11. SITE 192

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 30 Aug-4 Sept 71.

Position:
192: 53°00.57′N; 164°42.81′E
192A: 300 ft., 200°T from 192.

Water Depth: 3014 meters, both holes.

Penetration:
192: 942 meters
192A: 1057 meters.

Number of Holes: Two.

Number of Cores:
192: 35
192A: 6.

Total Core Recovered:
192: 152 meters
192A: 38 meters.

Acoustic Basement:
Depth: 1044 meters
Nature: Basalt
Velocity: 4.4-5.1 km/sec.

Age of Oldest Sediment: Maestrichtian.

Basement: Basalt.

SUMMARY

Site 192, at a water depth of 3000 meters, is located atop Meiji Guyot at the northwest end of the Emperor Seamounts. The sediment and sedimentary rock sequence (0-1044 m) consists of Holocene through Pliocene (0-320 m) diatomaceous silty clay, and diatom ooze, with abundant volcanic ash beds and ice-rafted (?) erratics through the first 110 meters; upper Miocene (320-550 m) diatom ooze; lower upper Miocene through upper middle Miocene (550-705 m) diatom-rich clay; lower middle Miocene through Oligocene (705-940? m) claystone with minor calcareous layers; and upper Eocene to Cretaceous (lower Maestrichtian) (940?-1044 m) chalk and calcareous claystone and minor size-graded sand and silt beds between 950 and 1000 meters. An unconformity separates middle Eocene and Cretaceous (middle Maestrichtian) beds. At 1044 meters the sedimentary sequence apparently depositionally overlies a complex of alkali basalt and trachybasalt flows (see Stewart et al., this volume).

It is notable that abundant ice-rafted (?) debris and volcanic ash occur down to middle Pliocene deposits, although a few ash layers occur in lower Pliocene beds. Presumably this means that formation of glaciers in Kamchatka and a late Cenozoic episode of intense volcanism in the Kamchatka-Kuril region began about 3 m.y. ago.

The richly diatomaceous beds, 550 meters thick, overlying the seamount attest to high fertility of the overlying surface waters back to early late Miocene time (8-10 m.y.). Prior to this, and through the Oligocene, the seamount was buried beneath a nearly equally thick pile of palagic clay, 60 percent of which is now a worm-burrowed and mottled claystone. These fine-grained deposits are about 400 meters thick and, between early Miocene time and early late Miocene (15-8 m.y.), accumulated at a rate near 30 m/m.y., which, when roughly corrected for compaction (see Lee, this volume) converts to at least 50 m/m.y. This is an exceptionally high rate for pelagic deposits generally and for the northwestern Pacific specifically, where Pleistocene rates as high as 22 m/m.y. have been measured (Opdyke and Foster, 1970). Lower Miocene and Oligocene rates are more typical oceanic values, about 7 m/m.y. (uncorrected), and are similar to that (5-6 m/m.y.) for upper and middle Eocene claystone and chalk and middle and lower Maestrichtian chalk (3-4 m/m.y.) overlying the basaltic core of Meiji. Eocene turbidites and several species of nannoflora typically preserved only in shallow-water deposits suggest that Meiji Guyot was at or above sea level during this time.

Microfauna and flora suggest that the sediment-water interface has remained near the carbonate compensation depth throughout deposition of the entire sediment section cored at this site. Subarctic flora and fauna are present in the sedimentary section back through the Oligocene, implying that the north-to-south current presently passing over this site has been in this location since that time. The Eocene assemblage suggests a warmer climate; however, because the Eocene was a warm period globally, conclusions about the paleolatitude of Meiji in the Eocene cannot be made.

The thick, lower Miocene to lower upper Miocene (16-8 m.y.) pelagic clay requires that parts of Meiji Guyot was near a sediment source at this time, and undoubtedly somewhat earlier because rapid claystone deposition began at an unknown time in the Oligocene or early Miocene. The only possible source areas are Kamchatka to the west and the Aleutian Ridge to the north, which were both tectonically and volcanically active in the mid-Tertiary.

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Inasmuch as Kamchatka, with its much larger drainage area and known thick Neogene deposits blanketing its eastern margin immediately west of Meiji, is the more obvious choice, it seems unlikely that the relative motion between the Pacific plate and Kamchatka has exceeded about 500 km during the last 16 to 10 m.y. (see Scholl and Creager, this volume).

BACKGROUND AND OBJECTIVES

Description

The Emperor Seamounts trend northwestward from west of Midway Island to the vicinity of the confluence of the Aleutian and Kuril trenches. Near its northwest terminus, the ruggedness of the volcanic core of the chain is lost owing to burial beneath as much as 1300 meters of topography-subduing deposits. Site 192 is located at the northwest end of the chain, at a water depth of 3000 meters, on the summit of Meiji Guyot.

Objectives

Results obtained at Site 183, Aleutian Abyssal Plain, implied that a large amount of relative motion between the Pacific and American plates may not have taken place during the Cenozoic. These findings must be regarded as inconsistent with most plate solutions for the north Pacific areas. Hence it seemed warranted to establish two additional control sites, one atop the recently named Meiji Guyot, which may have remained above the carbonate compensation depth during much of the Cenozoic, and the other southwest of the chain on the more deeply submerged floor of the Pacific plate (east of the Kuril Trench), where the age of the oceanic crust should be unaffected by the growth of the seamount chain.

Pertinent to the problem of determining relative plate motion is the establishment of a record of changes (or lack of them) in latitude with time. Site 183 nannofossils implied that at least since middle Eocene time the underlying Pacific crust has remained in high sub-boreal latitudes. Supporting information includes the Paleogene age of turbidite deposits that are most easily harmonized with an Alaskan source area immediately to the north. Thus one of the principal objectives for drilling at Site 192, which is about 2000 meters shallower than Site 183, was to sample a Cenozoic to possibly early Mesozoic section that may have accumulated in water shallow enough to have preserved carbonates. Hopefully, the cardinal aspects of high-latitude nanno and foraminiferal assemblages would be determined.

It is also of interest to determine the age of the northern end of the chain, which is generally thought to be its oldest part. Additional information relative to motion of the Pacific plate toward Kamchatka would be obtainable if volcanic ash was abundant. Presumably, if Cenozoic plate convergence had been rapid, then volcanic ash derived from Kamchatka or the northern Kuril Islands would not have been well represented in older (pre-early Pleistocene) beds.

OPERATIONS

Pre- and Post-drilling Survey

Site 192 is located atop Meiji Guyot at the northwest end of the Emperor Seamounts (Figure 1), at a water depth of 3014 meters, where the crest is mantled by as much as 1000 meters of sediment. The site was chosen along the track of a reference profile obtained by E. C. Buffington on 17 Aug 70 (Figure 2). This site was approached with a ship's heading of 145°T which was at approximately right angles to that of the reference track. The air-gun profile collected during the approach (Figure 3) showed a structure so similar to that of the reference profile that the beacon was dropped on the fly at 0300 hrs on 30 Aug 71. This beacon was not acquired, requiring an additional profile track and a second beacon drop at 0600 hrs (after the ship has lost way). The finally accepted position is: 53°00.57'N; 164°42.81'E. A sonobuoy reflection profile was made while occupying the site to better define the subbottom structure (Figure 4). No post-drilling survey was deemed necessary. The profile collected during departure from the site is shown in Figure 5. A map showing the approach, departure, and intermediate survey tracks is shown as Figure 6.

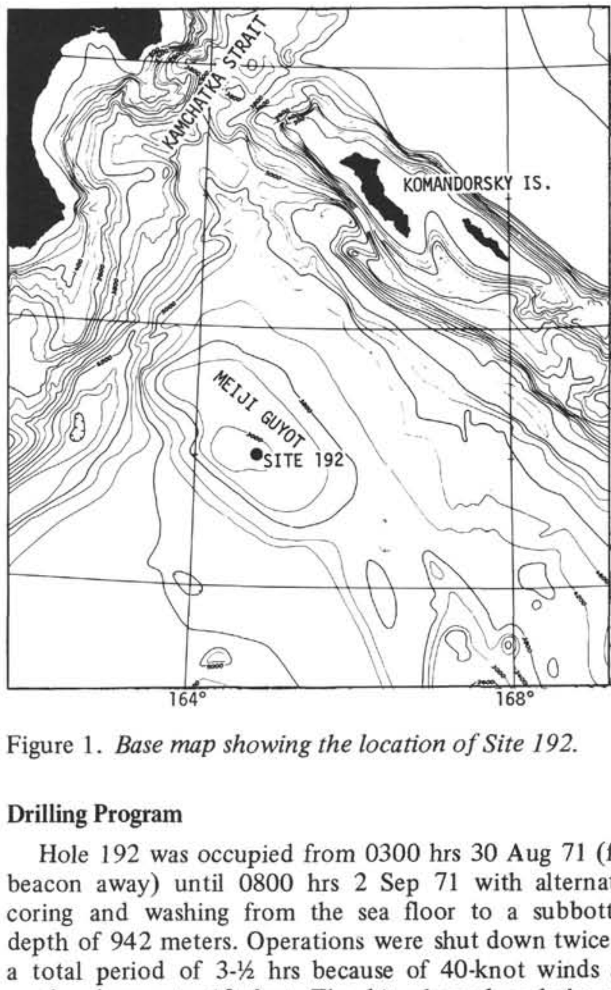

Figure 1. *Base map showing the location of Site 192.*

Drilling Program

Hole 192 was occupied from 0300 hrs 30 Aug 71 (first beacon away) until 0800 hrs 2 Sep 71 with alternating coring and washing from the sea floor to a subbottom depth of 942 meters. Operations were shut down twice for a total period of 3-½ hrs because of 40-knot winds and confused seas to 12 feet. The bit plugged and the core barrel stuck at a total depth of 942 meters below bottom, requiring that the hole be abandoned.

Using recently acquired hydorgraphic data, the sonic depth of 1612 fms was corrected to 2993 meters giving a water depth of 2999 meters and a drill-floor depth of 3009 meters. This compares with 3024 meters below drill floor based upon the "feel" of the drill string by the driller and

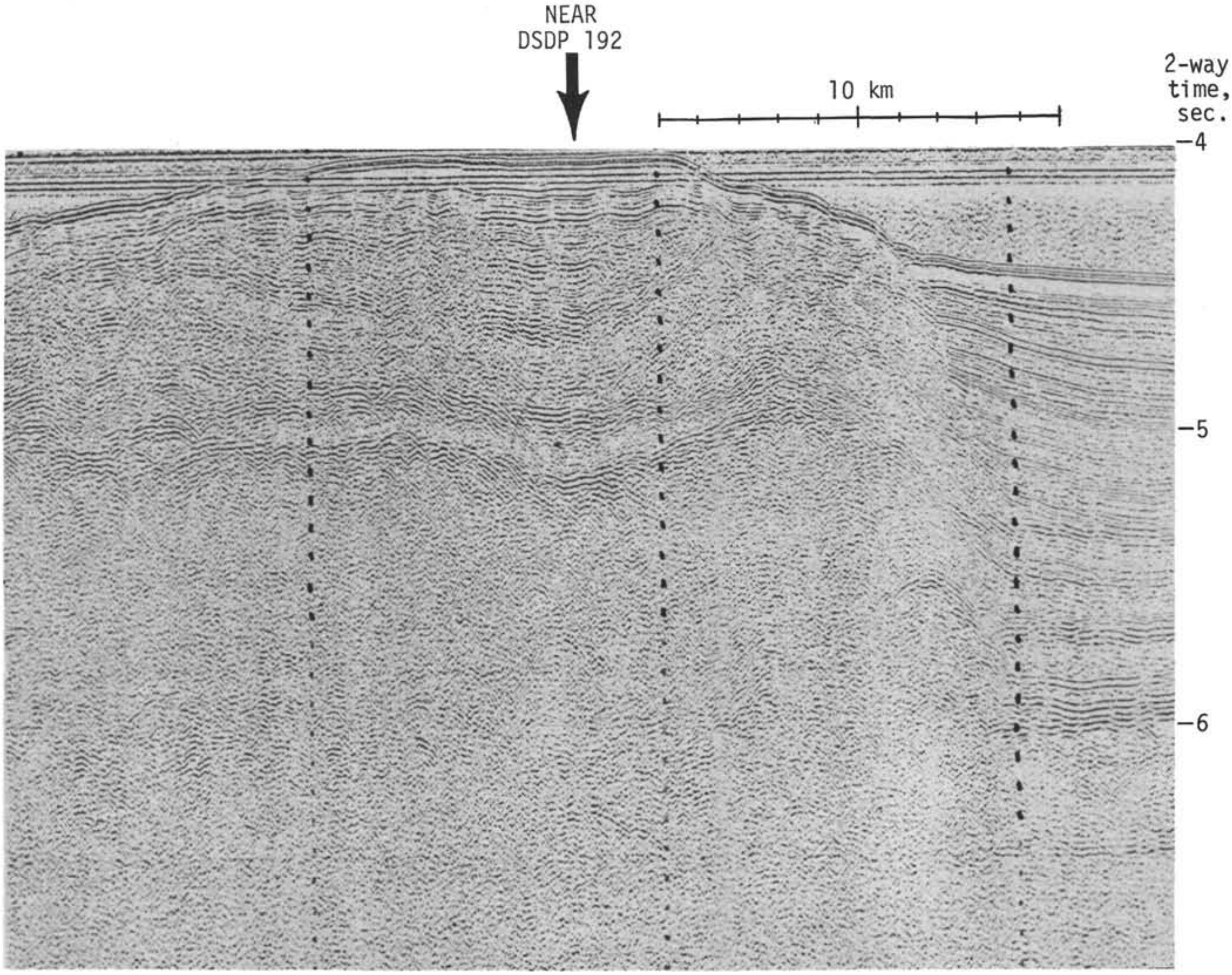

Figure 2. *Site 192 reference seismic reflection profile, obtained by E.C. Buffington, 17 Aug 70.*

some sediment recovery in the first core. The 3024 meters below drill floor, or 3014 meters below sea level, is the accepted depth for this site. No particular drilling difficulties are to be noted, with the exception of the plugging of the bit mentioned above that required abandoning the hole.

After 22 stands of drill string were pulled above the mud line the bit cleared, the core was recovered, and the ship was moved 300 feet along 220°T. At 0800 hrs 2 Sep 71 the string was again lowered and Hole 192A was drilled and cored until 0300 hrs 4 Sep 71. With the center bit in place, a hole was washed to a total subbottom depth of 942 meters. Below this depth the hole was alternately washed and cored to a total subbottom depth of 1057 meters. At 1044 meters basalt was recovered. After a total recovery of 13 meters of basalt, the bit was so badly worn (one cone lost) that the hole was abandoned. The same depths were accepted for this hole as for Hole 192. A coring summary is given in Table 1.

LITHOSTRATIGRAPHY

At Site 192 a 1044-meter thick sedimentary section overlies extrusive alkali basalt. Variations in the content of diatoms, clay, and nannofossil chalk permit division of the sedimentary section into three units (Table 2).

Unit A, 0 to 705 meters below bottom, is diatomaceous silty clay (0-140 m), diatom ooze (140-550 m), and diatom-rich clay (550-705 m). Above 110 meters, abundant volcanic ash beds and five zones containing ice-rafted (?) pebbles are present. However, layers of volcanic ash occur to a depth of about 240 meters in beds of middle Pliocene age. Calcareous debris, mostly nannofossils and disaggregated nannofossil plates, is scattered through the unit, and a nannofossil chalk occurs at 523 meters.

Unit B, 705 to 940(?) meters below bottom, is dominantly claystone, with the uppermost portion being transitional to the overlying diatomaceous units. Minor calcareous layers occur throughout the unit, although they are more numerous near the base. Composition of the carbonate zones ranges from a trace of carbonate in the claystones to pure nannofossil chalk.

Unit C, 940(?) to 1044 meters below bottom, consists of irregularly interbedded claystone, calcareous claystone, and nannofossil chalk, with the latter two types predominating. Minor size-graded sand and silt beds occur between 950 and 1000 meters. Much of the calcareous claystone and chalk is ferruginous.

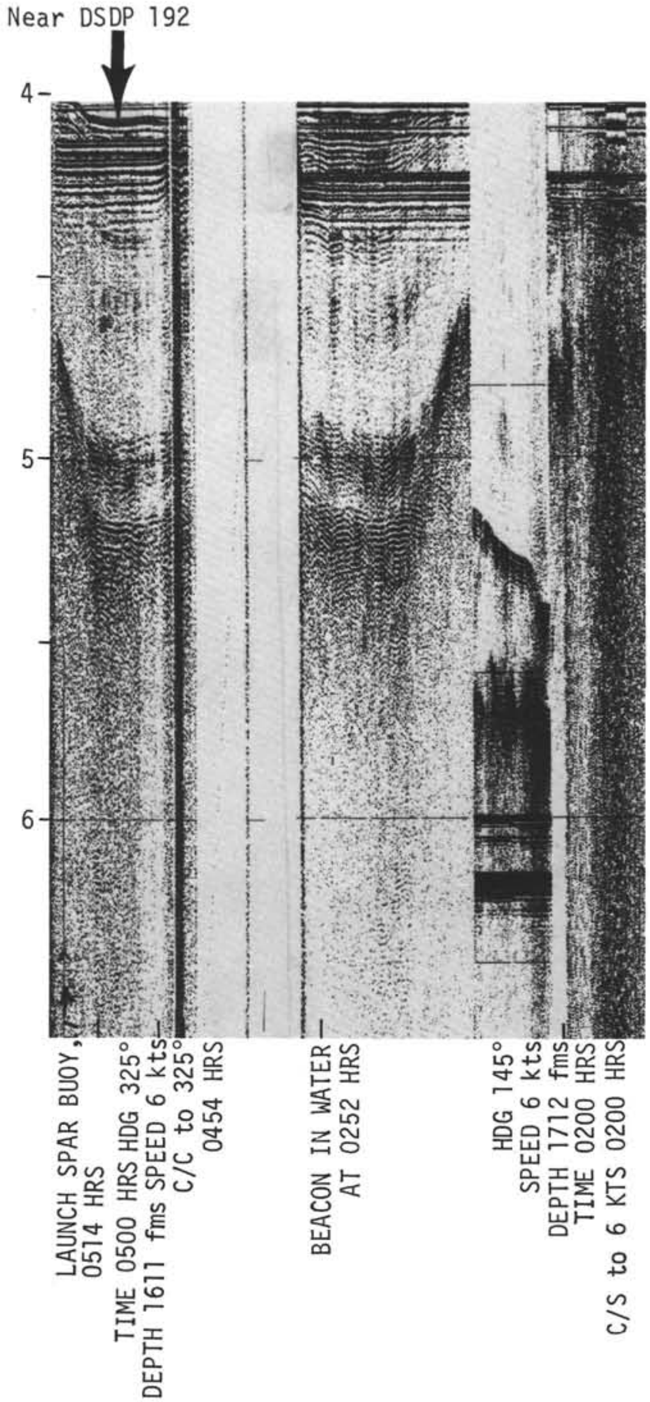

Figure 3. Glomar Challenger *air-gun profile, approach to Site 192.*

The sedimentary section apparently is in depositional contact with basalt at 1044 meters. From 1044 to 1057 meters as many as six alkali basalt flows, with fine-grained variolitic tops and coarse-grained diabasic interiors, are present. Vesicles and amygdules are abundant in the tops of most flows. All of the basalt is altered, with celadonite, chlorite, and montmorillonite replacing glass(?) and filling amygdules and interstitial voids. The calcic cores of the strongly zoned plagioclases are replaced by a zeolite, possibly laumontite.

Unit A – Diatomaceous Silty Clay (0 to 140 m), Diatom Ooze (140 to 500 m) and Diatom Rich Clay (550 to 705 m)

The sediments from 0 to 140 meters below bottom are dark greenish gray diatomaceous silty clay with intercalations of olive gray silt- clay-, and carbonate-bearing diatom ooze. The carbonate in the ooze is foraminifera and nannoplankton remains, often present in sufficient quantity to make the beds foraminifera-bearing, nannofossil-rich diatom oozes. Contacts of the two lithologies are usually gradational. Ash beds are abundant in this interval, and have colors ranging from dusky yellowish brown to dark greenish gray and light gray. As is true at the other sites on Leg 19, the darker colored ashes are coarser grained and contain colorless to light brown glass, crystal debris (feldspar and pyroxene), and abundant opaque inclusions in the glass, whereas the lighter colored ashes are almost pure colorless glass. Rafted(?) pebbles up to 4 cm in diameter are present at 0.5 meters (Core 1), 24 meters (Core 4), 31 meters (Core 5), and 75 meters (Core 7), and are particularly abundant between 96 and 101 meters (Core 8) in beds of early Pliocene age.

The interval 140 to 705 meters is composed primarily of diatom ooze. Clay content increases in the interval 550 to 705 meters, where the lithology is diatom-rich clay. Induration gradually increases downward, from pulpy diatom ooze (140 to 245 m) through thin indurated zones or "biscuit and paste rock" (245 to 500 m) (drill disturbed?) to semilithified diatom ooze and diatom-rich clay (500 to 705 m). Below approximately 297 meters the unit is extensively burrowed, mottled, and irregularly laminated. Minor concentrations of nannofossils and disaggregated nannofossil plates are scattered throughout the unit.

In the interval 140 to 550 meters below bottom, the sediments are uniform olive gray and dark greenish gray silt-bearing, clay-rich diatom oozes. Smear slide estimates indicate an average composition for the unit of 70 to 80% diatoms, 10 to 30% clay, and 2 to 10% silt (mostly glass, feldspar, and pyroxene).

Below 140 meters rafted(?) granules or pebbles are not present, and the abundance of ash beds rapidly decreases. The decrease in ash layers below 110 meters is very striking. From an average of 4.5 ash layers per core in Cores 1 through 8 (average recovery 5.4 m), the number of ash layers drops to 1 in Core 9 (7.9 m recovery) and 1 in Core 10 (6.8 m recovery). Single ash layers occur in Cores 11 (177 m) and 13 (237 m), with that in Core 13 (237 m) being the lowermost ash recovered at Site 192. A thin limestone layer occurs at 523 meters.

Diatom-rich clay in the interval from approximately 550 to 705 meters is primarily dark gray to dark greenish gray silt-bearing, diatom-rich clay, with smear slide estimates indicating an average composition of 80% clay, 15% diatoms, and 5% silt. Layers of clay with pyritized diatoms occur in Core 24 (625 to 634 m). The lithology of the single core recovered in the interval 650 to 705 meters (Core 25) suggests that diatoms may again be more abundant at the base of the unit, as Core 25 (671 to 680 m) is a clayey diatom ooze, with smear slide estimates indicating an average composition of 60% diatoms and 40% clay.

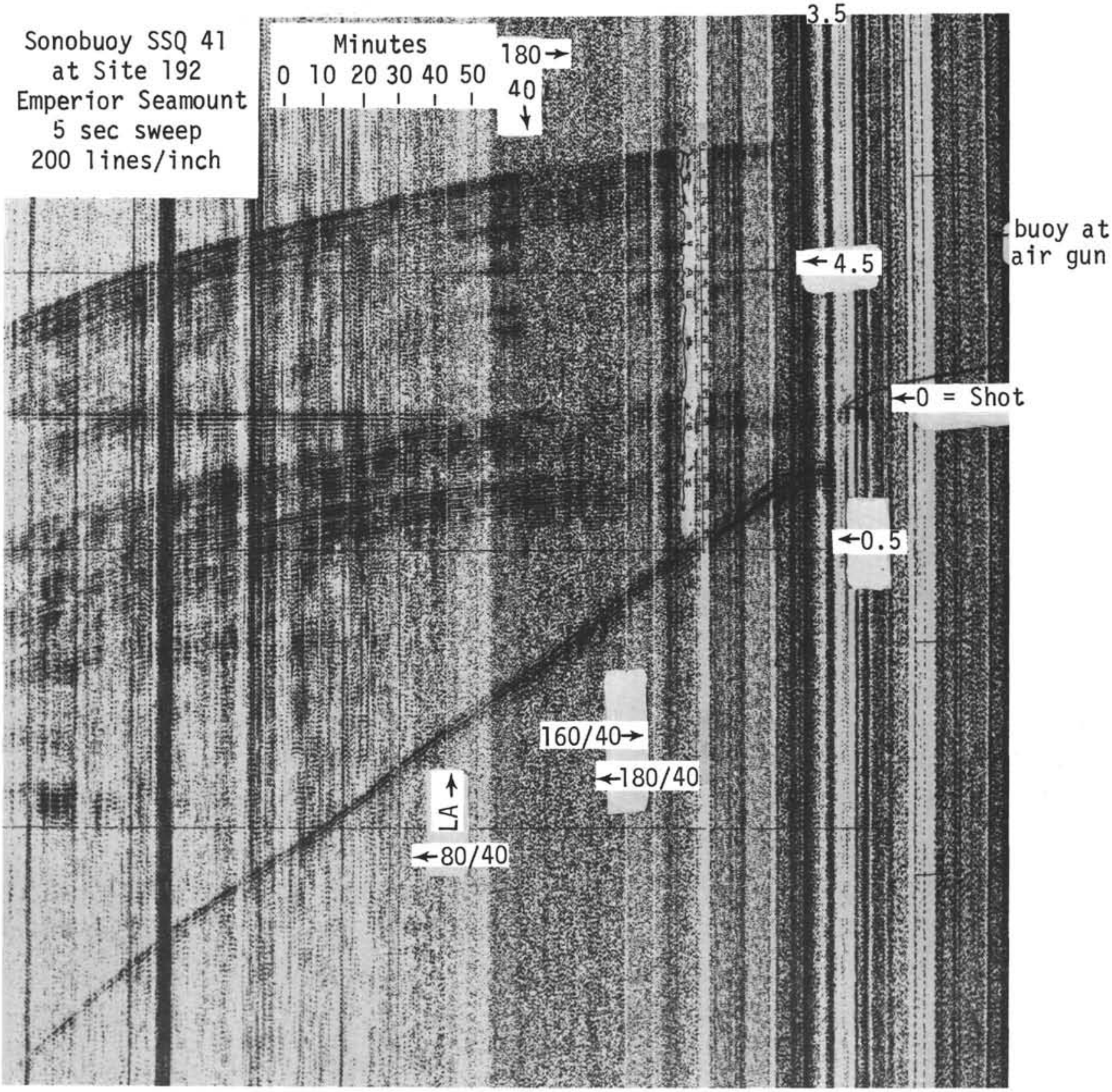

Figure 4. *Sonobuoy record, Site 192.*

Unit B – Claystone (705 to 940? m)

A distinct drilling break at 705 meters below bottom, probably coinciding with a sharp increase in induration, marks the top of Unit B. Unit B is largely dark greenish gray to olive gray claystone containing only minor amounts of silt (5% or less). The uppermost part of the unit (Core 26) is more diatomaceous than the rest and probably represents a transition to the overlying diatom-rich clay.

The claystone locally contains traces of carbonate in addition to discrete calcareous beds composed of varying amounts of clay, nannofossils, and recrystallized calcite. The calcareous layers are a few cm to 1 meter thick and occur more frequently toward the tottom of the unit. Colors range from the grays of the claystones to white in the pure calcite layers. Contacts between the claystones and the carbonates are typically gradational. Burrow mottling occurs throughout the unit.

Unit C – Chalk and Calcareous Claystone (940? to 1044 m)

Unit C is distinguished by a predominance of carbonate. The sediments are mostly nannofossil chalks, and carbonate- and nannofossil-rich claystones. These basic lithologies are both sharply and gradationally interbedded. In addition, numerous size-graded sand and silt layers occur in the interval 950 to 1000 meters. The thickness of the graded layers averages 3 to 5 cm with beds up to 30 cm thick present. The graded textures are observable in bulk samples, but the grains are extensively altered so that smear slides reveal only clay minerals and few altered plagioclase grains.

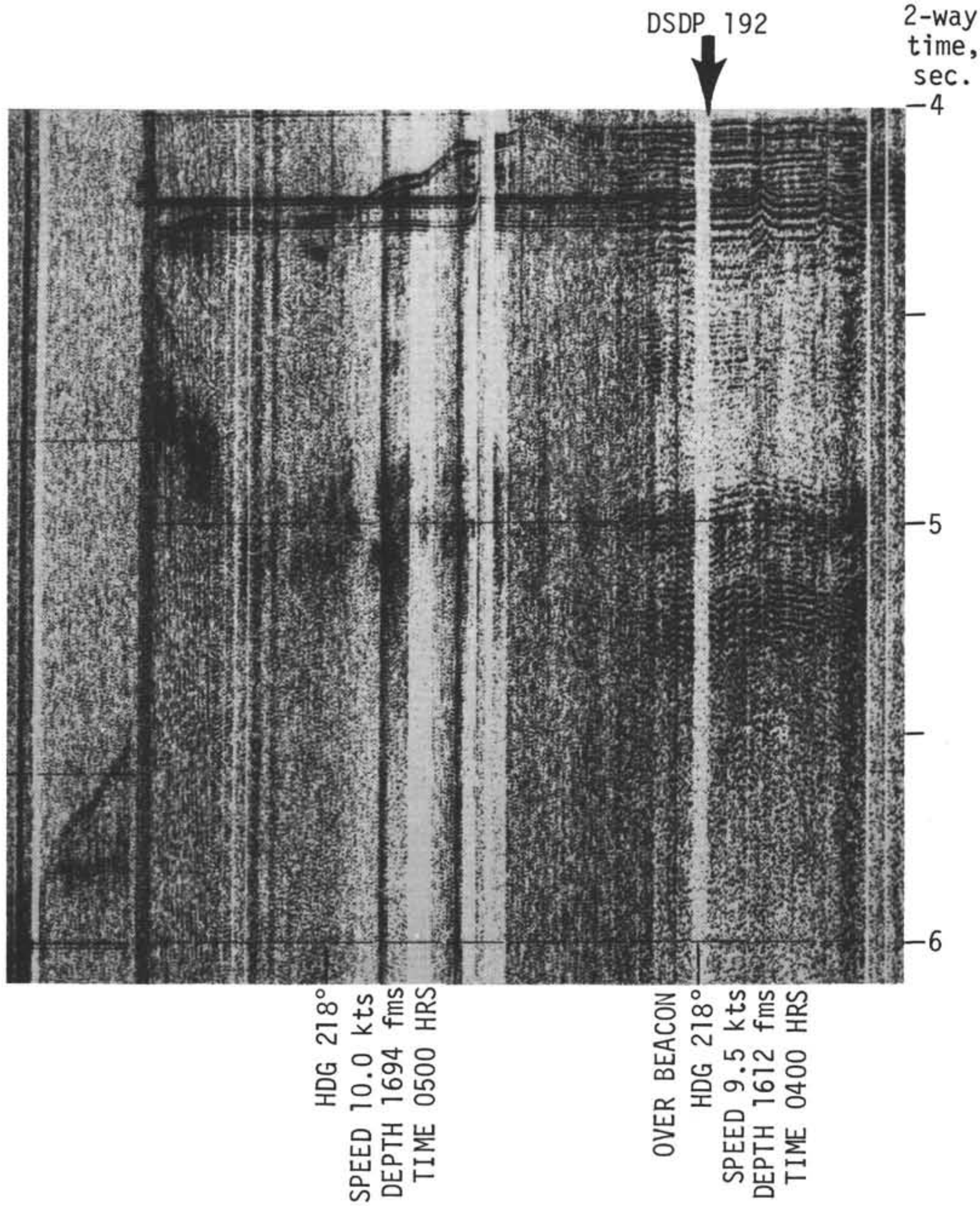

Figure 5. Glomar Challenger *air-gun profile, departure from Site 192.*

A variety of colors is an additional characteristic of Unit C. In general, the lighter the color, the greater the amount of carbonate. The nannofossil chalk layers are typically light gray to white, whereas the claystones and graded beds are darker grays. Much of the calcareous claystone and nannofossil chalk is ferruginous(?) and varies from light brown to dark reddish brown in color (see Natland, this volume).

Extensive burrowing occurs throughout Unit C, although it is particularly apparent near color boundaries. In these zones, burrows filled with the upper zone color occur in the underlying zone.

Immediately overlying the basalt is a 20-cm thick layer of pale green chalk containing altered (chlorite rimmed?) fragments of the underlying basalt.

Alkali Basalts – (1044 to 1057 m)

Five distinct flow units of highly altered pyroxene-plagioclase alkali basalt pillow lavas were recovered at Site 192, one of which is an 8.4-meter flow. Each unit has an upper chilled glassy margin and grades from there through variolitic to subdiabasic textures. All evidence points to an extrusive origin for the volcanics.

Chemically, the rocks are alkali basalts (see Stewart et al. this volume), but are intensely altered, with clays, calcite, and iron oxides filling abundant cracks and amygdules and replacing most intersertal material. Field relations and petrography are discussed in detail in an appendix to this chapter and in connection with overlying ferruginous sediments by Natland (this volume). Chemistry, mineralogy, and regional significance are discussed by Stewart et al. (loc cit.).

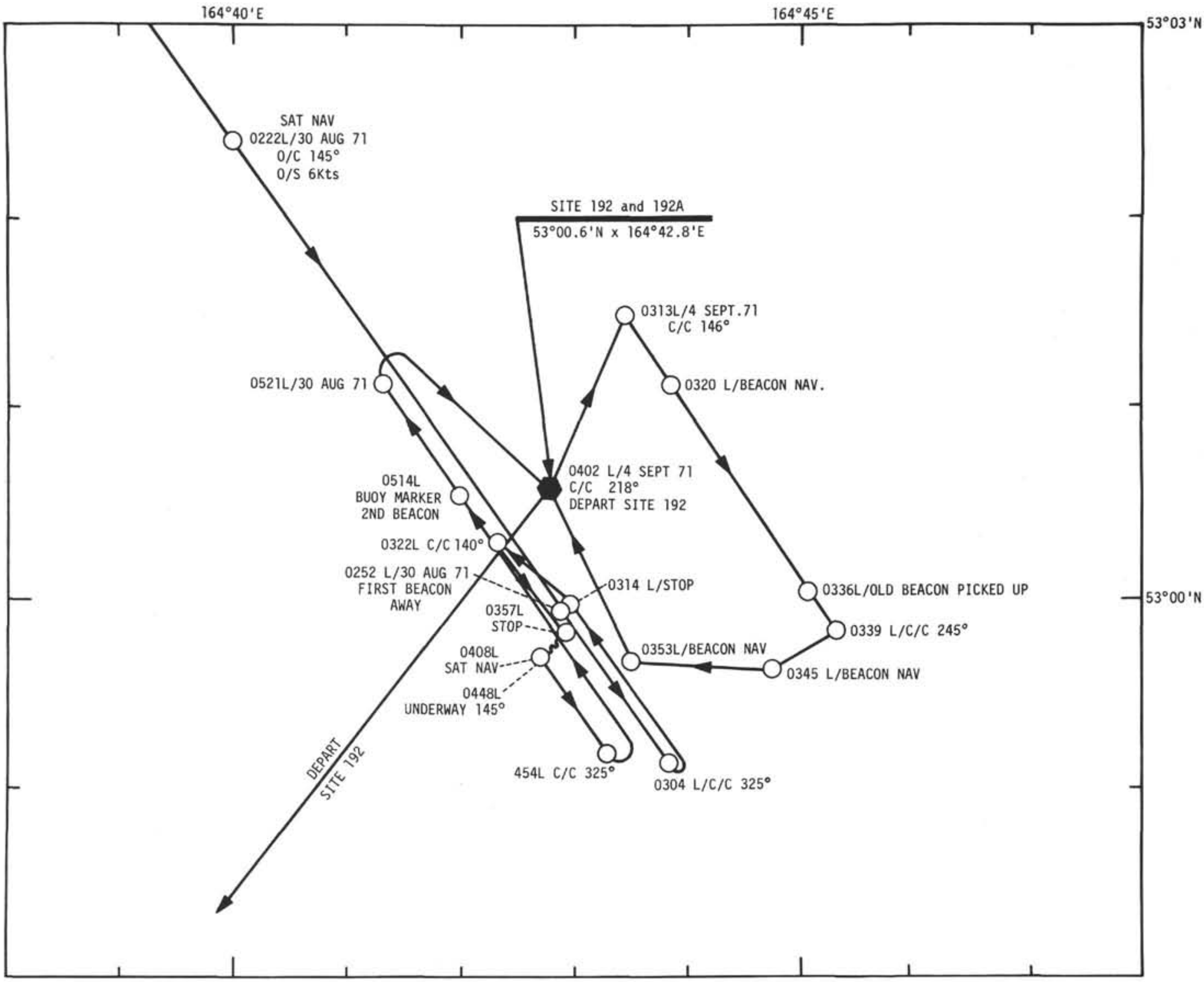

Figure 6. *Track chart of* Glomar Challenger *in the vicinity of Site 192.*

PHYSICAL PROPERTIES

Bulk density (measured by the usual techniques), water content, natural gamma radiation, acoustic velocity, vane shear strength, and residual negative pore pressure were measured on selected samples obtained at Site 192 and two unsplit samples were obtained for shore consolidation testing.

GRAPE densities are shown on the core summary sheets. Mean GRAPE densities (averaged for each section), water displacement densities, shore laboratory densities, and acoustic velocities are shown on the site summary sheet.

The quality of the soft sediment cores at Site 192 was not good from a physical properties point of view. Complete mixing of the sediment was apparent in many sections. As an example, the material from identifiable ash layers could be seen for a meter or more below their evident point of occurrence. Apparently the cause of this disturbance to the soft sediments was the type of bit used.

Bulk Density

The GRAPE density was measured to a depth of 475 meters, below which the sediment no longer filled the core liner. Densities for the remainder of the sediment and rock were measured by the water displacement method.

