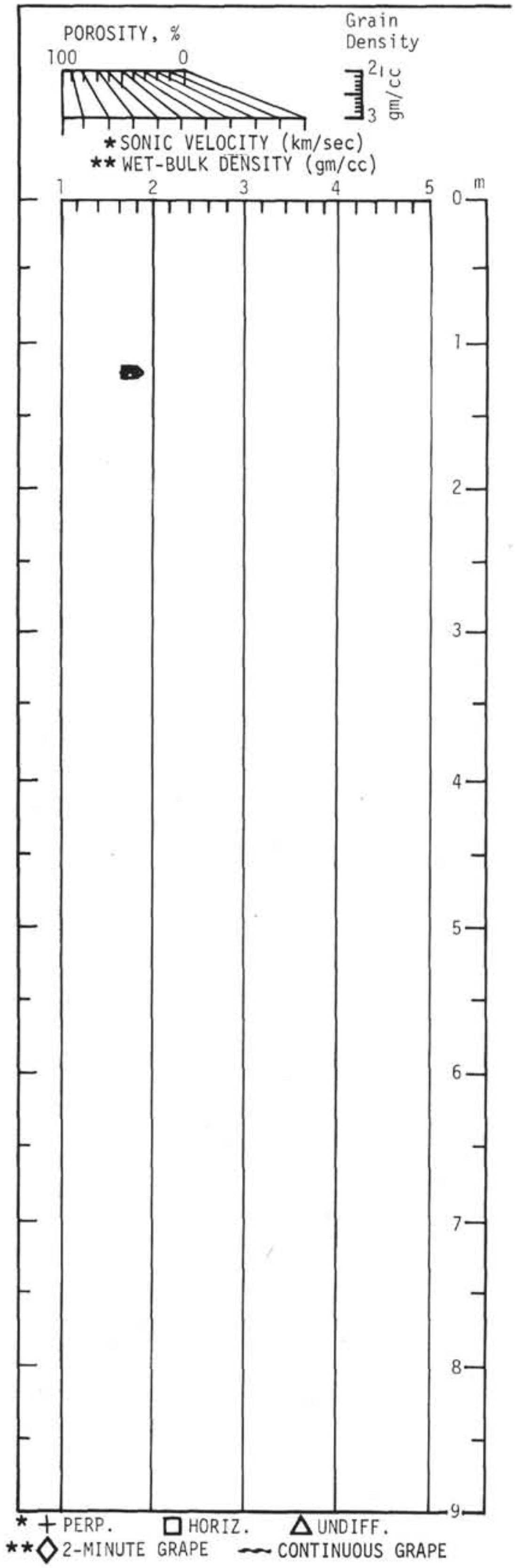

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP. □ HORIZ. △ UNDIFF.
** ◇ 2-MINUTE GRAPE ~ CONTINUOUS GRAPE


SECTION
1
cm
0
25
50
75
100
125
150

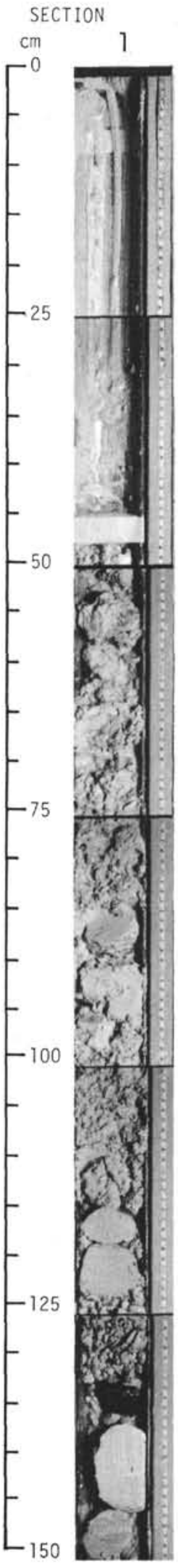

