7. SITE 188

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 15-16 Aug 71.

Position:
53°45.21′N
178°39.56′E.

Water Depth: 2649 meters.

Penetration: 638 meters.

Number of Holes: One.

Number of Cores: 18.

Total Core Recovered: 57.4 meters.

Acoustic Basement:
Depth: Greater than 1.0 sec and
Nature: Unknown
Velocity: Unknown.

Age of Oldest Sediment: Upper Miocene.

Basement: Unknown.

SUMMARY

Site 188 is located at the outer edge of the mid-slope terrace on the western flank of Bowers Ridge, Bering Sea, in water 2649 meters deep. The 638-meter thick sedimentary sequence drilled and cored consists basically of a Pleistocene to upper upper Miocene (0-580 m) unconsolidated and semiconsolidated interbedded diatom ooze, silt-rich diatom ooze, and diatomaceous silt overlying mudstone (580-638 m) lacking diagnostic fossils. The upper diatomaceous unit is similar to Unit A at Sites 184 and 185, and the lower is similar to the mudstone sequence, Unit B, at Site 184.

Variations in the relative abundance of diatoms and inorganic silt plus thin layers of volcanic ash, black sand and silt, and limestone occur throughout the upper 580 meters. Foraminiferal assemblages are typical of present water depths.

Except for a few thin sand layers, no evidence of turbidite deposition was encountered at Site 188, hence it seems unlikely that any part of the Neogene section was deposited beneath the abyssal floor of the adjacent Bowers Basin. Thus, the drilled section at Site 188 appears to be an in situ pelagic and terrigenous blanket depositionally draped over a deeper basement underlying the inner flank of Bowers Ridge (Ludwig et al., 1971a).

The prominent reflection horizon "P" noted by Ewing et al. (1965) and Ludwig et al. (1971a; 1971b) in this area is caused by the major lithologic transition at a subbottom depth of 580 meters. This transition, from terrigenous-rich diatom ooze to terrigenous mudstone of late late Miocene age takes place over a vertical thickness less than about 15 meters. A similar lithologic break was found at Sites 184 and 185 and also in deposits of late Miocene age. The BSR beneath Umnak Plateau and the "P" horizon of Bowers Ridge are thus equivalent to the top of a lithified terrigenous sequence. However, the subbottom depth to this lithified section is not everywhere a measure to a stratigraphic level; the BSR is time transgressive and its position and geometry is partly related to diagenetic alteration of terrigenous-rich diatomaceous deposits of early late to late late Miocene age (see Scholl and Creager; Stewart; Fullam et al.; all in this volume).

BACKGROUND AND OBJECTIVES

Description

Bowers Ridge is one of those rare bathymetric elements that is sharply arcuate in form and nearly closes on the principal structure (i.e., Aleutian Ridge) from which it extends. Site 188 is located at a depth near 2600 meters on the lower part of the westward-sloping inner flank of this northward-looping ridge (Figure 1).

Acoustic reflection profiles crossing this flank reveal a thick sequence of sedimentary beds covering an "acoustic basement" at a subbottom depth near 2 km. This basement can presumably be traced to exposure of deformed volcanic and siliceous sedimentary rocks underlying the shallowly submerged summit of Bowers Ridge. The younger sedimentary deposits underlying the middle and lower parts of the inner flank of the ridge can be traced downslope beneath a thick (approximately 1 km) turbidite sequence immediately underlying the flat floor of Bowers Basin. Beneath the basinward-sloping flank deposits, a prominent reflection occurs at a subbottom depth near 600 meters, this is horizon "P" of Ewing et al. (1965). Reflection records of exceptional quality suggest that this reflecting surface produces cross-bedding surfaces much as does the BSR or Bottom-Simulating Reflector (see site reports for 184 and 185) beneath Umnak Plateau.

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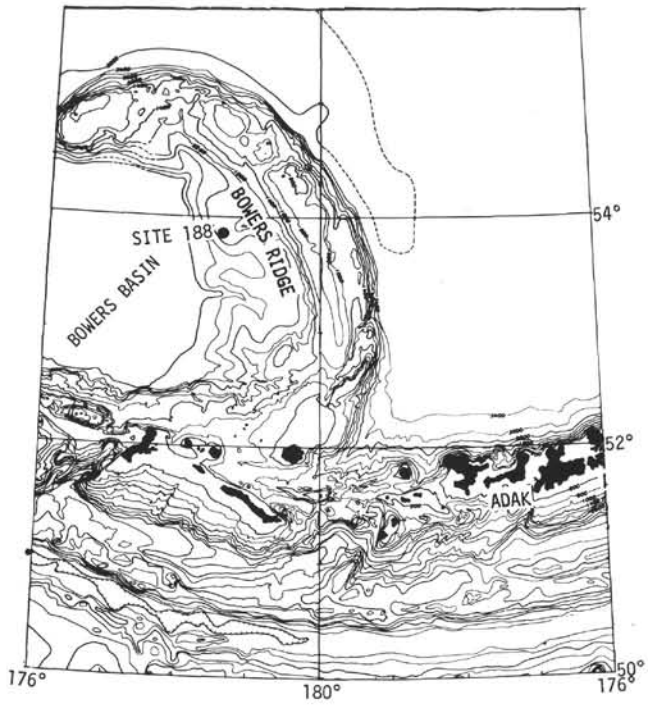

Figure 1. *Base map showing the location of Site 188, Bowers Ridge.*

Objectives

The principal reason for occupying Site 188 was to determine the geologic implication of reflector "P". Specifically, is it (1) a variety or type of bottom-simulating reflecting surface, possibly associated with gas and an overlying clathrated section, or (2) a lithologic boundary related to a fundamental change in style of sedimentation over the flank of the ridge? Additionally, the possibility that the ridge may have been formed as a result of late Tertiary uplift (Ewing et al., 1965) can be assessed by determining the probable depositional position of the flank deposits, i.e., are they in situ ridge deposits or uplifted Bowers Basin units.

OPERATIONS

Pre- and Post-drilling Survey

Site 188 is located on the western flank of Bowers Ridge along the track of the reference profile collected by G.G. Shor on 26 Jul 70 (Figure 2). The site was approached with a ship's heading of 301°T which was approximately the heading used in the collection of the reference profile. The air-gun profile obtained during the approach (Figure 3) so closely approximated the reference profile that the beacon was dropped on the fly at 0300 on 15 Aug 71. The finally accepted position is: 53°45.21′N; 178°39.56′E. No post-drilling survey was deemed necessary. A map showing the approach and departure tracks plus the site location is shown in Figure 4.

Drilling Program

Site 188 was occupied from 0300 hrs 15 Aug 71 (beacon away) until 1530 hrs 16 Aug 71 with alternating coring and washing from the sea floor to a subbottom depth of 638 meters. At approximately 580 meters mudstone was encountered. This sedimentary rock correlates well with the expected deepest reflector, the site target. Three more cores were taken to assure us that the target had been reached and that more drilling would not yield datable material. Satisfied in this, the hole was terminated.

Using Matthews Tables, the sonic depth of 1380 fms was corrected to 2607 meters giving a water depth of 2613 meters and a drill-floor depth of 2623 meters. This compares with 2659 meters below drill floor established on the basis of the first core collected containing sediment. The 2659 meters below drill floor, or 2649 meters below sea level, is the accepted depth for this site.

No difficulties were encountered in drilling this hole. Diatomaceous silty clay was present from the bottom to about 580 meters and mudstone and limestone were present from 580 to 638 meters. Drilling and coring became progressively harder with depth until the mudstone was reached, after which drilling was significantly more difficult. A coring summary is given in Table 1.

LITHOSTRATIGRAPHY

At Site 188 two major lithologic units were sampled. Unit A, from 0 to 580 meters below bottom is unconsolidated and semiconsolidated, interbedded diatom ooze, silt-rich diatom ooze, and diatomaceous silt. Unit B, from 580 meters to the bottom of the hole is mudstone.

Unit A – 0 to 580 meters

Unit A extends from 0 to 580 meters below bottom and is unconsolidated and semiconsolidated olive gray diatom ooze, silt- and clay-rich diatom ooze, and diatomaceous silt.

Thin layers of volcanic ash occur at 37 to 38 meters and 284 meters. Black sands and silts occur at 30 to 34 meters, 100 meters, and 283 to 284 meters.

Thin (5-10 cm) limestone layers are present at 283 meters and 425 meters. The first occurrence of very hard, conchoidally fractured black mudstone was in the core catcher of Core 14 at approximately 273 meters. A second large fragment of the olive black mudstone was cored at 580 meters.

From the surface to about 315 meters Unit A is unconsolidated, while from 315 to 573(?) meters it is semilithified with the exception of unconsolidated material between 573 and 582 meters, which could be the result of drilling disturbance.

Unit B – 582 to 638 meters

Unit B is olive black mudstone. Some fragments are very hard, have a waxy luster, and a distinct conchoidal fracture. In addition to clay, feldspar, pyrite, and muscovite, traces of chlorite, zircon, and pyroxene were observed in samples of the hard mudstone. The rest of the mudstone is thinly (regularly and irregularly) laminated with bands and lenses 1 mm to 3 cm thick. Traces of sponge spicules, radiolarians, and foraminifers are present.

A 20-cm layer of light olive gray limestone occurs at 601 meters.

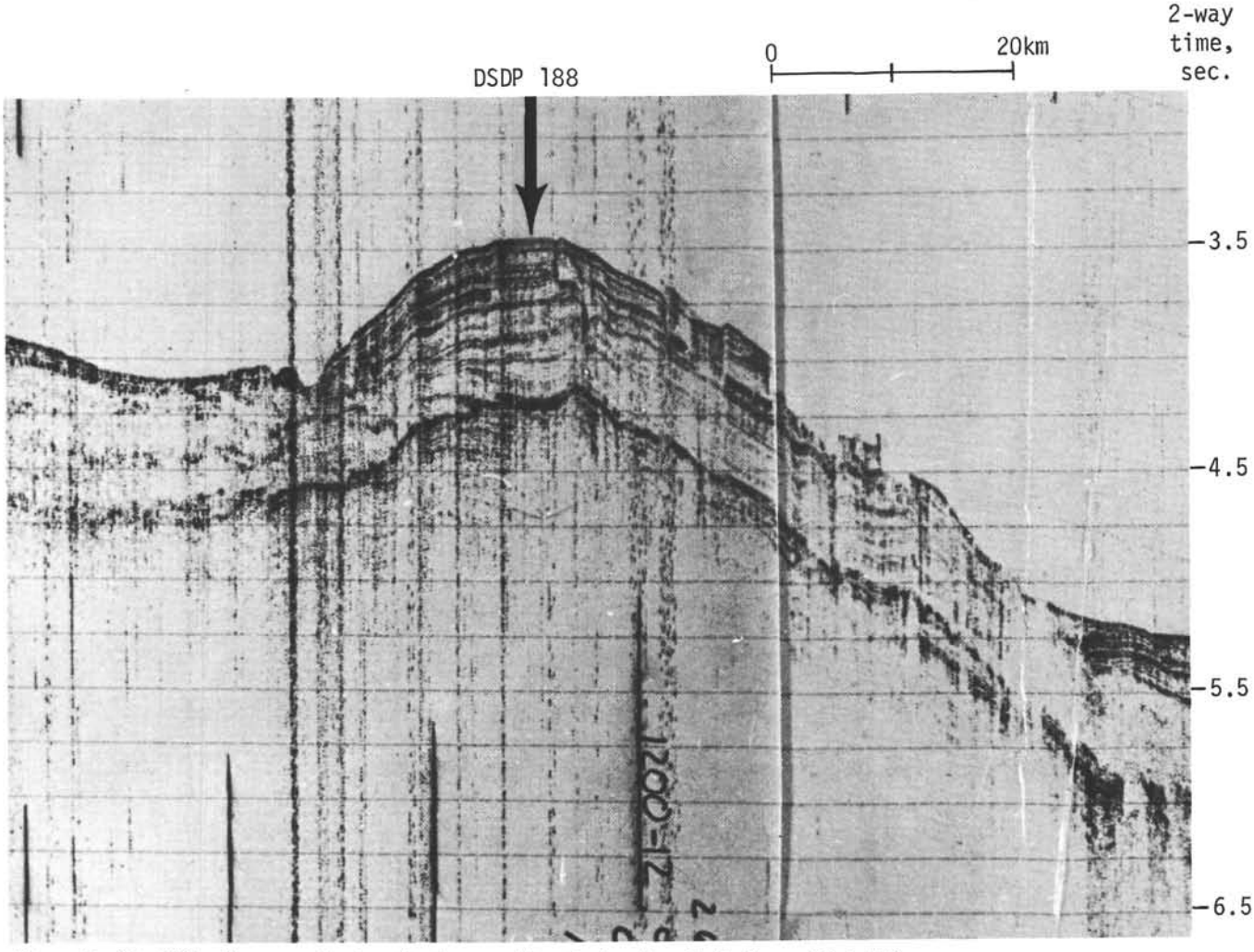

Figure 2. *Site 188 reference seismic reflection profile, obtained by G. G. Shore, 26 Jul 70.*

PHYSICAL PROPERTIES

Physical properties measured at Site 188 include bulk density, water content, natural gamma radiation, acoustic velocity, vane shear strength, and residual pore water pressure. Bulk density was measured with the GRAPE system, calculated on the basis of shore laboratory water contents, and, for the harder materials, measured by the water displacement method.