A number of trends are apparent from the density-depth plot on the site summary sheet. For the first 130 meters the density increases in a manner typical of cohesive, normally consolidated sediments. The rate of increase in the first 10 meters is rapid, followed by reduced rate for the next 120 meters. A plot of void ratio versus the logarithm of effective overburden stress for this section would yield approximately a straight line, an unusual characteristic for normally consolidated material (i.e., a material which has never been stressed beyond its current in situ stress level). The basic sediment for this range is a plastic clay, and the relatively rapid increase in density with depth is typical for this compressible material.

TABLE 1
Coring Summary – Site 192

Core	Cored Interval Below Bottom (m)	Cored (m)	Recovered (m)	Recovered (%)
Hole 192				
1	0-1	1	0.8	80.0
2	1-10	9	5.2	57.8
3	10-19	9	5.4	60.0
4	19-28	9	9.5	105.6
5	28-37	9	7.8	86.7
Wash				
6	55-64	9	2.0	22.2
Wash				
7	74-83	9	5.1	56.7
Wash				
8	92-101	9	7.8	86.7
Wash				
9	121-130	9	7.9	87.8
Wash				
10	148-157	9	6.8	75.6
Wash				
11	176-185	9	1.9	21.1
Wash				
12	204-213	9	6.0	66.7
Wash				
13	232-241	9	6.2	68.9
Wash				
14	250-259	9	4.5	50.0
Wash				
15	269-278	9	5.8	64.4
Wash				
16	297-306	9	4.5	50.0
Wash				
17	325-334	9	3.4	37.8
Wash				
18	353-362	9	8.7	96.7
Wash				
19	391-400	9	3.0	33.3
Wash				
20	429-438	9	2.0	22.2
Wash				
21	475-484	9	2.9	32.2
Wash				
22	522-531	9	5.0	55.6
Wash				
23	569-578	9	2.1	23.3
Wash				
24	625-634	9	1.8	20.0
Wash				
25	671-680	9	2.8	31.1
Wash				
26	709-718	9	2.0	22.2
Wash				
27	746-755	9	6.8	75.6
Wash				
28	784-793	9	1.4	15.6
29	793-802	9	0.5	5.6
Wash				
30	849-858	9	3.8	42.2
Wash				
31	896-905	9	2.0	22.2
32	905-912	7	3.1	44.3
33	912-922	10	3.5	35.0
34	922-932	10	7.7	77.0
35	932-942	10	2.7	27.0
		308	152.4	49.5

TABLE 1 – *Continued*

Core	Cored Interval Below Bottom (m)	Cored (m)	Recovered (m)	Recovered (%)
Hole 192A				
Wash				
1	942-951	9	8.8	97.8
2	951-960	9	8.5	94.4
Wash				
3	983-989	6	3.1	51.7
Wash				
4	1018-1027	9	4.8	53.3
Wash				
5	1043-1053	10	9.5	95.0
6	1053-1057	4	3.5	87.5
		47	38.2	81.3

TABLE 2

Unit	Cores	Depth Below Sea Floor (m)	Lithology	Age
A	1-9	0-140	Diatomaceous silty clay, diatom ooze, and abundant volcanic ash beds	Pleistocene and Pliocene
	10-22	140-550	Diatom ooze	Pliocene and upper Miocene
	23-25	550-705	Diatom-rich clay	Upper and middle Miocene
B	26-35	705-940?	Claystone	Middle Miocene to lower Oligocene
C	1A-5A	940?-1044	Chalk and calcareous claystone with silts and sands	Upper Eocene to upper lower Eocene unconformity K (middle to lower Maestrichtian)
Basalt	5A, 6A	1044-1057+	Pyroxene-plagioclase diabasic basalt	

For the section 130 to 740 meters, a different density trend may be observed. A rapid decrease in density around 130 meters is followed by a very gradual, consistent increase to 740 meters. This is again characteristic of a normally consolidated material, although in this case a relatively incompressible one. The sediment here is primarily a diatom ooze and this incompressibility was observed for other, similar materials sampled on this leg.

The section from 740 to 940 meters has a high density which continues to increase over this depth range. The material is basically a claystone and its compressibility characteristics appear similar to those of the clay zone, 0 to 130 meters. The density-depth plot for the lower range appears to be an approximate continuation of that for the upper zone.

From 940 to 1040 meters, the density data on the site summary sheet split. The high density (2.2-2.5 g/cm^3) points represent chalk while the lower density (1.7-2.1 g/cm^3) points represent claystone. Interestingly, the claystone density values for this zone are lower than those for the zone immediately above. This could indicate a change in the type of sediment present in the claystone. However, it is also possible that the claystone below 940 meters is underconsolidated, that is, it has not compressed as much as it could under the in situ effective stresses. A situation such as this would occur if the chalk layers prevented the drainage of water out of the clay. The material at the bottom of the hole is basalt with a density ranging between 2.61 and 2.81 g/cm^3.

Acoustic Velocity

The acoustic velocity increases steadily from 1.5 to 1.7 km/sec over the range 0 to 740 meters. The transition from clay to ooze at 130 meters, which could be clearly noted in the density profile, cannot be discerned. The velocity increases rapidly to 1.8 km/sec at 740 meters and then continues to rise until a value of 2.2 km/sec is reached at 940 meters. From 940 to 1040 meters, the acoustic velocity follows a trend similar to that of the density. The velocity in the claystone decreases slightly to 2.1 km/sec, while that in the chalk increases rapidly to 3.0 to 3.6 km/sec. The basalt below 1044 meters has an acoustic velocity ranging between 4.35 and 5.08 km/sec.

Summary

Two sediment types, from a physical properties point of view, occur in the first 940 meters of Site 192. The sediment from 130 to 740 meters is a relatively incompressible, apparently normally consolidated material (diatom ooze). The sediment from 0 to 130 meters and from 740 to 940 meters is a significantly more compressible, normally consolidated material (clay). Clay also occurs from 940 to 1044 meters but here may be underconsolidated, perhaps as a result of the presence of frequent layers of chalk which could effectively prevent the drainage necessary for consolidation. The material below 1044 meters is basalt of typically high density and velocity.

PALEONTOLOGY

In diatom ooze, the predominant sediment type from the surface to 718 meters below bottom, excellent stratigraphic control provided by diatoms and silicoflagellates shows that all microfloral zones are present back to the middle Miocene. Through the late Miocene, successions at Site 192 are similar to those in the Bering Sea. A middle Miocene flora was found at only one site (Site 190) in the Bering Sea; those found at Site 192 are similar to those of the Onnagawa Formation of Japan and the upper Mohnian of California. The abundance of diatoms decreases below the upper Miocene. Below 718 meters (Core 26), preservation of siliceous microfossils is too poor for identification of species, except for a sparse, altered microflora from limestone at 897 meters (within Core 31) indicative of a lower middle Miocene age.

In contrast to Bering Sea sites, where carbonate fossils are virtually absent below the Pleistocene, calcareous nannoplankton are present (although not common in diatomaceous sediments) in most samples and planktonic foraminifera occur intermittently. Below 746 meters (Core 27) coccoliths assume rock-forming importance in chalks which alternate with claystones.

Shortly below the bottom of continuous siliceous fossil control (718 m), a planktonic foraminiferal assemblage occurs that indicates proximity to the top of the lower Miocene (Core 28, core catcher, 793 m). From there to a depth of 940 meters, where upper Eocene nannofossil assemblages were encountered, biostratigraphic control is not good. Presumably, however, the lower Miocene and Oligocene are represented by long-ranging planktonic foraminiferal and nannofossil species.

The core catcher of Core 4 (Hole 192A) contained both Eocene and middle Maestrichtian sediment, demonstrating the presence of a major unconformity. Core 5A samples contained lower Meastrichtian nannofossil ooze lying above and within cracks in the basalt.

The sediment-water interface apparently remained near the carbonate compensation depth (CCD) throughout deposition of the sediment column at Site 192. Even in the Paleogene and Cretaceous chalks, the foraminiferal faunas are often sparse and dominantly arenaceous. During parts of the upper Miocene and lower Pliocene calcareous fossils are absent, implying sedimentation below CCD. In comparison to sites from similar depths in the Bering Sea, however, there is more carbonate overall and it appears that downward fluctuations of the CCD began in the late Pliocene rather than at the base of the Pleistocene.

Implied proximity to the carbonate compensation depth, together with benthic foraminiferal faunas of the genera *Martinottiella, Bathysiphon, Stilostomella, Pleurostomella, Gyroidina,* and *Oridorsalis,* among other typical bathyal and abyssal forms, indicate that water depths were bathyal and deeper through the Tertiary.

Since its birth, Meiji Guyot has presumably moved generally northward with the crustal plate upon which it sits, possibly from somewhere in the tropics to well within the subarctic zone. To some degree the floras and faunas may be used to estimate the rate of movement, but the results are not always unambiguous. Site 192 lies within the zone of subarctic floras and faunas about 800 km from the zone presently transitional to biotas of warmer waters. Currents presently flowing across Meiji Guyot from north to south exclude all but typical subarctic species. These same conditions are inferred to have prevailed back through the Oligocene. The upper lower Eocene has elements that are indicative of slightly warmer waters, a few discoasters, sphenoliths, and a vaguely keeled globorotalid, but these are not dominant and imply cool-temperate rather than warm-water conditions. Considering that the Eocene was a time of generally warm climates, it cannot be concluded that the character of these assemblages are indicative of former proximity of the seamount to the present transitional biota zone.

Foraminifera

At Site 192, as at Bering Sea sites, the Quaternary contains alternating intervals of rich and poor planktonic foraminiferal faunas (see Chapter 23, Table 7). Unlike at the Bering Sea sites, however, sparse populations of planktonic and calcareous benthic tests also occur in the upper part of the Pliocene (Cores 7 and 8). Lower Pliocene and upper and upper middle Miocene diatom oozes and diatom-rich clays usually have sparse arenaceous assemblages consisting of *Martinottiella communis, Eggerella* sp., and occasional test fragments of other arenaceous species. However, planktonic foraminifera are common in two samples from this interval (13-4, 20 cm, and 18-2, 120 cm) and there are a few planktonic tests in some other samples. A few calcareous benthic tests also occur, usually in the same samples having planktonic tests, and there are two samples from the upper Miocene in which calcareous benthics are common (21-1, 23 cm and 24, CC).

The benthic assemblage in the core catcher of Core 24 consists of: *Oridorsalis umbonatus* (Reuss) (dominant), *Melonis pompilioides* (Fichten and Moll), *Pullenia bulloides* (d'Orbigny), *Pleurostomella alternans* Schwager, *Nodosaria* sp., *Eponides tumidulus* (Brady), *Epistominella pulchella* Husezima and Maruhasi, *Laticarinina pauperata* (Parker and Jones), *Sphaeroidina bulloides* d'Orbigny, *Gyroidina orbicularis* d'Orbigny, *Gyroidina subplanulata* Echols, *Gyroidina* cf. *G. nipponicua* Ishizaki, *Fissurina* sp., *Pyrgo murrhini* (Schwager), *Martinottiella communis* (d'Orbigny), *Eggerella bradyi* (Cushman), *Karrariella* sp., *Reophax* sp., and *Cribrostomoides* sp.

From the lower middle Miocene through the upper lower Eocene there are alternations of claystones with sparse arenaceous assemblages, impure (gray or brown) chalks with faunas ranging from arenaceous to richly calcareous, and pure (white) chalks that are not readily disaggregated. Very poorly preserved radiolarians and sponge spicules are moderately common in some samples, notably in Core 30, core catcher; Core 33, Section 1, 90 cm; Core 2A, Section 4, 94 cm; and Core 2A, core catcher. In this part of the section dominantly arenaceous assemblages occur in many samples down to Core 1, core catcher. Arenaceous forms include *Martinottiella communis, Glomospira charoides, Bathysiphon* sp., *Cyclammina* sp., and *Ammodiscus* sp. The species occurring in four samples dominated by calcareous forms are listed below. One of these (35, CC) is from the basal Oligocene, two (2A-5, 21 cm and 131 cm) are from the upper Eocene, and the fourth (4A-4, 117 cm) is from the upper lower Eocene. The two samples from Core 2A, Section 5, are from above and below graded beds of detrital sand and silt. Foraminifera are rare in a sample of a graded bed.

35 CC (Oligocene)

Oridorsalis ecuadorensis (Galloway and Morrey), *Gyroidina octocamerata* Cushman and Hanna, *G. planata* Cushman, *Gyroidina* sp., *Cassidulina globosa* (Hantken), *Cibicides grimsdalei* Nuttall, *C. perlucida* Nuttall, *Anomalina pompilioides* Gallaway and Heminway, *Pullenia* sp., *Pleurostomella subnodosa* (Guppy), *Dentalina* sp., *Fissurina* sp., *Globulina* sp., *Bovininopsis attenuata* Cushman, *Bolivinopsis* sp., *Glomospira charoides, Karrariella* sp.

2A-5, 21 cm (upper Eocene)

Oridorsalis ecuadorensis, Gyroidina octocamerata, Cibicides grimsdalei, Nuttallides trumpyi (Nuttall), *Anomaline venezuelana* (Nuttall), *Pseudoeponides ? crassiformis* (Cushman and Seigfus), *Pleurostomella subnodosa, Pleurostomella alazanensis cubensis* Cushman and Bermudez, *Oolina* sp., *Nodosaria* sp.

2A-5, 131 cm (upper Eocene)

Oridorsalis ecuadorensis, Cibicides grimsdalei, Nuttallides trumpyi, Pseudoeponides ? crassiformis, Cassidulina globosa, Pleurostomella subnodosa, Stilostomella atlantisae (Cushman), *Chilostomella ovoidea* Reuss, *Ellipsoidina ?* sp., *Dentalina* sp., *Nodosaria* sp., *Astacolus* sp.

4A-4, 117 cm (lower Eocene)

Oridorsalis ecuadorensis, Gyroidina planata Cushman, *Nuttallides trumpyi, Anomalina cushmani* (Nuttall), *Bulimina impendens* Cushman and Parker, *Aragonia* sp., *Pleurostomella subnodosa, Stilostomella?* sp., *Nodosaria* sp.

Two samples of Cretaceous chalk were examined. Core 4A, core catcher, contains a very poorly preserved assemblage dominated by arenaceous forms among which are *Gaudryina* sp., rzehakinids, trochamminnids, and lituolids. Core 5A, Section 1, 117 cm, contains a few planktonic forms, and a moderately abundant calcareous benthic fauna including *Globorotalites micheliani, Pyramidina limbata,* and *Aragonia* sp.

The discontinuous record of planktonic foraminifera at Site 192 includes distinct assemblages from the Upper Cretaceous (rare), upper lower Eocene, Oligocene, and lower Miocene, middle and upper Miocene, lower Pliocene, upper Pliocene, and middle and upper Pleistocene. These assemblages, and some of the paleoenvironmental implications to be drawn from them, are discussed in a later chapter.

Test preservation in strata below the lower part of the middle Miocene (Core 28 and below) is frequently poor. Tests are usually deformed by compression and both calcareous and arenaceous tests are sometimes completely flattened. All carcareous tests are infilled and recrystallized.

As discussed by Scholl and Creager (this volume), graded beds of detrital sand and silt in Core 2A, Section 5, suggest that some part of the basalt core of Meiji Guyot was near or above sea level in the late Eocene. The highest known elevation of the basalt core (acoustic basement) is only taken about 500 meters above the level from which Core 2A was taken. This, therefore, suggests that the sediment of Core 2A, Section 5, was deposited at a depth of about 500 meters or shallower. On the other hand, the character of the benthic foraminiferal fauna from fine-grained sediment associated with the graded beds in Core 2A, Section 5 suggests that the late Eocene water depth at Site 192 was not much less than 500 meters. The genera in these faunas are typical of bathyal and abyssal depths in the modern ocean, and the species are typical of faunas from Eocene sediments deposited in relatively deep water, for example, the Chapapote and Aragon formations of Mexico (Nuttall, 1930). The late early Eocene and Oligocene faunas listed above are also of the bathyal type. Furthermore, alternation of arenaceous faunas consisting of bathyal genera with calcareous assemblages begins in the Tertiary at the top of the Eocene (Core 1A, core catcher) suggesting that since that time the sea floor has remained near the carbonate compensation depth and thus probably at considerable water depth. In the early part of the late Miocene extant species appear (in Core 24, core catcher) that do not live at depths much less than 2000 meters (*Melonis pompilioides, Eponides tumidulus*). However, the top of Meiji Guyot may have subsided to depths greater than 2000 meters earlier than the late Miocene.

Calcareous Nannoflora

Site 192 is characterized by thick Neogene diatom ooze and clay overlying thin Paleogene and Maestrichtian chalks. The Neogene nannoflora (Cores 1 to 32) is very low in diversity and number of individuals in the cores containing nannofossils. In what is probably the Oligocene (Cores 33 to 35), carbonate content increases. Chalk of probable early Oligocene age occurs in Core 35. The section is richer in chalk below this core. Core 1A is late late Eocene and is characterized by a sharp change in nannofossil content from superjacent Core 35 (Hole 192), suggesting there may be an Oligocene-Eocene unconformity at the site. Cores 2A and 3A are middle late and early late Eocene respectively. Core 4A contains the Mesozoic-Cenozoic boundary in the core catcher, with middle Eocene in contact with middle Maestrichtian. The red Maestrichtian pelagic chalk of Core 4A, core catcher, is impoverished with respect to nannofossils and is devoid of planktonic foraminifera whereas the superjacent Eocene is rich in foraminifera. Core 5A contains a fairly diverse early Maestrichtian nannoflora.

The low Neogene nannofossil diversity suggests high-latitude deposition not far above carbonate compensation depth (CCD). The absence of nannofossils in Cores 8 to 11 (upper Miocene-middle Pliocene) and virtual absence in Cores 16 to 23 (early late Miocene) may indicate that Site 192 was below CCD at these times. The middle Miocene through Oligocene remained essentially above CCD although still in a subpolar regime.

The Oligocene age assignment of Cores 33, 34, and 35 is based largely on negative evidence. Species diversity is very low but specimens are much larger than those at lower latitude. Except for larger size, they are comparable to those restricted to the Oligocene elsewhere. The early Oligocene age assignment of Core 35 is based on the presence of *Chiasmolithus omaruensis* without characteristic Eocene species.

The Eocene of Cores 1A, 2A, 3A, and 4A lacks *Helicopontosphaera* and *Discoaster* with the exception of *D. barbadiensis* in Core 4A. However, the occurrence of *Sphenolithus moriformis* and *S. radians* with *D. barbadiensis* suggests cool-temperate conditions.

The impoverished assemblage of Core 4A, core catcher, contains *Tetralithus* aff. *murus* and *Arkhangelskiella parca* and is devoid of planktonic foraminifera. This suggests that CCD began its upward incursion in the lower to middle Maestrichtian because Core 5A contains a diverse lower Maestrichtian nannoflora and a few planktonic foraminifera.

Radiolaria and Silicoflagellates

The sediments of the upper two-thirds of the section at Site 192 yield assemblages of Radiolaria and silicoflagellates ranging in age from Pleistocene to middle Miocene, with most of the species observed during this leg being encountered. The lower one-third interval of the site, from Core 26 to Core 35, and Hole 192A are barren of these siliceous microfossils, except the chalk in Core 31.

Although numerous species of Radiolaria were recovered from Site 192, the presence of only a few guide-forms coupled with the fact that most species present are rather long ranged (Table 11, Chapter 28) make attempting recognition of stratigraphic zones difficult.

A few tripylean radiolarians were also recovered from this site.

Occurrence of silicoflagellates from Site 192 is shown in Table 11, Chapter 27. The microfloral succession recognized here is similar to that found at Bering Sea sites.

Chalk of Sample 31-1 (88 cm) contains *Corbisema triacantha, Distephanus schauinslandii,* and *Naviculopsis* sp., as well as *Ebriopsis antiqua* (spineless form) and *Cannopilus hemisphaericus,* whose skeletons were replaced by pyrite. A similar assemblage was encountered in Cores 20 and 21 of Site 183.

The highest occurrence of *Corbisema triacantha* in the experimental Mohole samples at Guadalupe site is at the top of the Louisian (lower middle Miocene) (Ling, 1972). *Distephanus schauinslandii,* originally described from the Sarmatian (upper Micoene) of Yugoslavia (Lemmermann, 1901), has been observed in samples from the Calvert Formation (Miocene) of Maryland. Fragments of *Naviculopsis* were also noted but identification to specific level is not possible.

Diatoms

Diatoms are abundant and well preserved down to Core 22, are common and moderately well preserved between Cores 22 and 26, and poorly preserved in the underlying sediments. The stratigraphic distribution of diatoms is presented in Table 10, Chapter 30.

The chalk sample of Core 31 contains the following diatom valves (replaced by opaque material): *Coscinodiscus* aff. *obscurus, C. symbolophorus, Kisselevilla carina,* etc. This assemblage seems to indicate middle Miocene age.

CORRELATION BETWEEN REFLECTION PROFILE AND STRATIGRAPHIC COLUMN

The reflection profile taken by E. C. Buffington (1970) that was used to select Site 192 is shown on Figure 7 along with the stratigraphic column and physical properties. The profile was taken on a NE-SW track (NE to Right). Sediments are 1.0 to 1.2 sec thick above a caldera-like basement topography, which underlies the crest of the seamount. The *Glomar Challenger* approached this site from the northwest and found a similar basement ridge on that side and, thus, reinforced the suggestion that the basement morphology may have been formed by a volcanic process.

The first distinct acoustic reflector occurs at 0.68 sec and appears to correlate with the top of the lower diatom-bearing clay of Unit A (550 m) (the top 0.2 sec are mixed with the direct arrival from the air gun). The combined average velocity down to this reflector is 1.6 km/sec by the travel-time method, which is slightly above the laboratory values of 1.5 km/sec.

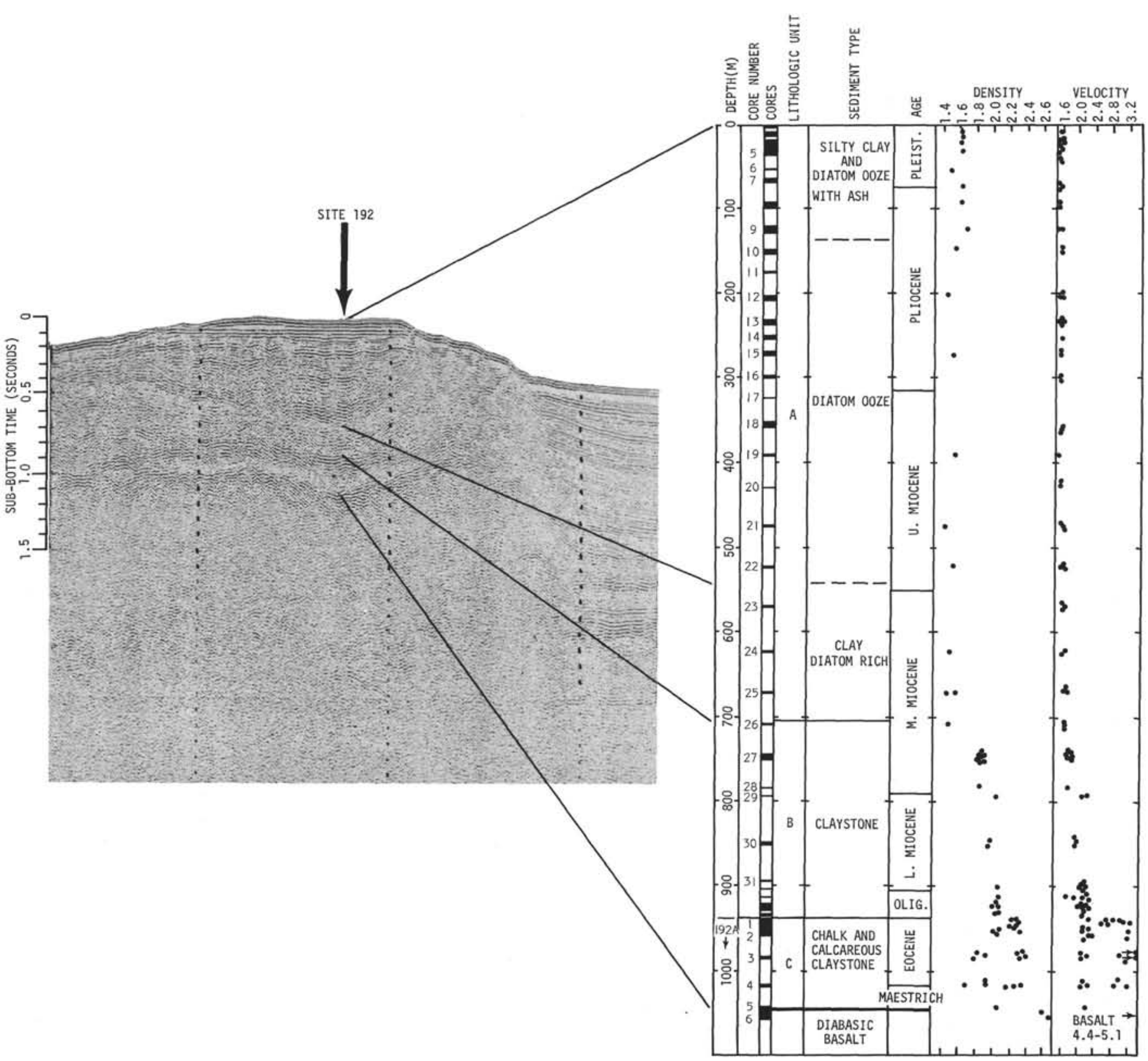

Figure 7. *Correlation of reference seismic reflection profile with physical properties and lithologic column, Site 192.*

The next reflector, at 0.87 sec, appears to be the top of the claystone of Unit B (705 m). The density and the velocity both show a marked increase below 705 meters. The interval velocity between 540 and 705 meters appears to be about 1.6 km/sec based on travel-time method and is again slightly higher than the 1.5 to 1.6 km/sec measured in the laboratory.

Below the top of the claystone at 0.87 sec (705 m) and above the basement at 1.15 sec (1044 m), the densities and velocities both increase. The interval velocity averages 2.4 km/sec (travel-time method) in these claystone and chalk units.

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APPENDIX
FIELD RELATIONS AND PETROGRAPHY OF BASALTS, HOLE 192A

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Field Relations

Thirteen meters of altered pyroxene-plagioclase alkali basalts were recovered at Site 192. Six separate flow units were cored with essentially complete recovery. Each flow has an upper chilled glass margin grading to amygdular variolitic basalt, and then to subdiabasic or diabasic rock. Some of the glass zones are oblique to the core. These relations suggest a series of flows with fine-grained vesicular tops and coarse, slowly cooled interiors. This is typical of lava pillows of subaqueous extrusive flows. The second glassy interval, 35 cm into the volcanics (192A-5-1, 119-123 cm), has vesicles on either side grading to a variolitic texture both above and below. The plagioclase-pyroxene phenocryst assemblage on either side is identical in proportions, size, habit, and composition. The topmost flow thus appears to be a small lobe that ballooned upward from the still molten and moving flow beneath, then rolled to one side annealing its lower chilled margin to the top chill rind of the lower flow. No sediments were trapped in between, proof of extrusion.

The second flow unit, beginning with the two annealed chill margins, extends 8.4 meters through all the rest of Core 5 to the topmost centimeters of Core 6, Section 2. Below Core 5, Section 1, this flow is diabase, large feldspar laths giving it a felty texture. With one exception, the only interruptions in this flow are cracks filled with secondary calcite, red-brown iron oxides, and micrite-cemented basaltic sand. The exception is an apparent xenolithic boulder, or perhaps an outcropping edge of a previous flow, projecting into the cored portion of the 8.4-meter flow. This fragment (192A-5-2, 22-35 cm) is moderately vesicular, fine grained and dark gray, all contrasts to the altered greenish felty diabase on either side. The contacts with the diabase are oblique, not defined by chilled glassy zones. As discussed below, this interval is petrographically distinct as well; all evidence thus points to an exotic origin for this part of the core. Four glassy zones grading to amygdular basalt and diabase define flows ranging from 40 cm to 1 meter in Cores 192A-6-2 and 192A-6-3 bringing to six the number of flows cored at Site 192.

At the sediment basalt contact is 3 to 4 cm of recrystallized calcite, cementing altered basalt glass fragments. These fragments are dusky green clay minerals (mostly nontronite, an iron-montmorillonite of the smectite group) interlaced with bladed 0.5-cm clear rhombic calcite crystals. The encasing matrix is milky microcrystalline calcite. Sediments immediately above this breccia contain unrecrystallized nannofossils, and apparently are unmetamorphosed. Sediments largely of limestone are found in cracks throughout the core, and above two of the lower glassy intervals, but there is no way of knowing whether they were there when the volcanics above them were erupted; they may have sifted downward along cracks.

Cracks, large and small, riddle the entire volcanic section. In the 8.4-meter flow they range from less than 1 mm to several centimeters wide, having a tendency to be oblique to the core in the upper few meters of the flow, and parallel or perpendicular to the direction of the core toward the base of the flow. Vertical cracks up to 1.5 meters long occur in Core 5, Sections 3, 5, and 6, while horizontal cracks cross the core every 10 to 50 cm. These cracks suggest columnar jointing, only they are much less perfect. Still, they allow a picture of the large flow to be contructed consisting of a network of vertical cracks spaced a few centimeters apart. While coring naturally sampled every horizontal crack in its path, close spacing of the vertical cracks is inferred from their common presence in the core in spite of the intrinsic tendency not to sample them. Had they been widely spaced, they would only rarely have been cored. Sometimes, however, even intersecting vertical cracks were cored. The horizontal cracks persist to the top of the flow, but there the vertical cracks give way to oblique and irregular cracks. Cracks tend to be wider toward the top, filled with secondary calcite, brown-red ironoxides, and/or micrite-cemented basaltic sands. Deeper cracks in the 8.4 m flow are narrower, tending to be filled only with clear crystals of calcite intergrown from either side. The cracks in the lower flow units are typically wide, filled again with calcite, iron oxides, and sands, and they generally are irregular and oblique. The last material recovered in the deepest flow is cracked to the point of brecciation, with 2- to 4-cm cracks filled with micrite-cemented sands intersecting at oblique angles. The large 8.4-meter flow would clearly have crushed and burst pillows with a large fraction of molten material, so the deeper flows must have been solid when the large flow buried them. The intense fracturing of these deeper flows may have been caused by the crushing weight of the massive flow.

The network of cracks, caused variously by contraction during cooling or by crushing, plus the comparatively open spaces between flows, were the sites of extensive migration of fluids which precipitated calcite and iron oxides (goethite and hematite) in the cracks. Intense alteration of the volcanics surrounding the cracks attended the fluid migration, and zones of deep green or brown coloration extend 2 to 3 centimeters away from cracks on either side. Up to 50% of a given section can be altered this intensely. Fine brownish iron oxide bands parallel to the cracks lace through these deeply altered zones, which contrast to the less altered gray-green zones of rock away from the cracks. Basalts cores from Site 163, south of Hawaii[2] also have numerous calcite-filled cracks but they are generally anastomosing and oblique even in a 4.7-meter flow. Here, too, the most intense alteration is next to the cracks. At Site 192 though, even the less altered zones are shot through with secondary green clays, and hydrochloric acid placed anywhere on the core will fizz, since secondary calcite is ubiquitous in vesicles and interstitial voids. The alteration is so intense, and its relationship to the throughgoing network of cracks so intimate, that the source of the iron and manganese oxides filling many of the cracks and

[2](Yeats et. al., in press).

coloring several meters of sediment overlying the volcanics appears to have been the basalts themselves. This interpretation is discussed more fully in the chapter on ferromanganoan sediments (Natland, this volume). Here it is sufficient to say that a network of closely spaced fractures developed by various means, but largely by post-consolidation cooling and contraction in the thick flow, and that fluids streamed through these fractures apparently in quite large volume from depths unknown. They may have been hydrothermal fluids, circulating seawater mobilized by a near-surface, underlying magma chamber (possibly the very source of the cored volcanics), or they may have been tied up in flows breccias only to be squeezed outward and upward by the weight of successive volcanic and sedimentary deposits. Formation of secondary minerals, dissolution, and leaching of the volcanics resulted.

Petrography

A thin section through the chilled rind of the 8.4-meter flow shows the glass to be almost completely darkened by reddish iron oxides and to have about 15% plagioclase, clinopyroxene, and minor altered olivine phenocrysts. Incipient variolitic texture can be seen, but only faintly because the glass is so charged with submicroscopic opaques, reddish in reflected light. Green wormy patches of nontronite, or nontronite and celadonite, and lesser calcite, fill amygdules and finely dot the altered glass. Some clays are stained orange with iron oxides.

The plagioclase is labradorite (An_{70}), and forms about 10% of the section. It forms 1- to 3-mm elongate euhedral laths usually quite clear, showing albite or pericline twins, and is generally unzoned. The pyroxenes are salites ranging in size from 0.5 to 1 mm. They are euhedral and subhedral, clear, and rarely twinned. The minor euhedral olivines are about the same size as the pyroxenes, but are altered to orange-brown fibrous iddingsite pseudomorphs. They are more abundant in the better developed variolitic portions of the section than in the glass.

Where the variolites are not so clouded with opaques, the typical sheaf-shaped pyroxenes and acicular andesine needles can be discerned. Magnetite is still abundant, but larger (~0.05 mm), forming 15% of the groundmass. Even finer reddish goethite and green nontronite have replaced every speck of interstitial glass.

In the diabasic portions, phenocryst minerals are about the same size as they are in the glass, but olivine is completely absent. In addition, large glomeroporphyritic clots and phenocrysts of feldspar (up to 0.5 cm) can be seen. These prove to be potash sanidine (see Stewart et al., this volume) sharply rimmed with labradorite. Many of the smaller plagioclase laths in the diabases also have sanidine cores, though usually very irregular in outline. Crystals with sanidine cores were not found in the glassy and variolitic portions of the flows. In the chapter on basalts (Stewart et al., this volume) arguments against a magmatic origin for this sanidine are presented and a case is made that they are secondary, replacing calcic cores of plagioclase.

In the diabases, phenocrysts and groundmass minerals differ in several respects. Clinopyroxene phenocrysts tend to be clear or pale brown, with 2V+=55°. Groundmass pyroxenes are tinged with pink and have smaller optic angles. Plagioclase phenocrysts tend to be labradorite (An_{70-50}) while the groundmass feldspar can be as sodic as sodic andesine (An_{30}) forming laths usually with albite twins. Opaques form elongate crystals up to 0.2 mm, typically with tattered edges. Interstitial feldspars with irregular extinction and outline and with 2V+ ranging from 20° to 50° are common; these are the optical properties of the so-called "potash-oligoclase" found in many alkali basalts and related rocks (Macdonald, 1942). In the Site 192 diabases, lower 2V+ (20°) feldspars are most often the most interstitial, irregularly outlined groundmass minerals visible. Larger, more regular crystals have higher 2V+ (up to 50°), but still are not twinned and have irregular extinction. Alteration minerals are ubiquitous, nontronite or celadonite, and ovoidal or interstitial calcite replacing every possible patch of interstitial glass.

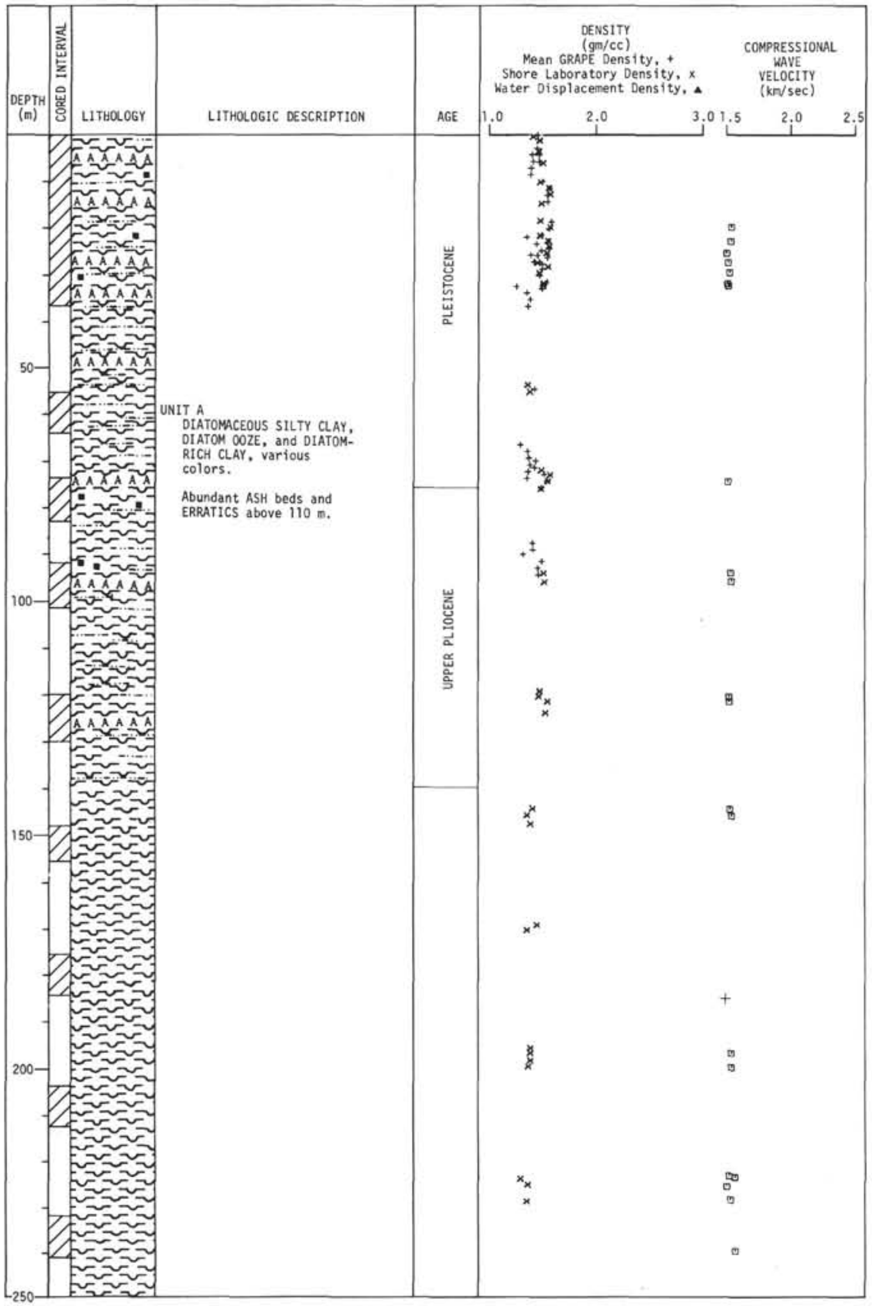
The basalt portions of the 8.4-meter flow are essentially equigranular with the exception of the plagioclase phenocrysts and are composed of cumulate plagioclase and pyroxene. Opaques tend to be equant, about 0.1 mm. The percentage of the section that can be called interstitial is very small, indicating some diffusive growth of cumulus minerals, and "potash oligoclase" is very rare. What interstitial material that can be seen is completely replaced by calcite, clays or botryoidal growths of probably a mixture of clays and iron oxides, as they are brown, fibrous, and have moderate birefringence.