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

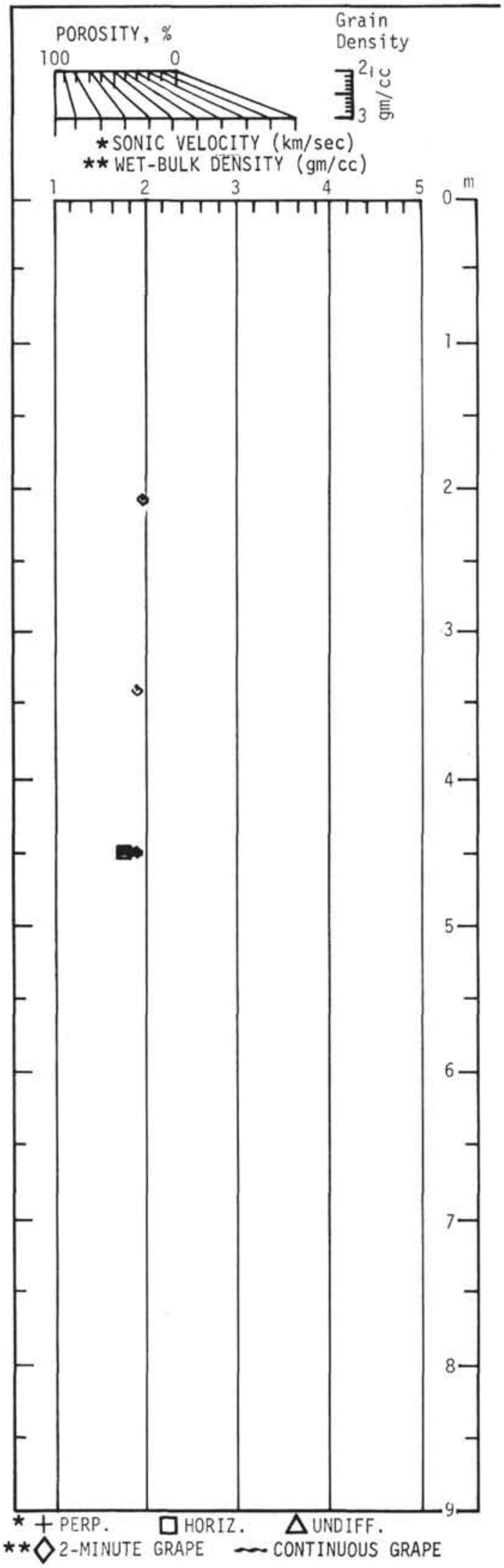
329-28


SECTION
cm
1
0
25
50
75
100
125
150

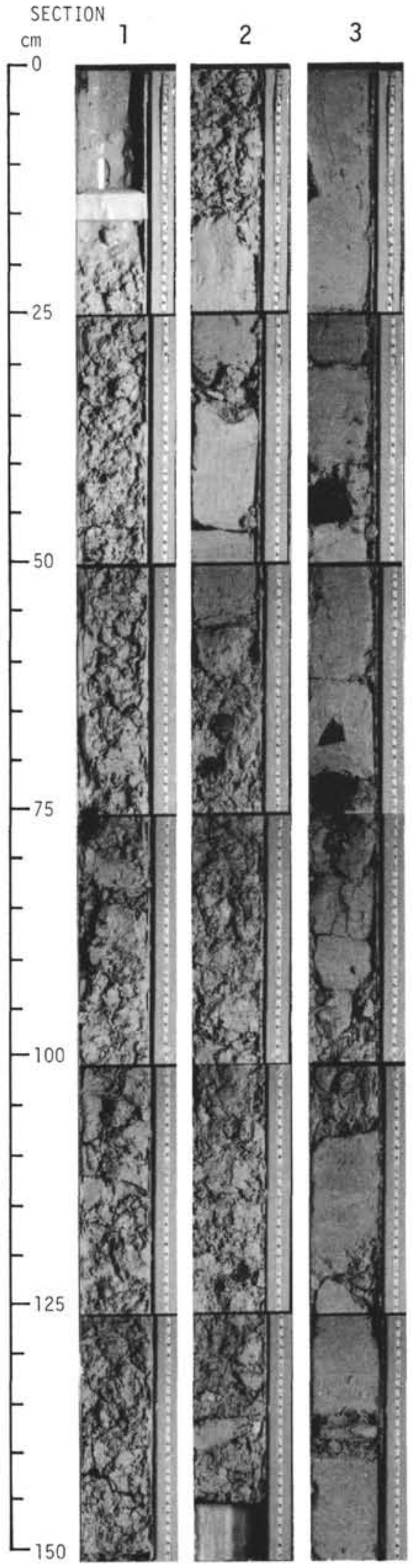

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP. □ HORIZ. △ UNDIFF.