The bulk densities are presented on a core basis opposite the core summary sheets. Mean GRAPE densities, water displacement densities, shore laboratory densities, and acoustic velocities are shown on the site summary sheet.

Bulk Density

GRAPE densities were obtained to a sediment depth of about 290 meters. Below this point the sediment was broken and no longer filled the core liner completely. Several water displacement densities were obtained for the deeper material.

The measurements at Site 188 disclose a zone extending from 0 to 600 meters which has a low, uniform density (1.3 to 1.4 g/cc). There is virtually no increase in density with depth, indicating that the diatom ooze is practially incompressible. On a core level there is some variation depending upon the clay and silt content. The more clayey sections have densities about 15 percent higher than the nearly pure oozes. Also, the few ash layers are apparent as high-density zones. At about 600 meters there is a sharp break in the trend with the density increasing rapidly to 1.8 g/cm^3.

Acoustic Velocity

The acoustic velocities measured with the Hamilton Frame follow the same trend as the densities. A zone extends from 0 to 600 meters over which the acoustic velocity gradually, but very consistently, increases from 1.55 to 1.65 km/sec. At 600 meters there is a sharp break with velocities increasing to 2.4-2.6 km/sec in the mudstone and 4.5 km/sec in a layer of limestone.

Summary

The density and acoustic velocity measurements indicate a uniform, low-density, low-velocity zone extending from the sea floor to a sediment depth of 600 meters. Below 600 meters, a zone of relatively high-density, high-acoustic

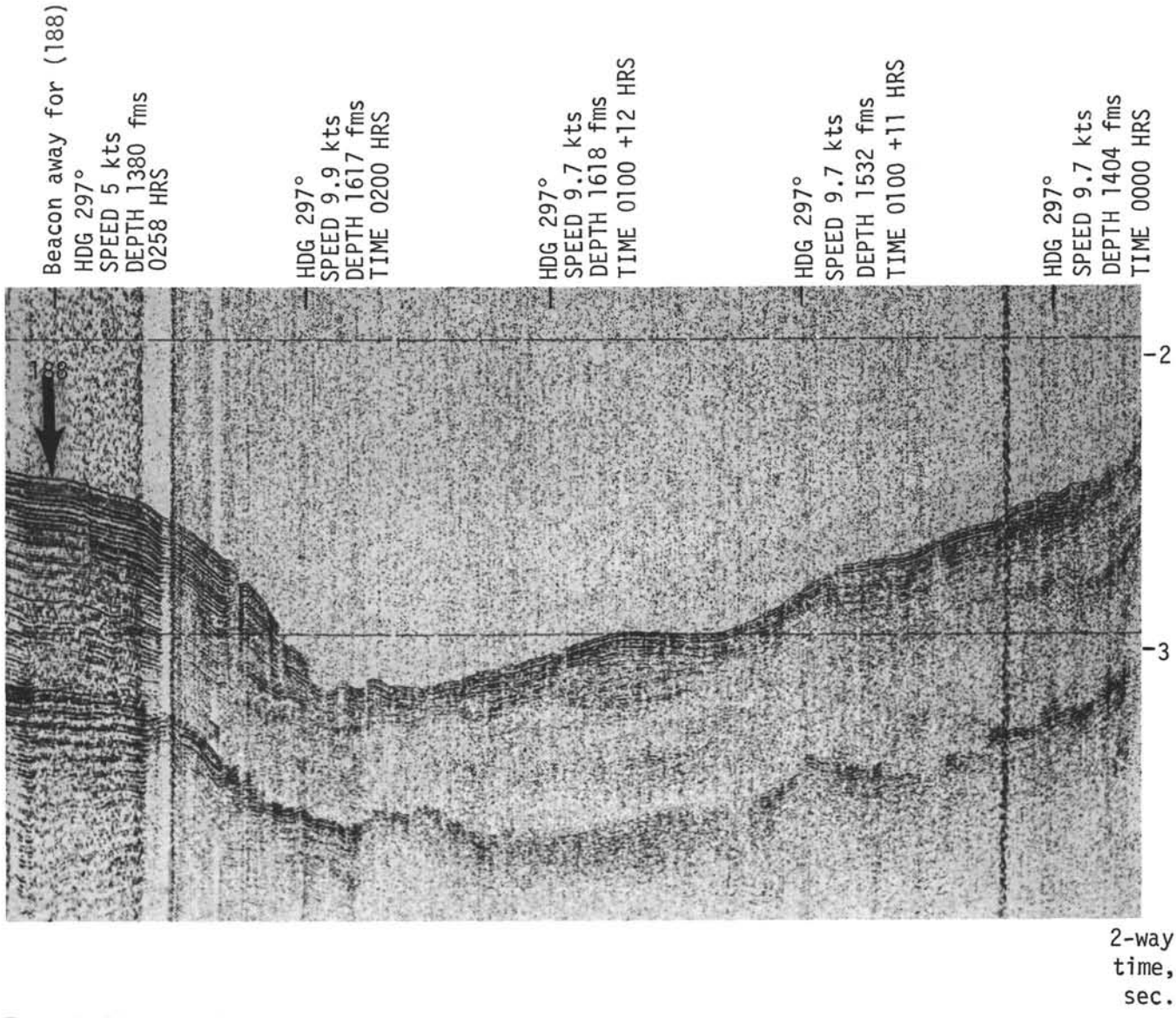

Figure 3. Glomar Challenger *seismic reflection profile obtained on approach to Site 188.*

velocity material is encountered. The density measurements indicate that the diatom ooze of the upper zone is relatively incompressible.

PALEONTOLOGY

Within the upper 300 meters of diatomaceous sediments (Cores 1 through 10), Pleistocene and late Pliocene age, nannofossils are found sparsely distributed through the first six cores. Species diversity of radiolarians and silicoflagellates decrease downward, and calcareous benthic foraminifera are present down to the level of Core 8. Solution-corroded planktonic foraminiferal specimens are observed above Core 5.

In the underlying early Pliocene and late Miocene semilithified diatomaceous section (Cores 12 through 15), radiolarians become rather scarce, but the number of silicoflagellate specimens as well as species increase. The underlying mudstone unit failed to yield any index microfossils.

As in previous sites, the absence of all calcareous fossils in the Pliocene section (Cores 8-11) is probably indicative of an elevated carbonate compensation depth.

Foraminifera

In the Quaternary section (Cores 1-8) planktonic foraminifera vary from abundant to absent and calcareous benthics are usually present. Above the core catcher of Core 5, planktonic foraminiferal tests are more or less uniformly corroded, but preservation of some of the tests in the core catcher of Core 5 and the top and bottom (but not the middle) of Core 6 is excellent.

In the Pliocene section (Cores 9-13) the only foraminiferan found is a probable new species of *Eggerella* that also occurs in the Scotia Sea area of the southern Atlantic Ocean (Echols, 1971). It has a test that is insoluble in dilute HCl and therefore unlike the calcareous tests of morphologically similar forms of *Eggerella* that are associated with the calcareous faunas in the Quaternary section at this site.

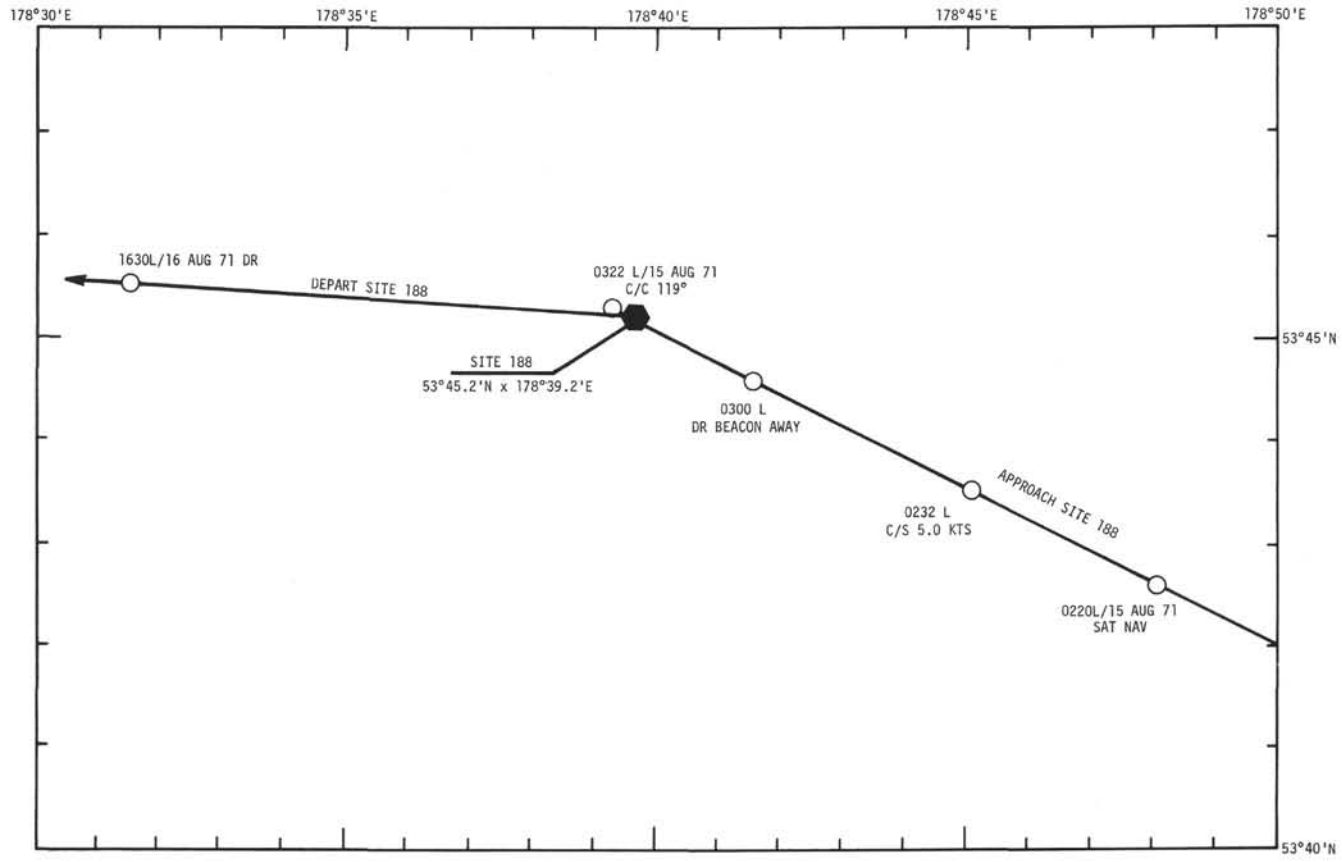

Figure 4. Glomar Challenger *approach and departure tracks, Site 188.*

At the level of Core 12 the sediment becomes difficult to disaggregate and in Cores 15 and 16 it hardens to mudstone; identifiable foraminifera have not been found in these sediments, but fragments of arenaceous tests could be present in Core 17.

Populations of *Globigerina pachyderma* at this site consist of dominantly sinistral form with relatively small pores and a dominantly dextral form with large pores. Populations are 96 to 100% sinistral to the bottom of Core 5. They are 85% sinistral in the core catcher of Core 5 and from there the frequency of sinistral forms appears to fall off gradually with depth, becoming 75% at two levels in Core 6 and 40% in Core 7. The smaller populations of Core 8 are also dominantly dextral. The large-pored form appears first down the core at the top of Core 5. According to subdivisions based on diatoms at this site, the large-pored form appears first in middle middle Pleistocene, becoming dominant in the upper lower Pleistocene.