A section of the curious xenolithic boulder in Core 5, Section 2, contains more vesicles than any other material cored, and has purplish, almost variolitic pyroxenes, acicular andesine laths, and a large fraction of the low 2V+ feldspar. Phenocrysts are minor, and crystals with sanidine cores nonexistent. Many of the feldspar grains have elongate glass cores darkened with opaques, a feature unique to this part of the core.

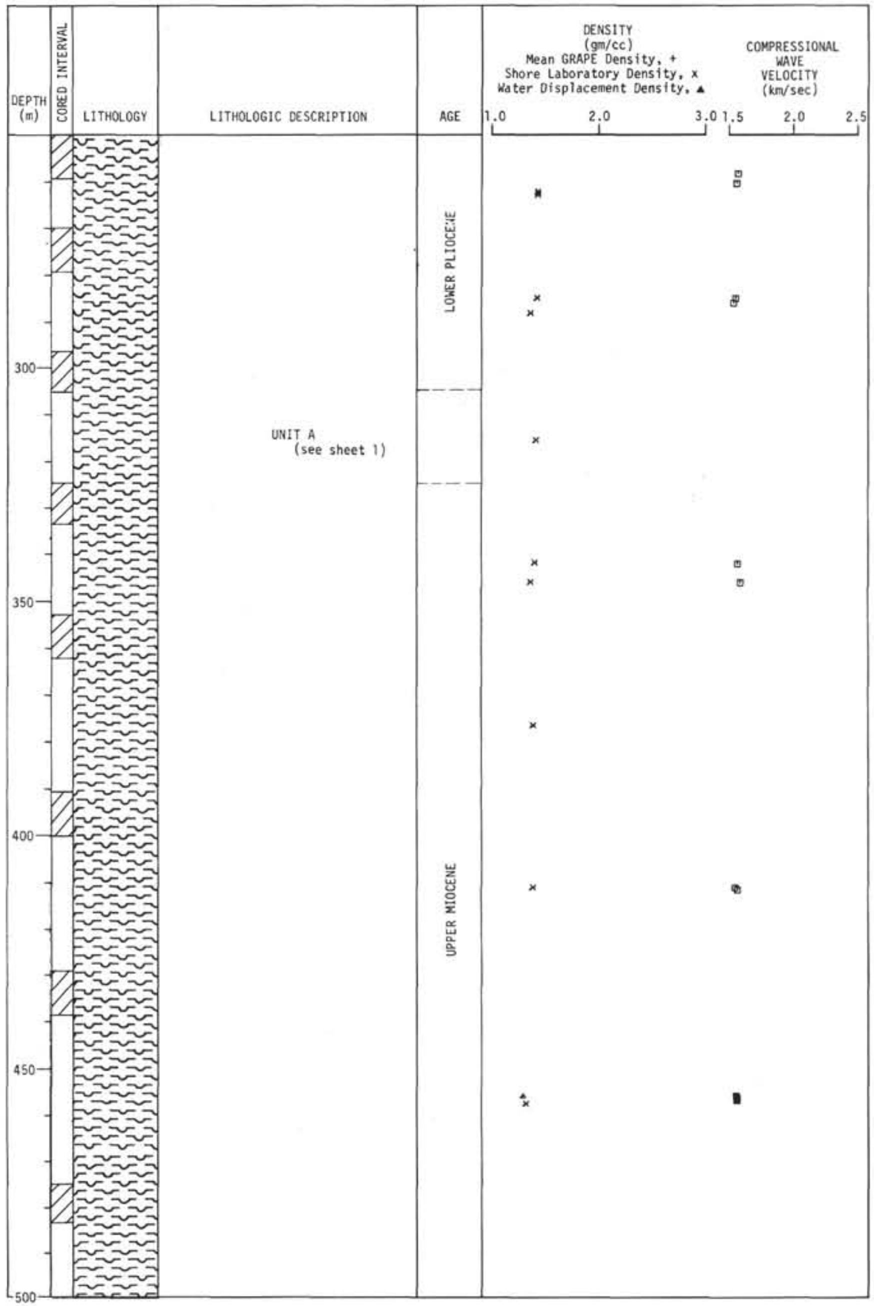
In summary, the Site 192 volcanics are chiefly pyroxene-plagioclase basalts with minor olivine as phenocrysts. Olivine does not appear in the more slowly cooled portions of the flows hence there it must be resorbed. Magnetite is not a quench phase, but is abundant in the diabases, forming larger and more perfect crystals in those parts of flows with cumulate features; perhaps magnetite replaced olivine in the more oxidizing environment of crystallization where the flows mixed with seawater. Variation in compositions of feldspars and pyroxenes from phenocrysts to groundmass minerals (Stewart et al., this volume) define a fractionation trend which may be reflected in bulk chemistry changes, particularly in the thick 8.4-meter flow where basal cumulus textures are fairly well developed. Abundant potash sanidine replacing calcic cores of plagioclase, extensive development of clays, ovoidal calcite, and void-filling iron oxides imply extensive metasomatism so that large bulk chemical changes must have resulted. Some diversity among flows seems indicated, at least by differences in color of pyroxenes and presence or relative absence of interstitial "potash oligoclase." The xenolithic boulder or outcrop fragment, while generally similar, has the mineral assemblage of a more differentiated rock than the flow that overwhelmed it; it may be a trachybasalt.

Alteration has clearly radically affected the entire volcanic section. Essentially all interstitial glass has been replaced by secondary clays or calcite. Clusters of clay minerals and iron oxides grow inward into vesicles and cracks, which then are filled completely with calcite and iron oxides, usually goethite. On a microscopic scale, at least, the clays and iron oxides are thus not all replacement minerals; some did precipitate directly from solutions. Considering the evidence for large-scale fluid migration through the volcanics, a similar origin for clays and iron oxides in the overlying sediments is at least in part suggested.

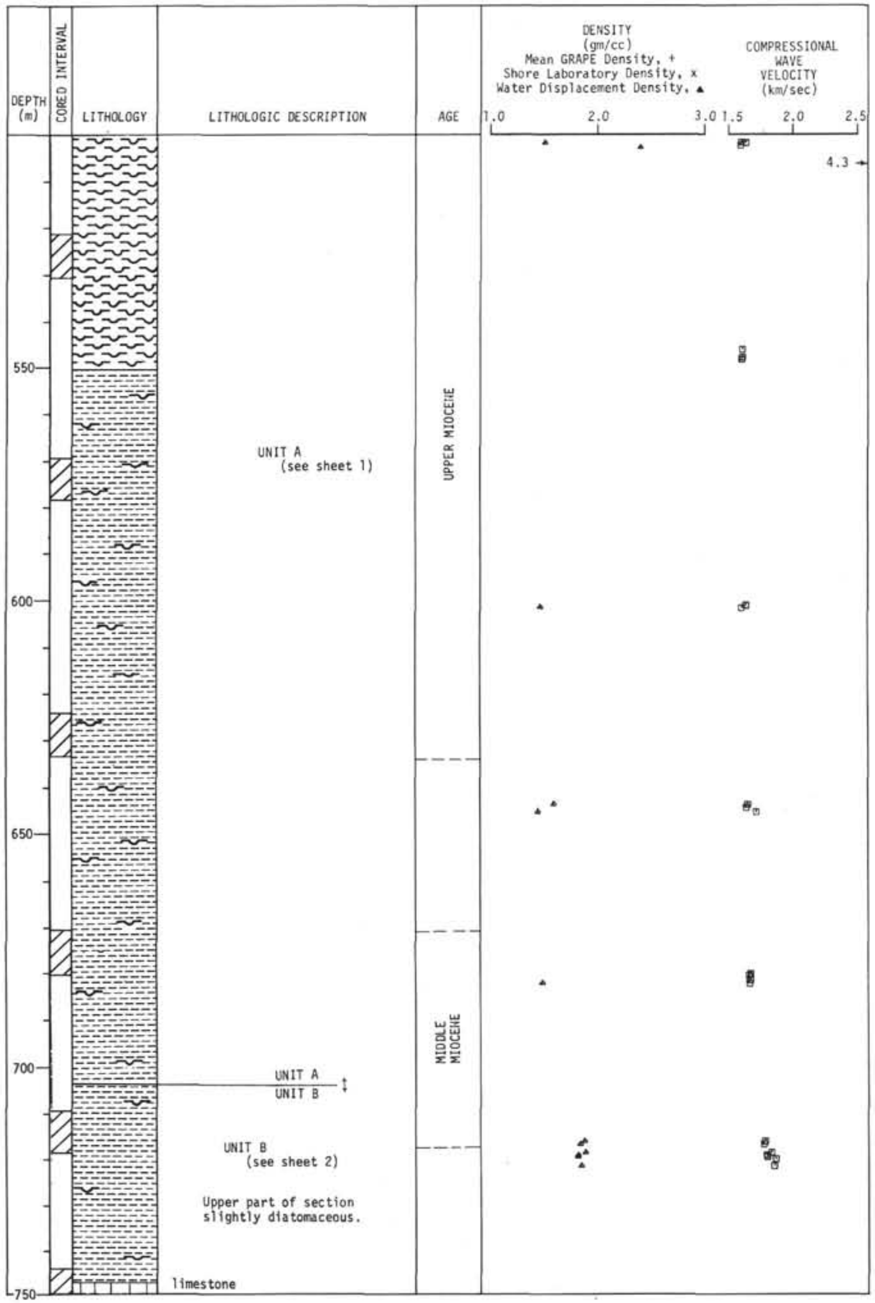
SITE 192



SITE 192



SITE 192



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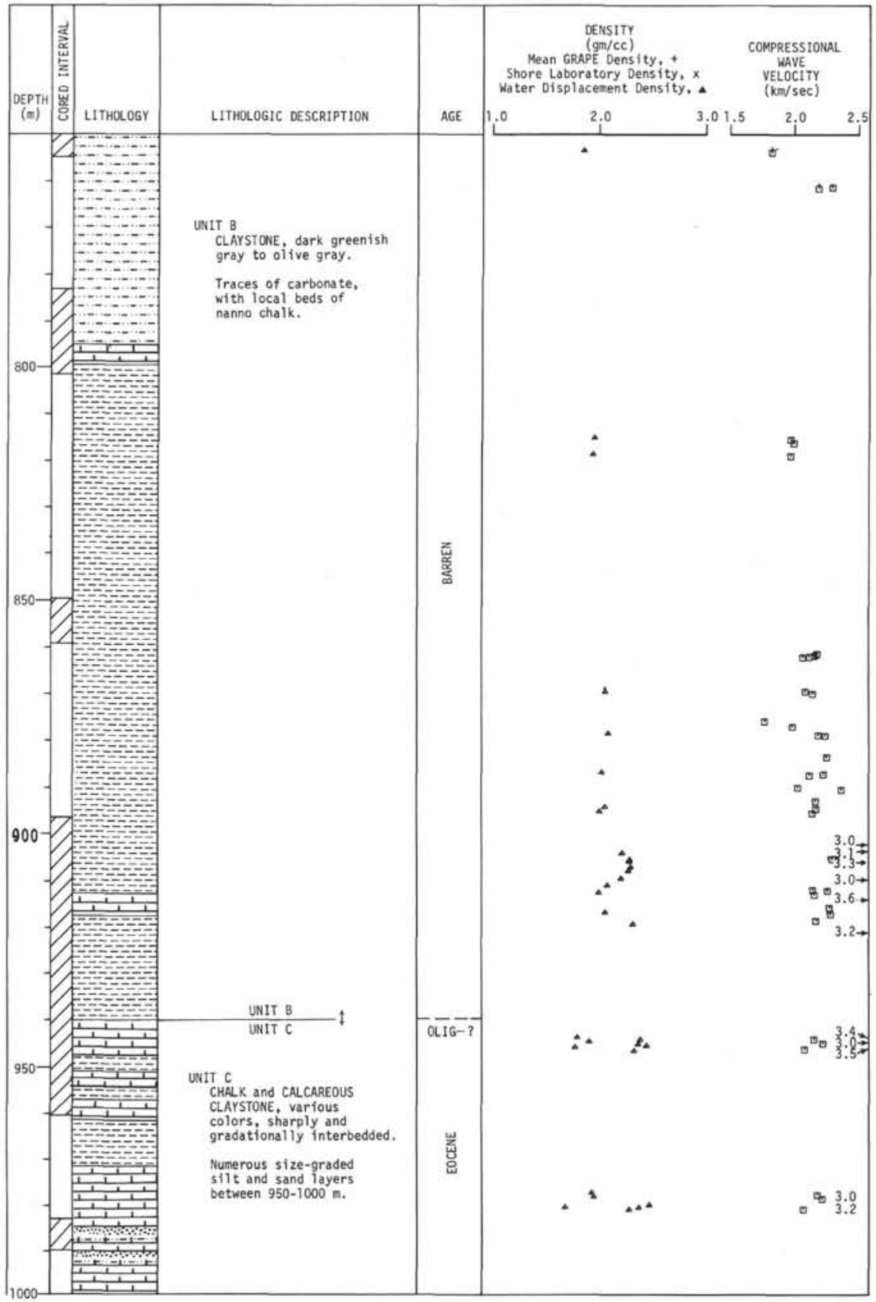

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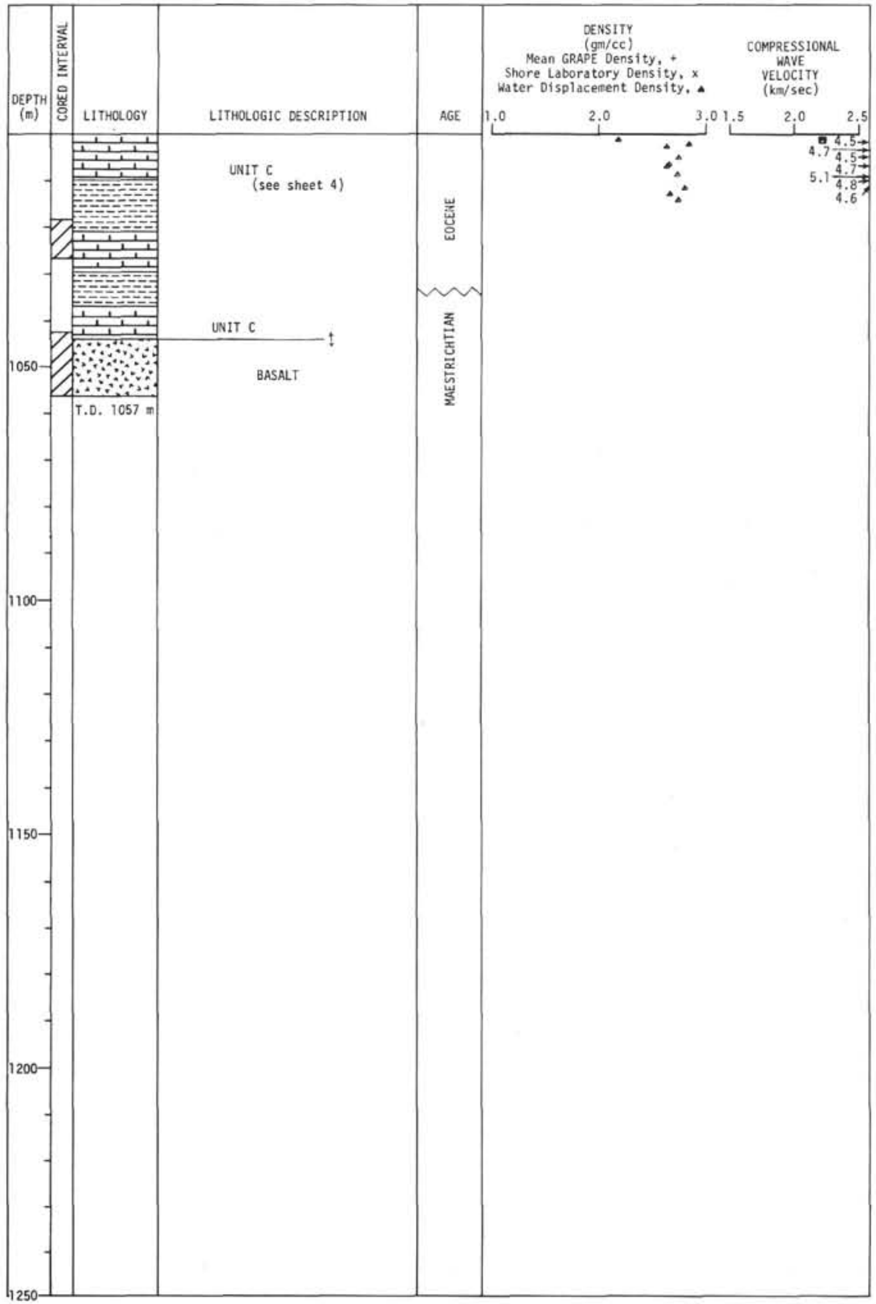
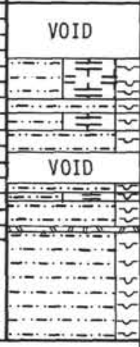

DEPTH (m)
CORED INTERVAL
LITHOLOGY
LITHOLOGIC DESCRIPTION
AGE
DENSITY (gm/cc)
Mean GRAPE Density, +
Shore Laboratory Density, x
Water Displacement Density, ▲
COMPRESSIONAL WAVE VELOCITY (km/sec)
1.0
2.0
3.0
1.5
2.0
2.5
4.5
4.7
4.5
4.7
5.1
4.8
4.6
UNIT C
(see sheet 4)
EOCENE
UNIT C
BASALT
MAESTRICHTIAN
T.D. 1057 m
1050
1100
1150
1200
1250

Site 192 Hole Core 1 Cored Interval: 0-1

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
UPPER PLEISTOCENE	(D) Denticula seminae *	PF BF D R S N	A C A R R C	G G M M G	1	0.5 1.0			50 66 121 135 142
					Core Catcher				

LITHOLOGIC DESCRIPTION

Basic lithologies:

1) DIATOM RICH SILTY CLAY
   dark gray (5Y 4/1)
   locally glass rich

2) DIATOM, FORAM, and NANNO RICH SILTY CLAY
   dark yellowish brown (10YR 3/2 - 5/2)
   layers occur at:
   35 - 60 cm
   70 - 80 cm
   and 119 - 126 cm

Thin, 1-2 cm VITRIC ASH layers occur at 121 cm, 142 cm and in core catcher.

Slide 1-50 (lithology 2)
- 30% clay
- 20% nannos
- 20% diatoms
- 15% forams
- 10% feldspar
- 5% glass

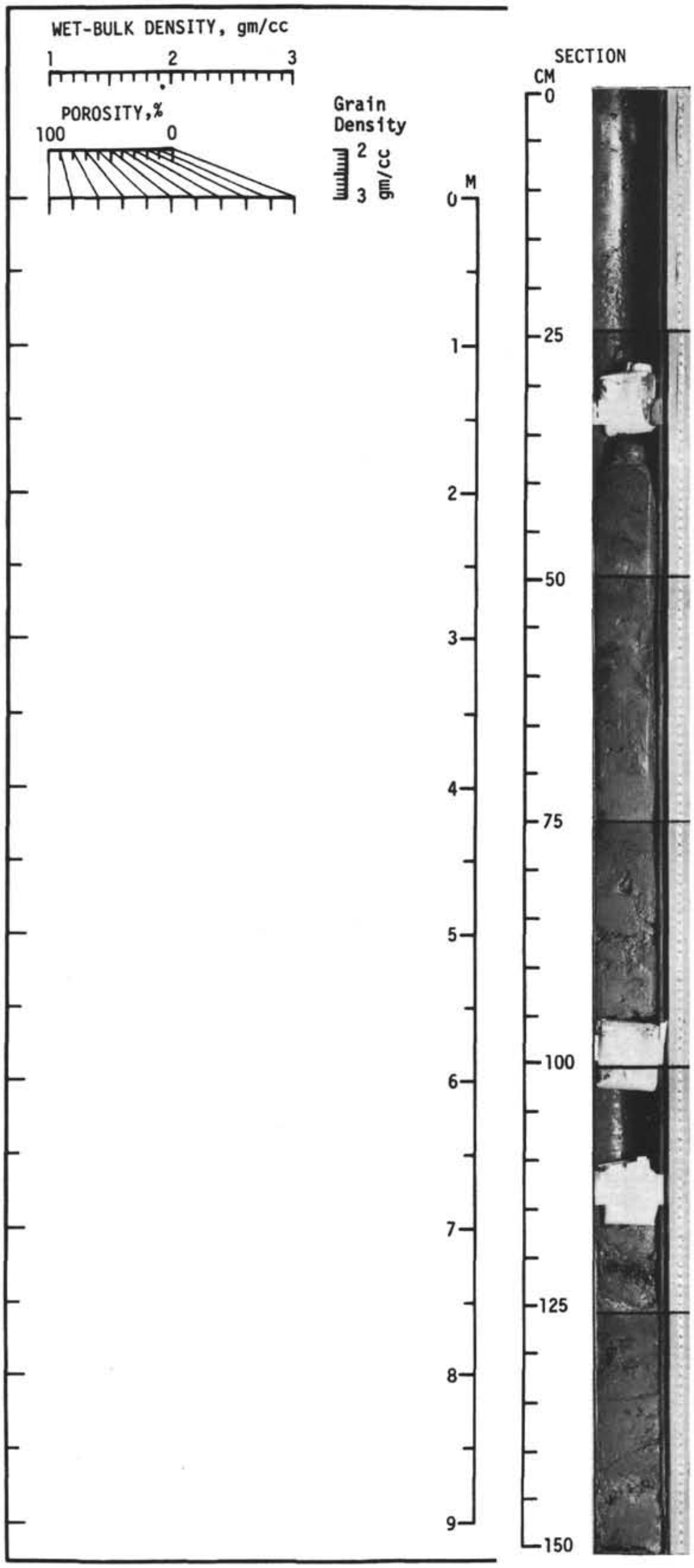
Core Catcher:

N	C	M
D	A	G
R	R	M
S	R	M
PF	F	M
BF	F	

Slide 1-66 (lithology 1)
- 60% clay
- 20% feldspar
- 5% pyroxene and hornblende
- 5% glass
- 10% diatoms

Explanatory notes in Chapter 1

*(S) Distephanus octangulatus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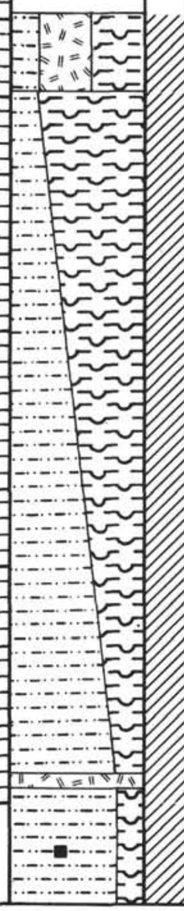
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150

192-1-1

Site 192 Hole Core 2 Cored Interval: 1-10

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLEISTOCENE	(D) Denticula seminae				1	0.5	VOID			Slide 1-120 40% diatoms 40% glass 10% clay 10% feldspar, qtz, etc.
		N	R	G	1	1.0			120 148	SILT BEARING DIATOMACEOUS VITRIC ASH olive gray (5Y 4/1)
		PF BF N D R S	A F C A R -	G G G G M -	2				67 85	NANNO, SILT and CLAY BEARING DIATOM OOZE medium dark gray (N4) 70 - 80% diatoms 0 - 10% nannos 10 - 20% silt and clay
		N	-	-	3					grades downward to:
		N	-	-	4				70 82	GLASS BEARING DIATOM RICH SILTY CLAY medium dark gray (N4) Slide 4-70 55% clay 20% silt 25% diatoms
					Core Catcher					SANDSTONE ERRATIC, black

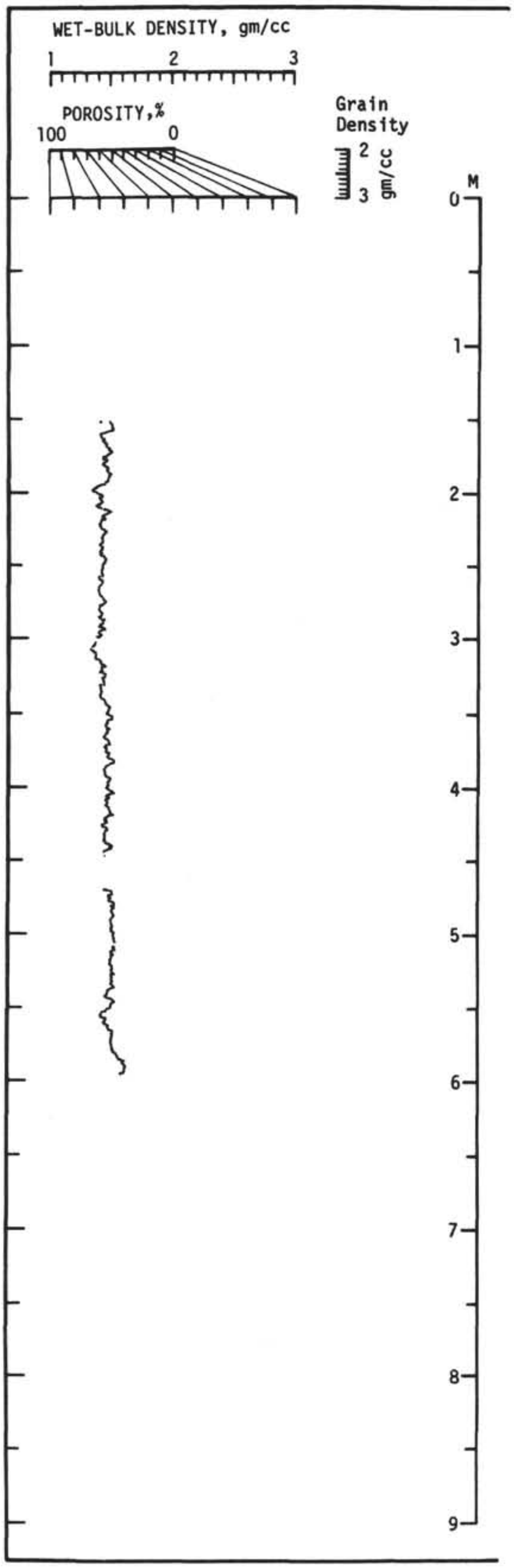


Core Catcher:

N	-	-
D	A	G
R	R	M
S	R	M
PF	R	
BF	R	

Disturbed pods of VITRIC ASH occur throughout the core.

Explanatory notes in Chapter 1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3
POROSITY,%
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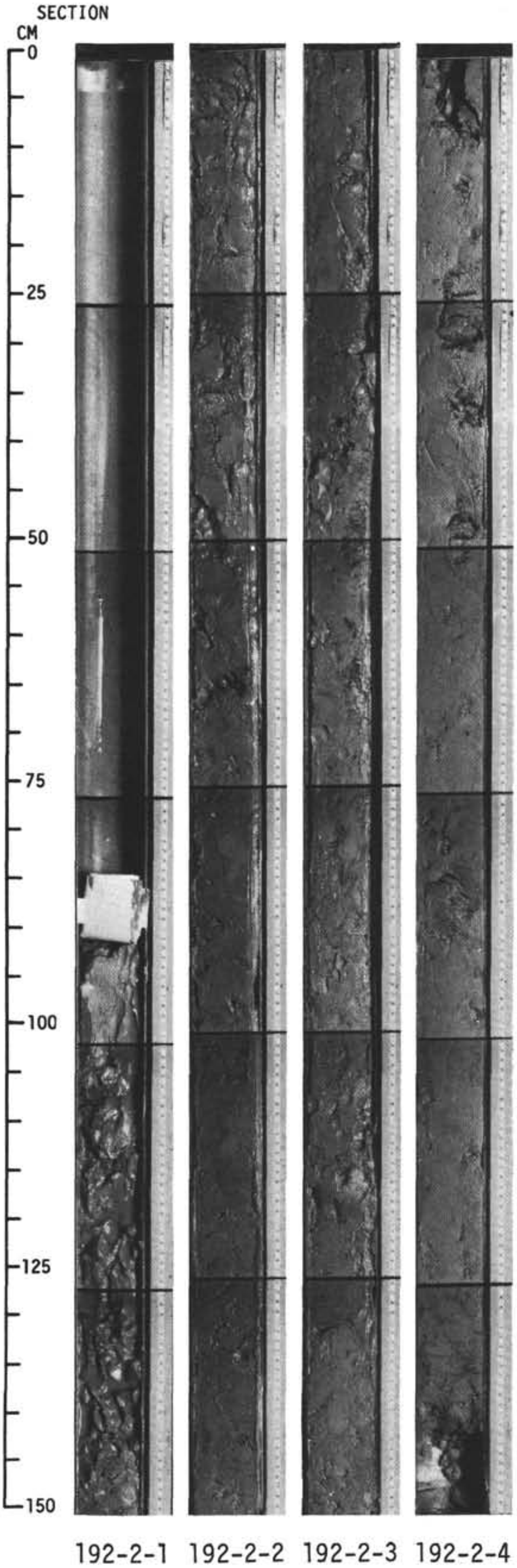
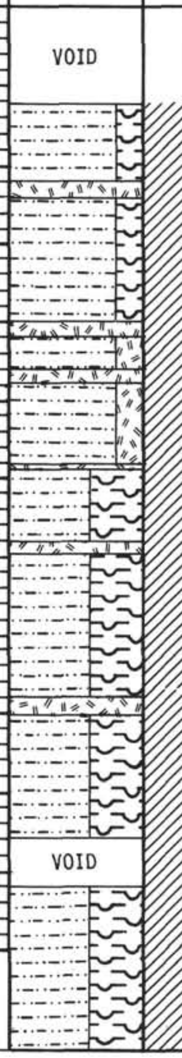
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9

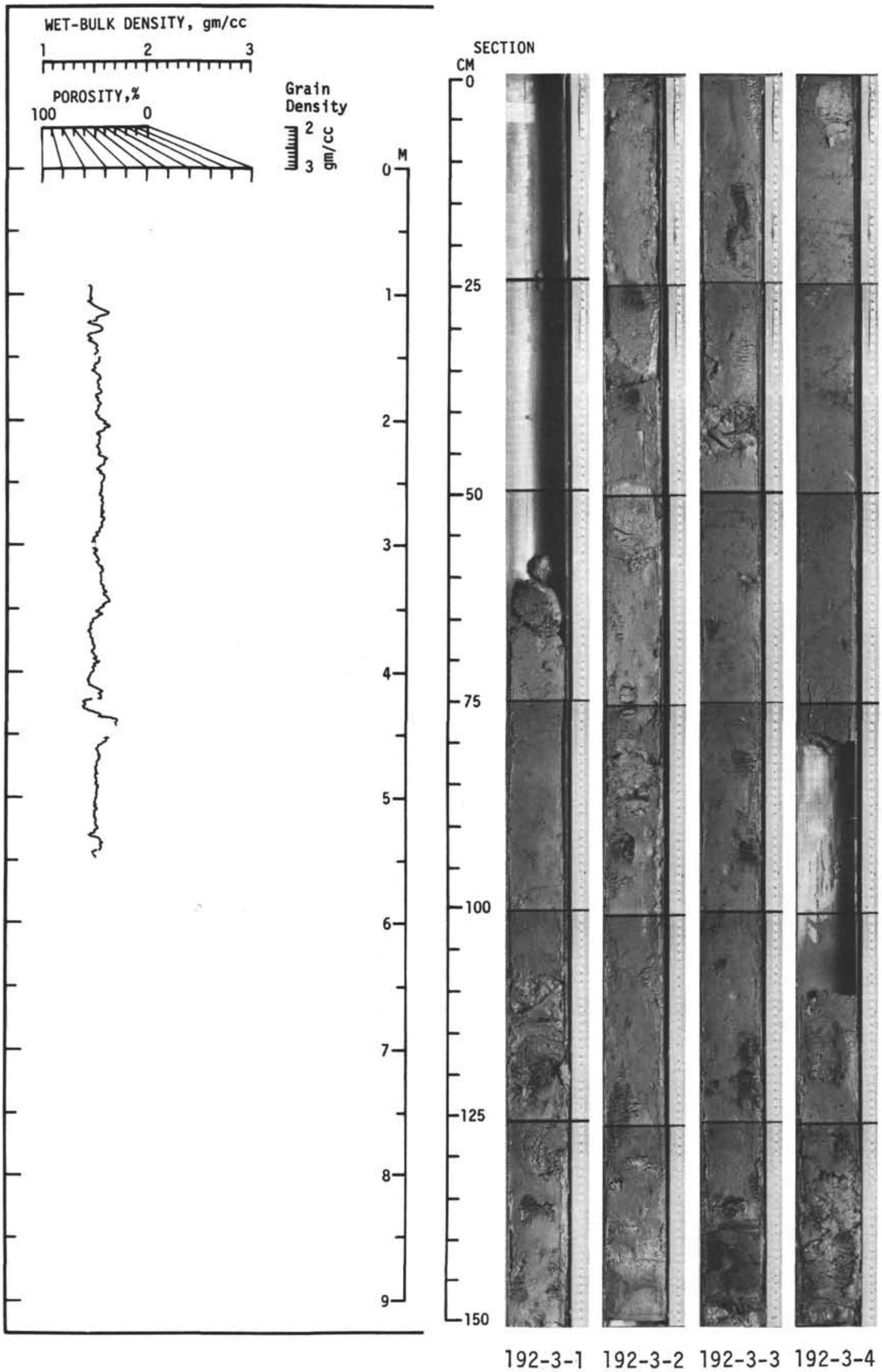

SECTION
CM
0
25
50
75
100
125
150
192-2-1
192-2-2
192-2-3
192-2-4

Site 192 Hole Core 3 Cored Interval: 10-19

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE PLEISTOCENE	(D) *Rhizosolenia curvirostris* (S) *Distephanus octonarius*	N PF BF	- - -	-	1	0.5 1.0	VOID		90 118 135	GLASS BEARING DIATOM RICH SILTY CLAY dark gray (5Y 4/1) Slide 1-90 55% clay 20% silt 5% glass 20% diatoms
		N	-	-	2				30 42 72 125 150	DIATOM BEARING GLASSY, SILTY CLAY dark gray (5Y 4/1) Slide 2-72 40% clay 30% silt 25% glass 5% diatoms
		D R S N	A R R -	G M M -	3				45 71 142	SAND BEARING DIATOMACEOUS SILTY CLAY dark gray (5Y 4/1)
		N	R	M	4		VOID		76 113 115	Entire core contains layers and pods of VITRIC and CRYSTAL ASH, various colors: dusky brown (5YR - 10YR 2/2) grayish brown (10YR 5/1) light olive gray (5Y 6/1) etc.
		N PF BF	R F R	M M	Core Catcher					



Explanatory notes in Chapter 1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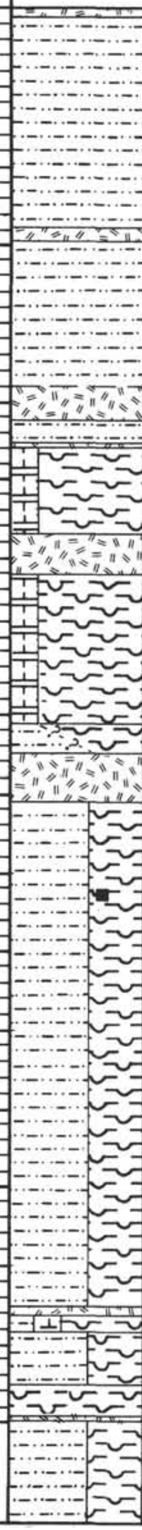
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192-3-1
192-3-2
192-3-3
192-3-4

Site 192 Hole Core 4 Cored Interval: 19-28

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHO. SAMPLE
MIDDLE PLEISTOCENE	(D) Rhizosolenia curvirostris (S) Distephanus octonarius	N	-	-	1	0.5 1.0	75
		PF BF N	- R -	 -	2		45
		D R S N	A C R C	G M M M	3		45 80
		N	-	-	4		30 40 100
		D R S N PF BF	A R R - F R	G M M - P 	5		130
		N	A	G	6		60 86 130
					Core Catcher		

LITHOLOGY



LITHOLOGIC DESCRIPTION

ASH, dark greenish gray (5G 4/1)

Slide 1-75
70% clay
30% silt
TR diatoms

SILTY CLAY and CLAYEY SILT
dark gray (5Y 4/1)

Slide 2-45
40% clay
30% feldspar
20% glass
10% pyroxene

VITRIC ASH, light brownish gray (5YR 6/1)

ASH, dusky to dark yellowish brown (5YR 2/2 - 10YR 4/2)
upper contact gradational
2 cm layer VITRIC ASH, pale brown (5YR 5/2)

VITRIC ASH, olive gray (5Y 4/1) to dusky yell. brown (5Y 2/2)

SILT, CLAY, and CARBONATE BEARING DIATOM OOZE
olive gray (5Y 3/2)