**◇ 2-MINUTE GRAPE ~ CONTINUOUS GRAPE

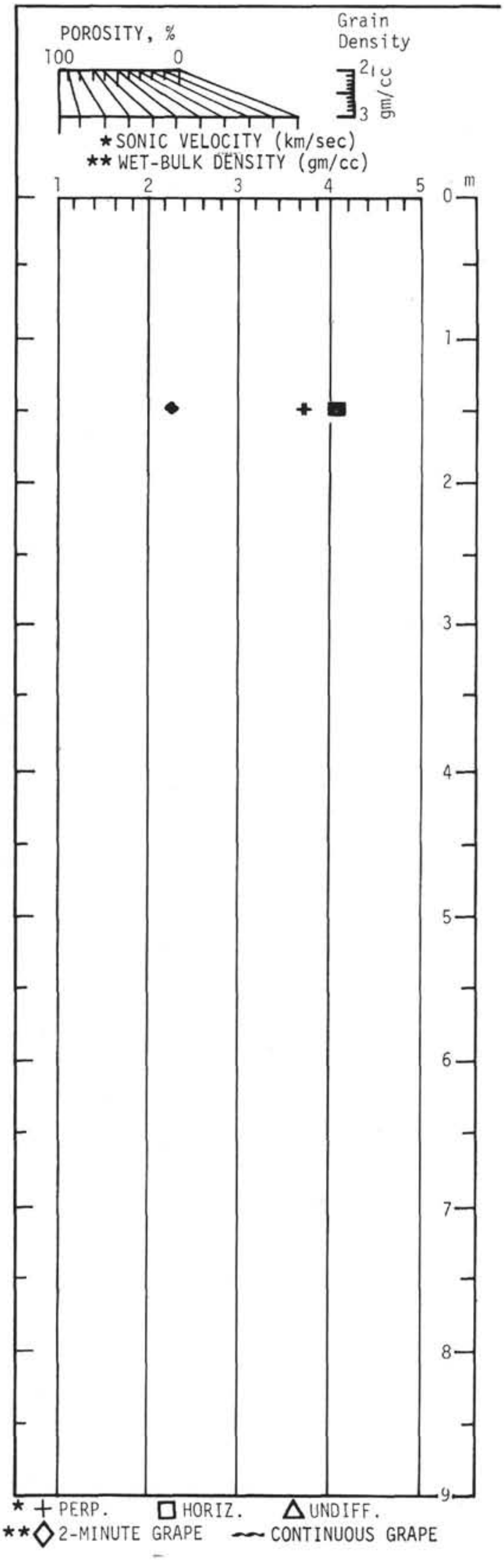
329-29


SECTION
cm
1
0
25
50
75
100
125
150

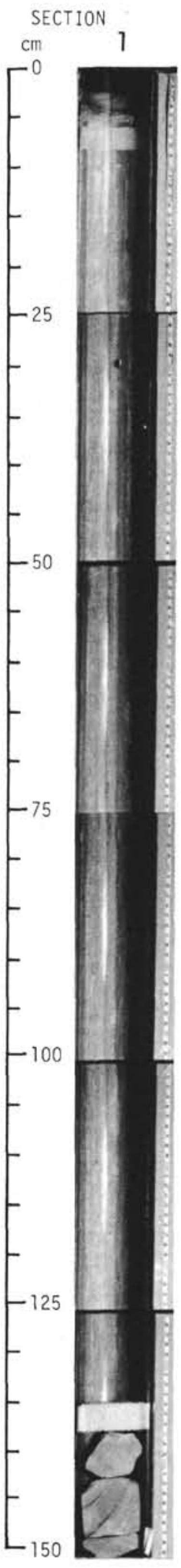

POROSITY, %
100
0
Grain Density
2
3
gm/cc
*SONIC VELOCITY (km/sec)
**WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