A sand layer in Core 6, Section 1, Interval 80-82 cm, is rich in planktonic and benthic tests. The benthic fauna is dominated by *Bulimina exilis; Uvigerina senticosa, Melonis barleanus, Pullenia bulloides,* and two species of *Globobulimina* are common. These and other less common species are typical of the present water depth at Site 188, therefore, they provide no evidence that the sand layer is a turbidite.

Calcareous Nannoflora

At Site 188, only the topmost six cores (130 m) were fossiliferous with respect to calcareous nannoplankton. Species diversity is expectably low and the only diagnostic species found for this entirely Pleistocene sequence were a few partially dissolved specimens of *Gephyrocapsa* sp. and *Emiliania* cf. *huxleyi* in Core 4. Core 5 was conspicously richer in nannoplankton than other cores, although most specimens were *Coccolithus pelagicus*.

Radiolaria and Silicoflagellates

Occurrence of Radiolaria is discussed in Chapter 28 (Ling, this volume). Cores 1 and 2 yield a typical Bering Sea (surface sediments) fauna. *Eucyrtidium tumidulum* was recovered in Core 3 and rare occurrence of *Druppatractus acquilonius* (=*Stylacontarium acquilonium* in this paper) was noted in Core 7. Radiolarians are rather scarce throughout the Pliocene and upper Miocene sections and are essentially absent below Core 15.

Stratigraphic distribution of silicoflagellates from this site is similar to those of previous sites. Like radiolarians, silicoflagellates are also absent below Core 15.

TABLE 1
Coring Summary – Site 188

Core	Cored Interval Below Bottom (m)	Cored (m)	Recovered (m)	Recovered (%)
1	0-1	1	1.0	100.0
2	1-10	9	4.5	50.0
Wash				
3	30-39	9	9.1	101.0
Wash				
4	59-68	9	3.1	34.0
Wash				
5	87-96	9	2.5	27.0
Wash				
6	124-133	9	5.3	58.0
Wash				
7	171-180	9	9.5	105.0
Wash				
8	227-236	9	9.5	105.0
Wash				
9	283-292	9	4.5	50.0
10	292-293	1	0.1	10.0
Wash				
11	330-339	9	1.1	12.0
Wash				
12	425-434	9	1.2	13.0
Wash				
13	527-536	9	2.1	23.0
Wash				
14	564-573	9	1.3	14.0
15	573-582	9	1.7	18.0
16	582-591	9	CC	0.0
Wash				
17	601-610	9	0.9	10.0
Wash				
18	629-638	9	CC	0.0
		146	57.4	39.3

Diatoms

Although diatoms are still abundant and well preserved within the upper unit of diatomaceous sediments, decrease in abundancy was noticed in comparison with previous sites. Occurrence of diatom taxa at this site is shown in Table 6, Chapter 30.

CORRELATION BETWEEN REFLECTION PROFILE AND STRATIGRAPHIC COLUMN

The reflection profile, taken by G.G. Shor on the R/V *Melville* (1970), which was used to select Site 188, is shown in Figure 5 along with the stratigraphic column and physical properties. The reflection profile was taken on a course of 287°T (to the right) and was very close to the *Glomar Challenger's* course of 296°T. The only strong reflector on the record is at a depth of 0.72 sec and no basement can be seen although the penetration is at least 1.0 sec. While there are numerous thin reflectors within the column above 0.72 sec, the lithology of these upper units is a moderately homogenous diatom ooze with various amounts of silt and clay. Consequently, there is no clear correlation between the upper lithologic subunits and these minor reflectors. The prominent reflector at 0.72 sec is the mudstone. Density and velocity plots also show only one major discontinuity at the top of the mudstone.

Interval velocities for Unit A are near 1.6 km/sec according to shipboard measurements, in agreement with that (1.62 km/sec) calculated by reflection time and measured drill distance.

REFERENCES

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Ewing, M., Ludwig, W.J. and Ewing, J., 1965. Oceanic structural history of the Bering Sea. J. Geophys. Res. **70**(18), 4593.

Ludwig, W.J., Murauchi, S., Den, N., Ewing, M., Hotta, H., Houtz, R.E., Yoshii, T., Asanuma, T., Hagiwara, K., Sato, T. and Ando, S., 1971a. Structure of Bowers Ridge, Bering Sea. J. Geophys. Res. **76**(26), 6350.

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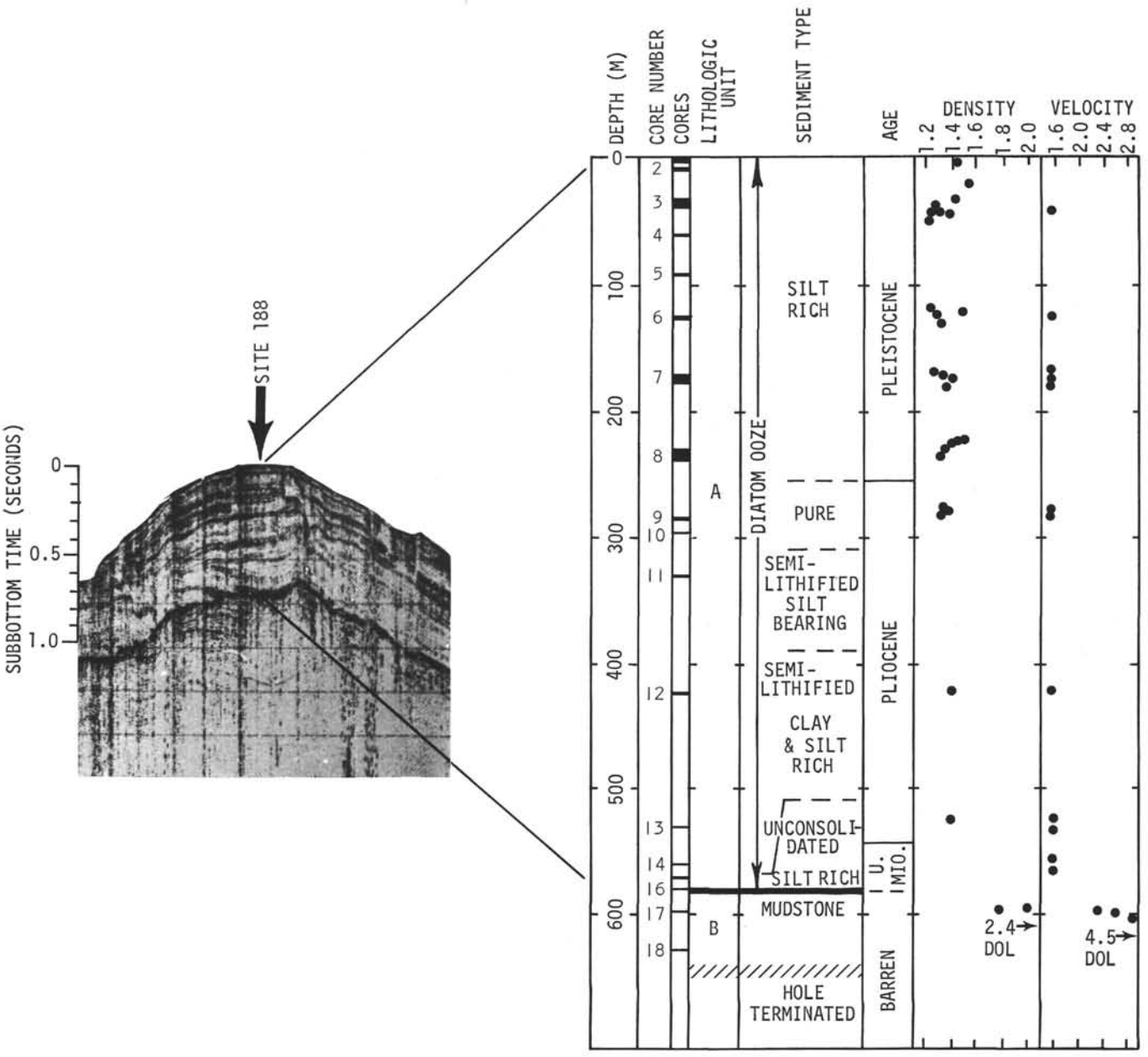
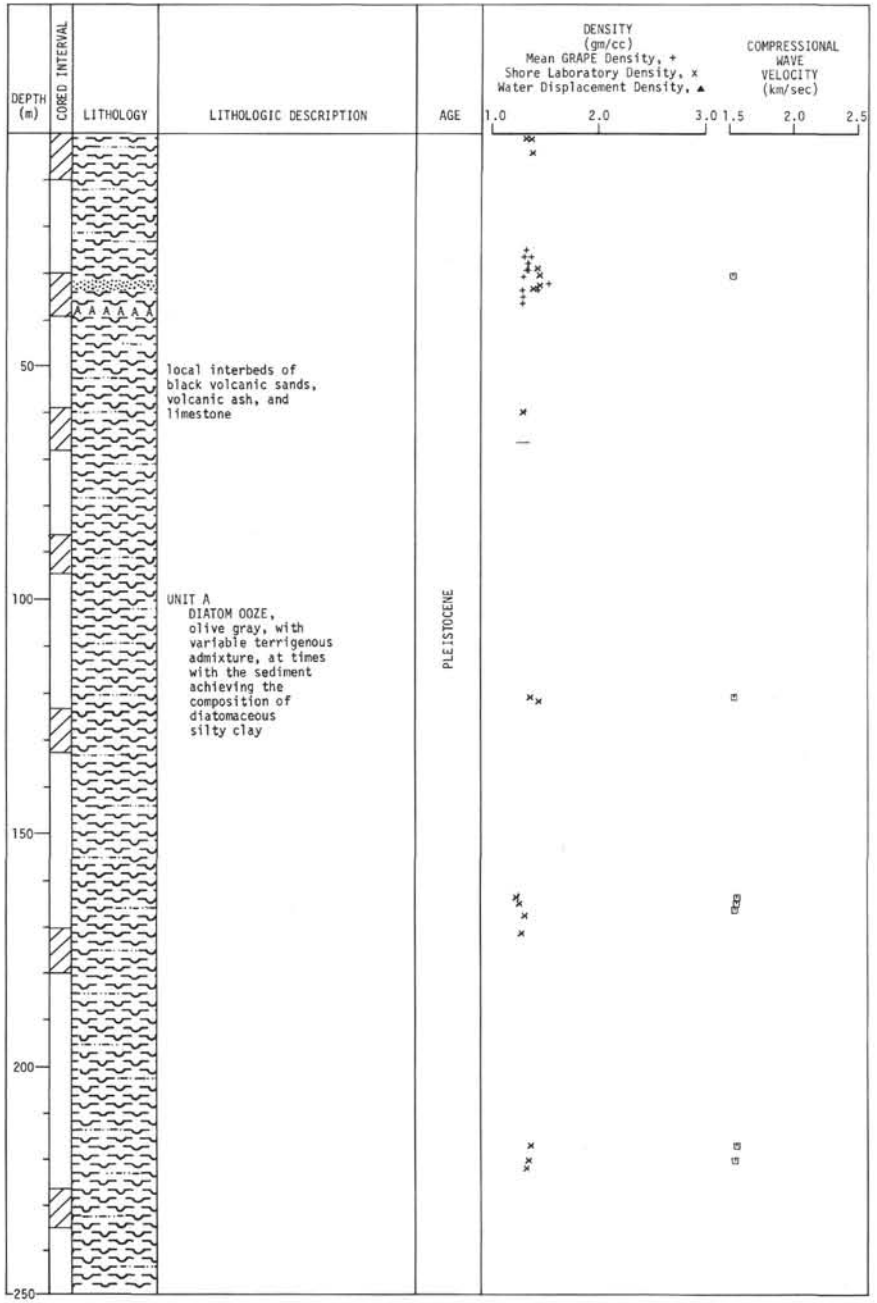
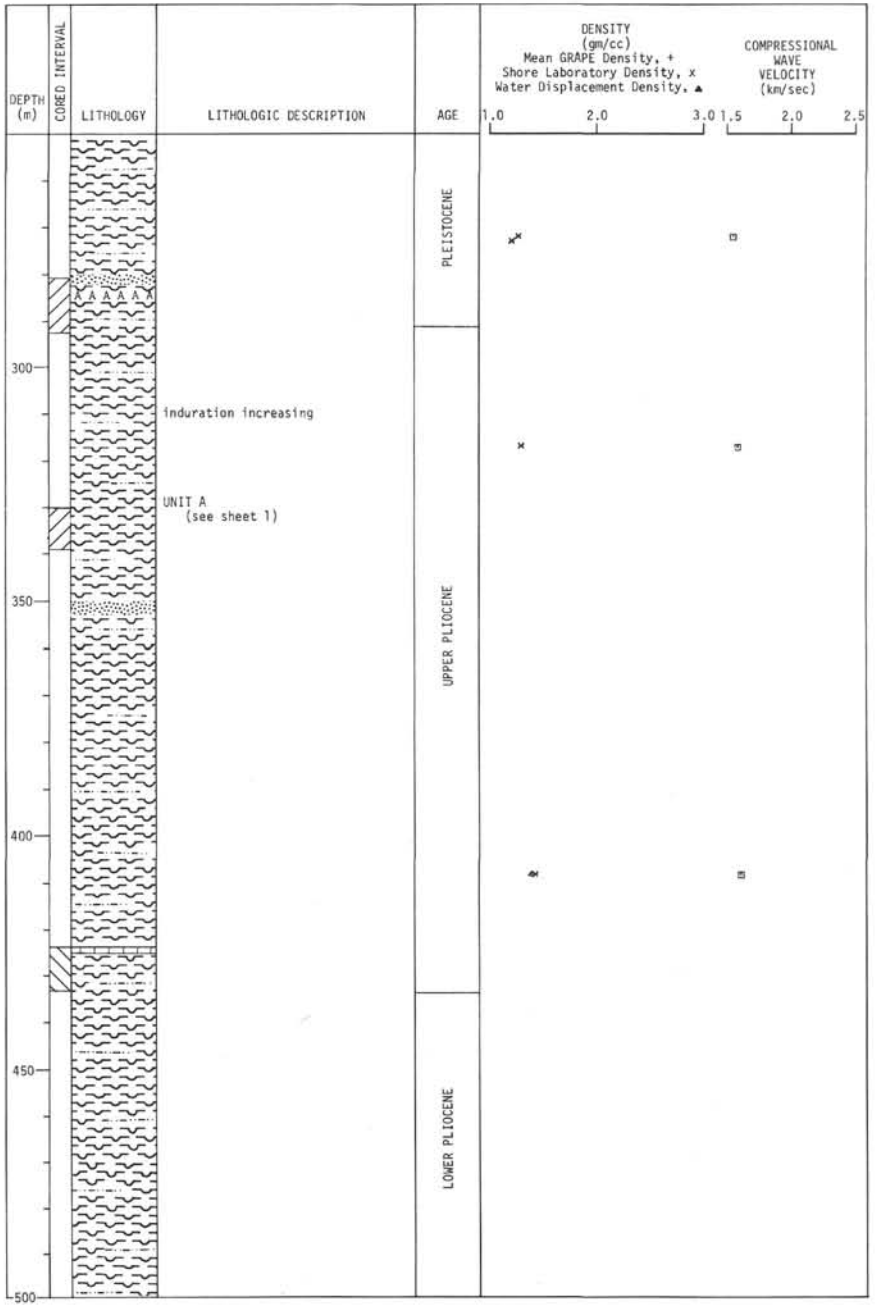