Slide 3-80
85% diatoms
5% silt and clay
10% carbonate

VITRIC ASH

Slide 4-100
30% diatoms
30% silt
40% clay

ERRATIC

DIATOMACEOUS SILTY CLAY
dark gray (5Y 4/1)

Core Catcher:

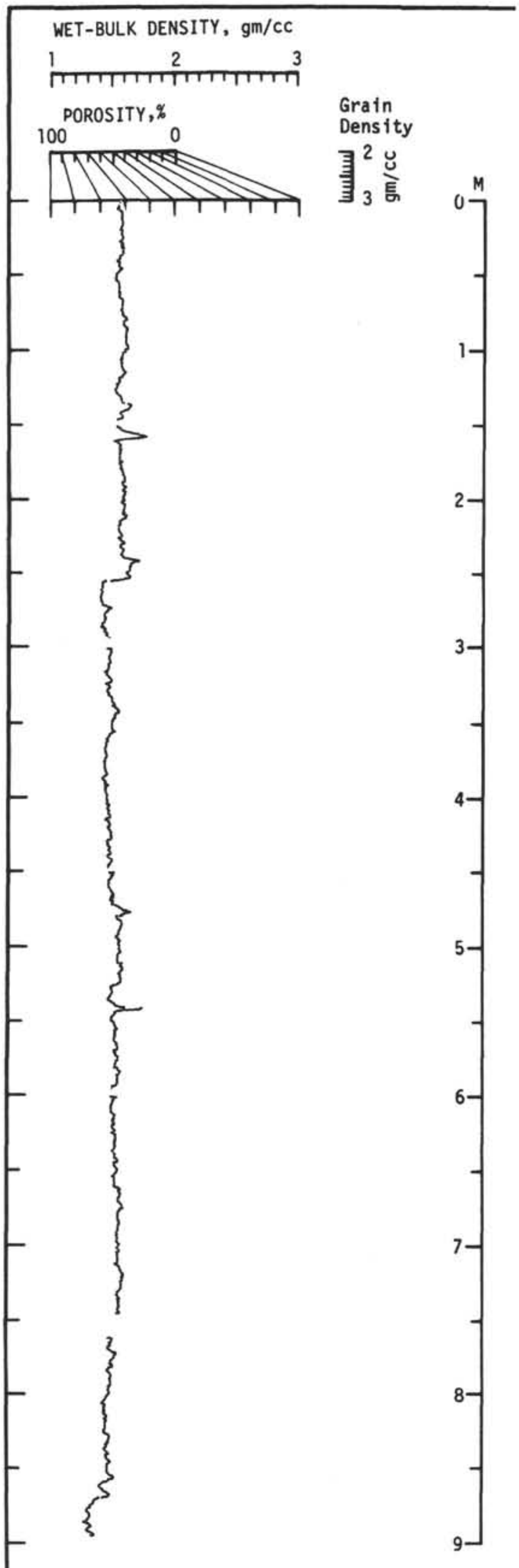
PF	C	M
BF	F	
N	C	M
D	A	G
R	R	M
S	A	M

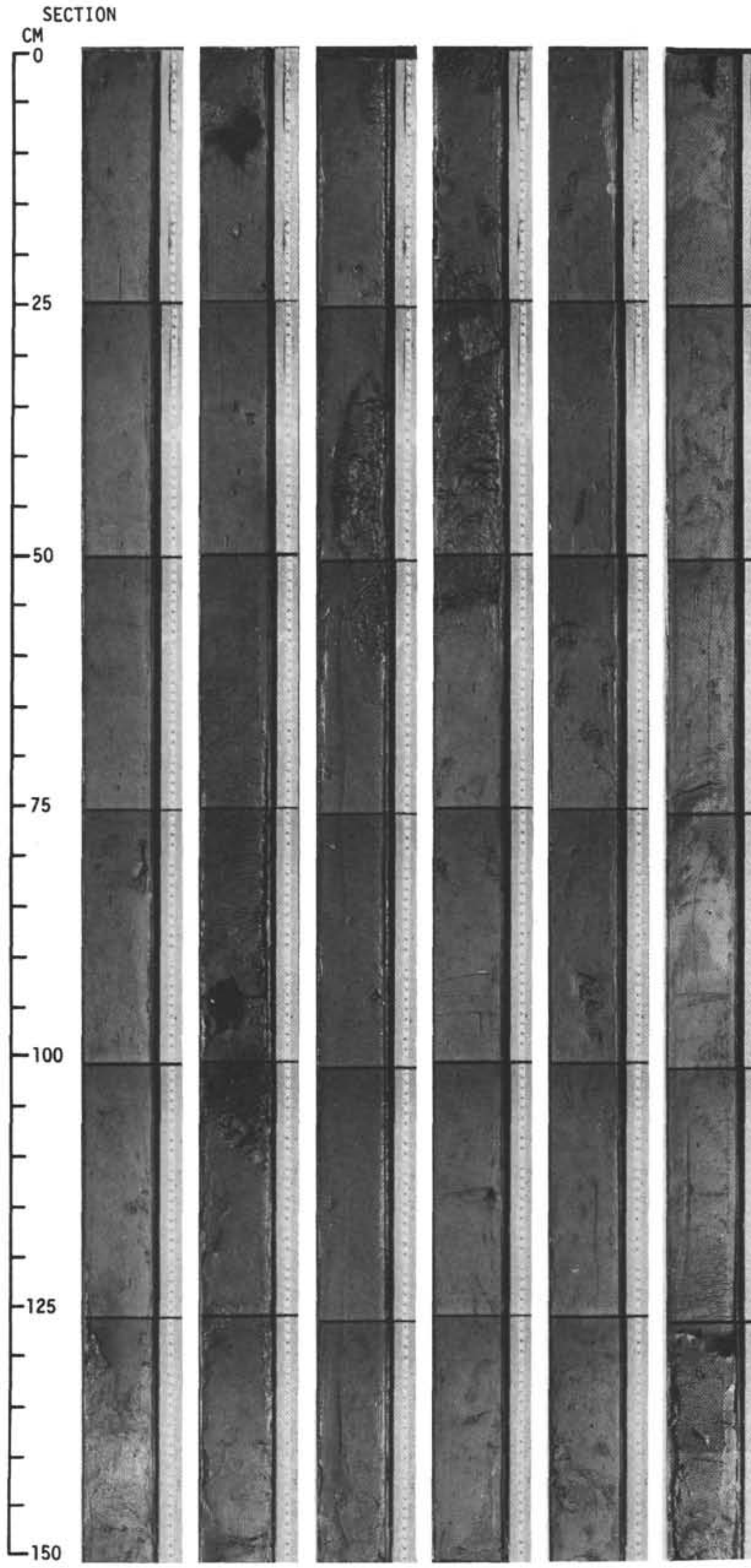
Slide 5-130
30% diatoms
20% silt
50% clay

ASH FORAM, SILT, and CLAY BEARING NANNO RICH DIATOM OOZE, gray (5Y 5/1) 60% diatoms, 20% nannos, 15% clay and silt, 3% forams

NANNO and CLAY BEARING DIATOM OOZE, gray (5Y 5/1)
VITRIC ASH

Explanatory notes in Chapter 1





192-4-1 192-4-2 192-4-3 192-4-4 192-4-5 192-4-6

Site 192 Hole Core 5 Cored Interval: 28-37

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MIDDLE PLEISTOCENE	(D) Rhizosolenia curvirostris (S) Distephanus octonarius	N N*	- C	- M	1	0.5 1.0			-75
		PF BF N	C R -	M -	2				-80 -126 -136
		D R S N	A C F C	G M M G	3				-15 -50 -85 -110 -125
		N PF BF	- R F	-	4				-10 -70 -90 -100 -110
LOWER PLEISTOCENE	(D) Actinocyclas oculatus (S) Dictyocha subarctios	N	-	-	5				-80 -125
		N	-	-	6		VOID		-140 -147
					Core Catcher				

LITHOLOGIC DESCRIPTION

DIATOM RICH SILTY CLAY
dark gray (5Y 4/1)

Slide 1-75
20% diatoms
35% silt
45% clay

ASH, dark yellow brown (10YR 4/2)

ASH

DIATOMACEOUS SILTY CLAY
dark gray (5Y 4/1)
with thin (2-10 cm) layers of
SILT and CLAY BEARING DIATOM OOZE
(90-95% diatoms) light olive gray
(5YR 5/2)
SILT and CLAY RICH DIATOM OOZE
olive gray (5Y 4/1)

erratic

CARBONATE and CLAY BEARING DIATOM OOZE
olive gray (5Y 4/1)

VITRIC ASH, dusky yellow brown (10YR 2/2)
GLASS and SILT RICH CLAY
dark greenish gray (5GY 4/1)

DIATOMACEOUS SILTY CLAY
dark greenish gray (5GY 4/1)

VITRIC ASH

VITRIC ASH

Slide 4-100
50% clay
35% diatoms
10% feldspar, etc.
3% glass
2% rads

SILT and CLAY RICH DIATOM OOZE
dark greenish gray (5GY 4/1)

VITRIC ASH

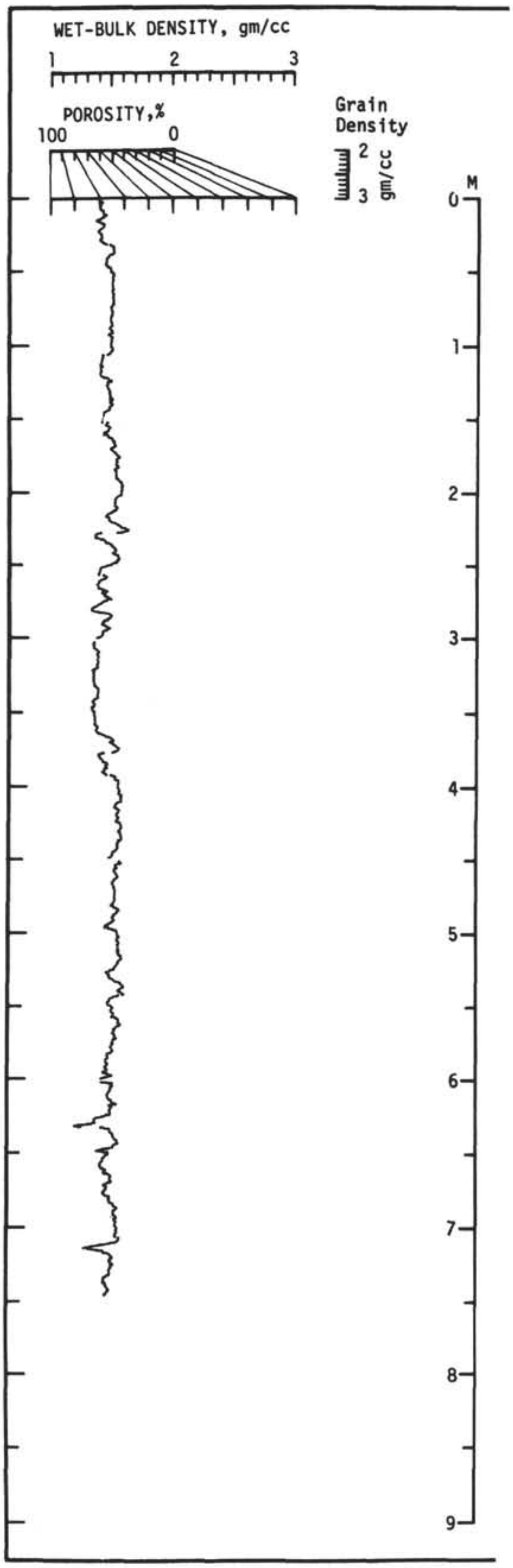
Core Catcher:

PF	VA	G
BF	F	
N	C	M
D	A	G
R	R	M
S	R	M

Slide 5-80
70% diatoms
15% clay
15% feldspar, qtz., etc.

DIATOMACEOUS SILTY CLAY
dark greenish gray (5GY 4/1)
pods of VITRIC ASH
30% diatoms, 25% silt, 45% clay

Explanatory notes in Chapter 1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2
3
POROSITY,%
100
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Grain Density
2
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gm/cc
M
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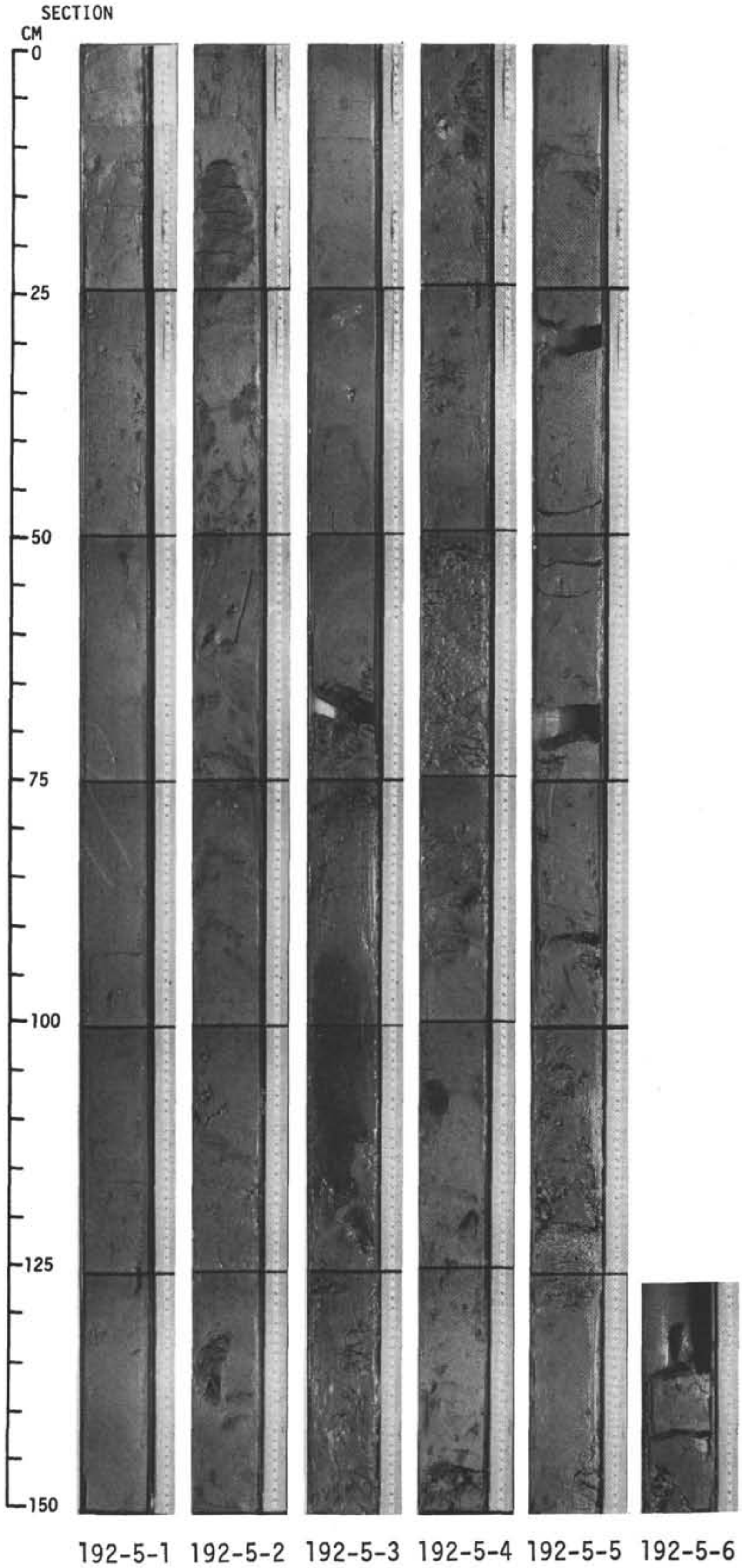
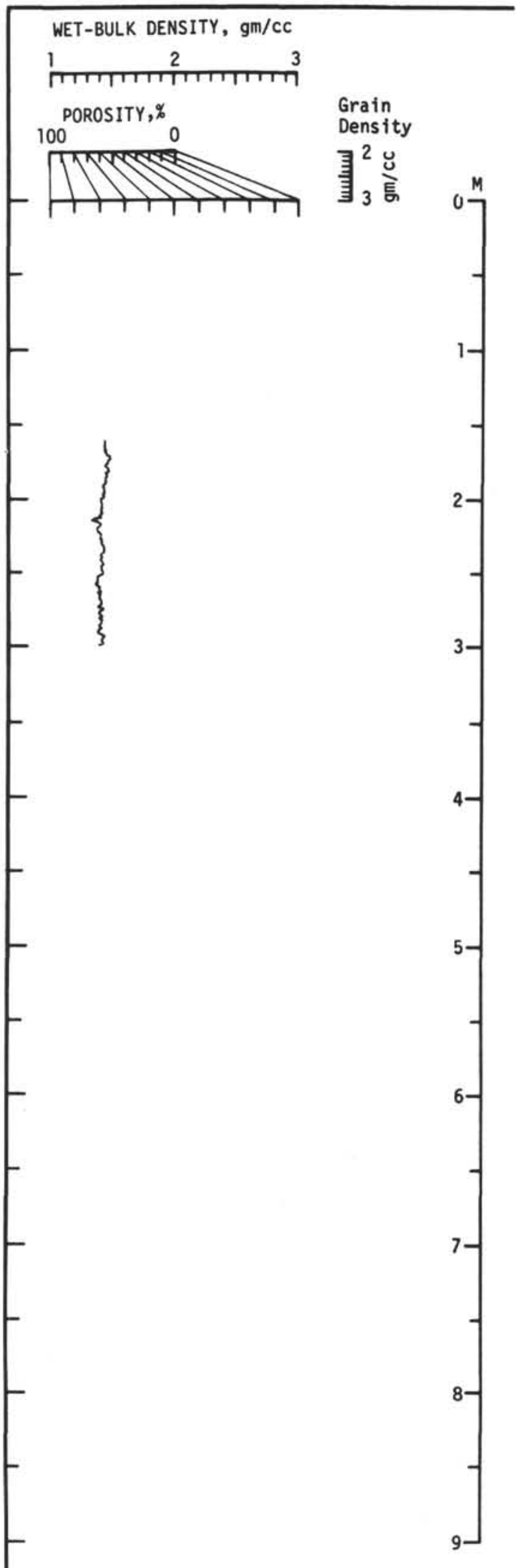
1
2
3
4
5
6
7
8
9


SECTION
CM
0
25
50
75
100
125
150
192-5-1
192-5-2
192-5-3
192-5-4
192-5-5
192-5-6

Site 192 Hole Core 6 Cored Interval: 55-64

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLEISTOCENE	(D) Actinocyclas oculatus (S) Dictyocha subarctios	N D R S PF BF N	- A C R - R -	- G M M -	1	0.5 1.0	VOID		-130	SILT and CLAY RICH DIATOM OOZE olive gray (5Y 3/2) scattered compact CLAY PODS, greenish black (5GY 2/1)
					2				-75	
					Core Catcher					Core Catcher: N - - D A G R R M S F M PF R BF R Slides 1-130 and 2-75 70% diatoms 20% clay 10% silt

Explanatory notes in Chapter 1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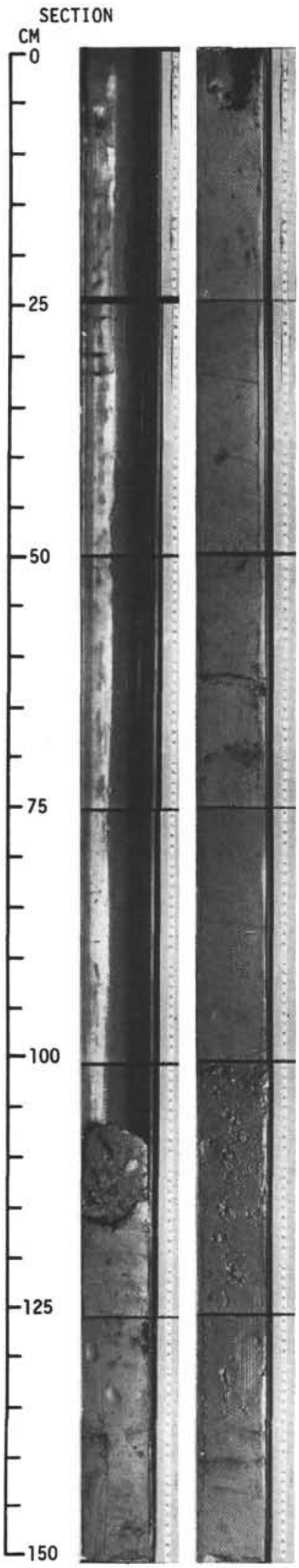
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9

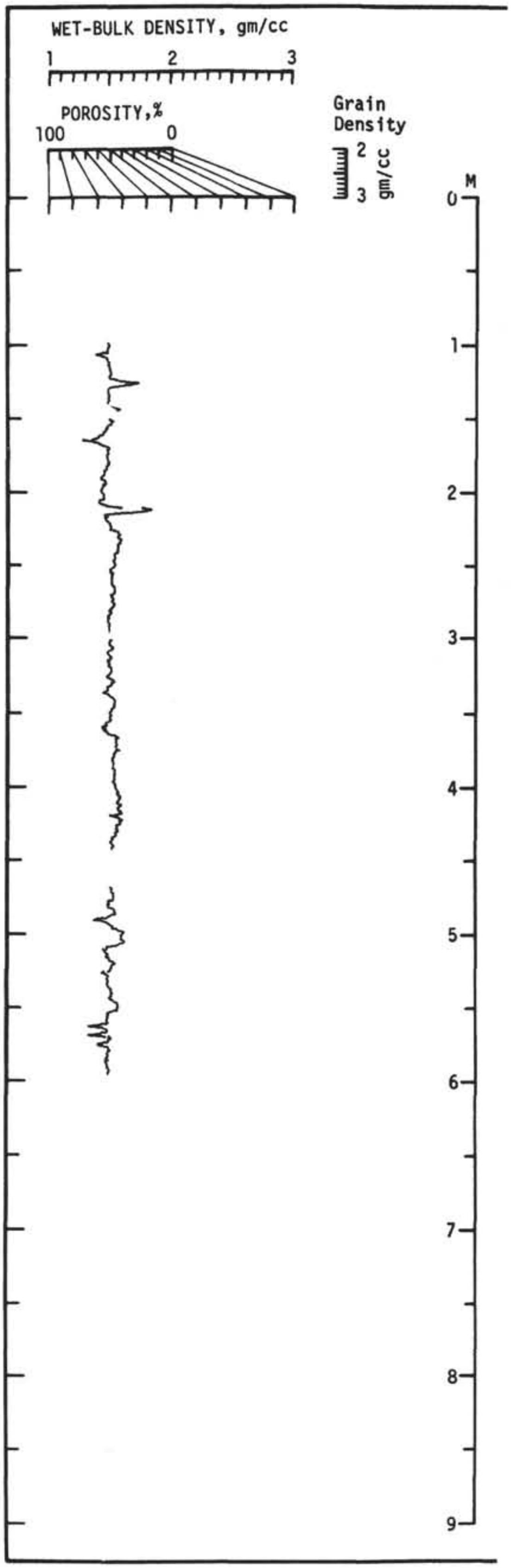

SECTION
CM
0
25
50
75
100
125
150

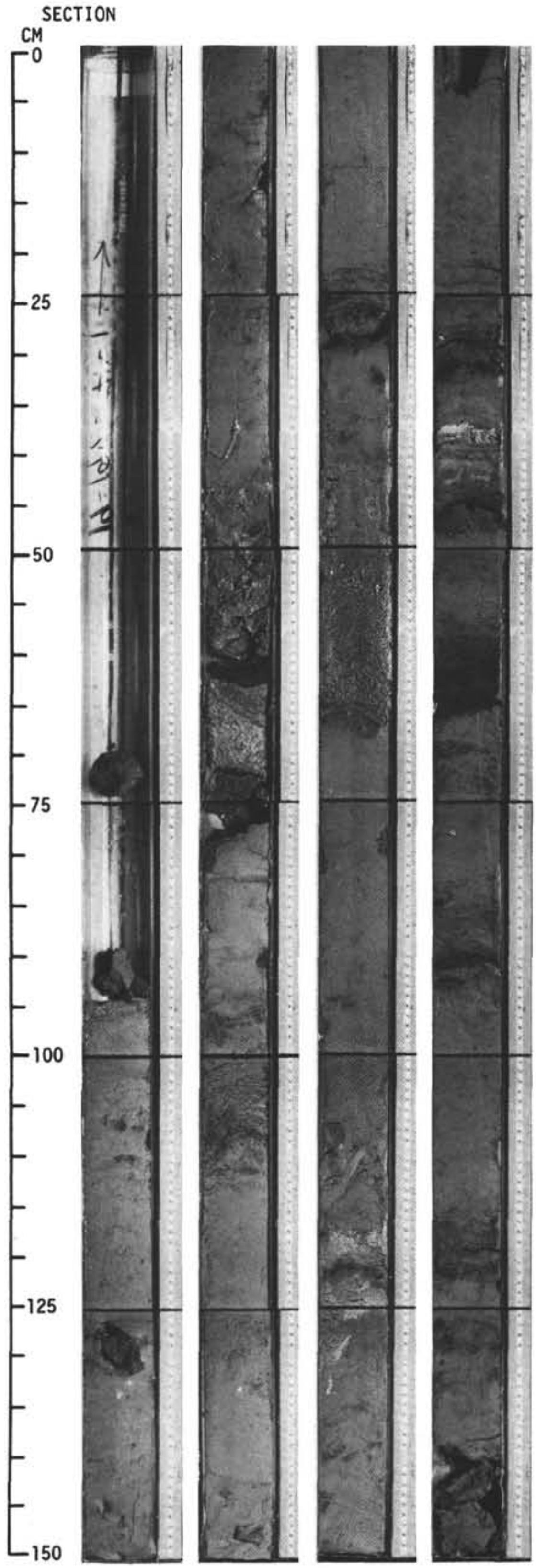
192-6-1 192-6-2

Site 192 Hole Core 7 Cored Interval: 74-83

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLEISTOCENE	(D) Actinocyclas oculatus (S) Dictyocha subarctios	N PF BF D R S N	- R R A R R -	- G M M -	1 2	0.5 1.0	VOID		125 70 78 100 10 55 65	Basic lithology DIATOMACEOUS SILTY CLAY dark greenish gray (5GY 4/1) composition range: 35 - 50% diatoms erratics 10 - 25% silt 35 - 55% clay locally up to 70% diatoms numerous beds of VITRIC ASH, various colors, dark brown (10YR 3/2) to very light gray (N8)
UPPER PLIOCENE	(D) Thalassiosira zabelinae	N PF BF N PF BF	- - R - - R	- -	3 4				85 150 42 48 65 100	DIATOM BEARING, GLASS and SILT RICH CLAY dark greenish gray (5GY 4/1) Slide 3-85 5 - 10% diatoms 15% glass 20 - 25% silt 55% clay Core Catcher: N R M D A G R R M S F M PF C M BF F
					Core Catcher					

Explanatory notes in Chapter 1





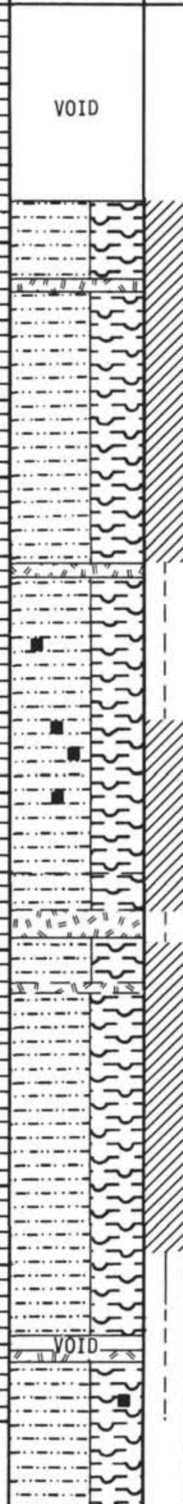
192-7-1 192-7-2 192-7-3 192-7-4

Site 192 Hole Core 8 Cored Interval: 92-101

AGE: UPPER PLIOCENE

ZONE: (D) Thalassiosira zabelinae; (S) Ammodochium rectangulare

SECTION	FOSSIL	ABUND.	PRES.	LITHO. SAMPLE
1 (0.5, 1.0 m; VOID)	N D R S	- A R -	- G M -	135
2	N	-	-	
3	N PF BF	- - R	-	60 125
4	N PF BF D R S	- - R A R R	- G M M	70 135
5	N	-	-	50 75
6	PF BF N	- R -	-	75
Core Catcher				



LITHOLOGIC DESCRIPTION

CRYSTAL ASH dark yellowish brown (10YR 4/2)

Basic lithology
DIATOMACEOUS SILTY CLAY
dark greenish gray (5GY 4/1)
composition range:
45 - 50% diatoms
5 - 25% silt
30 - 50% clay

CRYSTAL ASH dark yellowish brown (10YR 4/2)
Slide 3-60
45% glass
40% feldspar
10% pyroxene and amphibole
2% diatoms
3% other

ERRATICS

zone of intermixed ash and basic lithology

VITRIC ASH olive gray - olive black (5Y 4/1 - 2/1)

pods of brown VITRIC ASH

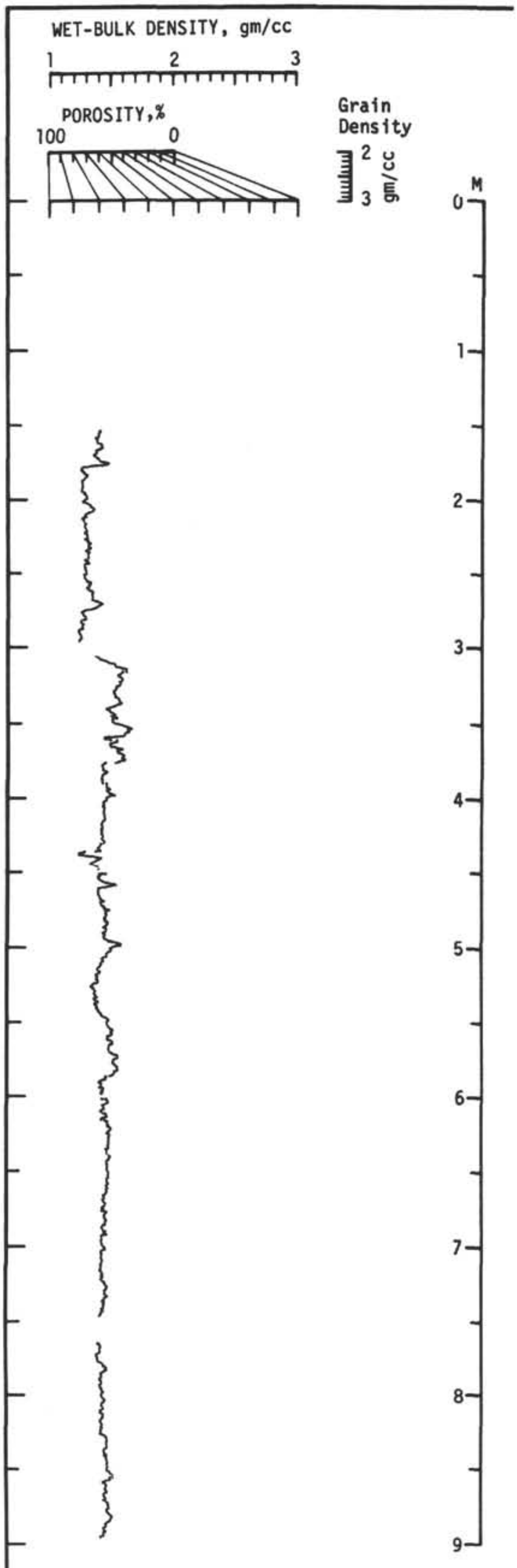
VITRIC ASH light gray (N7)

ERRATIC

Core Catcher:

PF	F	M
BF	F	
N	-	-
D	A	G
R	R	M
S	F	M

Explanatory notes in Chapter 1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POROSITY,%
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Grain Density
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gm/cc
M
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2
3
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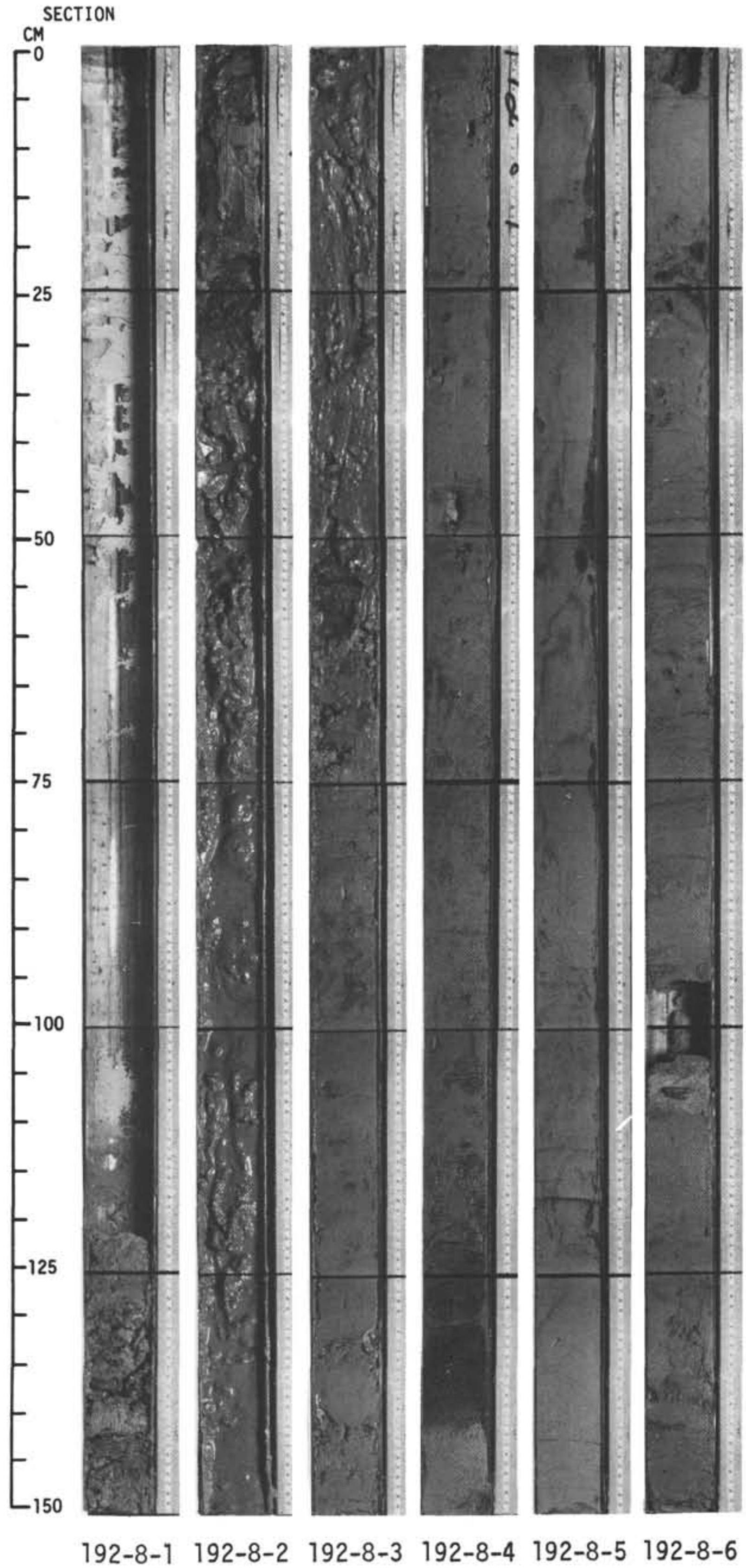
SECTION
CM
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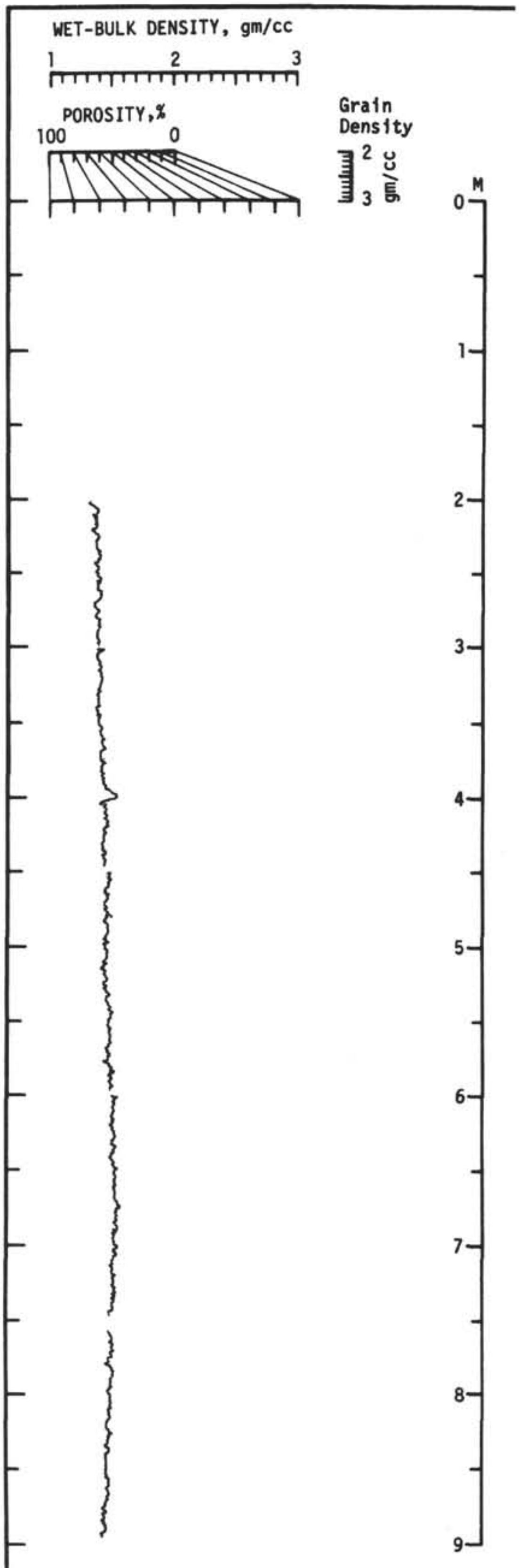
50
75
100
125
150
192-8-1
192-8-2
192-8-3
192-8-4
192-8-5
192-8-6