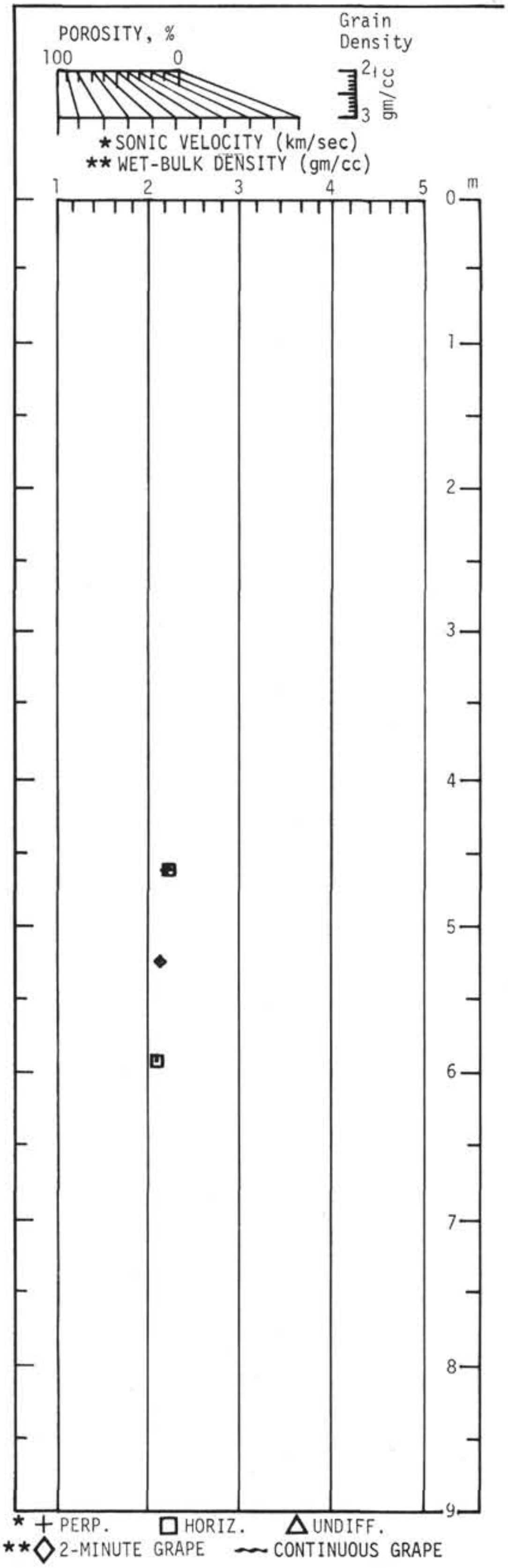
329-30

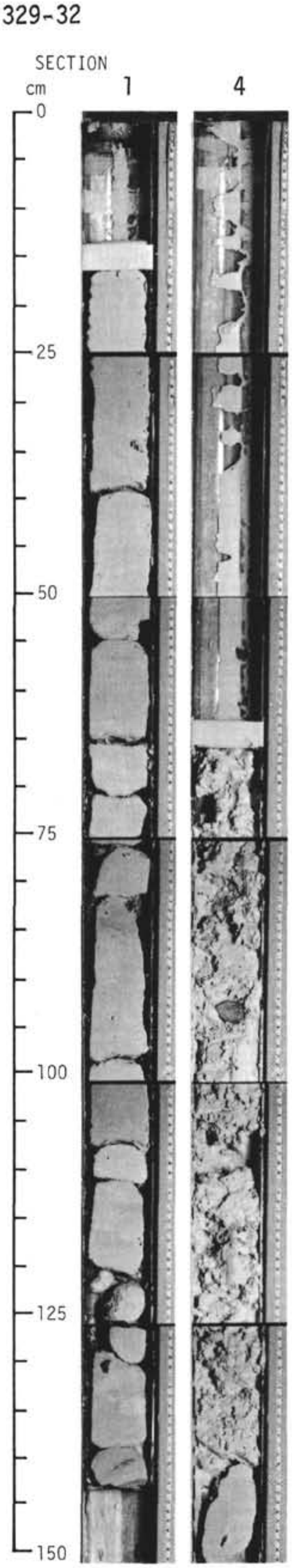

SECTION
cm
1
2
3
0
25
50
75
100
125
150

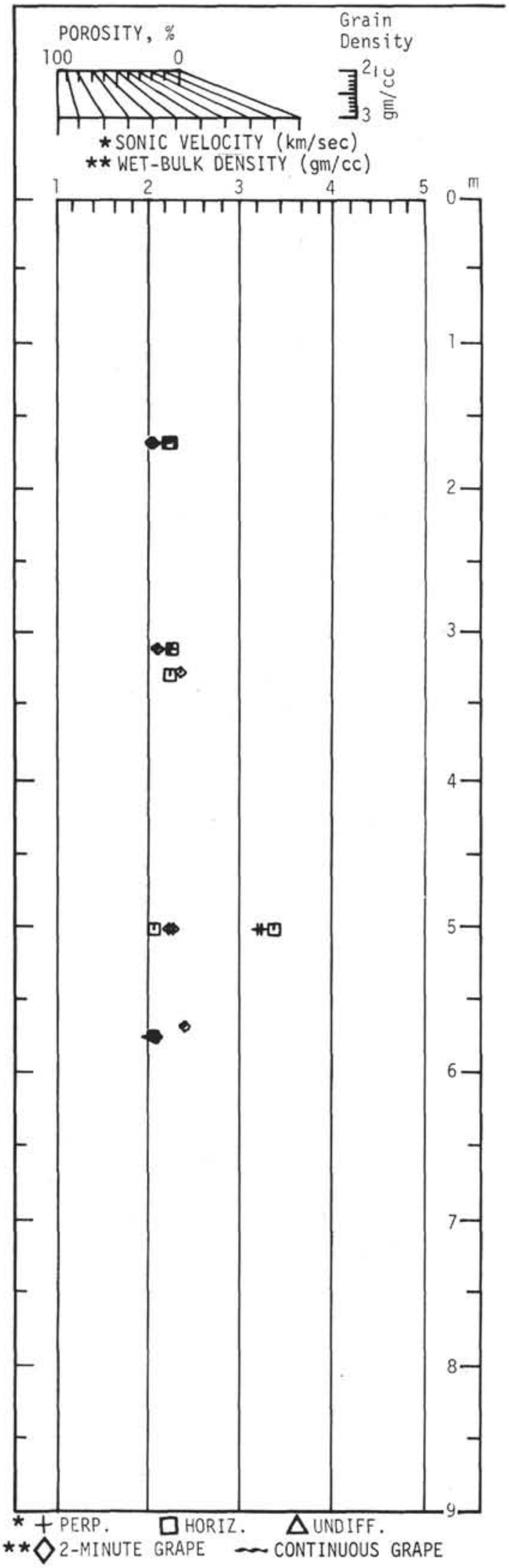

POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
~ CONTINUOUS GRAPE

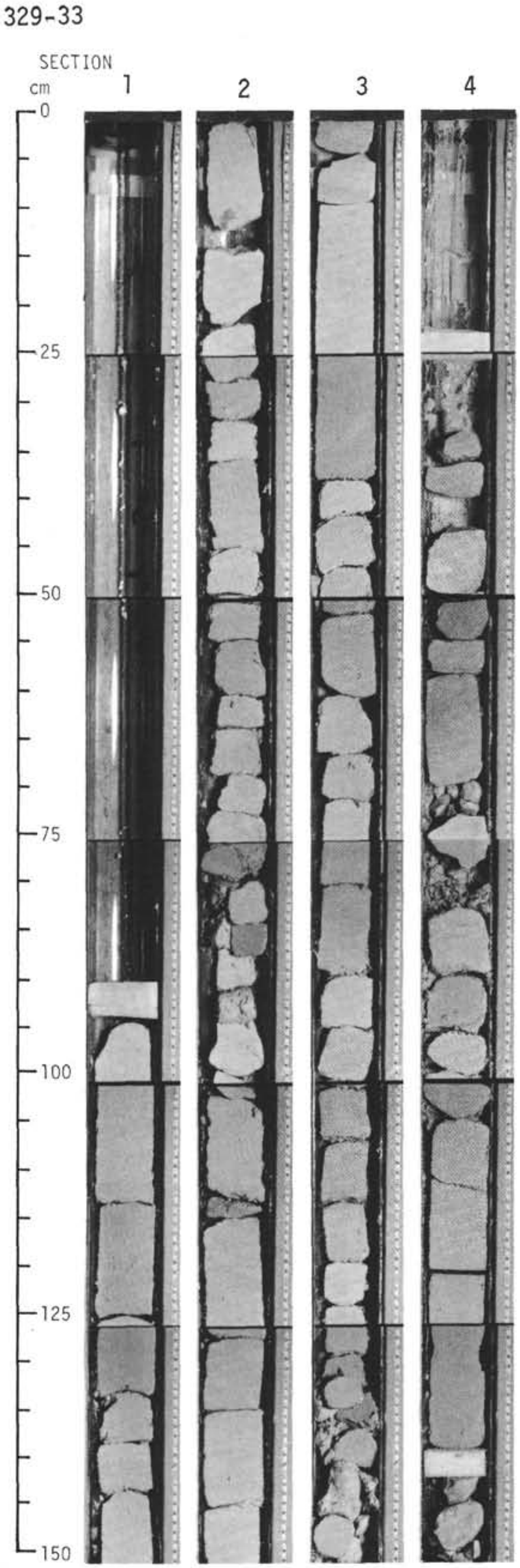
329-31


SECTION
1
cm
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
☐ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
〰 CONTINUOUS GRAPE


329-32
SECTION
cm
1
4
0
25
50
75
100
125
150


POROSITY, %
100
0
Grain Density
2
3
gm/cc
* SONIC VELOCITY (km/sec)
** WET-BULK DENSITY (gm/cc)
1
2
3
4
5
m
0
1
2
3
4
5
6
7
8
9
* + PERP.
□ HORIZ.
△ UNDIFF.
** ◇ 2-MINUTE GRAPE
CONTINUOUS GRAPE


329-33
SECTION
cm
1
2
3
4
0
25
50
75
100
125
150