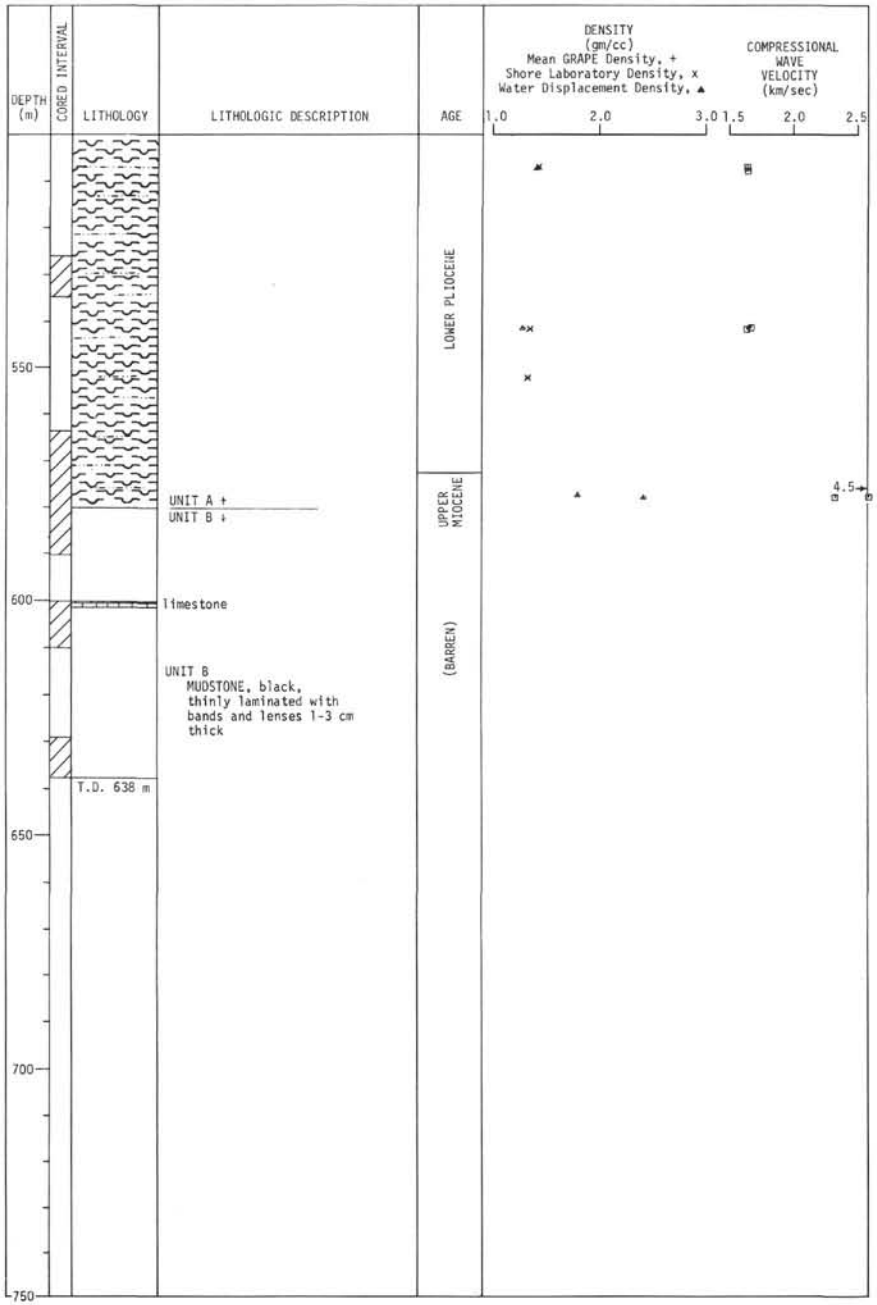
Figure 5. *Correlation of seismic reflection profile with physical properties and lithologic column, Site 188.*

SITE 188



SITE 188




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
550
600
650
700
750
LOWER PLIOCENE
UPPER MIOCENE
(BARREN)
UNIT A +
UNIT B +
limestone
UNIT B
MUDSTONE, black, thinly laminated with bands and lenses 1-3 cm thick
T.D. 638 m
4.5

SITE 188

Site 188 Hole Core 1 Cored Interval: 0-1

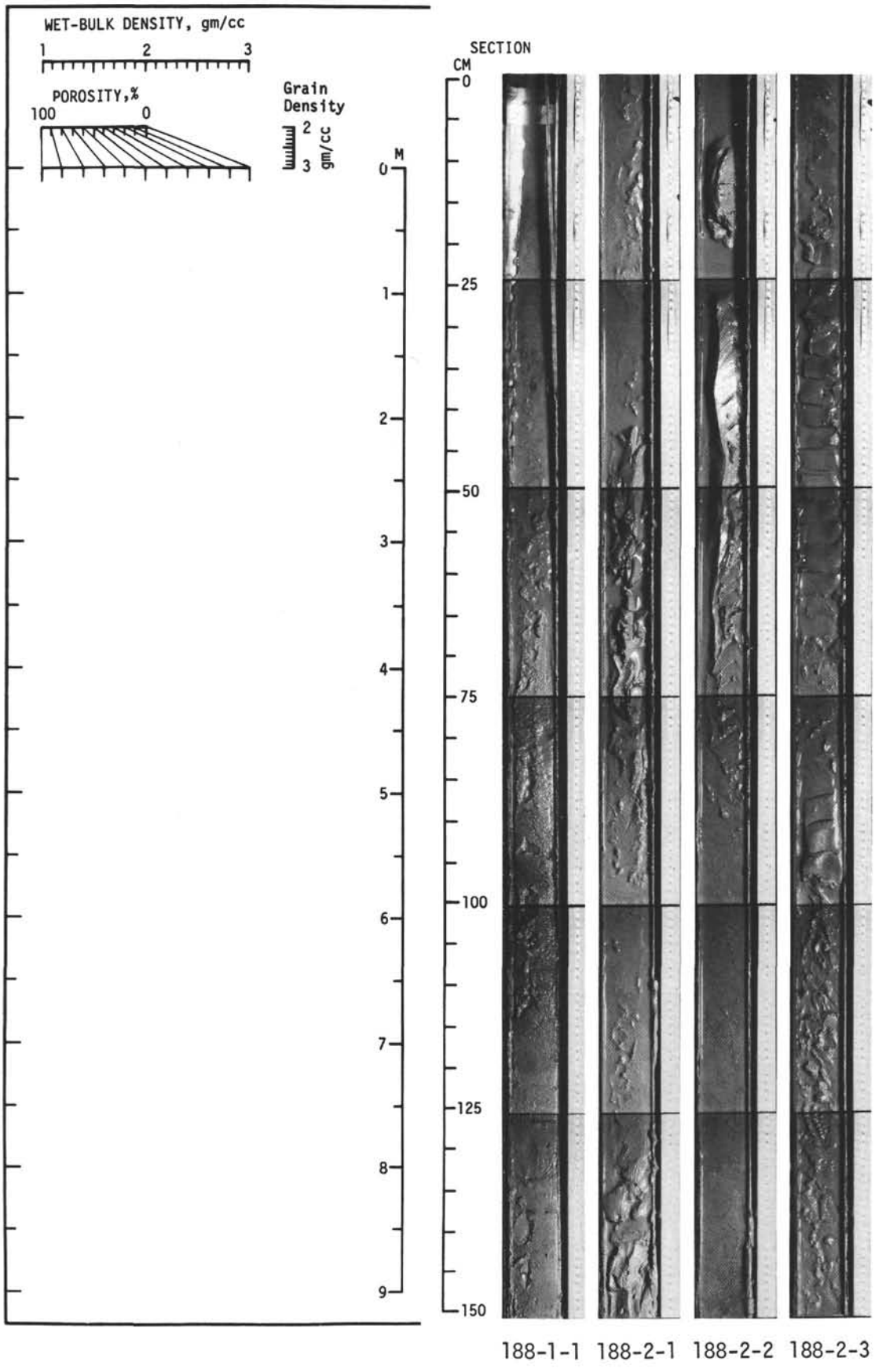
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLEISTOCENE	(D) Denticula seminae *	PF BF D R S N PF BF	A C A F C A A C	M G M M G M	1	0.5 1.0	VOID		-107 -125	SILT RICH, SPICULE RICH CLAYEY DIATOM OOZE olive gray (5Y 3/2) 105-110 cm FORAM BEARING DIATOM OOZE moderate olive brown
		D N R S	A - F R	G - M M	Core Catcher					