Site 192 Hole Core 9 Cored Interval: 121-130

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare	N	-	-	1	0.5 1.0	VOID			Basic lithology: SILT BEARING DIATOMACEOUS CLAY dark greenish gray (5GY 4/1)
		D R S PF BF N	A F R - - -	G M M -	2		VOID		75	Slides 2-75 and 6-70 45% diatoms 50% clay 5% silt
		N	-	-	3				104	FELDSPAR RICH VITRIC ASH dark yellowish brown (10YR 4/2) 70% glass 25% feldspar 5% pyroxene
		PF BF D R S	- R A R R	 G M M	4					
		N	-	-	5					
		N	R	P	6				70	Core Catcher: PF R BF R N - - D A G R R M S R M
					Core Catcher					

Explanatory notes in Chapter 1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POROSITY,%
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Grain Density
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gm/cc
M
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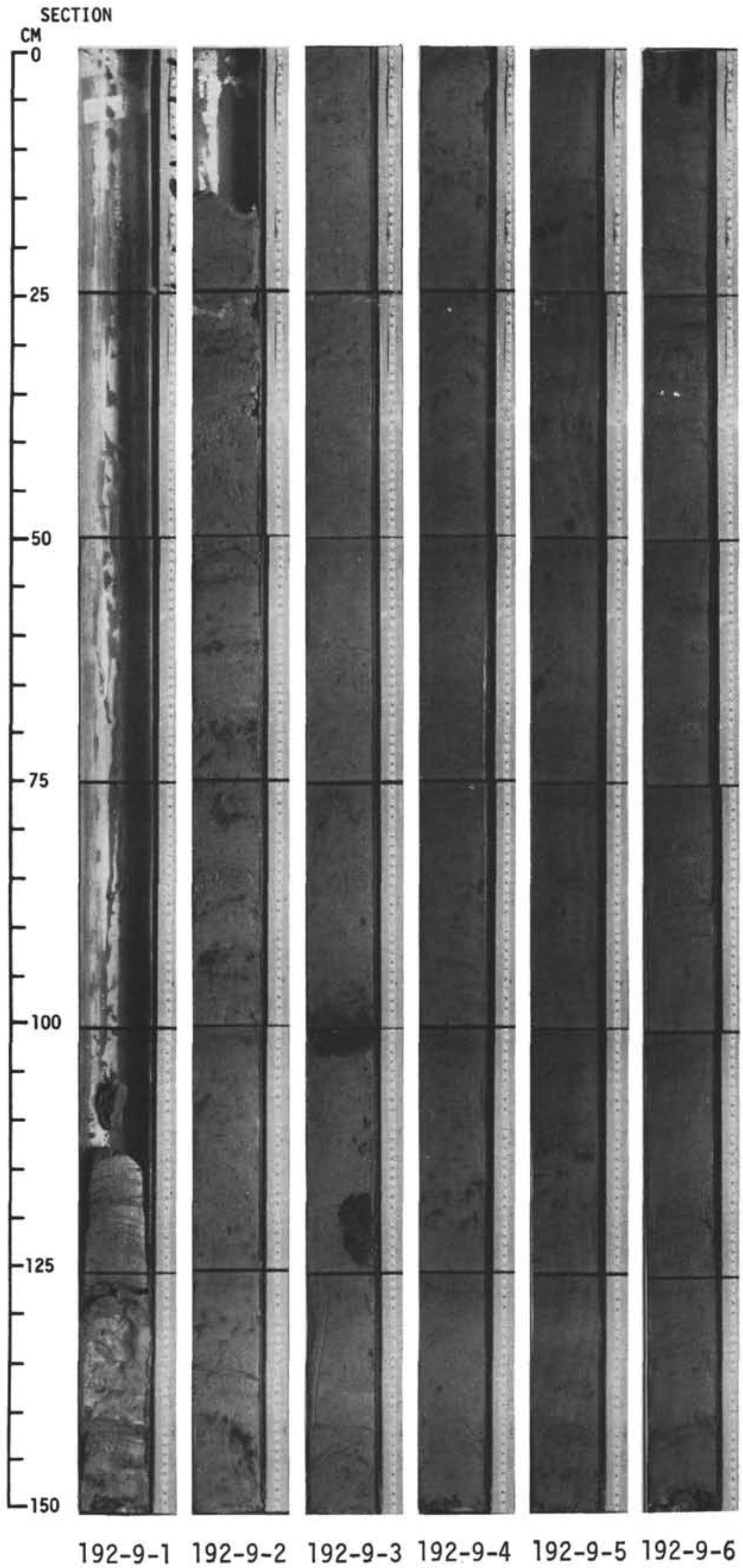
5
6
7
8
9


SECTION
CM
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25
50
75
100
125
150
192-9-1
192-9-2
192-9-3
192-9-4
192-9-5
192-9-6

Site 192 Hole Core 10 Cored Interval: 148-157

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica (S) Ebriopsis antiqua (without spine)	D R S PF BF N	A R C - - -	G M M -	1	0.5 1.0	VOID		
		N	-	-	2		VOID		70
		N	-	-	3				
		D R S N PF BF	A R F C - F	G M M M	4		VOID		
					5				80
					Core Catcher				

LITHOLOGIC DESCRIPTION

CLAYEY DIATOM OOZE
dark greenish gray (5GY 4/1)

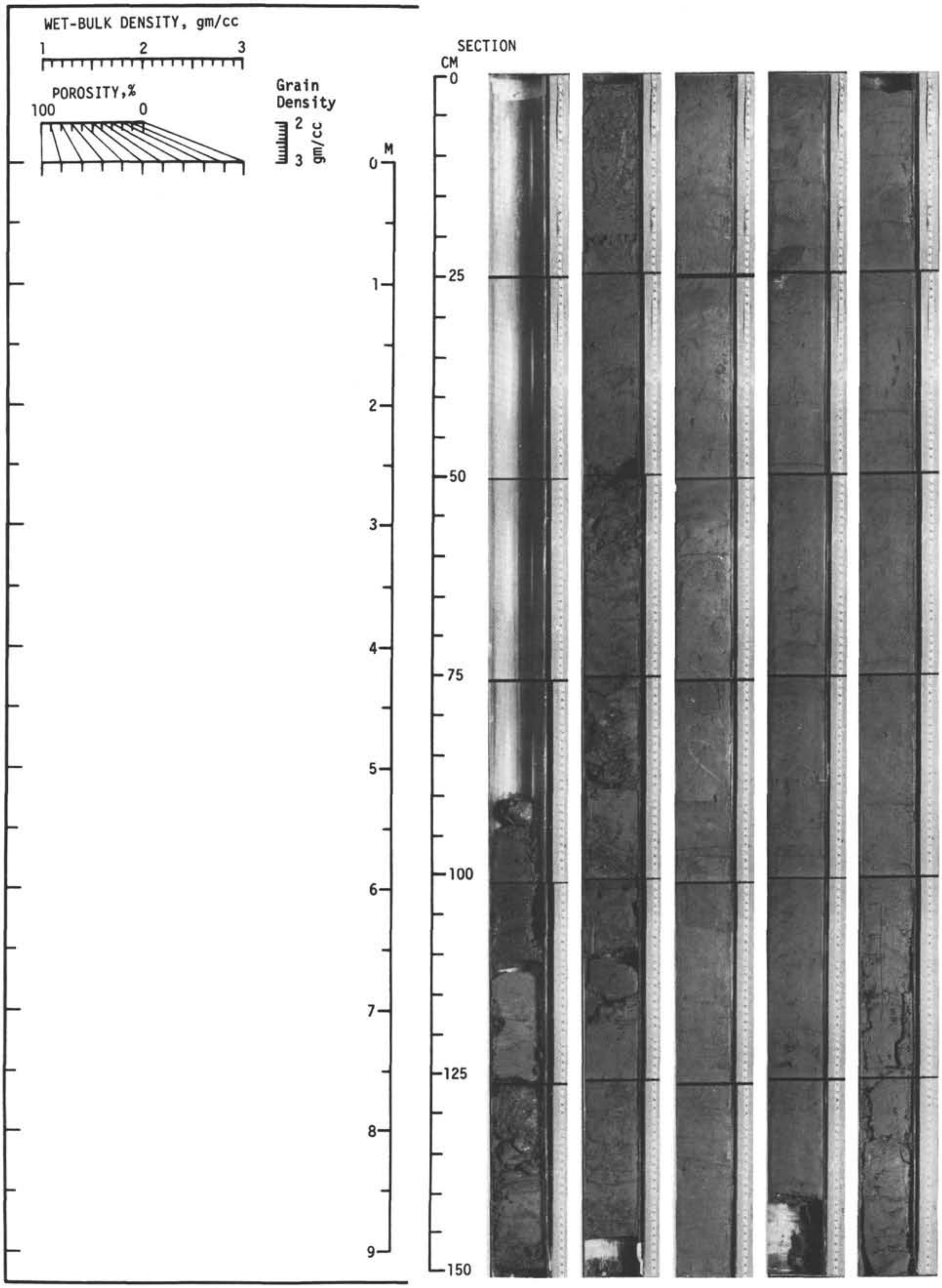
Slides 2-70 and 5-80
60% diatoms
40% clay
2% silt

minor pods of dark ash

Core Catcher:

N	-	-
PF	-	
BF	F	
D	C	G
R	R	M
S	R	M

Explanatory notes in Chapter 1

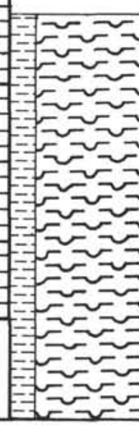


192-10-1 192-10-2 192-10-3 192-10-4 192-10-5

Site 192 Hole Core 11 Cored Interval: 176-185

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica (S) Cannopilus hemisphaericus *	N D R S	- A R C	- G M M	1	0.5 1.0	VOID			SILT BEARING CLAY RICH DIATOM OOZE dark gray (5Y 4/1)
		N	R	P	2			-70		Slide 2-70 80% diatoms 20% clay 3% silt thin VITRIC ASH bed in section 1, 145 cm
					Core Catcher					

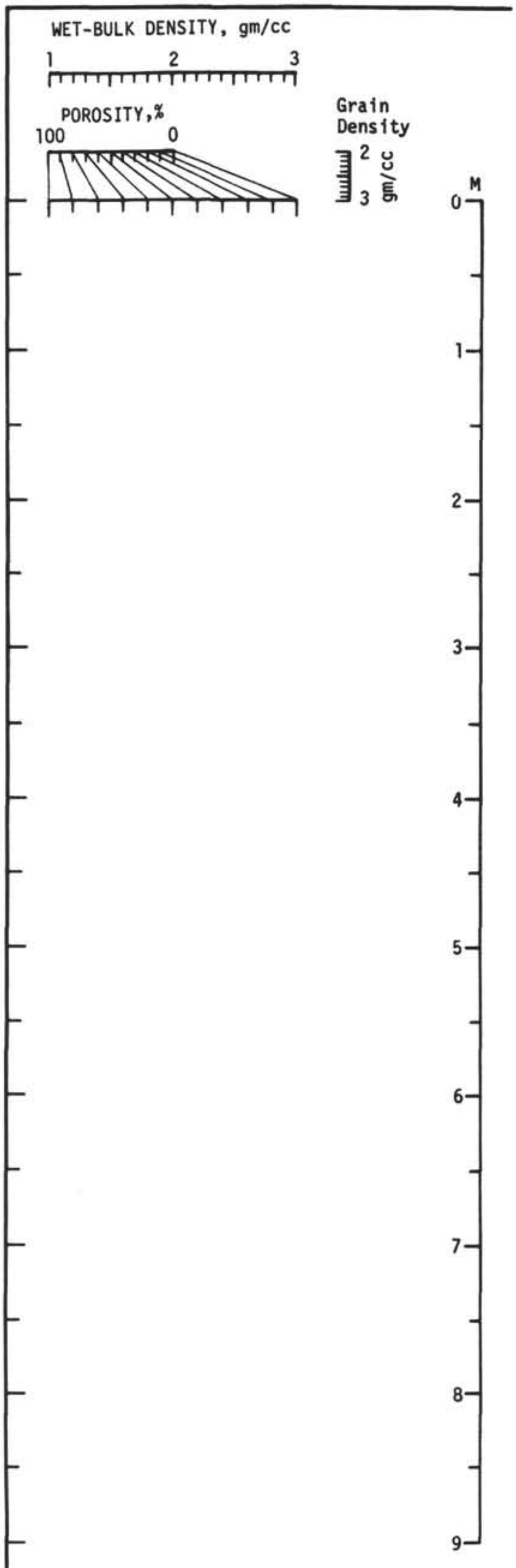
FOSSIL CHARACTER

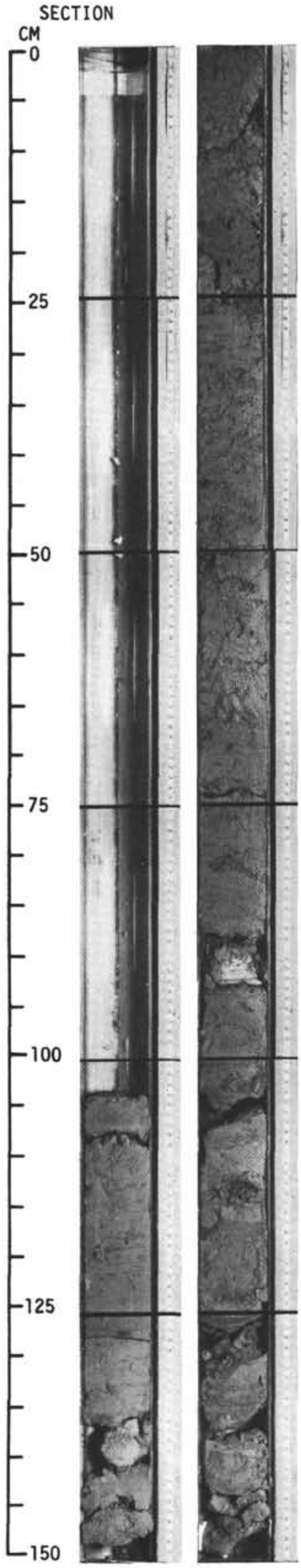


Core Catcher:

N	-	-
D	A	G
R	R	M
S	R	M
PF	-	
BF	R	

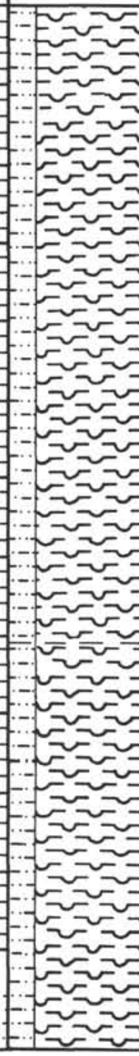
Explanatory notes in Chapter 1 * (S) Ebropsis antiqua (without spine)





192-11-1 192-11-2

Site 192 Hole Core 12 Cored Interval: 204-213

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica (S) Cannopilus hemisphaericus	N D R S PF BF	C A F C R R	M G M M	1	0.5 1.0			
		N	C	M	2				75
		N	C	M	3				
		PF BF N	- F C	M	4				75
					Core Catcher				

LITHOLOGIC DESCRIPTION

SILT and CLAY BEARING DIATOM OOZE
dark greenish gray (5GY 4/1) and
olive gray (5Y 3/2)

olive gray portion below 100-110 cm
in section 3 contains minor carbonate

Slide 2-75
2 - 5% terrig. silt
10% clay
85%+ diatoms

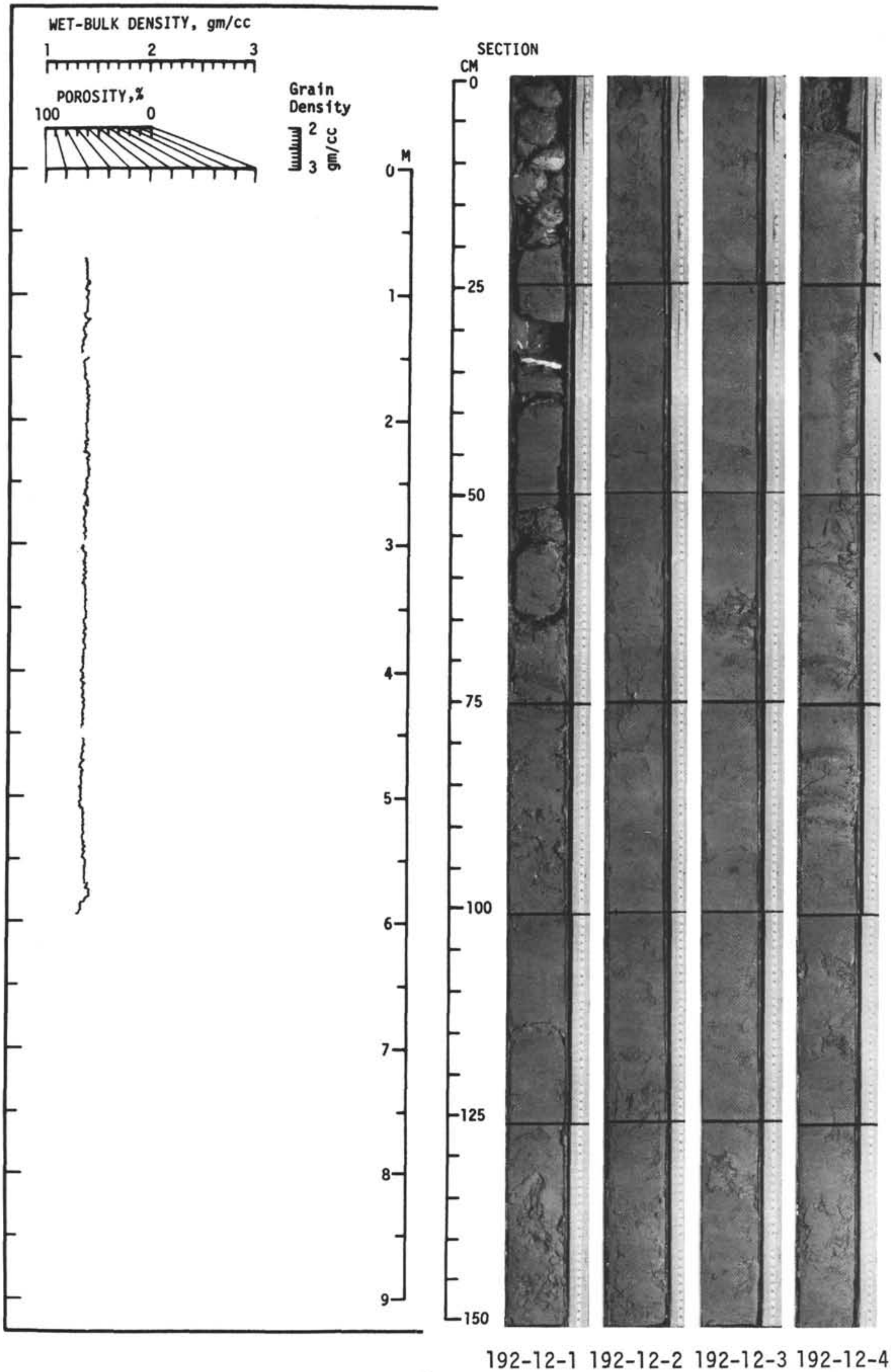
color change

Slide 4-75
2 - 5% silt
10% clay
85% diatoms
1% carbonate
including TR nannos

Core Catcher:

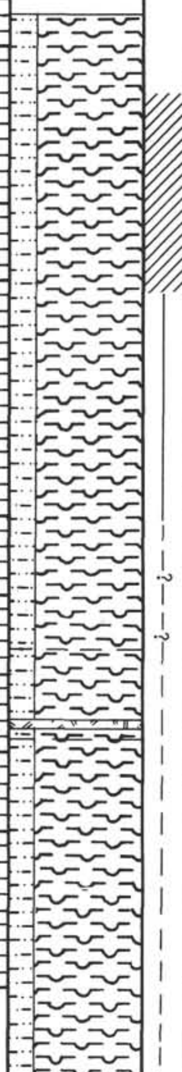
N	R	M
PF	F	M
BF	F	
D	C	G
R	R	M
S	R	M

Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9
SECTION
CM
0 25 50 75 100 125 150
192-12-1 192-12-2 192-12-3 192-12-4

Site 192 Hole Core 13 Cored Interval: 232-241

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica				1	0.5, 1.0	VOID		15
		D R S PF BF N	A - C - F -	G - M -	2				40 120 140
		N	C	M	3				75 129 145
		PF BF D R S N	C F A - R C	P G - M M	4				133
		N	C	M	5				13 20 140
					Core Catcher				



LITHOLOGIC DESCRIPTION

semi-indurated

SILT and CLAY BEARING DIATOM OOZE
and
SILT BEARING CLAY RICH DIATOM OOZE
olive gray (5Y 4/1 - 4/2)

composition range
75 - 85% diatoms
5 - 15% clay
0 - 5% silt
locally contains minor carbonate
including foram fragments and nannos

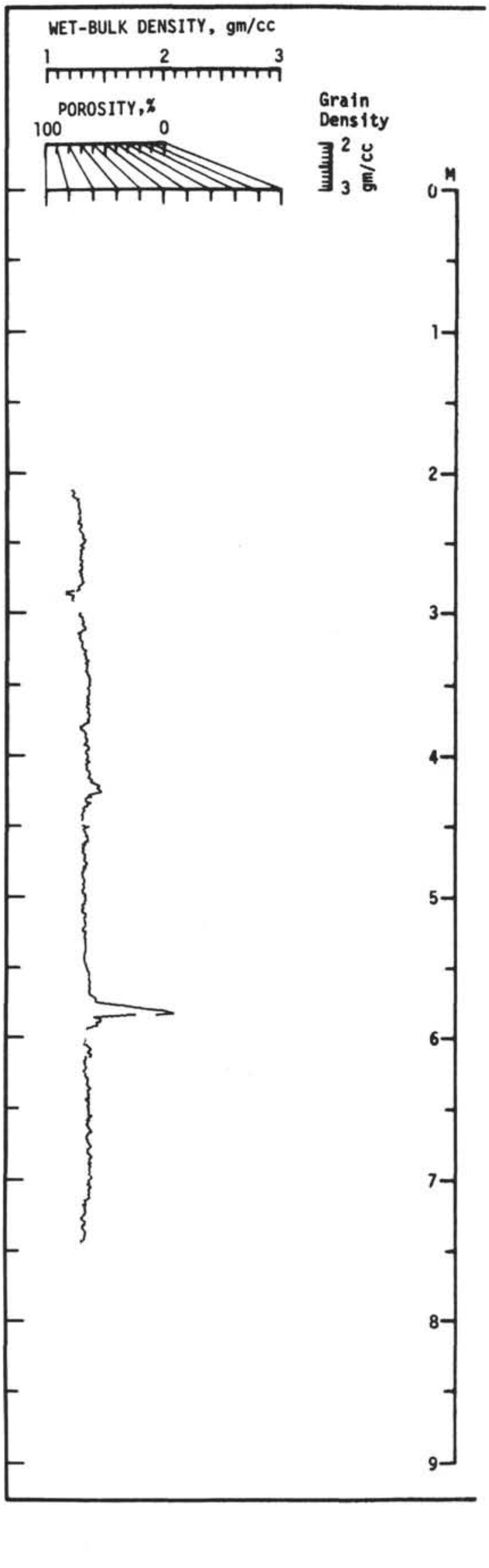
CRYSTAL ASH dusky brown (5YR 2/2)
zones above and below ash layer contain
mixed ash and basic lithology

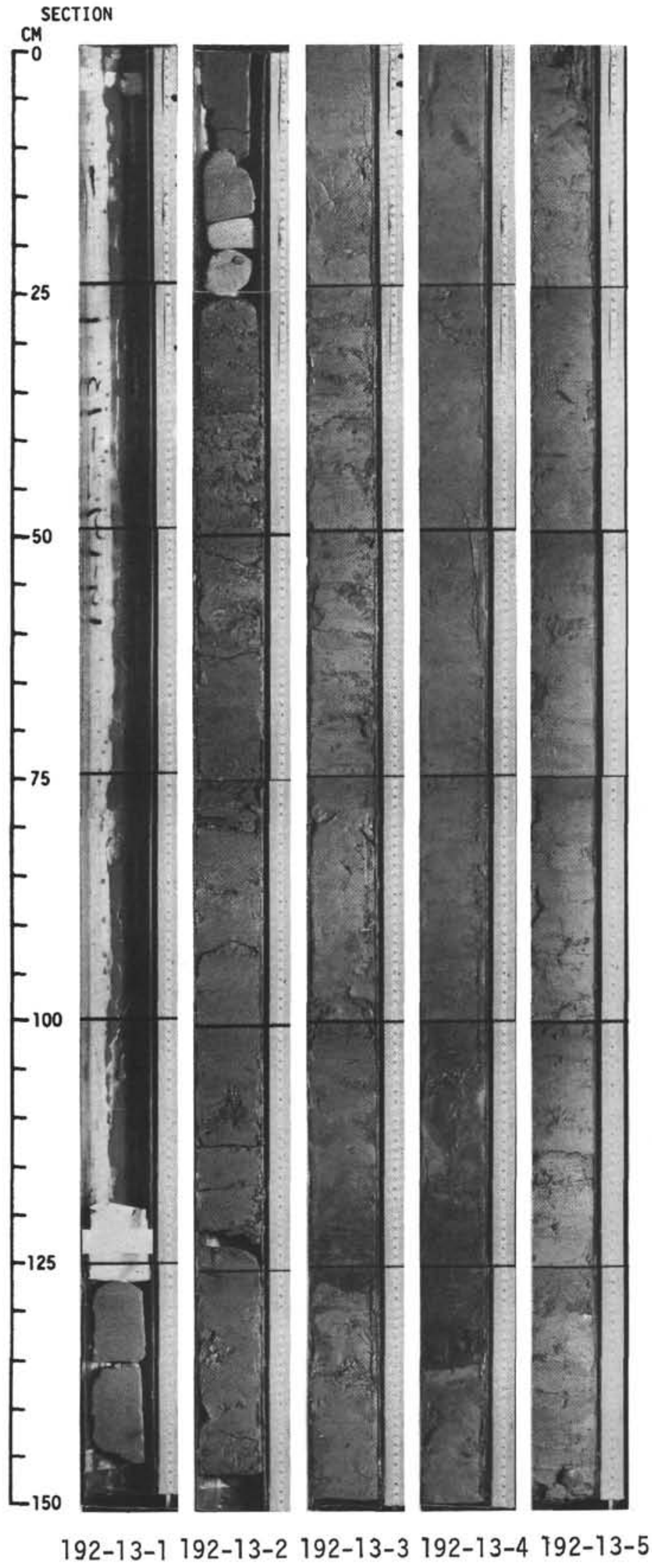
Slide 4-133
20% feldspar
75% dark and opaque grains of stained
and altered glass and lithic fragments
5% brown glass
1% pyroxene

Core Catcher:

N	R	M
PF	R	
BF	C	
D	C	G
R	R	M
S	F	M

Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0
1
2
3
4
5
6
7
8
9


SECTION
CM
0
25
50
75
100
125
150
192-13-1 192-13-2 192-13-3 192-13-4 192-13-5

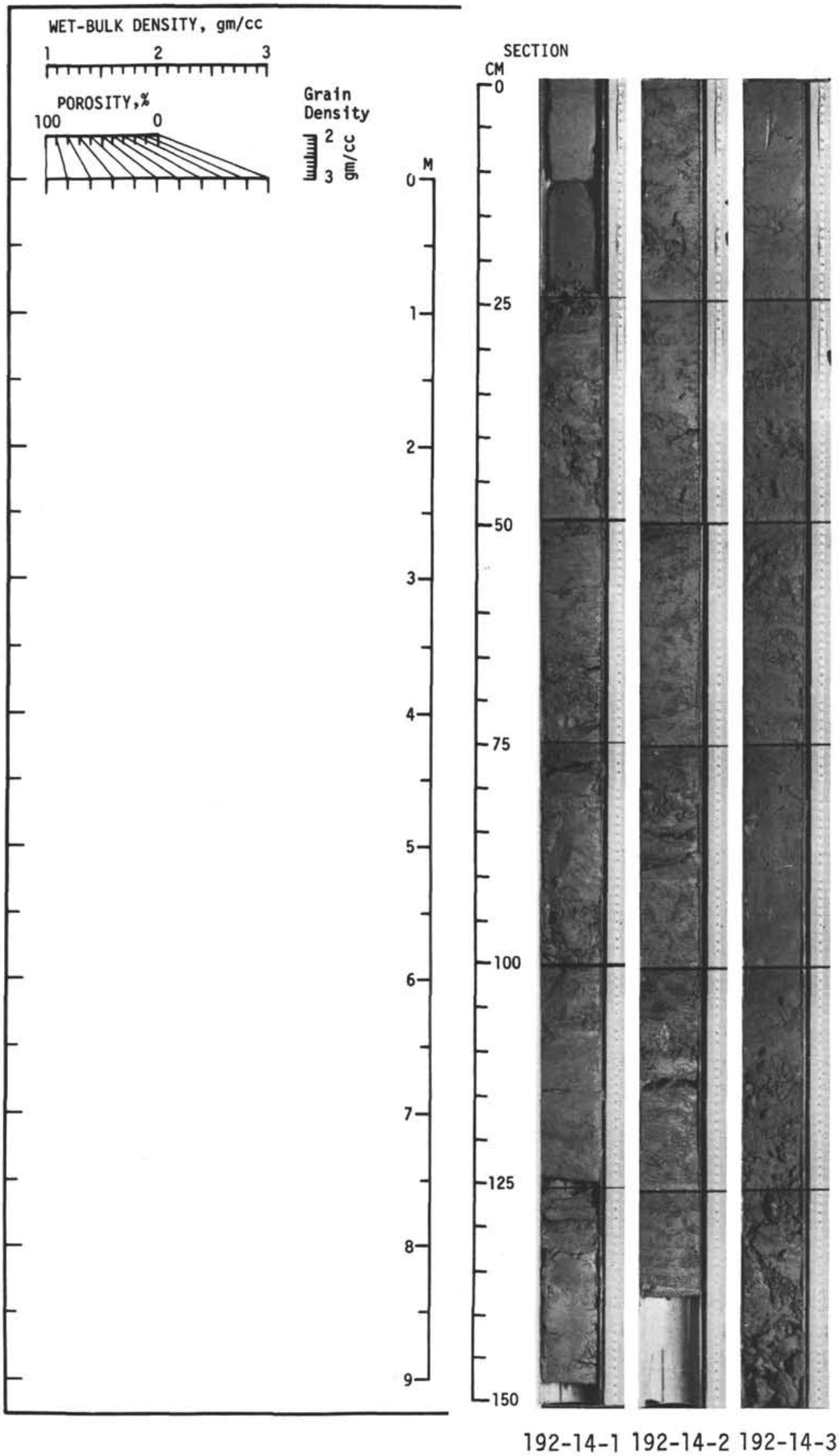
Site 192 Hole Core 14 Cored Interval: 250-259

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica	D R S N PF BF	R R C R - R	G M M M	1	0.5 1.0			10 65 107	semi-indurated alternating firm and soft layers pods of olive brown (5Y 3/4) containing traces of carbonate
		N	-	-	2		VOID		75	SILT and CLAY BEARING DIATOM OOZE dark grayish olive (10Y 3/2) locally contains trace of carbonate and/or slightly higher amounts of silt and clay composition range 2 - 5% silt 5 - 10% clay 85 - 95% diatoms 0 - 2% spicules
		N	C	M	3				75 145	color slightly browner, probably reflecting minor carbonate content
					Core Catcher					SILT and CLAY RICH DIATOM OOZE Slide 3-145: 70% diatoms, 10% silt, 20% clay, TR spicules Slide 3-75: 90%+ diatoms, 2% silt, 5% clay, TR carbonate

Core Catcher:

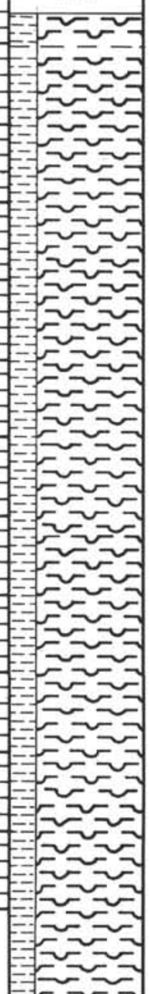
N	R	M
PF	-	
BF	R	
D	C	G
R	R	M
S	F	M

Explanatory notes in Chapter 1

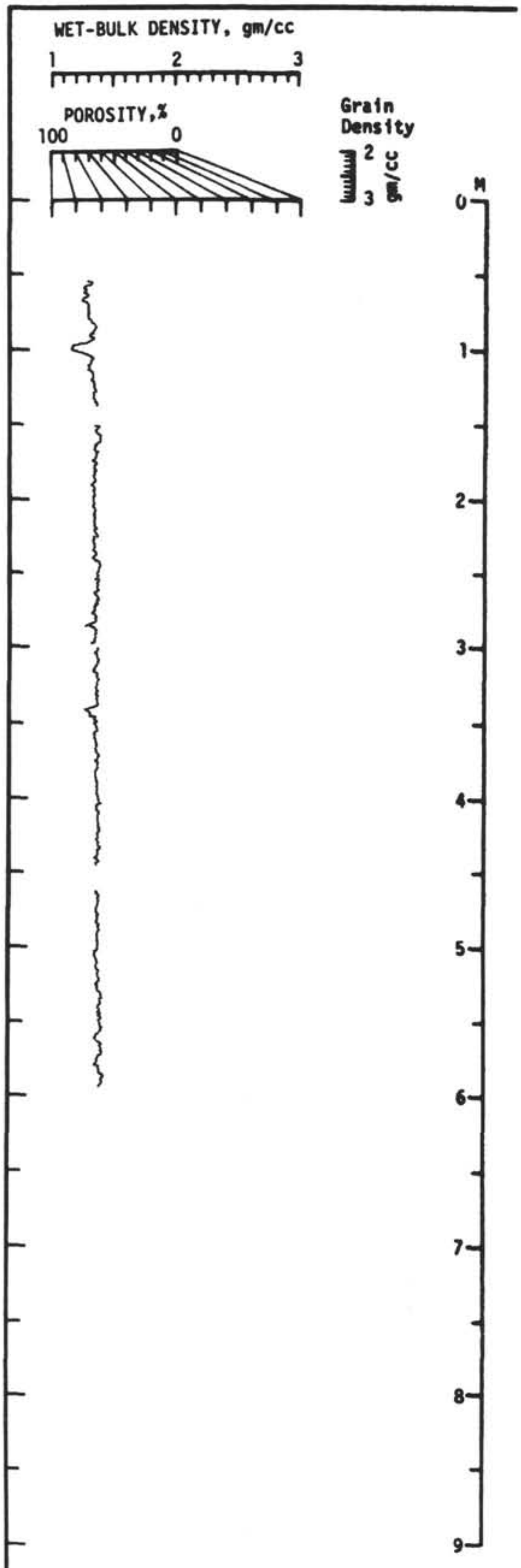

WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192-14-1
192-14-2
192-14-3

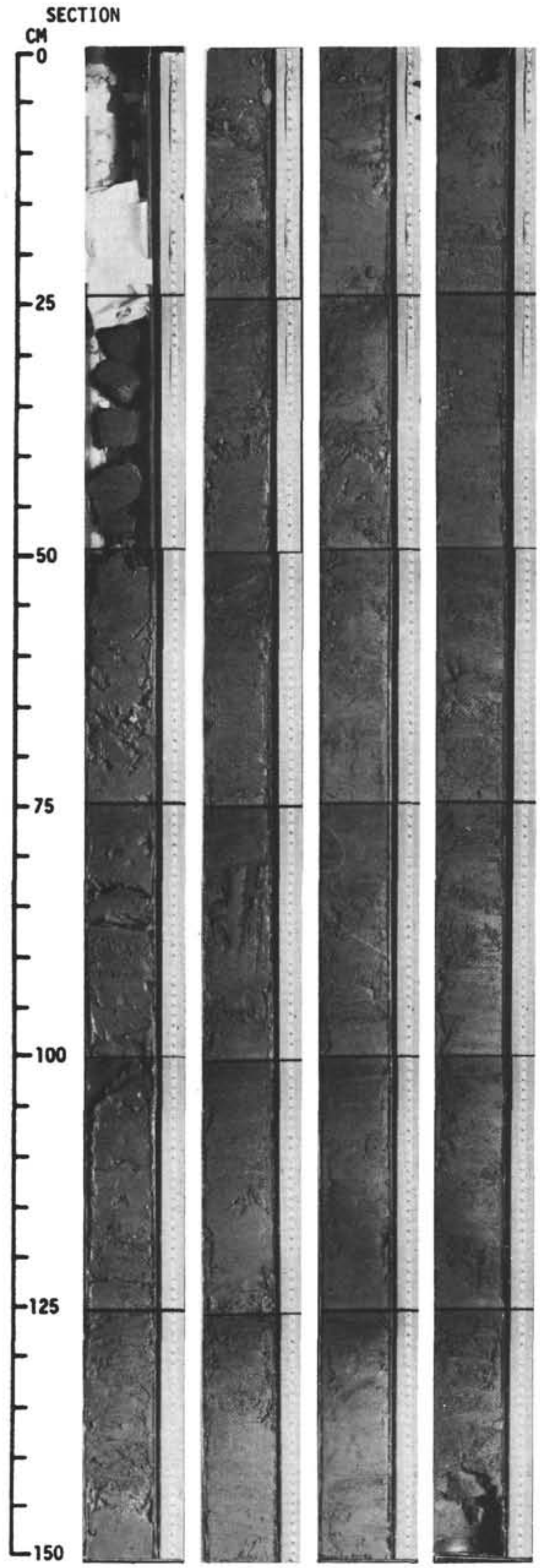
Site 192 Hole Core 15 Cored Interval: 269-278