*(S) Distephanus octangulatus

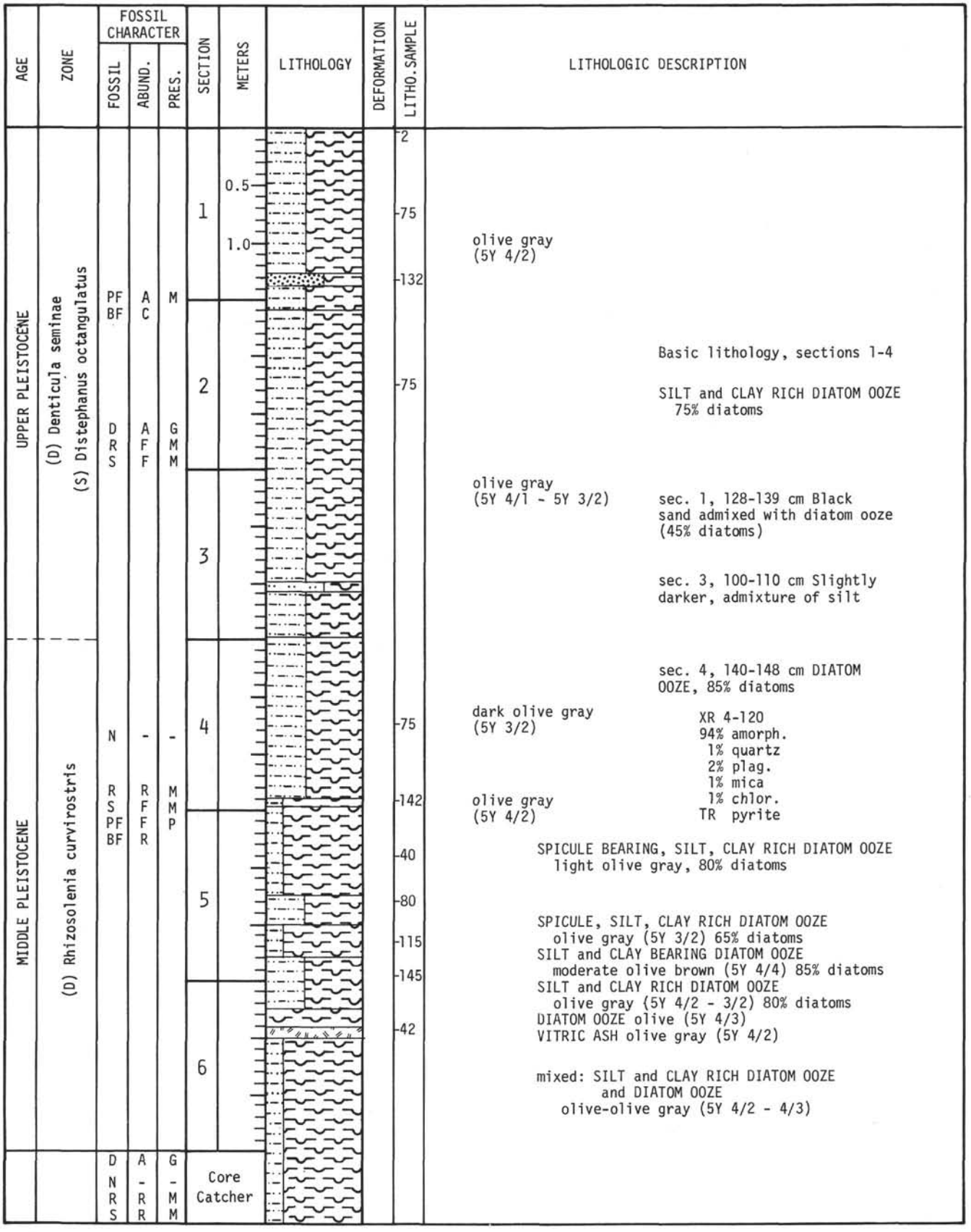
Site 188 Hole Core 2 Cored Interval: 1-10

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLEISTOCENE		PF BF N	C F -	M - -	1	0.5 1.0			1 -56 2 1 -120 2	1. SILT, CLAY, SPICULE BEARING DIATOM OOZE grayish olive (10Y 4/2) 2. SILT BEARING, CLAYEY DIATOM OOZE olive gray (5Y 3/2)
					2				-75	Slide 1-56 65% diatoms 25% clay 10% silt Slides 2-75, 3-75 80% diatoms 10% clay 10% quartz, feldspar sponge spicules
		N PF BF	- F -	- P	3				1 -75	Slide 1-120 85% diatoms 10% clay 5% silt
		D N R S	A - R R	G - M M	Core Catcher					

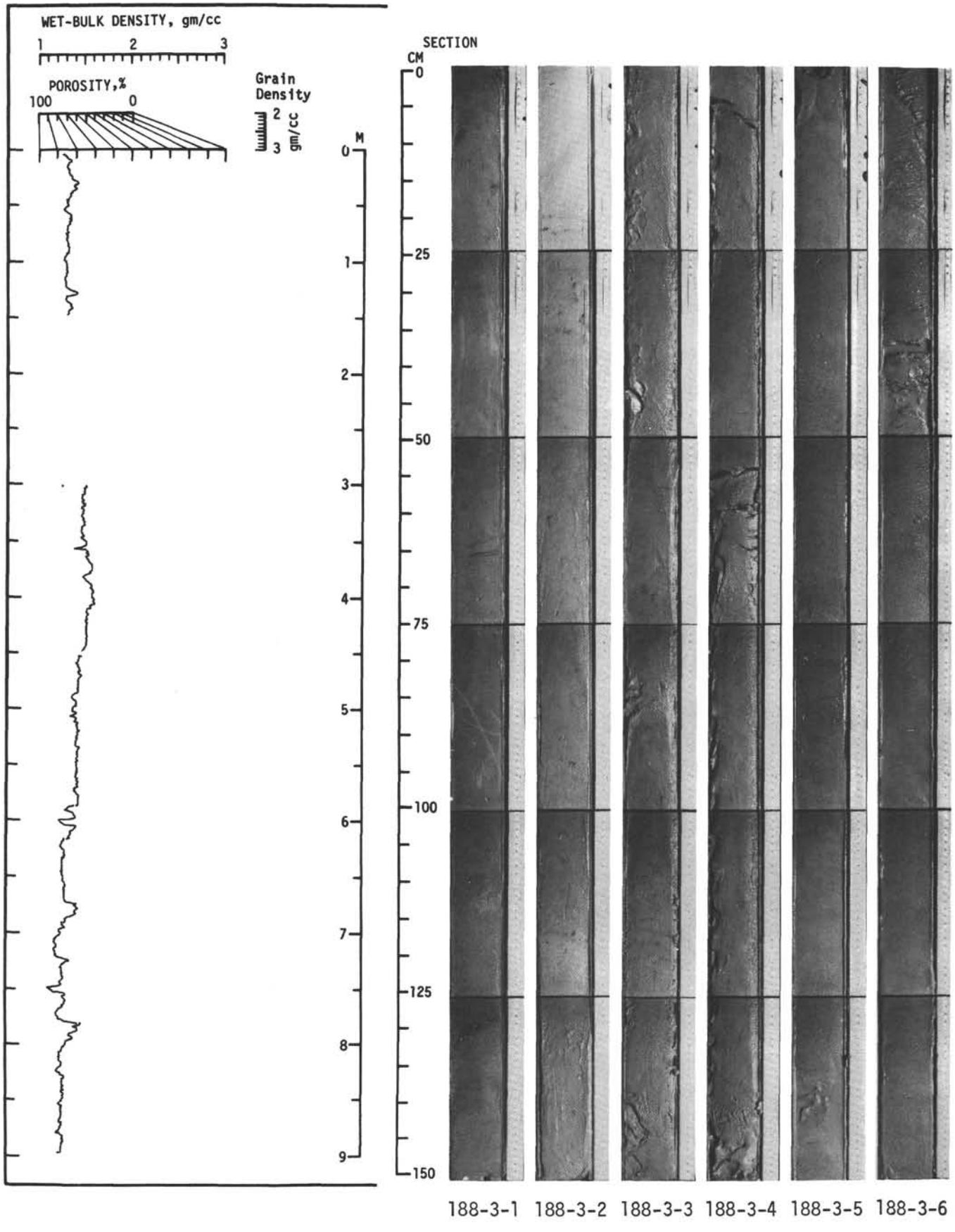
Explanatory notes in Chapter 1


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
188-1-1
188-2-1
188-2-2
188-2-3

Site 188 Hole Core 3 Cored Interval: 30-39



Explanatory notes in Chapter 1


WET-BULK DENSITY, gm/cc
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POROSITY,%
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Grain Density
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6
7
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9
SECTION
CM
0
25
50
75
100
125
150
188-3-1
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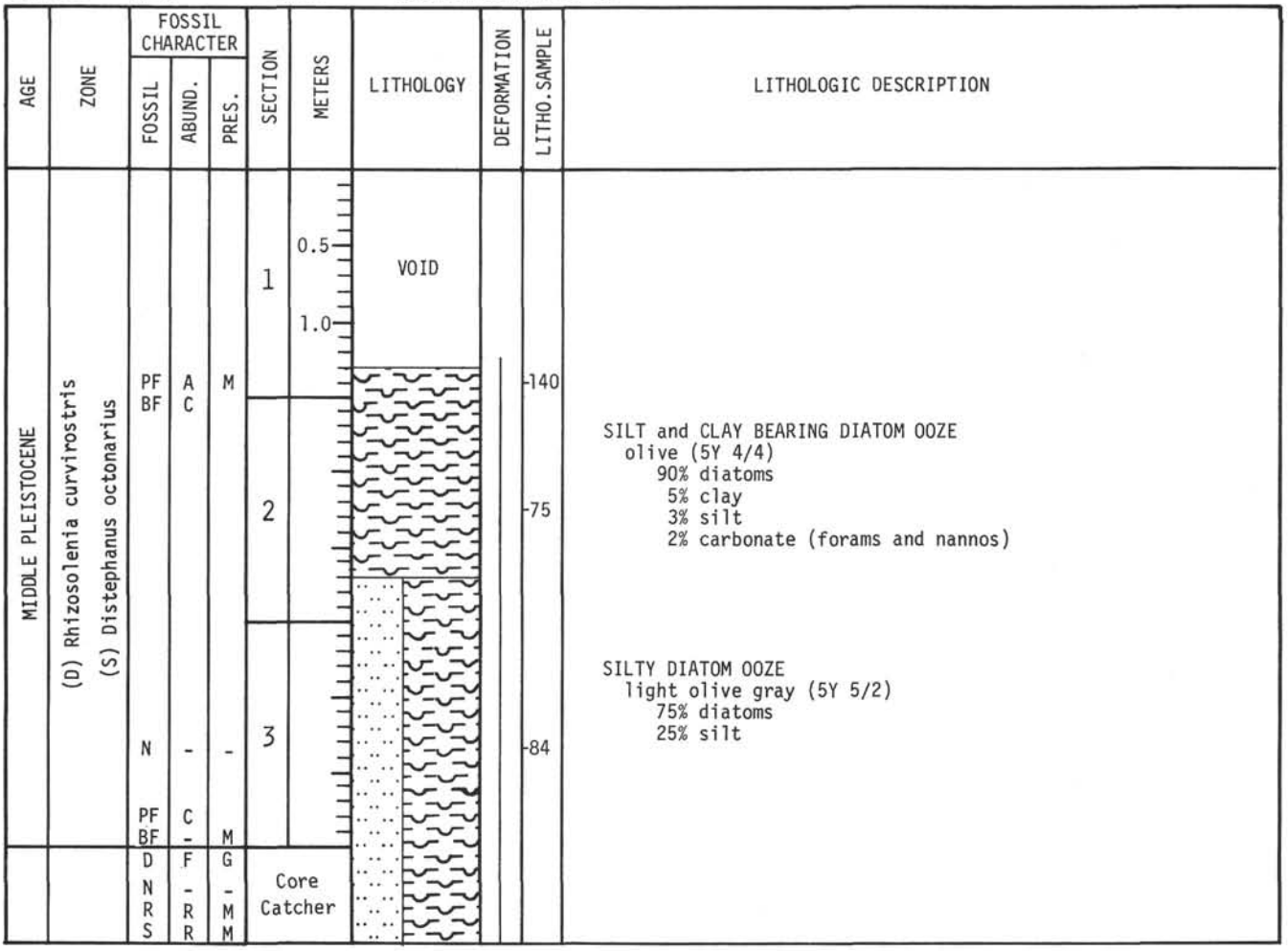
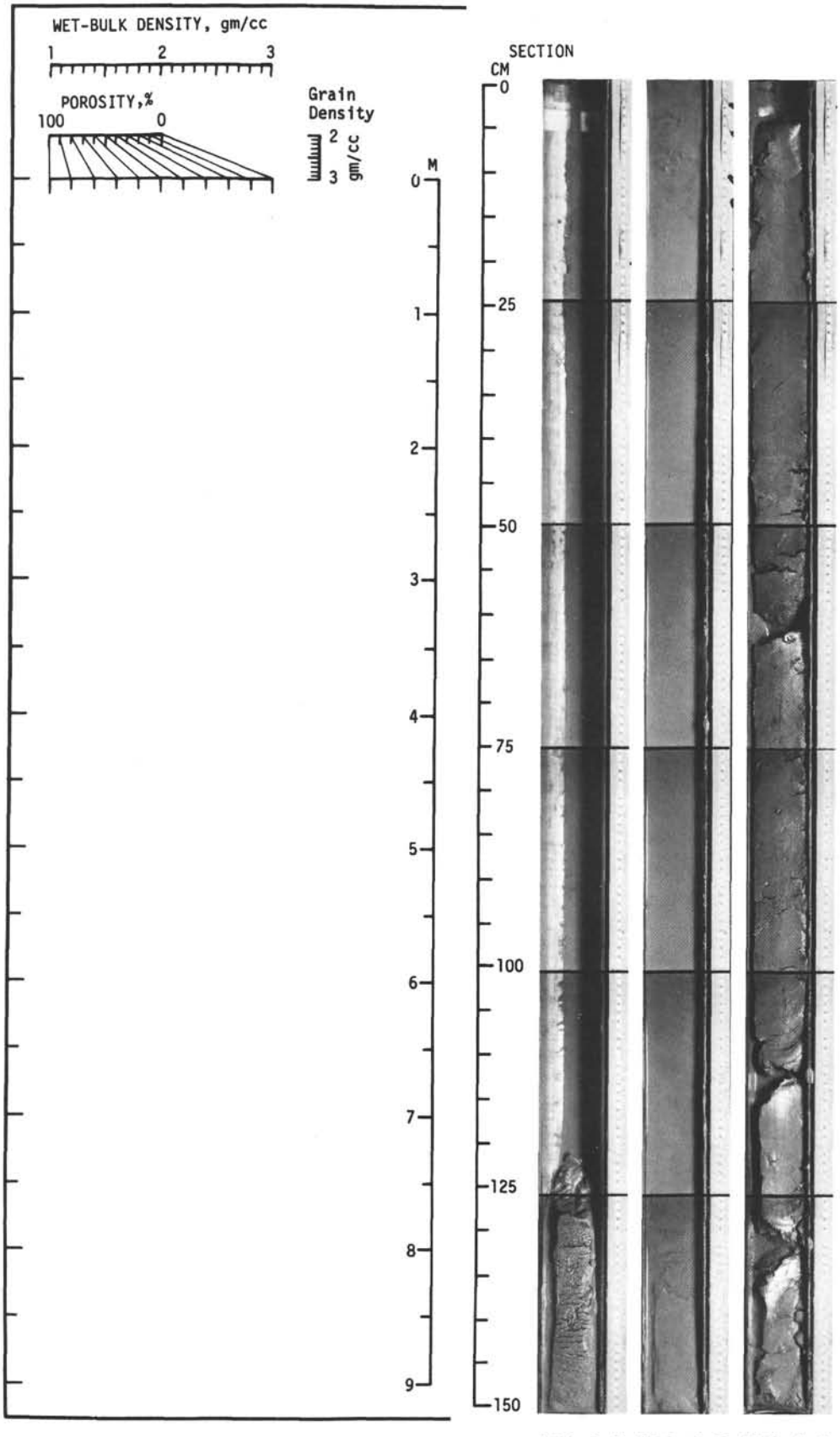
188-3-4
188-3-5
188-3-6

Site 188 Hole Core 4 Cored Interval: 59-68



Explanatory notes in Chapter 1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gm/cc
M
0
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2
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8
9
SECTION
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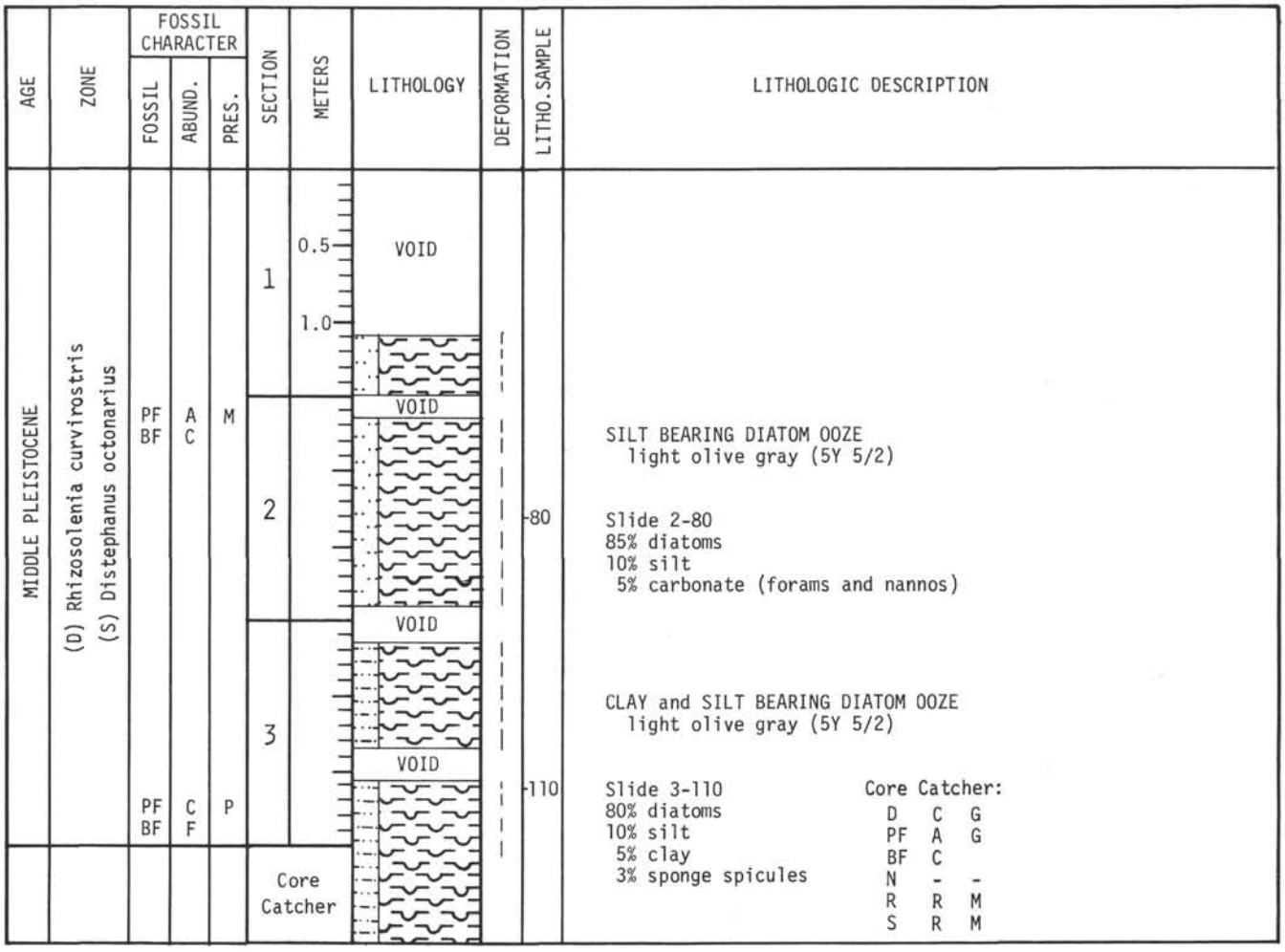
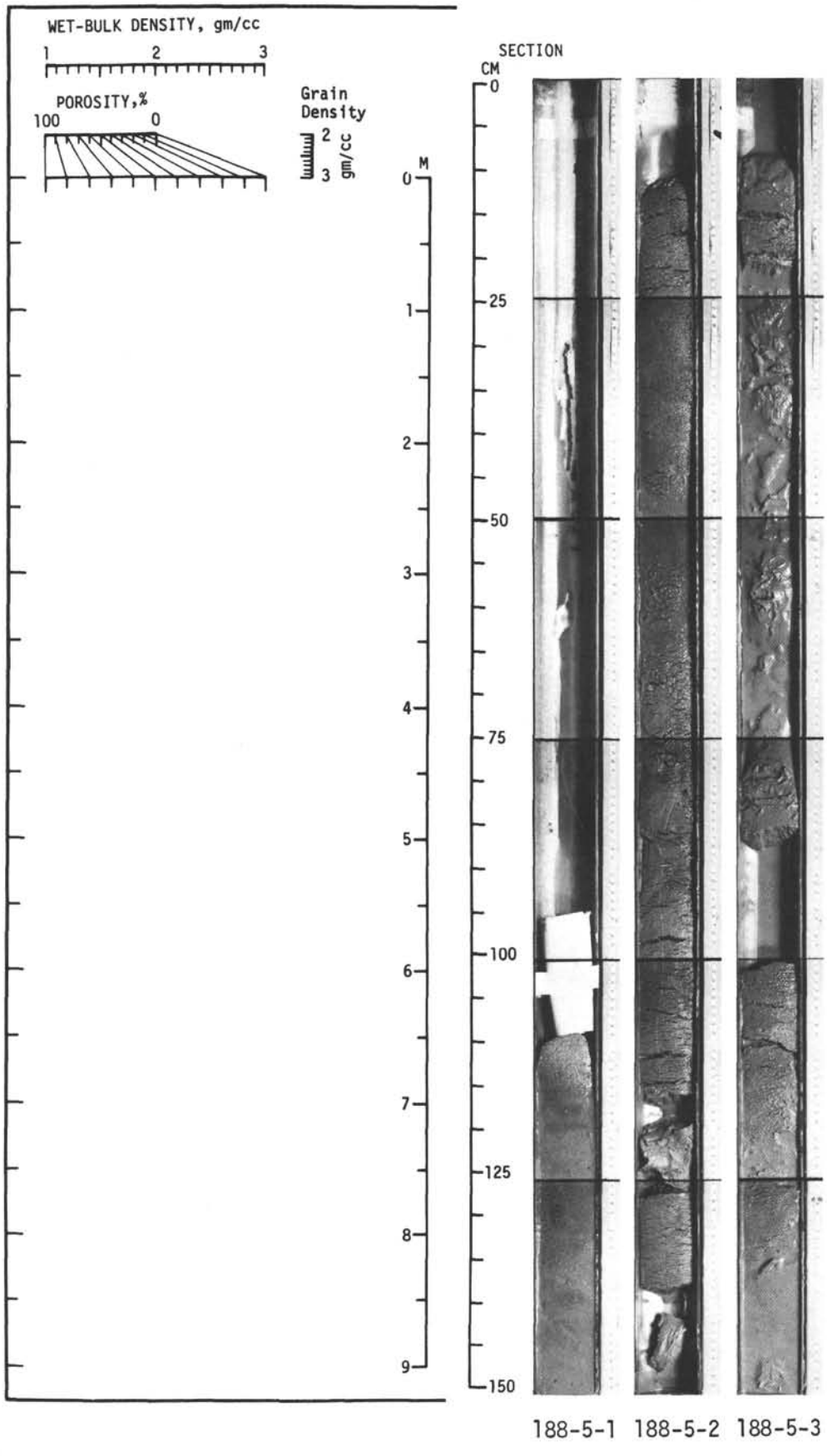
150
188-4-1
188-4-2
188-4-3