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica	N D R S PF BF	- A R F - R	- G M M	1	0.5 1.0	VOID		40 80	semi-indurated burrowed alternating firm and soft layers
		N	-	-	2					SILT BEARING CLAY RICH DIATOM OOZE olive gray (5Y 4/1) 75% diatoms 20% clay 5% silt (incl. TR of pyroxene and pyrite)
		N R S PF BF	- R F - R	- M M	3					
					4				140	Core Catcher: N R M PF F M BF F D A G R R M S F M
					Core Catcher					



Explanatory notes in Chapter 1



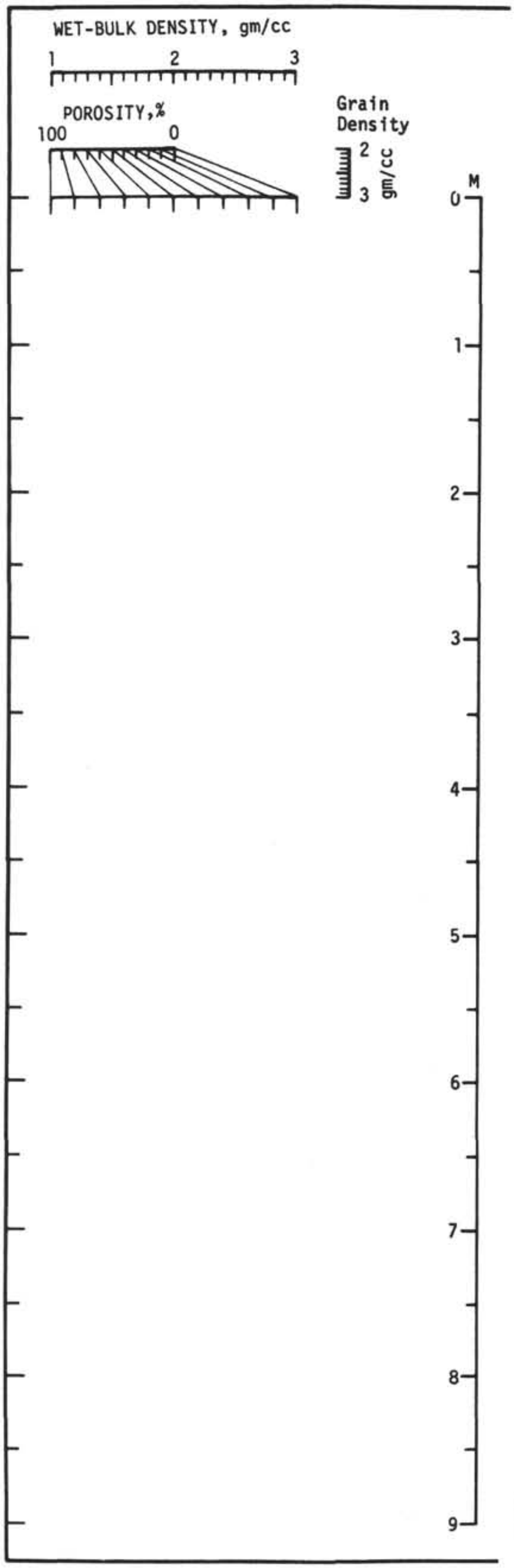


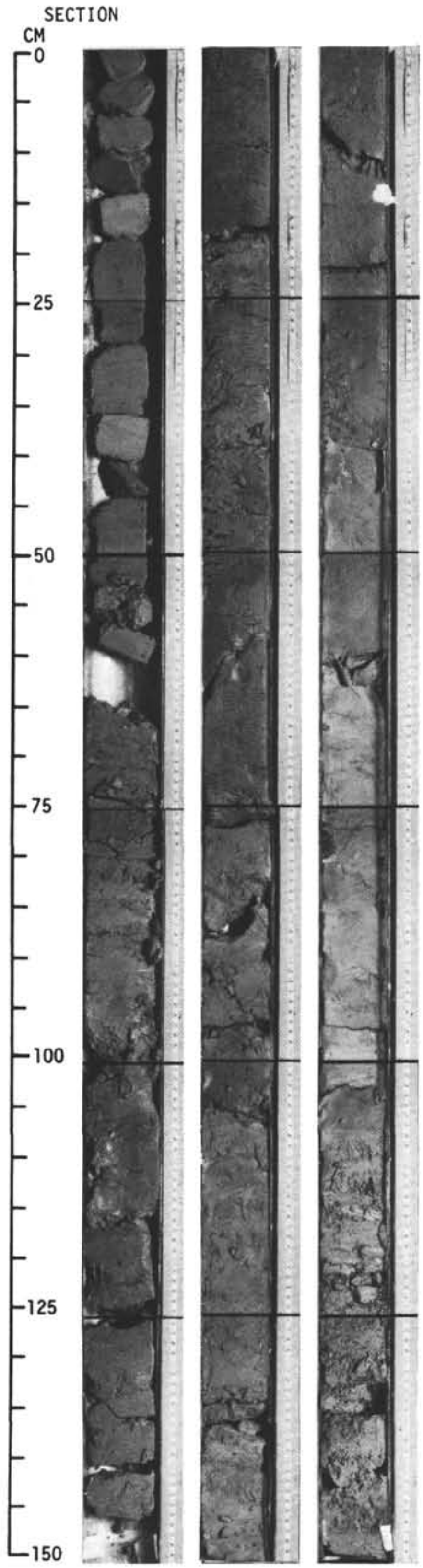
192-15-1 192-15-2 192-15-3 192-15-4

Site 192 Hole Core 16 Cored Interval: 297-306

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica	D R S N PF BF	A R C - - R	G M M -	1	0.5 1.0			25 80	semi-indurated, mottled, grayish olive (10Y 4/2) alternating firm and soft layers pods of grayish olive (10Y 4/2) diatom ooze
		N	-	-	2				140	SILT and CLAY BEARING DIATOM OOZE olive gray (5Y 4/1) 90% diatoms 8% clay 2% silt
		N	-	-	3					
					Core Catcher					Core Catcher: PF - BF R D A G R R M S C M

Explanatory notes in Chapter 1

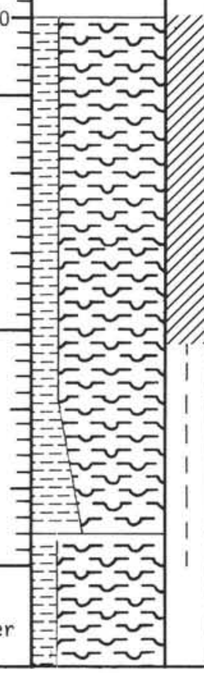




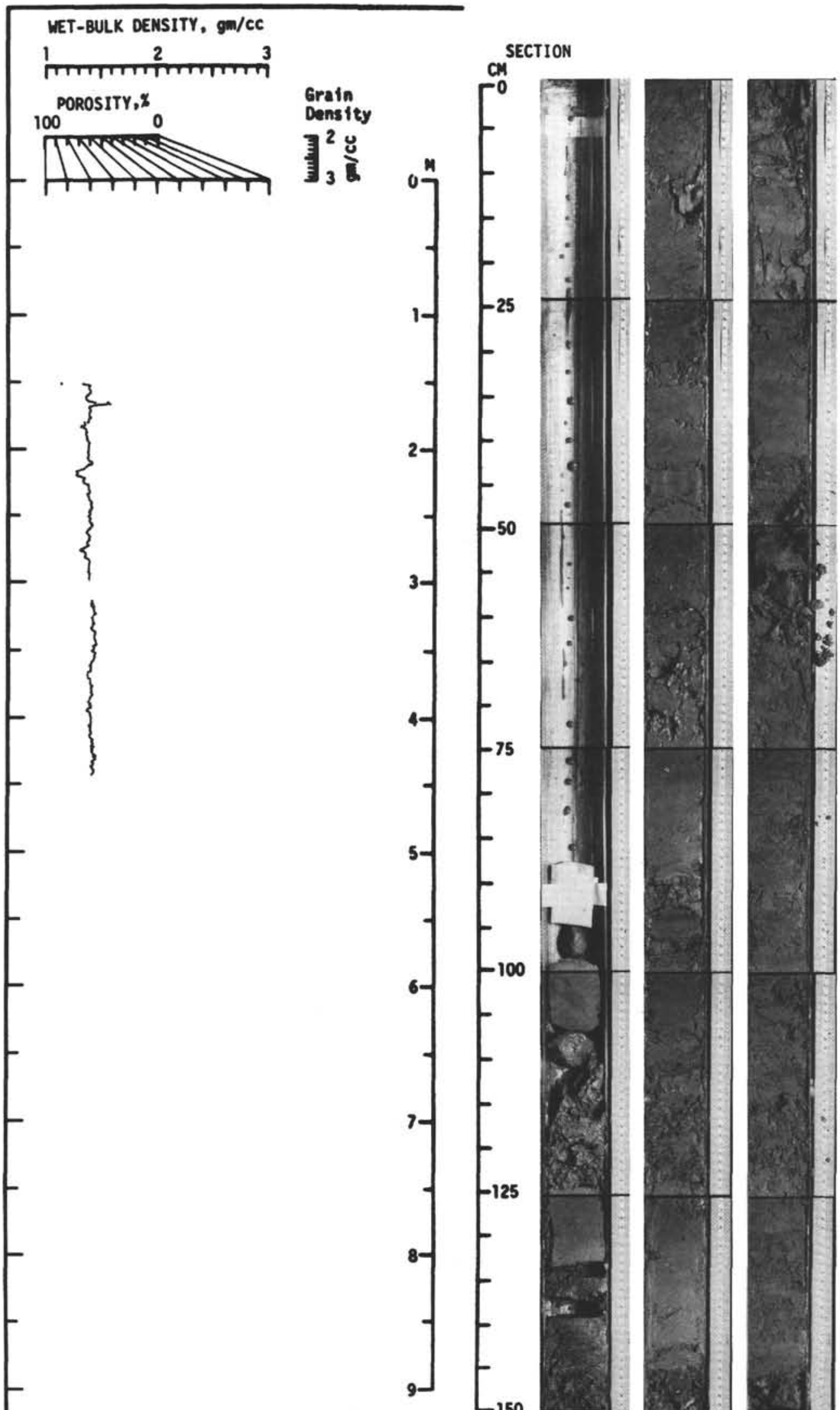
192-16-1 192-16-2 192-16-3

Site 192 Hole Core 17 Cored Interval: 325-334

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica (S) Distephanus speculum var. pentagonus	PF BF D R S N	- R C R C C	 G M M M	1	0.5 1.0	VOID			
					2				-90	alternating firm and soft layers, burrows visible in firm layers SILT BEARING, CLAY RICH DIATOM OOZE dark gray (5Y 4/1) Slide 2-90 80% diatoms 5% silt 15% clay
					3				-40 129 131	silt and clay content increases; layers, up to 1 cm thick, of 5Y 5/1 color contain TR carbonate sharp color contact Slide 3-129 70% diatoms 10% silt 20% clay TR carbonate
					Core Catcher					Core Catcher: N R M PF R BF R D C G R R M S R M Slides 3-40 and 3-131 85% diatoms 5% silt 10% clay



Explanatory notes in Chapter 1



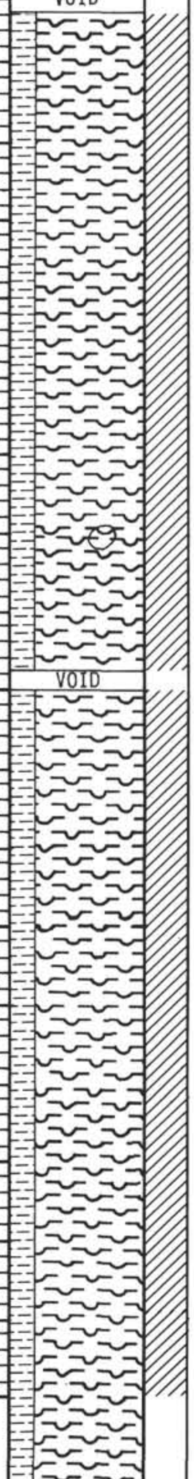
192-17-1 192-17-2 192-17-3

Site 192 Hole Core 18 Cored Interval: 353-362

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS
UPPER MIOCENE	(D) Denticula kamtschatica (S) Distephanus speculum var. pentagonus	N	A	G	1	0.5 1.0
		D R S N PF BF	C R F R C F	G M M M M 	2	
		N	C	M	3	
		PF BF D R S	- F C R C	 G M M	4	
		N	C	M	5	
					6	
					Core Catcher	

LITHOLOGY

VOID



VOID

LITHOLOGIC DESCRIPTION

CLAY RICH DIATOM OOZE
olive gray (5Y 4/1)

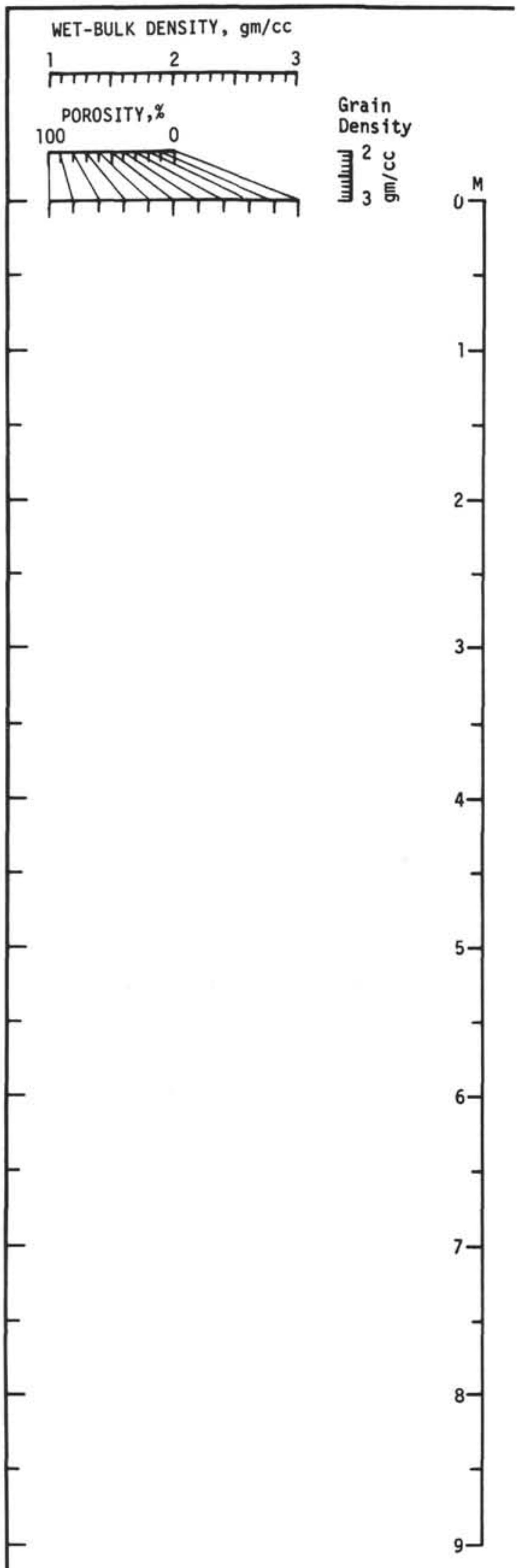
core highly disturbed - alternating firm and soft layers; firm layers show faint mottling, lenses, and burrows

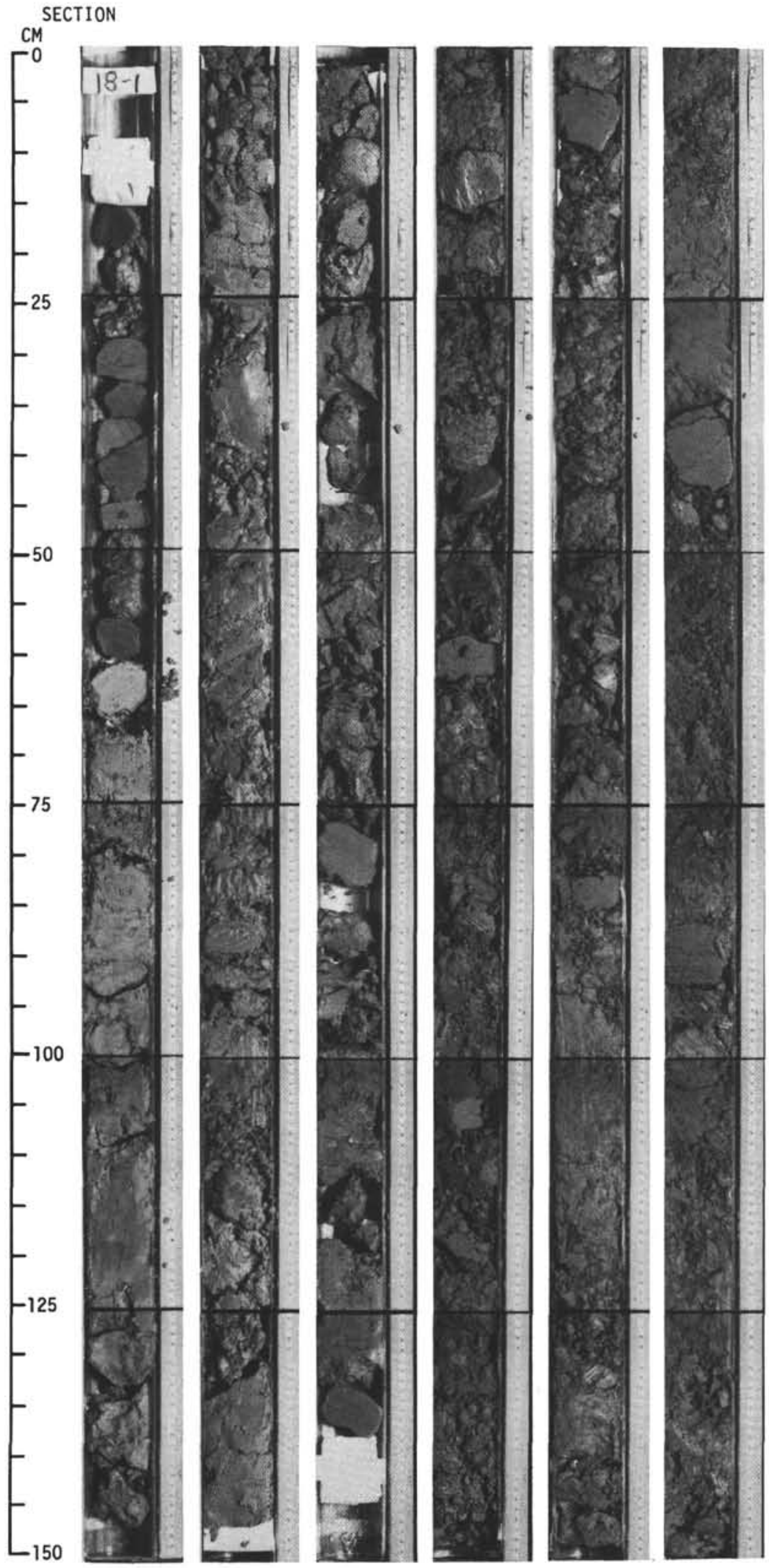
section 3, 51-52 cm: pod of
NANNO RICH DIATOM OOZE
light olive gray

Core Catcher:

PF	-	
BF	F	
N	-	-
D	A	G
R	R	M
S	F	M

Explanatory notes in Chapter 1





192-18-1 192-18-2 192-18-3 192-18-4 192-18-5 192-18-6

Site 192 Hole Core 19 Cored Interval: 391-400

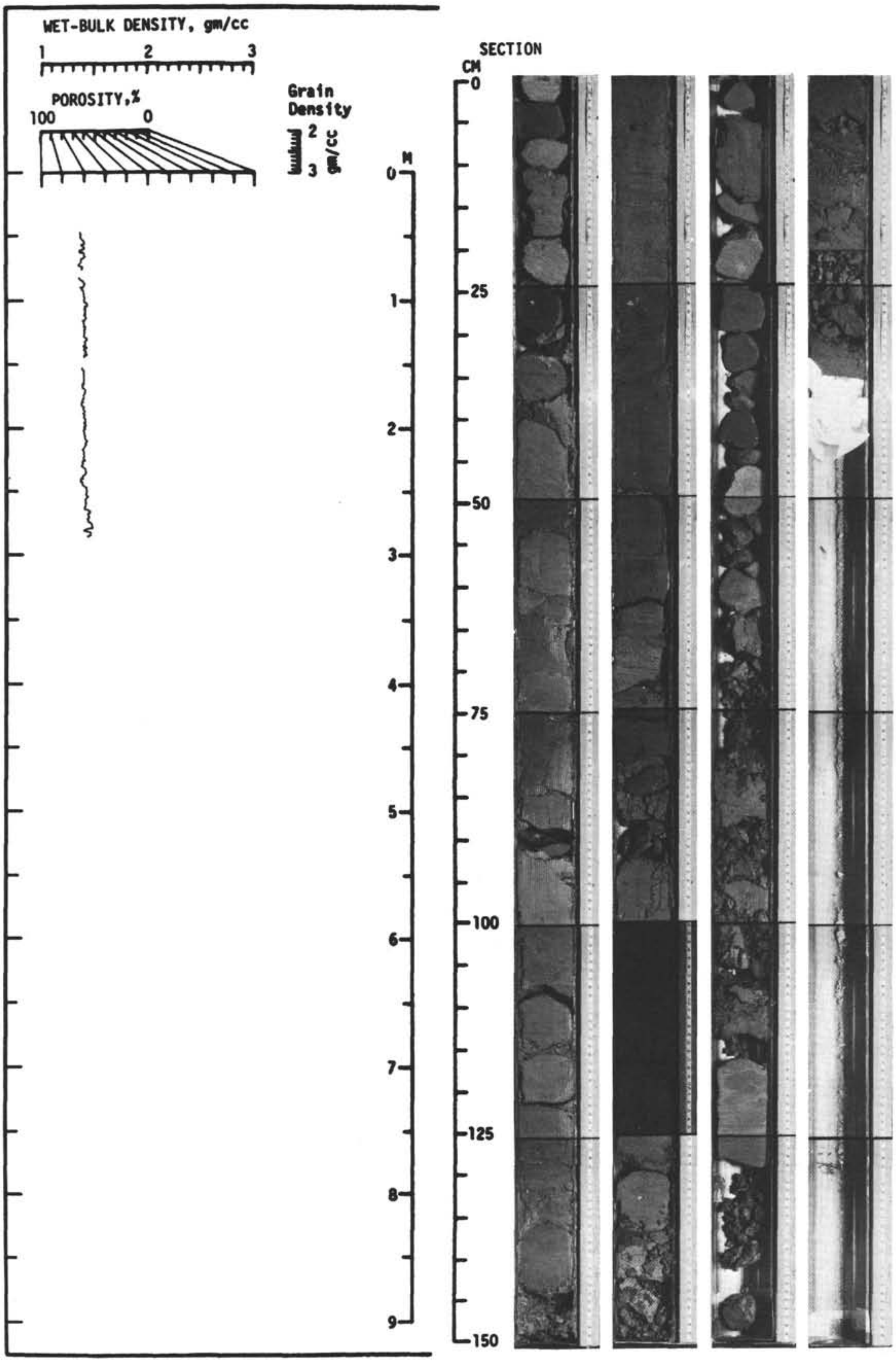
AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica (S) Distephanus speculum var. pentagonus	D R S PF BF	C R R - F	G M M	1	0.5 1.0			-30	alternating firm and soft layers firm layers show laminae and burrows (<1 mm to 3 cm thick)
		N	C	M	2				-135	SILT RICH CLAYEY DIATOM OOZE olive gray (5Y 4/1) 60% diatoms 10% silt (feldspar, pyroxene) 30% clay
					Core Catcher					Core Catcher: N - - PF - BF F D A G R R M S R M

Site 192 Hole Core 20 Cored Interval: 429-438

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica *	D R S PF BF N	A R R - R -	G M M -	1	0.5 1.0			-100	SILT BEARING, CLAY RICH DIATOM OOZE olive gray (5Y 3/2) semi-indurated, burrowed
		N	-	-						Core Catcher: N - - PF - BF F D A G R R M S R M
					Core Catcher					Slide 1-100 80% diatoms ~5% silt 10 - 15% clay

Explanatory notes in Chapter 1

* (S) Distephanus speculum var. pentagonus



192-19-1 192-19-2 192-20-1 192-20-2

Site 192 Hole Core 21 Cored Interval: 475-484

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
UPPER MIOCENE	(D) Denticula kamtschatica (S) Distephanus speculum var. pentagonus	N PF BF D R S	C F C A R R	G G G M M	1	0.5 1.0			10 100
		N	A	G	2				121 135
					Core Catcher				

LITHOLOGIC DESCRIPTION

SILT and CLAY RICH DIATOM OOZE
olive gray (5Y 3/2)

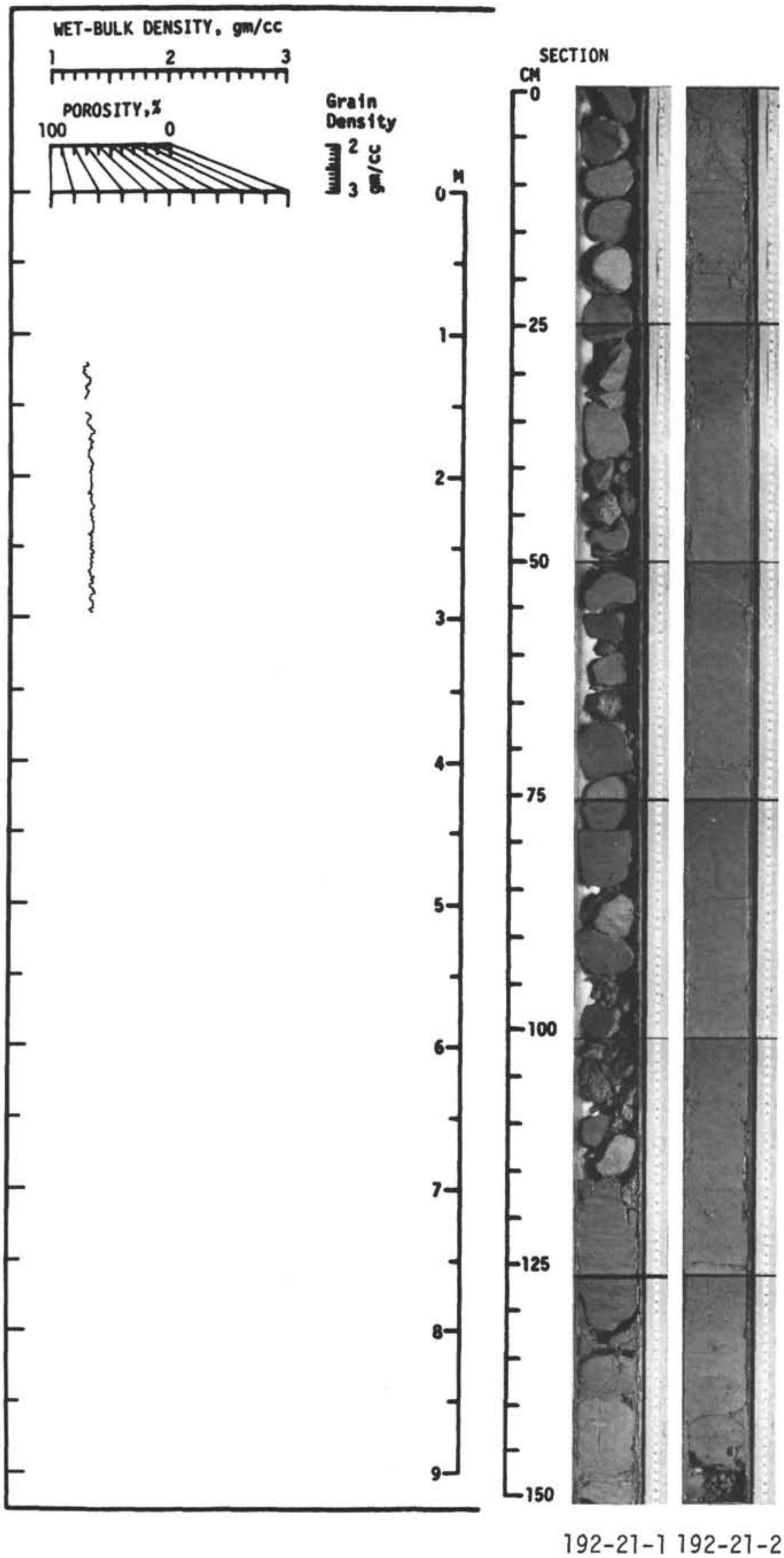
Slides 1-10 and 2-135
65% diatoms
15% silt
20% clay

faint laminae, lenses and burrows
olive black (5Y 2/2) and light olive gray (5Y 5/2); lighter lenses and burrows contain carbonate

Core Catcher:

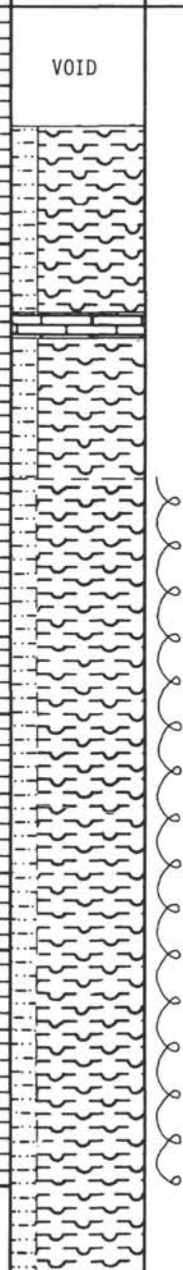
N	R	M
PF	-	
BF	R	
D	A	G
R	R	M
S	F	M

Explanatory notes in Chapter 1

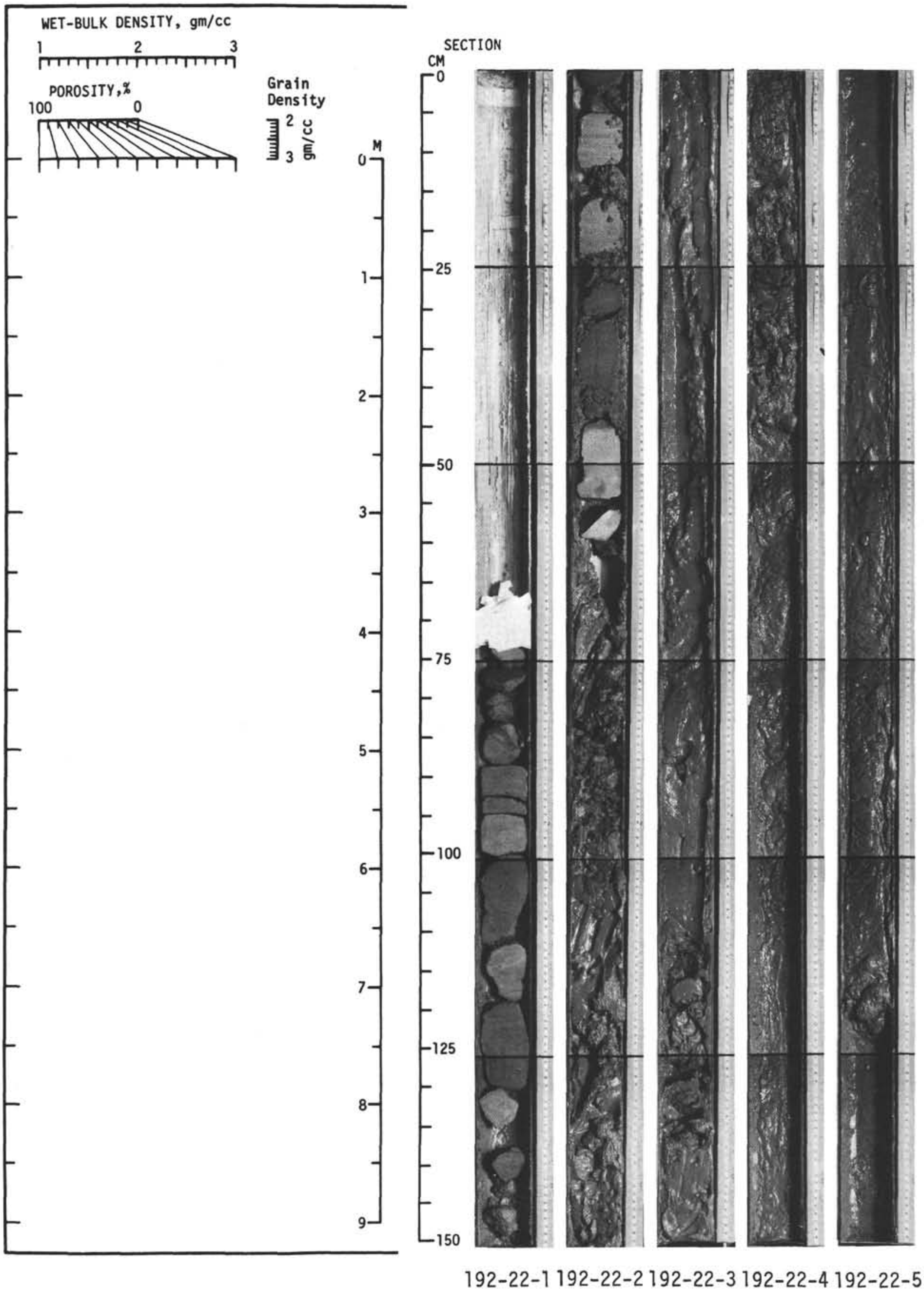

WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192-21-1 192-21-2

Site 192 Hole Core 22 Cored Interval: 522-531

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica	N PF BF	C - F	G	1	0.5	VOID			semi-lithified
		D R S	C - R	M -		1.0			110	SILT BEARING CLAY RICH DIATOM OOZE olive gray (5Y 3/2) Slide 1-110 80% diatoms 5% silt 15% clay TR carbonate
		N N	R R	M M	2				50	calcite cemented zone (?)
		N	R	M	3					
					4					sections 3, 4, and 5 drilling slurry
					5					
					Core Catcher					Core Catcher: N R M PF R BF R D C M R R M S F M



Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain
Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192-22-1
192-22-2
192-22-3
192-22-4
192-22-5

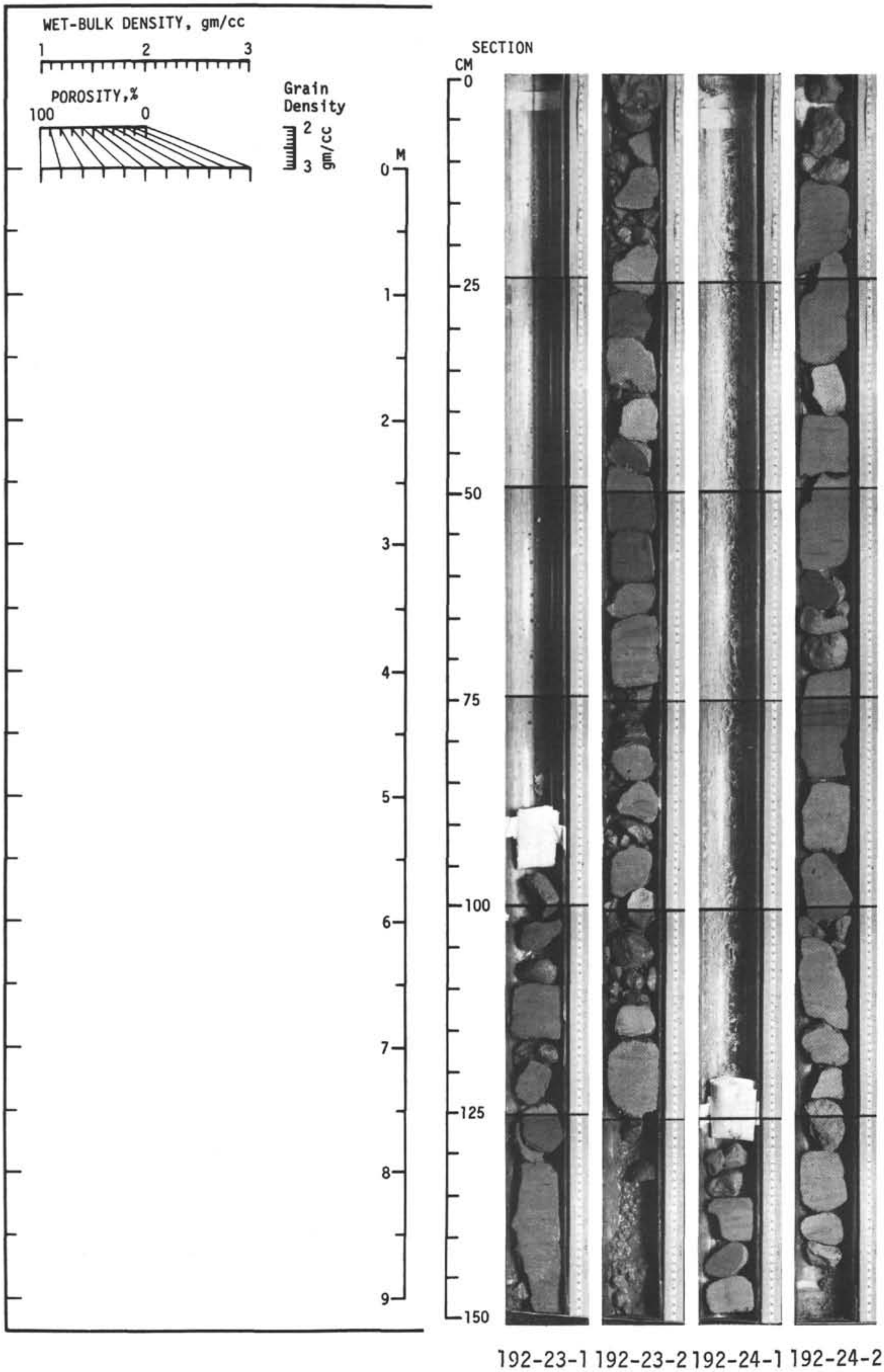
Site 192 Hole Core 23 Cored Interval: 569-578

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica (S) Mesocena circulus var. apiculata	D R S PF BF	C R F - -	M M M	1	0.5 1.0	VOID			Semi-lithified, burrowed
					2				75	SILT BEARING, DIATOM RICH CLAY dark gray (5Y 4/1) Slide 2-75 15% diatoms 5% silt 80% clay
					Core Catcher					Core Catcher: PF - BF R D A G R R M S R M

Site 192 Hole Core 24 Cored Interval: 625-634

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula hustedtii (S) Mesocena circulus var. apiculata	N	-	-	1	0.5 1.0	VOID			Basic lithology SILT BEARING, DIATOM RICH CLAY dark greenish gray (5GY 3/1) semi-indurated, burrowed XR 2-80 81% amorph. 5% quartz 5% plag. 5% mica 1% chlor. 3% mont. Core Catcher: N R M D C M R R M S R M PF R BF C
		D R S PF BF N	C - R R R -	M - M -	2				60 90	layers up to 1 cm thick of CLAY, greenish black (5GY 2/1) with partially dissolved and pyritized diatoms Slide 2-60 5% diatom fragments mostly pyritized 5% silt 90% clay Slide 2-90 10 - 15% diatoms TR spicules 5 - 10% silt 80% clay
					Core Catcher					

Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192-23-1
192-23-2
192-24-1
192-24-2

Site 192 Hole Core 25 Cored Interval: 671-680

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MIDDLE MIOCENE	(D) Denticula lauta	PF BF N D R S	F R A C - R	M - M M - M	1	0.5 1.0	VOID		
		N	R	M	2				55 75
					Core Catcher				

FOSSIL CHARACTER

LITHOLOGIC DESCRIPTION

CLAYEY DIATOM OOZE
gray (5Y 5/1)

Slide
60% diatoms
40% clay

Core Catcher:

N	R	M
D	C	M
R	R	M
S	R	M
PF	-	
BF	R	

semi-lithified, burrowed
burrows filled with lighter colored material containing carbonate

Slide 2-55, burrow filling
70% diatoms
20% clay
10% carbonate

Site 192 Hole Core 26 Cored Interval: 709-718

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
MIDDLE MIOCENE	(D) Denticulina lauta	D R S	F - -	M - -	1	0.5 1.0	VOID		
					2				75
					Core Catcher				

FOSSIL CHARACTER

LITHOLOGIC DESCRIPTION

XR 2-10
81% amorph.
4% quartz
4% plag.
4% mica
1% chlor.
5% mont.
TR clinop.