Site 188 Hole Core 5 Cored Interval: 87-96



Explanatory notes in Chapter 1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Grain Density
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gm/cc
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2
3
4
5
6
7
8
9
SECTION
CM
0
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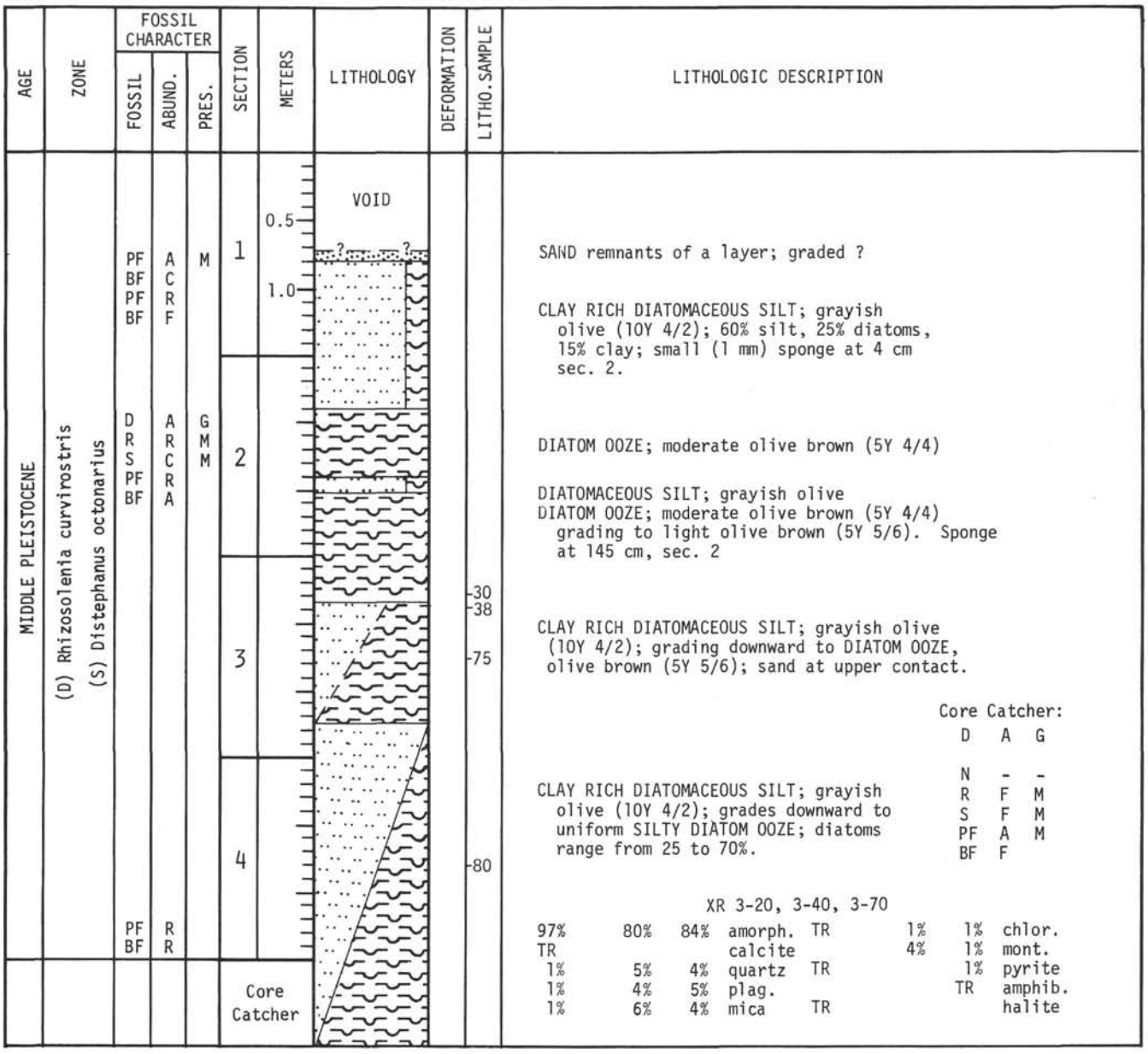
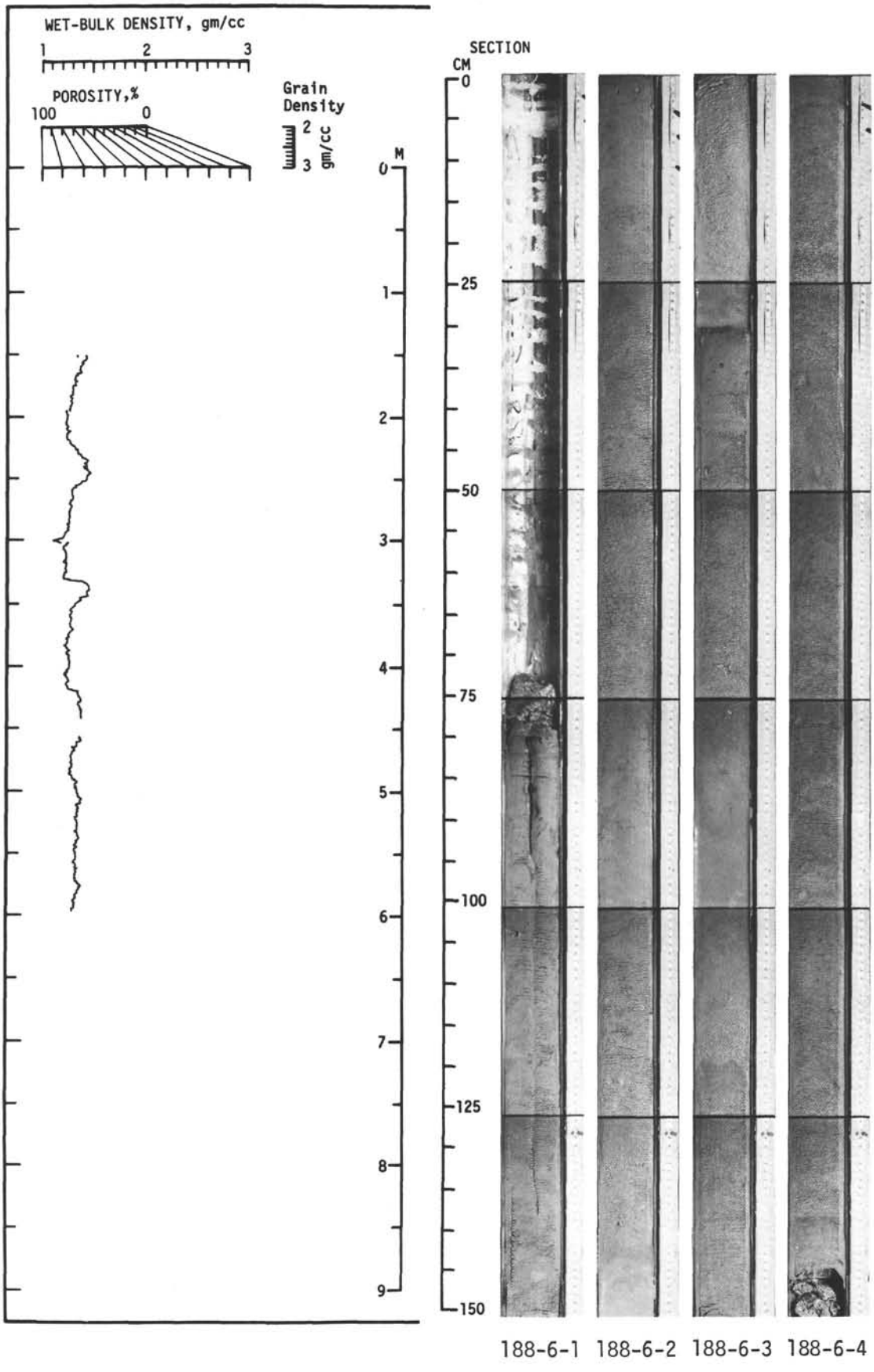
75
100
125
150
188-5-1
188-5-2
188-5-3

Site 188 Hole Core 6 Cored Interval: 124-133



Explanatory notes in Chapter 1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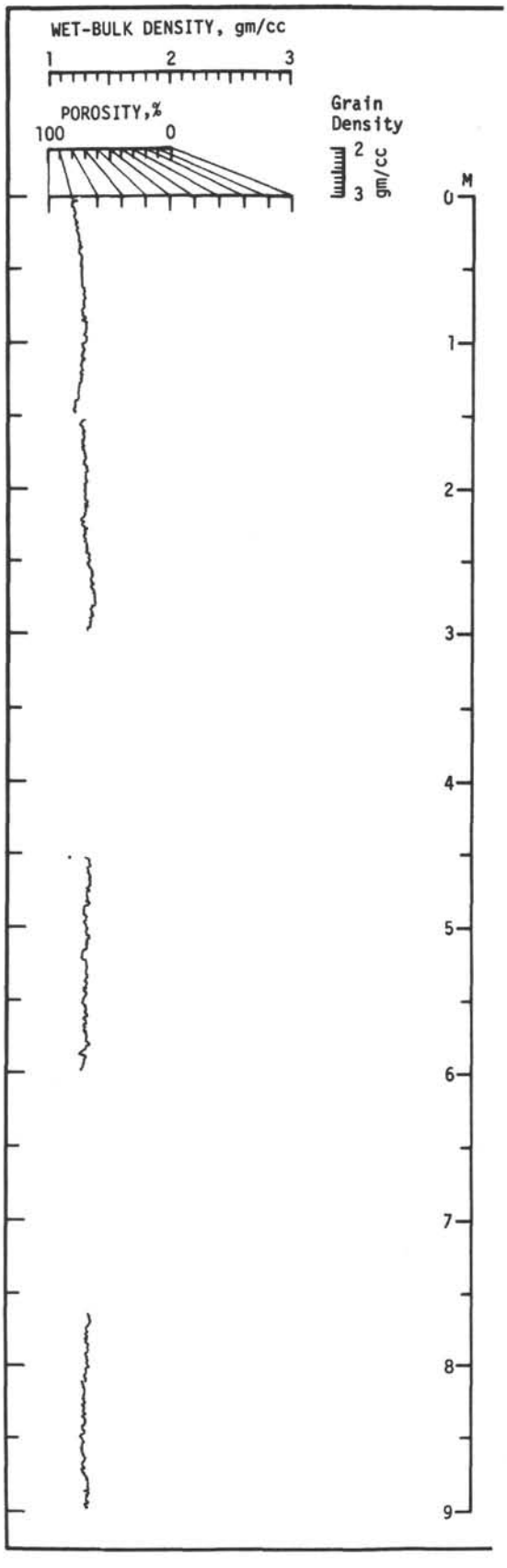
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
188-6-1
188-6-2
188-6-3
188-6-4

Site 188 Hole Core 7 Cored Interval: 171-180

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLEISTOCENE	(D) Actinocyclus oculatus (S) Dictyocha subarctios	PF BF	- R	-	1	0.5				
		N D R S	- A R A	- G M G		1.0			-149	zone of pure diatom ooze
					2					Basic lithology SILT BEARING to SILTY DIATOM OOZE grayish olive (10Y 4/2)
					3				-75	streaks and pods of DIATOM OOZE light olive brown (5Y 5/6)
		R S	F A	M G	4					fossil fragments
					5					XR 3-80 87% amorph. 2% quartz 5% plag. 2% mica 1% chlor. 3% mont. 1% pyrite
		PF BF	C R	M	6					
					Core Catcher					Core Catcher: D A G PF A M BF C N C M R R M S R M

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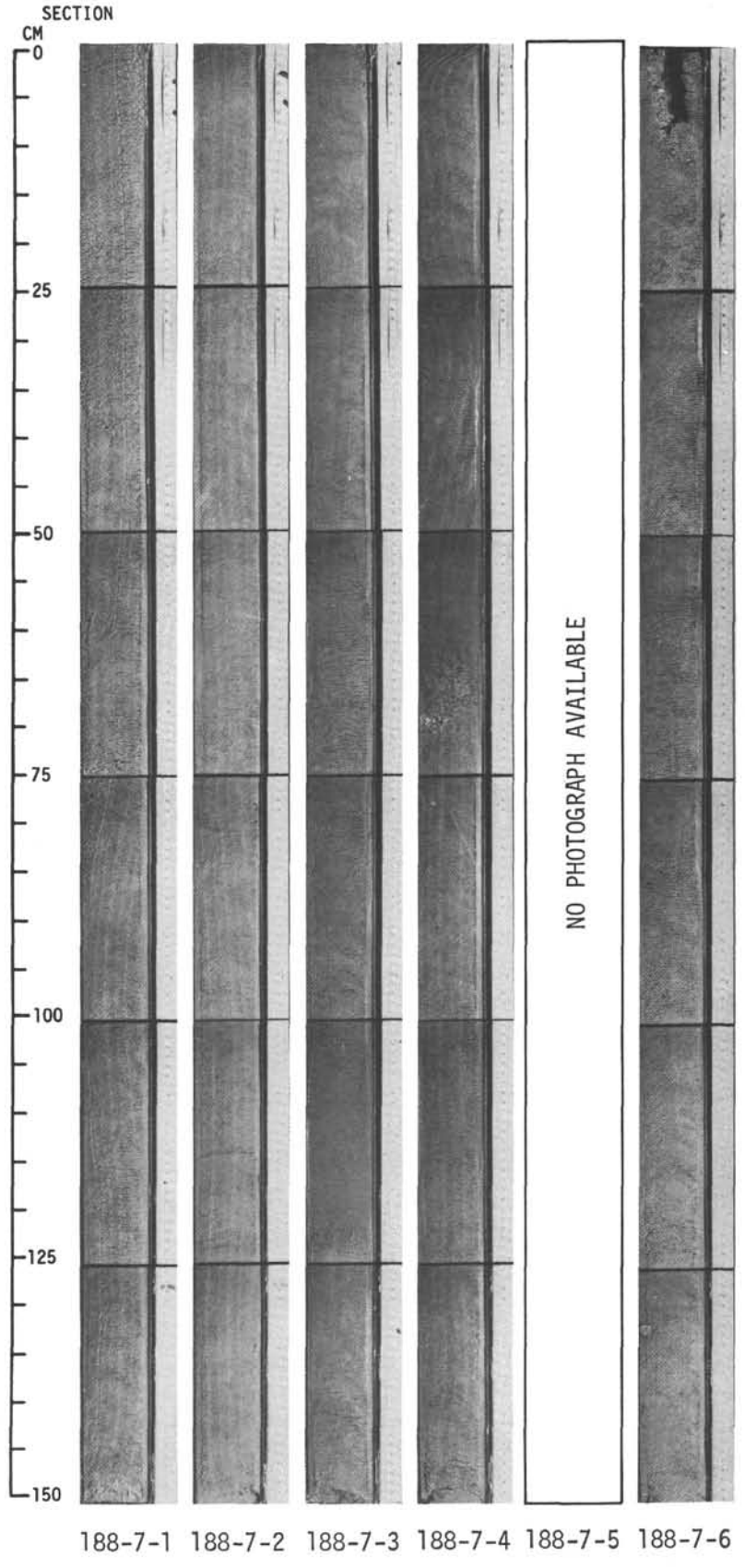
2
3
4
5
6
7
8
9