SILT RICH DIATOMACEOUS CLAY
gray (5Y 5/1)

Slide 2-75
40% diatoms
10% silt
50% clay

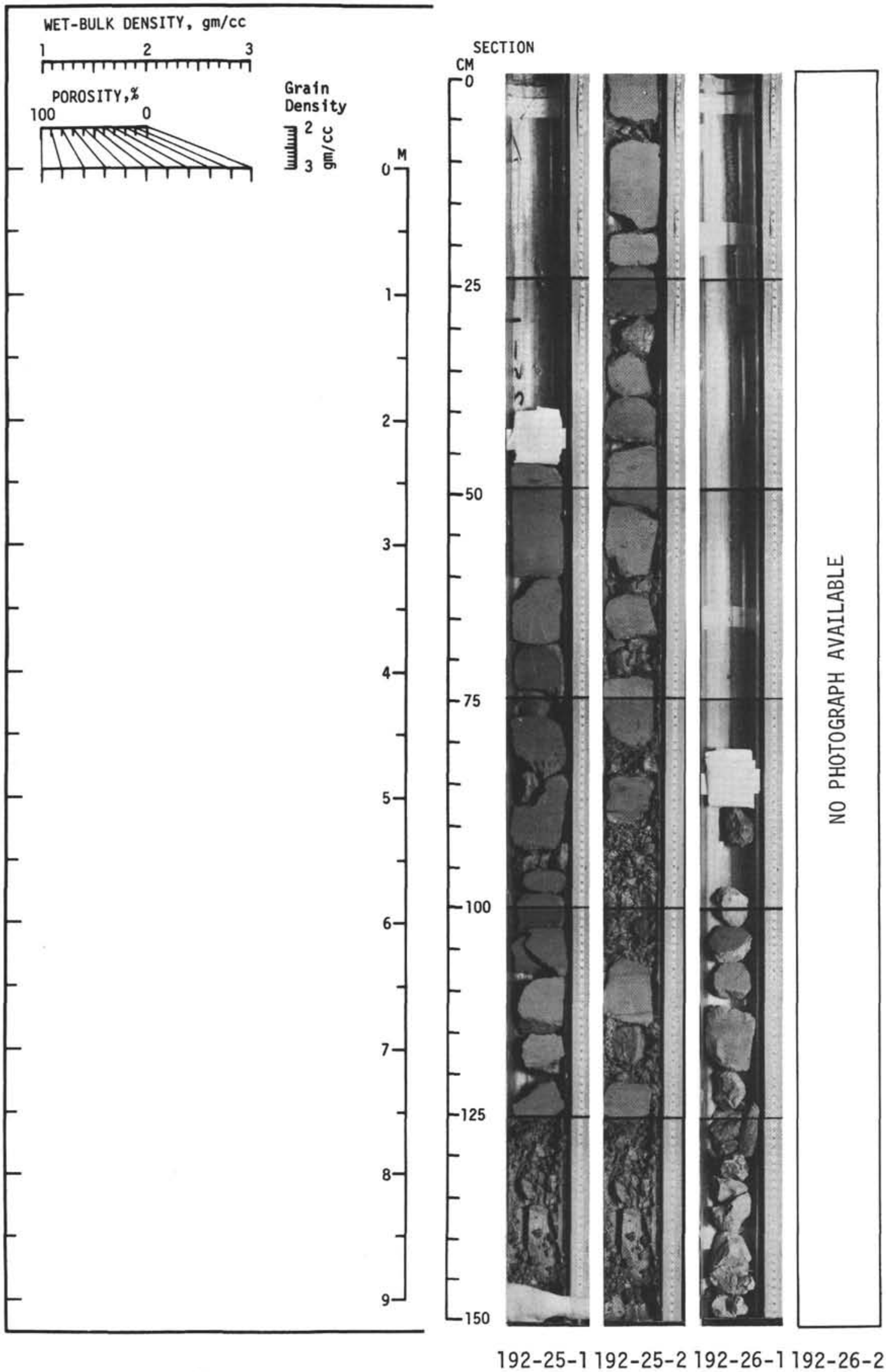
Core Catcher:

N	A	M
D	F	P
R	-	-
S	-	-
PF	-	
BF	R	

semi-lithified, burrowed, broken into separate pieces

also contained in the core are:
2 pieces (~5 cm) of black MUDSTONE
and 1 piece (~5 cm) of NANNOFOSSIL LIMESTONE
location arbitrary because core was dropped from broken liner

Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9
SECTION
CM
0 25 50 75 100 125 150
NO PHOTOGRAPH AVAILABLE
192-25-1 192-25-2 192-26-1 192-26-2

Site 192 Hole Core 27 Cored Interval: 746-755

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		PF BF N N	R R R -	 M -	1	0.5 1.0	VOID			
		N	-	-	2				10 75 120	hard zone, olive black (5Y 2/1), contains TR carbonate
		R S N N PF BF N	- - - - - R -	- - - - -	3					CLAYEY LIMESTONE
		N	R	P	4				60 75 82	
		N	R	P	5				75	
					Core Catcher					

Basic lithology
SILT BEARING CLAYSTONE to SILTY CLAYSTONE
bluish gray (5B 4/1) to
dark greenish gray (5G 4/1)

locally contains traces of carbonate, pyrite, and partially dissolved diatoms

composition range
65 - 95% clay
35 - 5% silt

burrowed, mottled, with thin lenses and dark laminae

XR 3-70
76% amorph.
4% quartz
6% cristo.
4% plag.
4% mica
1% chlor.
4% mont.
1% clinop.

Core Catcher:

N	-	-
D	-	-
R	-	-
S	-	-
PF	-	
BF	F	

Explanatory notes in Chapter 1

WET-BULK DENSITY, gm/cc

1 2 3

POROSITY,%

100 0

Grain Density

2 3 gm/cc

M

0 1 2 3 4 5 6 7 8 9

SECTION

CM

0 25 50 75 100 125 150

NO PHOTOGRAPH AVAILABLE

NO PHOTOGRAPH AVAILABLE

NO PHOTOGRAPH AVAILABLE

NO PHOTOGRAPH AVAILABLE

192-27-1 192-27-2 192-27-3 192-27-4 192-27-5

Site 192 Hole Core 28 Cored Interval: 784-793

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
*		N PF BF	A F F	M P	1	0.5 1.0	VOID		-75
					Core Catcher				

LITHOLOGIC DESCRIPTION

SILT BEARING CLAYSTONE to SILTY CLAYSTONE
dark greenish gray (5G 4/1)

Core Catcher:

	R	M
N	R	M
D	-	-
R	-	-
S	-	-
PF	A	P
BF	C	

Slide 1-75
95% clay
5% silt

lab grain size determ: 1-58
71% clay
29% silt

XR 1-60
80% amorph.
4% quartz
4% cristo.
3% plag.
5% mica
1% chlor.
2% mont.
1% clinop.

* LOWER OR MIDDLE MIOCENE (NEAR BOUNDARY)

Site 192 Hole Core 29 Cored Interval: 793-802

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
		N PF BF	R A C	M P	1	0.5 1.0	VOID		-115 -130
					Core Catcher				

LITHOLOGIC DESCRIPTION

Interbedded:
CLAYSTONE (100-102, 110-118 cm)
dark greenish gray (5GY 4/1)
contains TR carbonate

and

NANNO BEARING LIMESTONE
med. bluish gray (5B 5/1) to med. gray (N5)
contains rare fragments of partially
dissolved diatoms

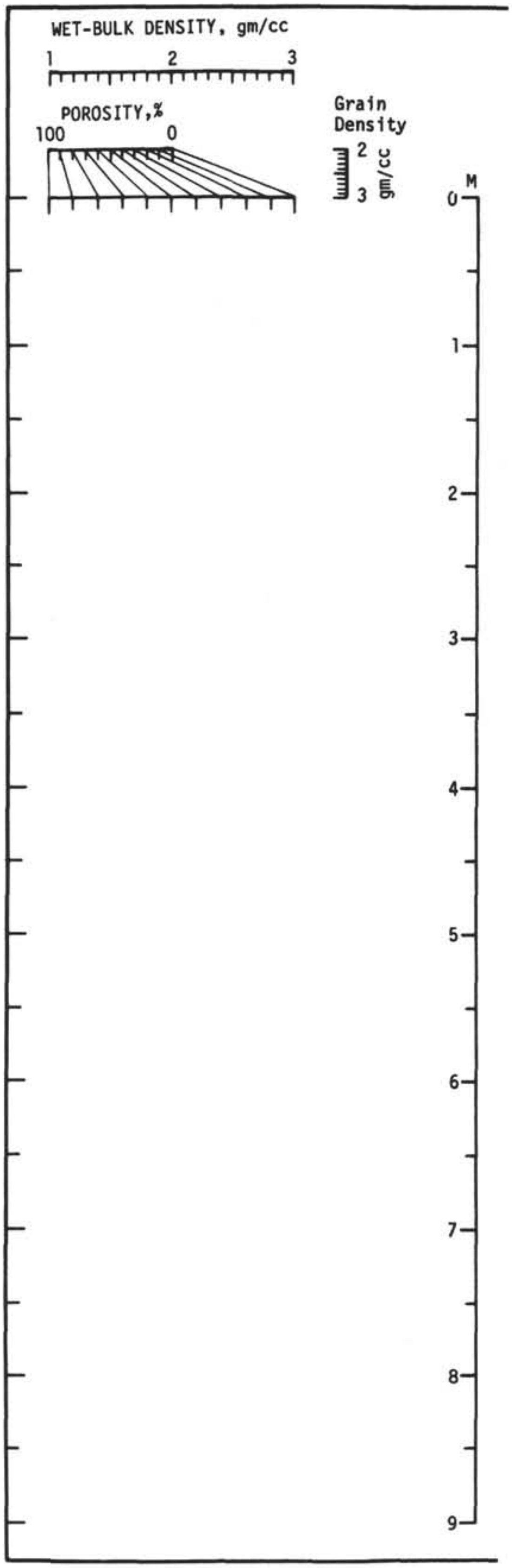
XR 1-130
66% amorph.
18% calcite
2% quartz
8% cristo,
2% plag.
2% mica
1% chlor.
1% mont.

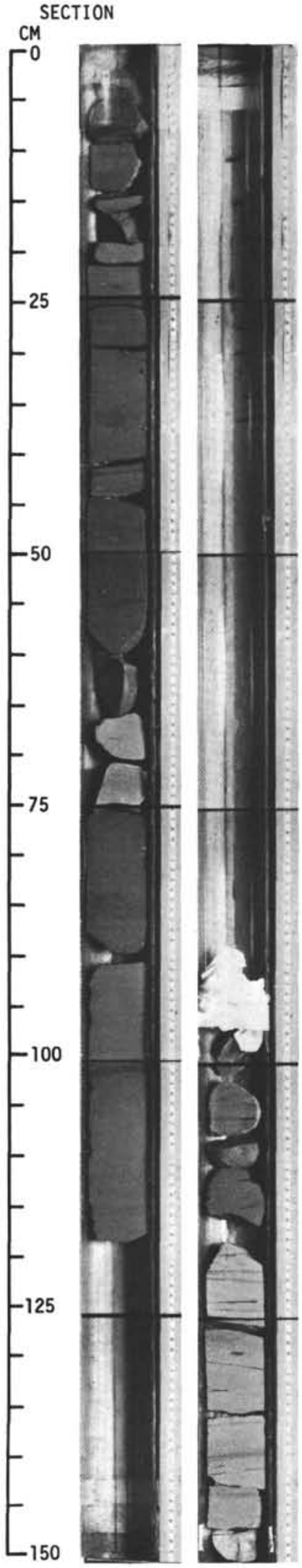
Core Catcher:

	R	M
N	R	M
D	-	-
R	-	-
S	-	-
PF	A	VP
BF	C	

Both units burrowed.

Explanatory notes in Chapter 1





192-28-1 192-29-1

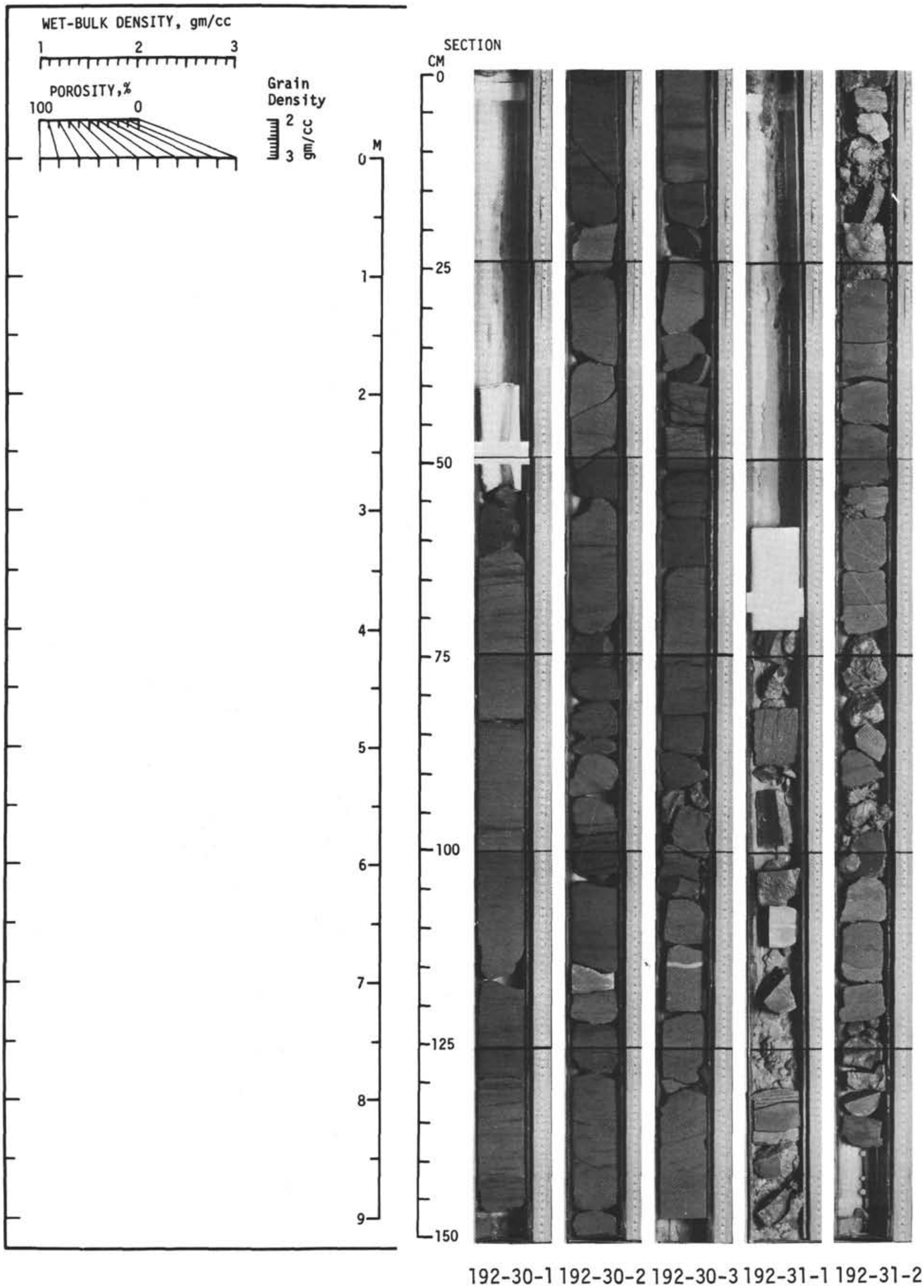
Site 192 Hole Core 30 Cored Interval: 849-858

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		PF BF N	- R R	 M	1	0.5 1.0	VOID			
		N	-	-	2				76 113	1 cm diam. PYRITE NODULE CLAYSTONE to SILTY CLAYSTONE dark greenish gray (5G 4/1) 60 - 99% clay
		N	R	M	3					moderately mottled, burrowed XR 2-140 72% amorph. 5% quartz 6% cristo. 3% plag. 4% mica 1% chlor. 8% mont. Core Catcher: N - - D - - R - - S - - PF - BF R
					Core Catcher					

Site 192 Hole Core 31 Cored Interval: 896-905

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		N D R D PF BF	R - - R - R	M - - M	1	0.5 1.0	VOID			
		N	-	-	2				75	CLAYSTONE dark greenish gray (5GY 4/1) ~100% clay burrowed, lenses
		N PF BF	R - R	M	Core Catcher					

Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9
SECTION
CM
0 25 50 75 100 125 150
192-30-1 192-30-2 192-30-3 192-31-1 192-31-2

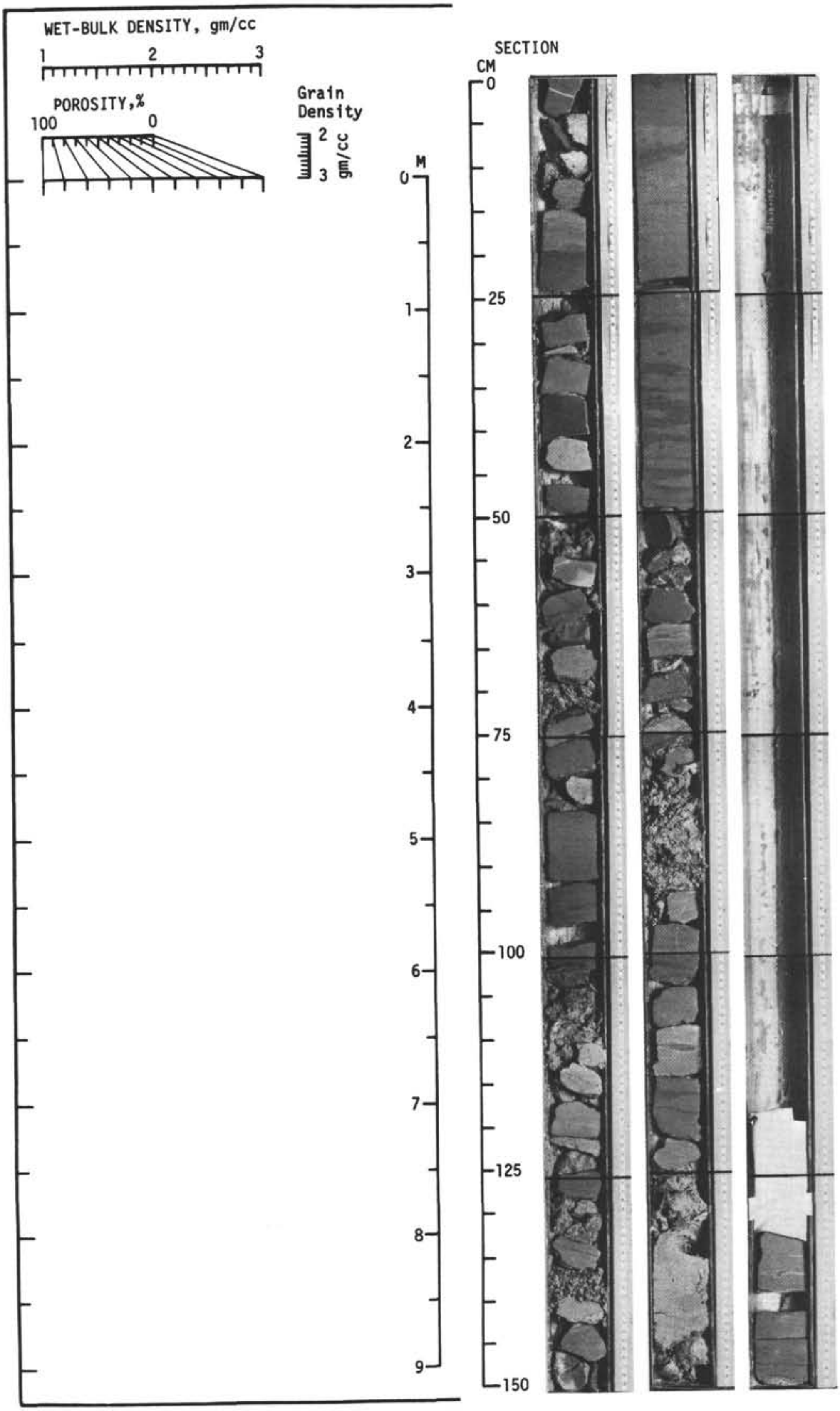
Site 192 Hole Core 32 Cored Interval: 905-912

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	VOID			
		N	R	M						
		N	A	M	2				75	CLAYSTONE dark greenish gray (5GY 4/1)
										Slide 2-75 2% silt 98% clay
		N	-	-	3					burrowed lensy bedding
					Core Catcher					

Core Catcher:

	C	M
N	C	M
D	-	-
R	-	-
S	-	-
PF	-	
BF	R	

Explanatory notes in Chapter 1



192-32-1 192-32-2 192-32-3

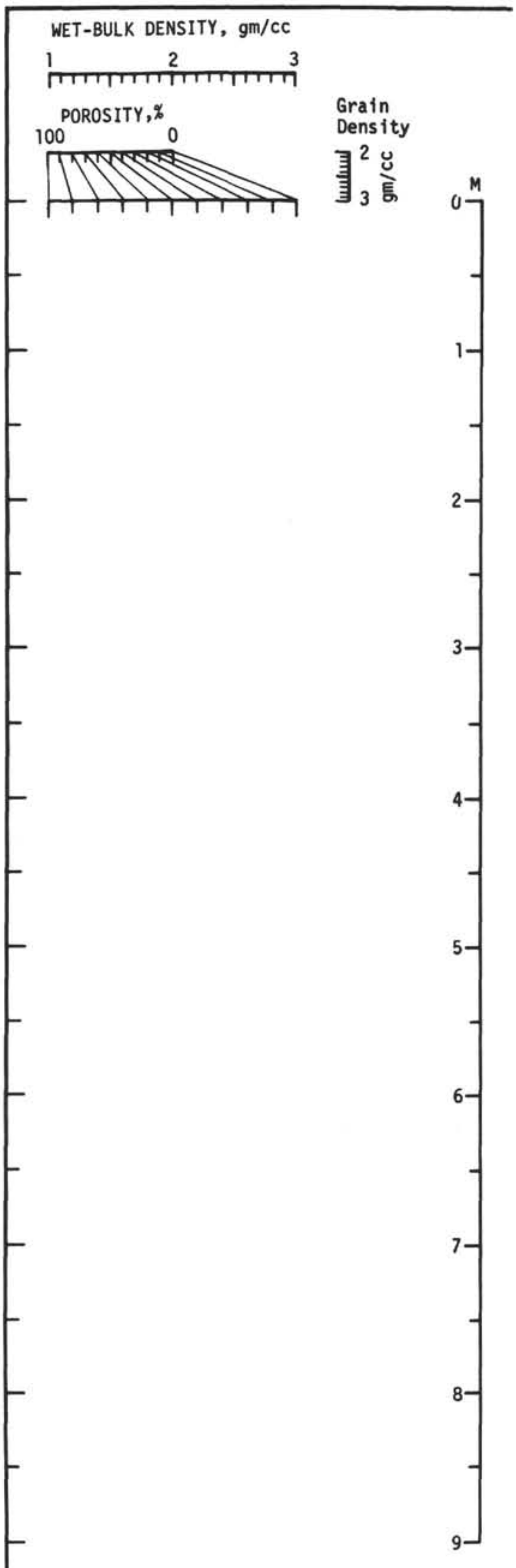
Site 192 Hole Core 33 Cored Interval: 912-922

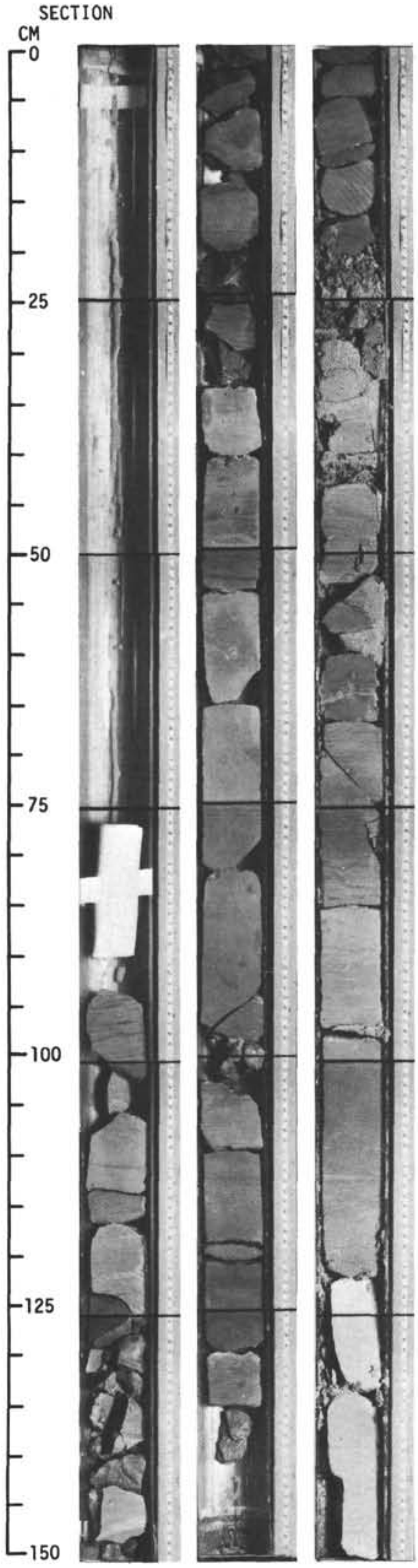
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		PF BF N	- - A	 M	1	0.5 1.0	VOID			
		N	-	-	2				40 50	CLAYSTONE dark greenish gray (5GY 4/1) ~100% clay locally contains traces of carbonate burrowed
		PF BF N	- R A	 M	3				10 40 85 125	NANNOFOSSIL CHALK dark greenish gray (5GY 4/1) to yellowish gray (5Y 8/1) burrowed moderately mottled; with thin lenses and laminae
					Core Catcher					

Core Catcher:

N	C	M
D	-	-
R	-	-
S	-	-
PF	C	P
BF	C	

Explanatory notes in Chapter 1

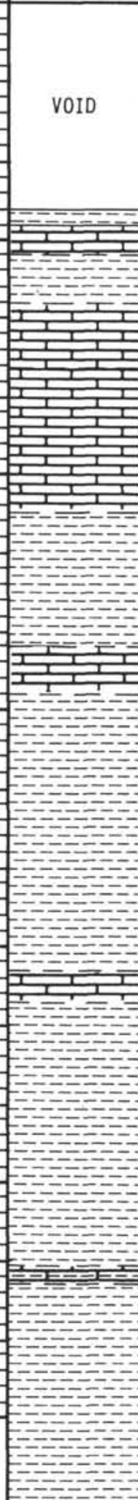




192-33-1 192-33-2 192-33-3

Site 192 Hole Core 34 Cored Interval: 922-932

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		N	C	M	1	0.5, 1.0	VOID			CLAY BEARING CHALK
		N N	A R	M M	2				75	CLAY BEARING CHALK CHALK, white (N9) mixed zone CLAY BEARING CHALK
		N	-	-	3					CLAY BEARING CHALK
		N D R S PF BF	R - - - - R	M - - -	4				75	
		N	-	-	5				25	LIMESTONE, light gray (N7), 100% carbonate
		PF BF N	- R R	 M	6				58	mixed LIMESTONE and CLAYSTONE, light gray (N7)
					Core Catcher					



Basic lithology
CLAYSTONE
olive gray (5Y 4/1 - 3/2)

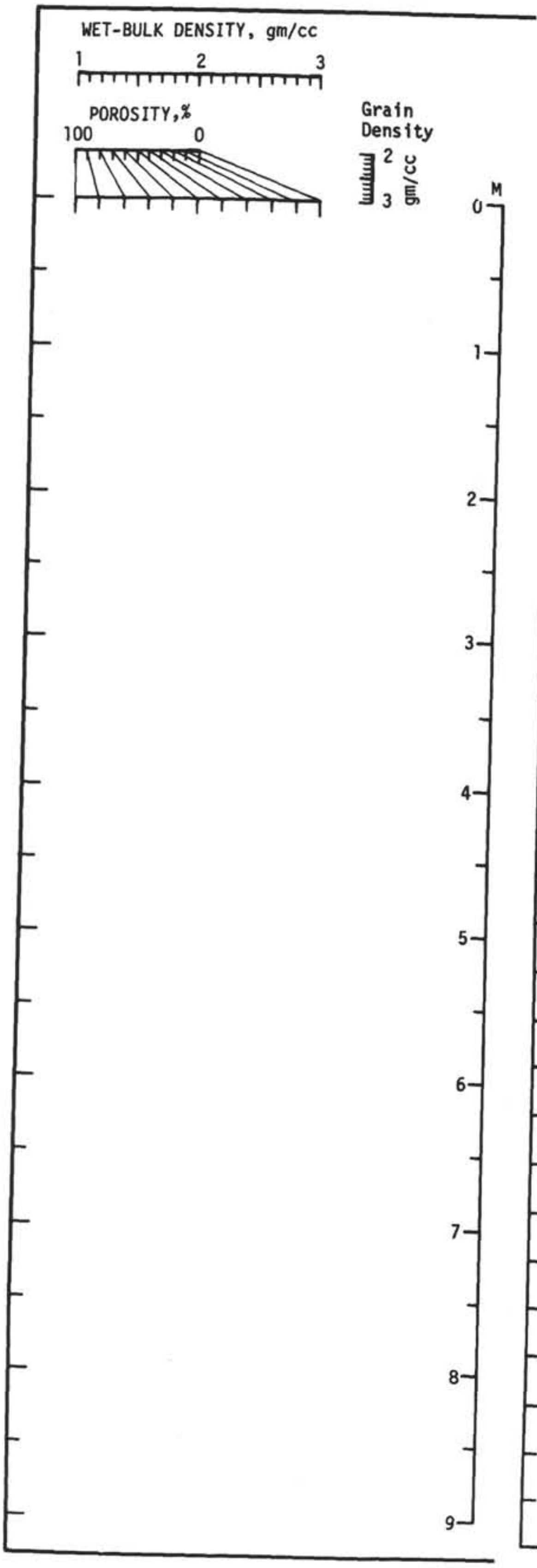
with interbeds of:
CLAY BEARING CHALK
light olive gray (5Y 6/1)
and
NANNOFOSSIL CHALK
light gray to white (N7 - N9)

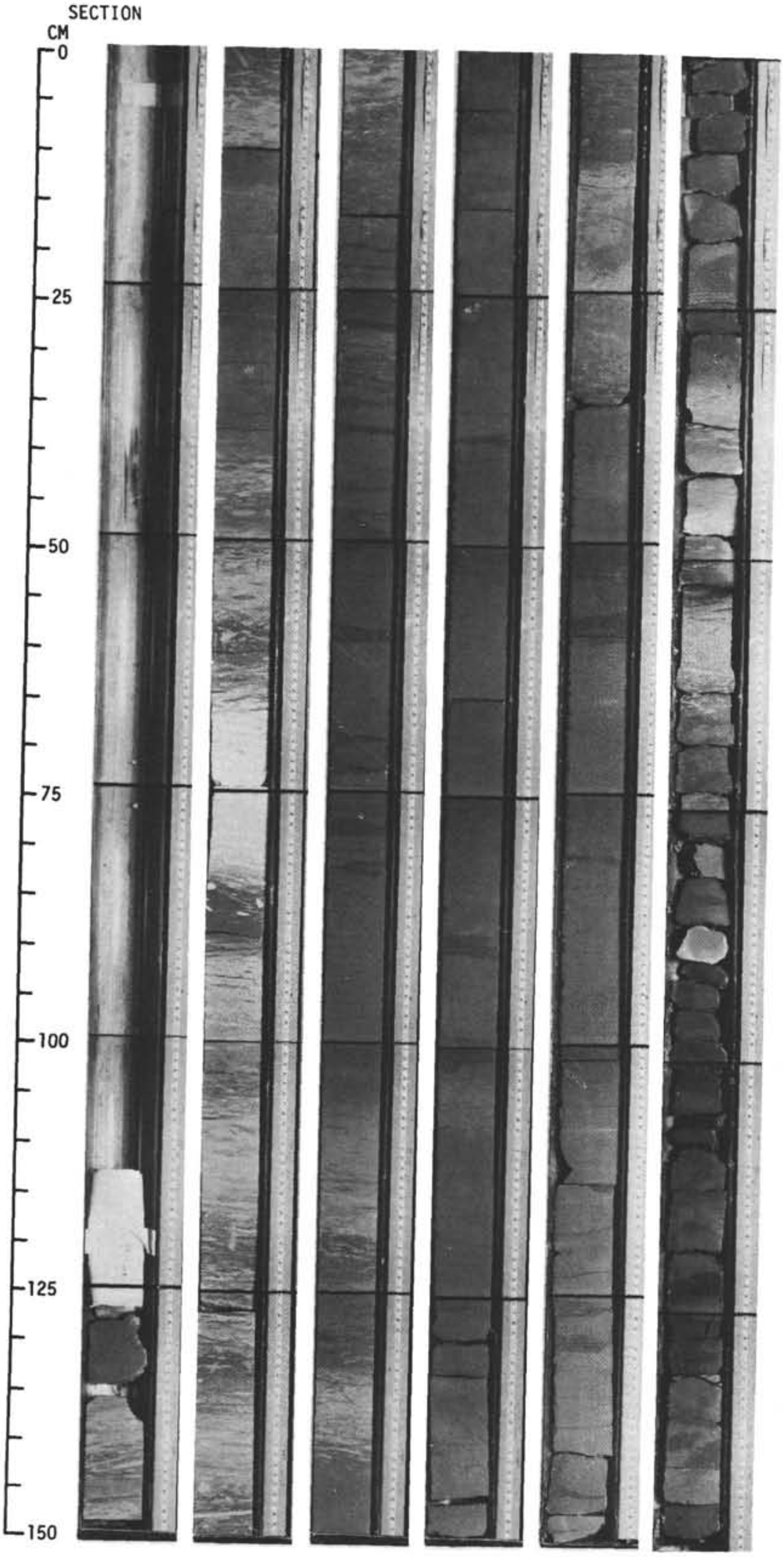
Core Catcher:

N	C	M
D	-	-
R	-	-
S	-	-
PF	-	
BF	R	

core mottled and burrowed
burrows most apparent near color boundaries where burrows in underlying unit are filled with overlying unit sediment

Explanatory notes in Chapter 1





192-34-1 192-34-2 192-34-3 192-34-4 192-34-5 192-34-6

Site 192 Hole Core 35 Cored Interval: 932-942

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		PF BF N D R S	C C C - - -	P M - - -	1	0.5 1.0	VOID		-50 -105	NANNO LIMESTONE
					2				-106	NANNO LIMESTONE NANNO LIMESTONE
					Core Catcher					

FOSSIL CHARACTER

Core Catcher:

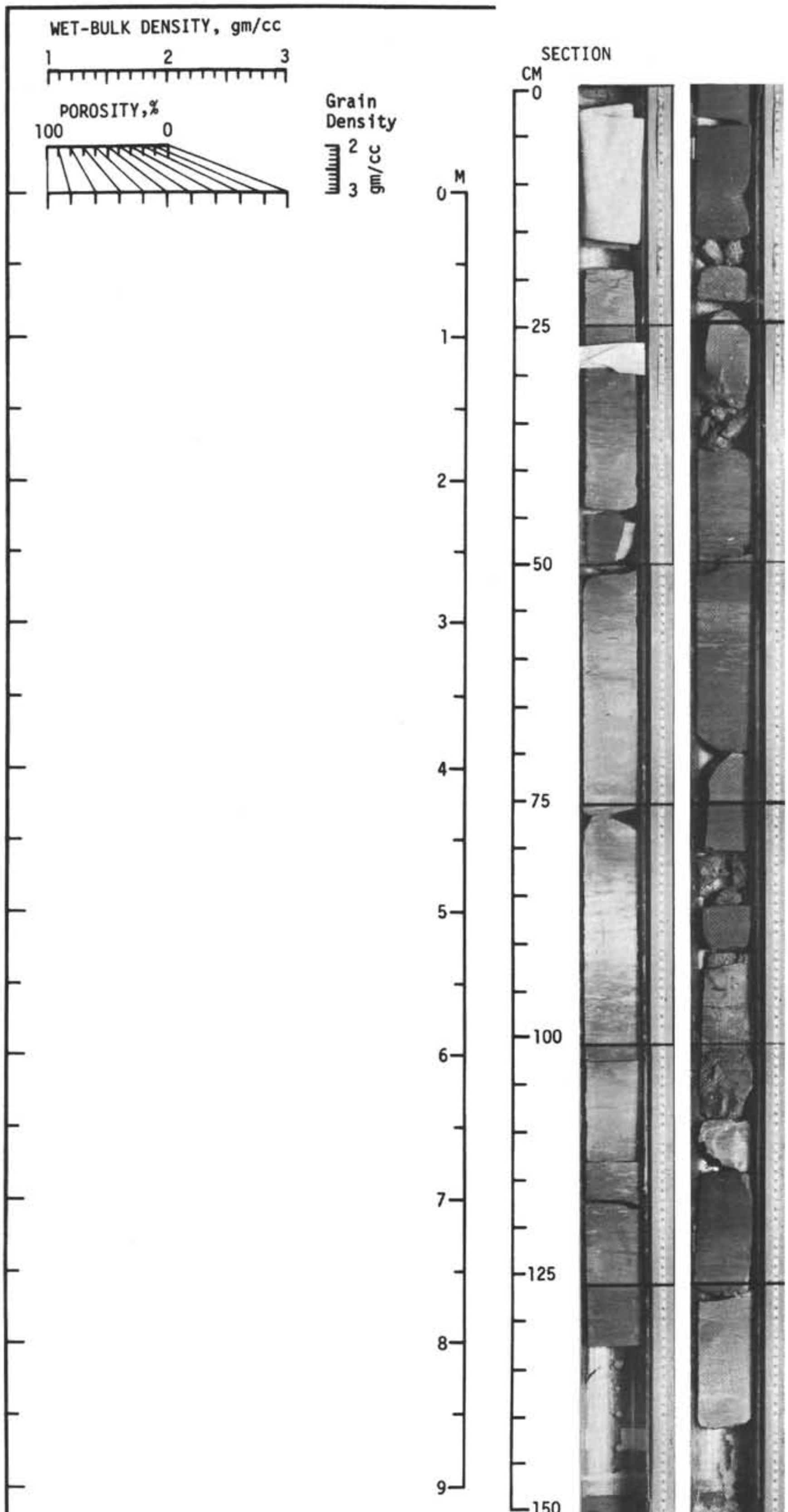
	A	M
N		
D	-	-
R	-	-
S	-	-
PF	F	P
BF	C	

Basic lithology

CLAYSTONE
dark greenish gray (5GY 4/1) to olive gray (5Y 3/2)

much is nanno bearing (5-10%) intermixed with variable amounts of NANNO LIMESTONE severely mottled, burrowed and mixed colors from white (N9) to dark greenish gray (5GY 4/1)

Explanatory notes in Chapter 1



192-35-1 192-35-2

Site 192 Hole A Core 1 Cored Interval: 942-951

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
UPPER UPPER EOCENE - LOWER LOWER OLIGOCENE	N - Isthmolithus recurvis to Helicopontosphaera reticulata (NP19-22)	N	C	M	1	0.5, 1.0	VOID		
		N	C	M	2				
		N	C	M	3				
		N	C	M	4				
		R S							
		N	C	M	5				
		N	R	P	6				-93
		N R S	C - -	M - -					-130
					Core Catcher				

LITHOLOGIC DESCRIPTION

Basic lithology

NANNOFOSSIL CHALK
white (N9) to greenish gray (5GY 6/1)
darker layers contain traces of pyrite and clay

moderately burrowed, burrows planar

section 6
gradationally interbedded:
NANNOFOSSIL CHALK olive gray (5Y 6/1)

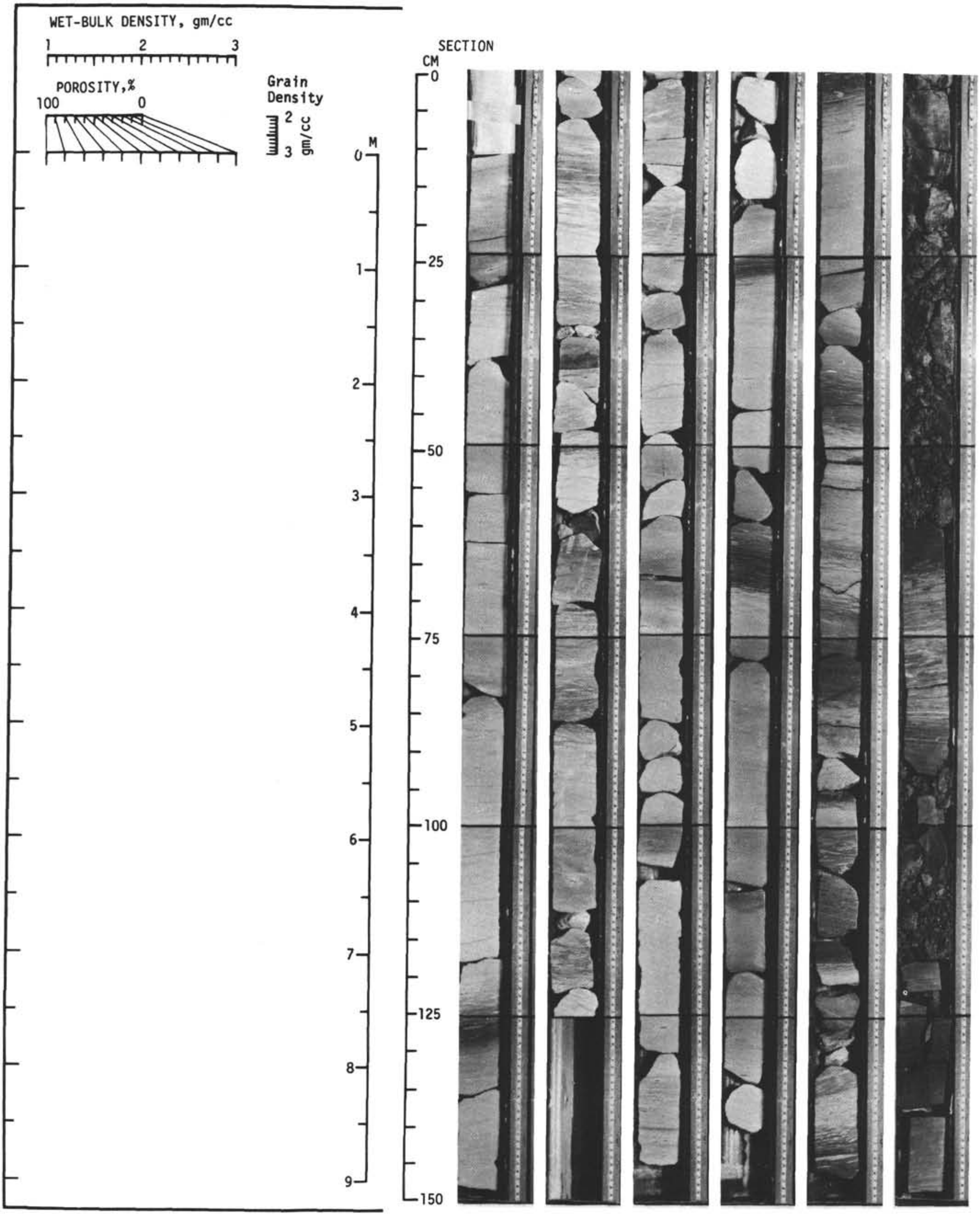
and SILT BEARING CARBONATE RICH CLAYSTONE light brown (5Y 6/4)

Slide 6-130
70% clay
10% silt (feldspar, quartz, opaques)
20% carbonate

Core Catcher:

N	C	M
D	-	-
F		
R	-	-
S	-	-
PF	-	
BF	F	

Explanatory notes in Chapter 1

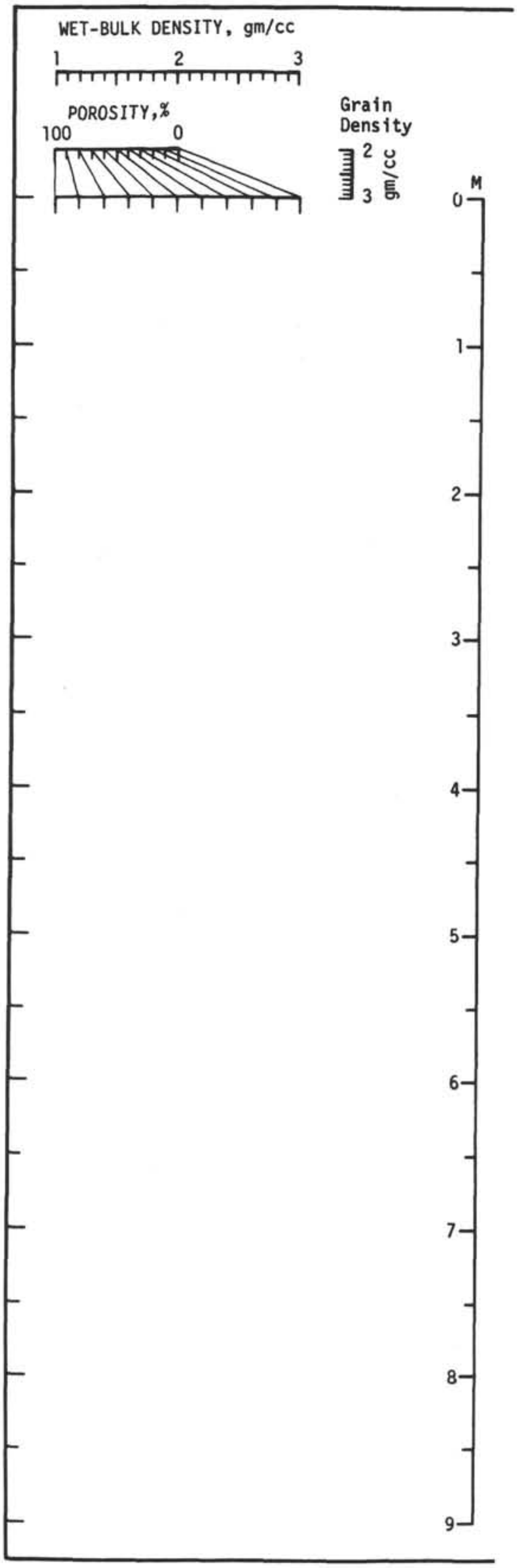


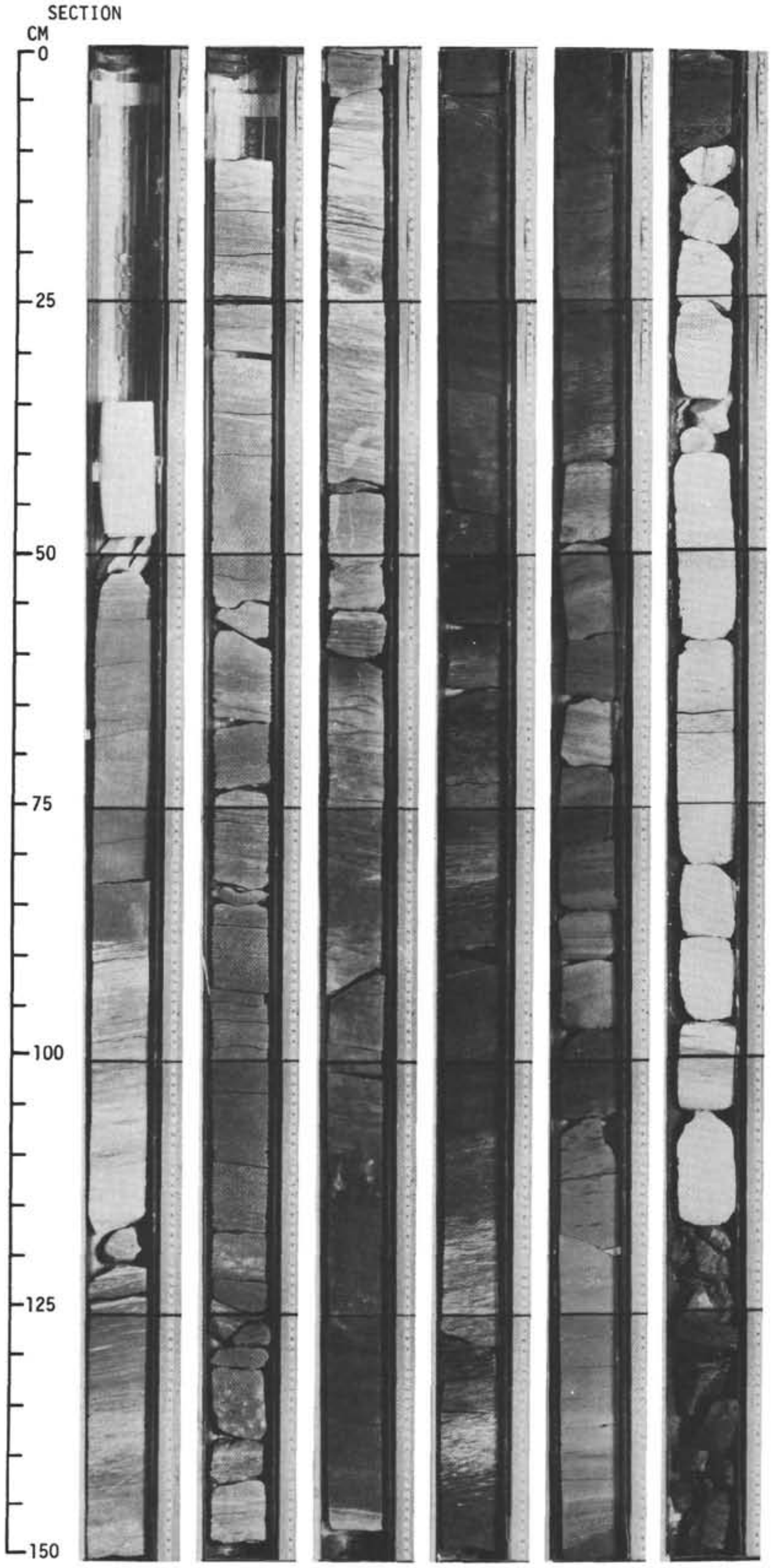
192A-1-1 192A-1-2 192A-1-3 192A-1-4 192A-1-5 192A-1-6

Site 192 Hole A Core 2 Cored Interval: 951-960

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER UPPER EOCENE	N - Discoaster saipanensis to Chiasmolithus omaruensis (NP17-18)	N	C	M	1	0.5 1.0	VOID		70 110 145	CHALK and CLAYSTONE intermixed very pale orange (10YR 4/4) to moderate brown (5YR 4/4) SILT RICH NANNOFOSSILIFEROUS CHALK olive gray (5Y 4/1) and white (N9), mottled VOID
		N N	C -	M -	2				100	SILT RICH NANNOFOSSIL CHALK, olive black (5Y 2/1) 85% carbonate, 15% silt and clay
		N R S	C	M	3				5 30 140	CHALK, white (N9), variable clay content SILTSTONE, size graded?, grains altered to clay
		PF BF N	- - C	M	4				147 35 85 97	Basic lithology CLAYSTONE moderate brown (5YR 4/4) to medium dark gray (N4) partly calcareous scattered layers of fine SANDSTONE and SILTSTONE; grains are altered to clay minerals but layers retain original textures in cut sections
		PF BF PF BF N PF BF PF BF	R F - R C - R R C	M	5				50 63 100	Entire cored locally mixed, mottled and burrowed; most contacts are gradational. SANDSTONE grading up to CLAYSTONE, calcareous greenish black (5G 2/1) to bluish gray (5B 5/1)
		N	C	M	6				8 145 150	CLAYSTONE with 1-2 cm CLAY PEBBLE CONGLOMERATE layers CHALK bluish white (5B 9/1) to medium dark gray (N4) mottled and streaked
					Core Catcher					Core Catcher: N C M D - - F R - - S - - PF - BF R

Explanatory notes in Chapter 1



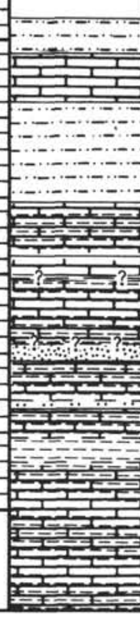


192A-2-1 192A-2-2 192A-2-3 192A-2-4 192A-2-5 192A-2-6

Site 192 Hole A Core 3 Cored Interval: 983-989

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
LOWER UPPER EOCENE	N - Discoaster saipanensis to C. omaruensis (NP17-18)				1	0.5 1.0	VOID		
		PF BF R S N	R F - - C	 - - M	2				75
		N	-	-	3				
					Core Catcher				

(FOSSIL, ABUND. and PRES. are grouped under the heading FOSSIL CHARACTER.)



LITHOLOGIC DESCRIPTION

Basic lithology
CLAYSTONE and CLAYEY LIMESTONE
grayish black (N2) to bluish white (5B 9/1)
mottled, intermixed and burrowed

CLAYSTONE with silt and sand laminae

CHALK, med. bluish gray to bluish white (5B 5/1 - 9/1)

CLAYSTONE, dark gray - grayish black (N3 - N2)
with size-graded, altered SAND and SILT layers
locally calcareous, layers 2-5 cm thick

CHALK, bluish white - bluish gray (5B 9/1 - 6/1)

SILTSTONE and SANDSTONE, med. dk. gray (N4), altered

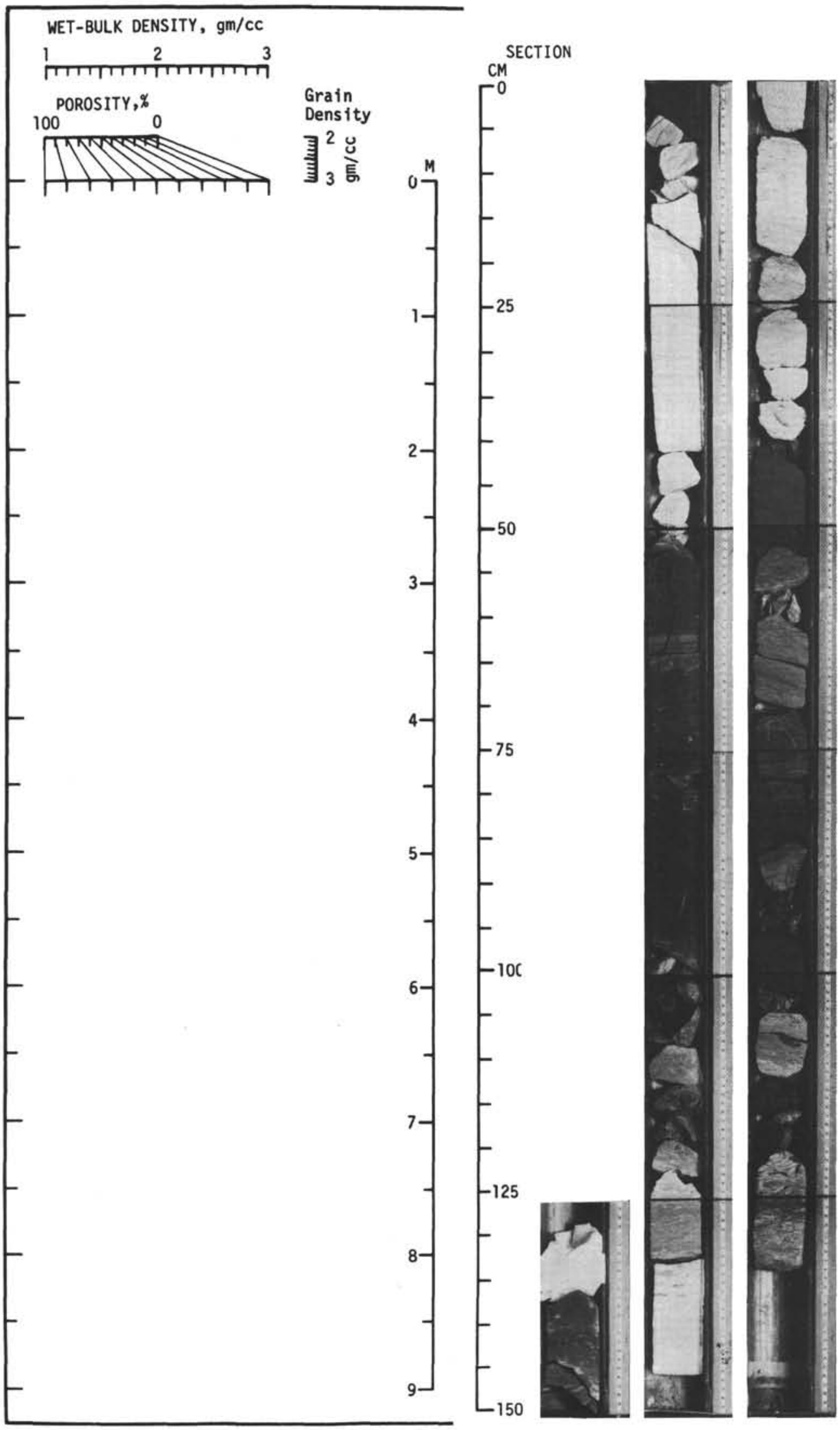
SILTSTONE, dark gray (N3), altered

CLAYSTONE, dark gray, (N3)

Core Catcher:

	N	C	M
	N	C	M
D	-	-	
R	-	-	
S	-	-	

Explanatory notes in Chapter 1



192A-3-1 192A-3-2 192A-3-3

Site 192 Hole A Core 4 Cored Interval: 1018-1027

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER LOWER EOCENE TO LOWER MIDDLE EOCENE	N - Marthasterites tribrachiatus to Discoaster sublodoensis (NP12-14)				1	0.5 1.0	VOID			
		N	C	M						
		R S	- -	- -	2					CLAYSTONE, dark gray to grayish black (N3 - N2), with sand and silt layers (graded?) up to a few cm thick, mostly calcareous to various degrees; Slide 2-75 contains 2-3% nannos.
		N N	C C	M M					75 103	
					3				38	NANNOFOSSIL CHALK, white (N9)
									110	
									148	SILTSTONE, medium gray (N5), altered CHALK, white (N9)
		N	A	M	4					
		PF BF N	C C -	P -						Basic lithologies CLAYSTONE dark reddish brown (5YR 3/2)
		PF BF R S	C C - -	P - -						and NANNOFOSSIL CHALK white (N9)
*	*				Core Catcher					Contacts between the two basic lithologies generally are gradational, and much of sections 3 and 4 consists of layers of intermixed chalk and claystone
										Entire core is burrowed and mottled

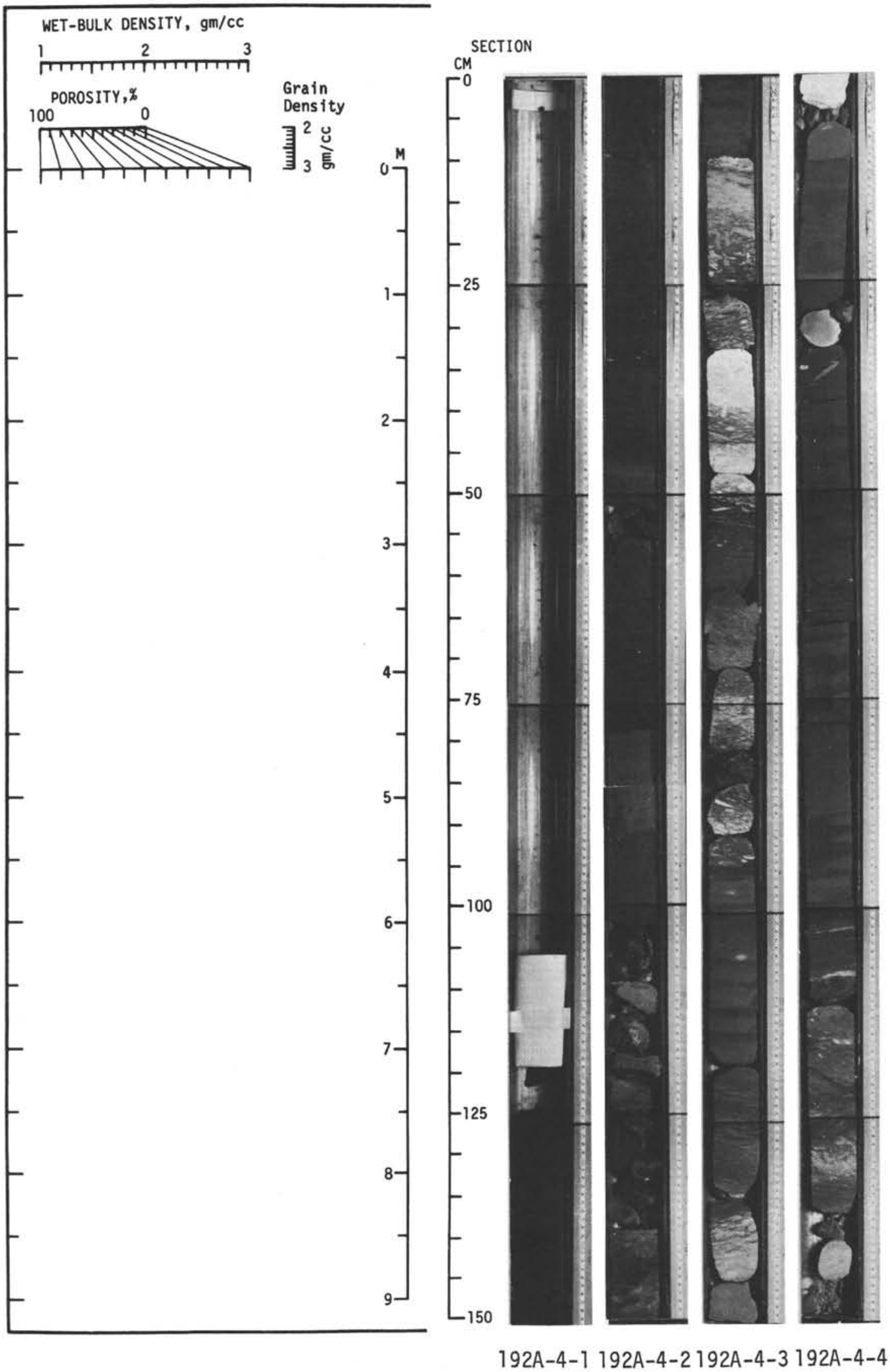
Core Catcher:

N	C	M
N	C	M
D	-	-
F		
R	-	-
S	-	-
PF	-	
BF	C	P

Explanatory notes in Chapter 1

* MID. MAESTRICTIAN

* ? Tetralithus murus?


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
192A-4-1
192A-4-2
192A-4-3
192A-4-4

Site 192 Hole A Core 5 Cored Interval: 1043-1053

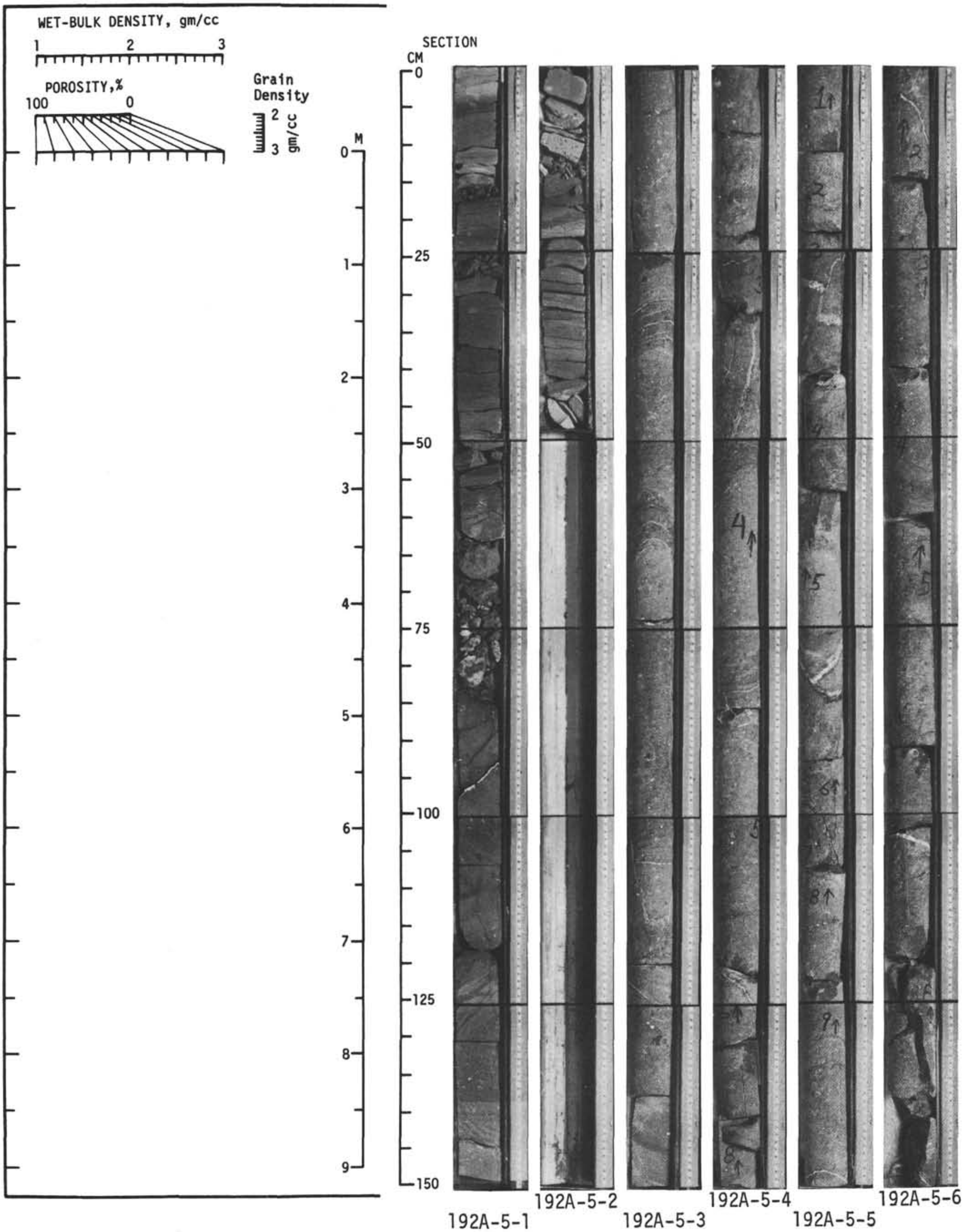
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE MAESTRICHTIAN		R S PF BF N N N	- - R C A A A	- - P M M M	1	0.5 1.0			-20 -70	NANNOFOSSIL CHALK moderate to light brown (5YR 3/4 - 6/4) grades downward to dark brown LIMESTONE, pale green (10G 6/2) contains fragments of underlying basalt
					2					BASALT fractures filled with moderate brown LIMESTONE
LOWER MAESTRICHTIAN		N	A	M	3					Note: 50 cm 0-section contains NANNOFOSSIL CHALK like that at the top of section 1
					4					
					5					
					6					
					Core Catcher					

XR 1-30, 1-70, 1-120*

1-30	1-70	1-120*	
64%	55%	61%	amorph.
30%	39%		calcite
1%	5%	1%	quartz
1%		13%	plag.
1%			mica
3%	1%	8%	mont.
		16%	augite

*basalt or fracture filling?

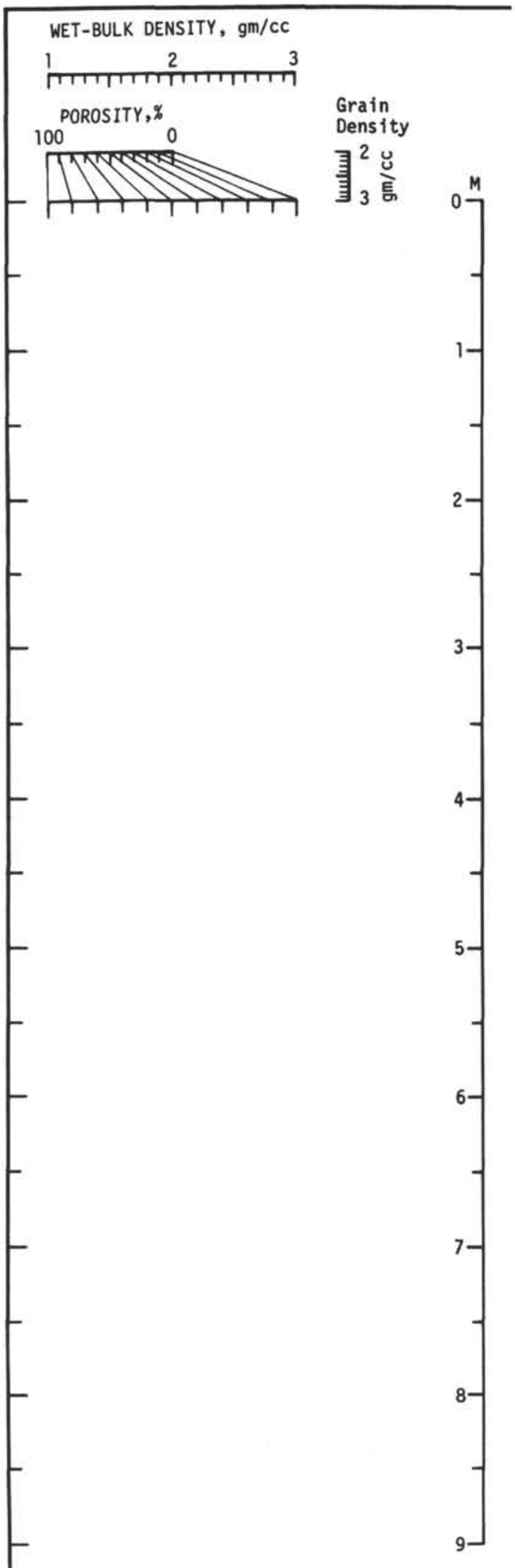
Explanatory notes in Chapter 1

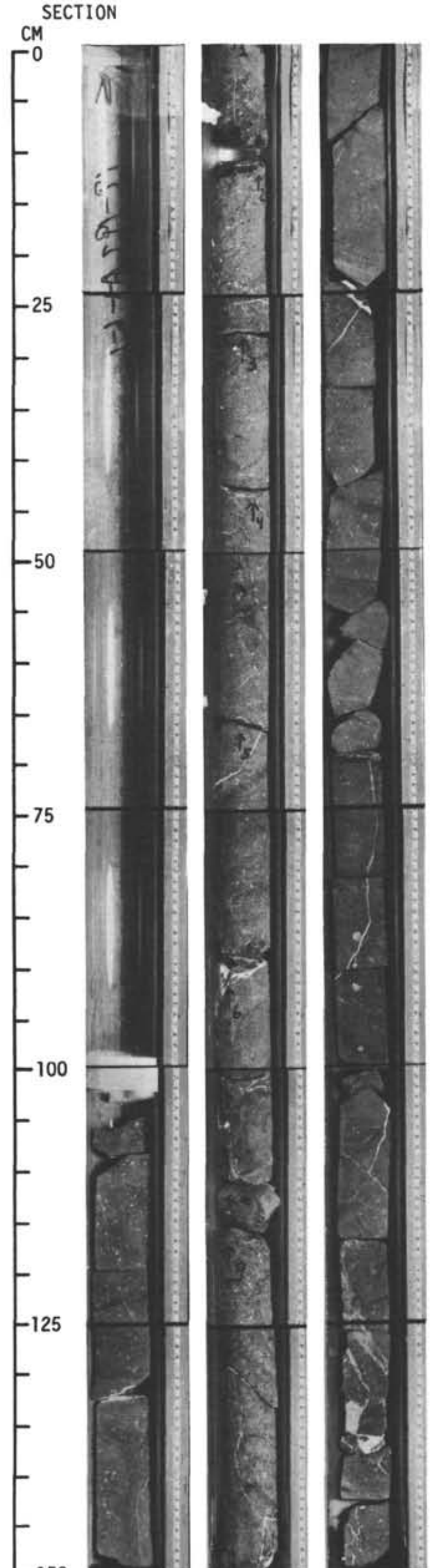

WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9
SECTION
CM
0 25 50 75 100 125 150
192A-5-1
192A-5-2
192A-5-3
192A-5-4
192A-5-5
192A-5-6

Site 192 Hole A Core 6 Cored Interval: 1053-1057

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
NO FOSSILS					1	0.5 1.0	VOID			
					2					BASALT fractures filled with calcite and brown limestone vesicular zones
					3					
		D F R S	- - -	- - -	Core Catcher					

Explanatory notes in Chapter 1





192A-6-1 192A-6-2 192A-6-3