SECTION
CM
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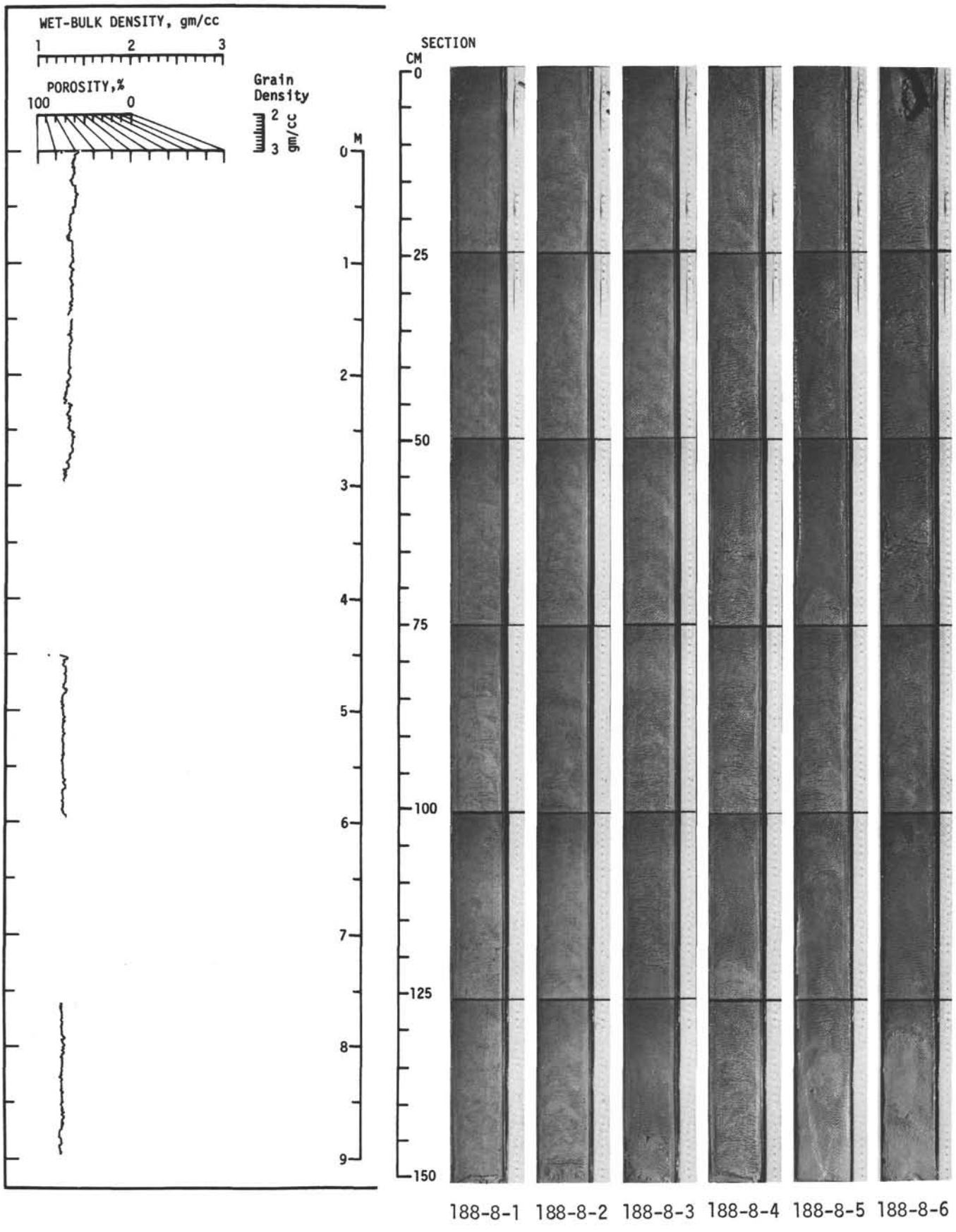
50
75
100
125
150
NO PHOTOGRAPH AVAILABLE
188-7-1
188-7-2
188-7-3
188-7-4
188-7-5
188-7-6

Site 188 Hole Core 8 Cored Interval: 227-236

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLEISTOCENE	(D) Actinocyclus oculatus (S) Dictyocha subarctios	PF BF N D R S	R F - A - A	- G -	1 2 3 4 5 6	0.5 1.0			-20	SILT RICH DIATOM OOZE olive gray (5Y 4/2) gradational change DIATOM OOZE olive (5Y 4/3) Core Catcher: D A G PF R M BF R N - - R R M S R M
		PF BF	- R		Core Catcher				-140	

Explanatory notes in Chapter 1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3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
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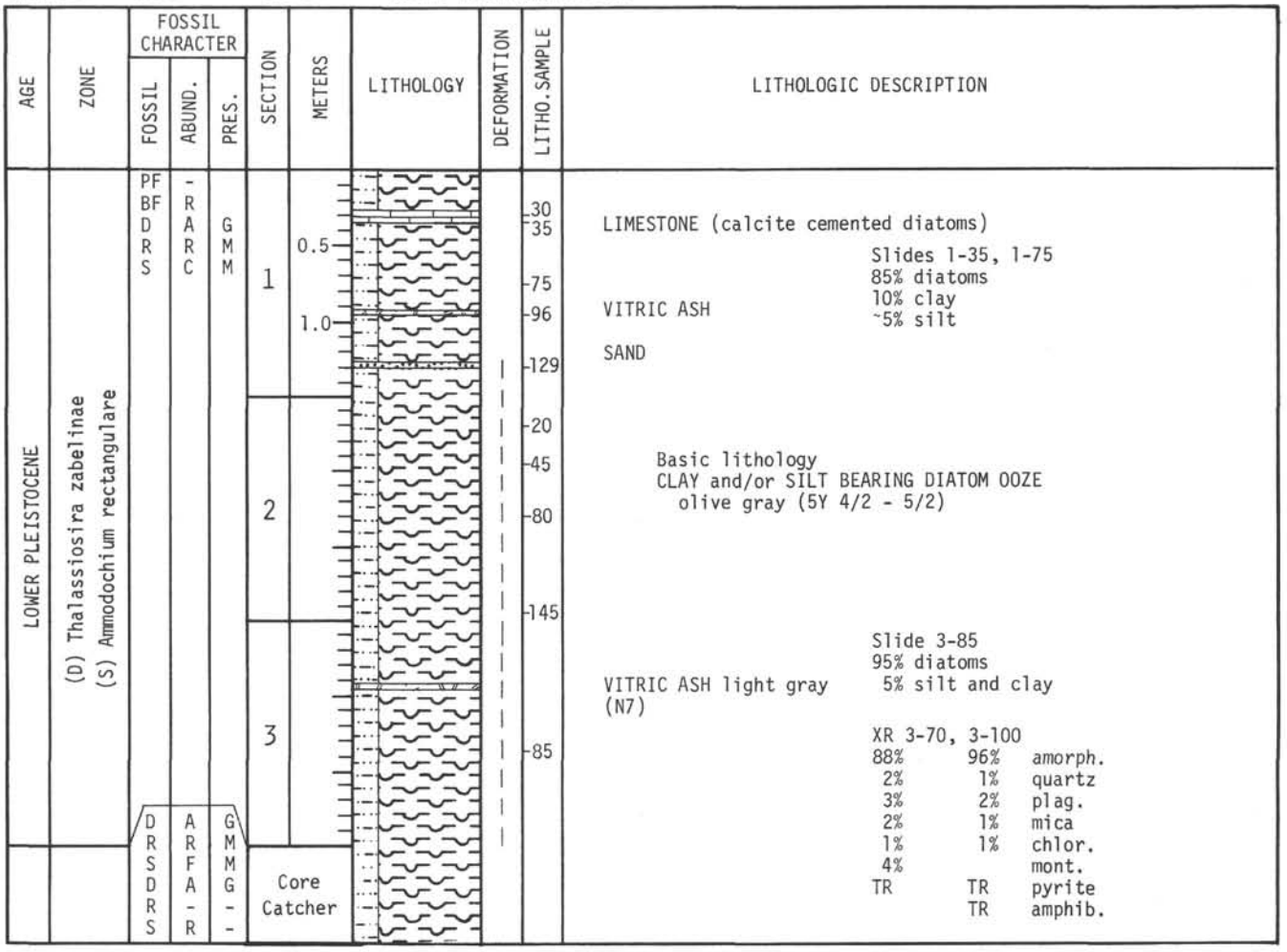
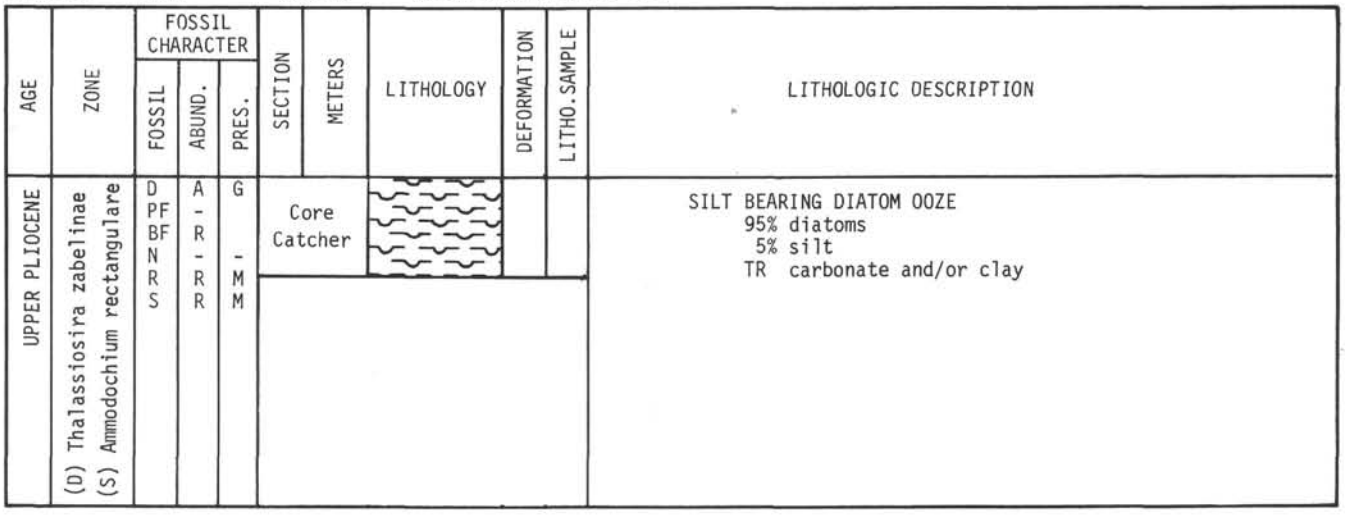
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
188-8-1
188-8-2
188-8-3
188-8-4
188-8-5
188-8-6

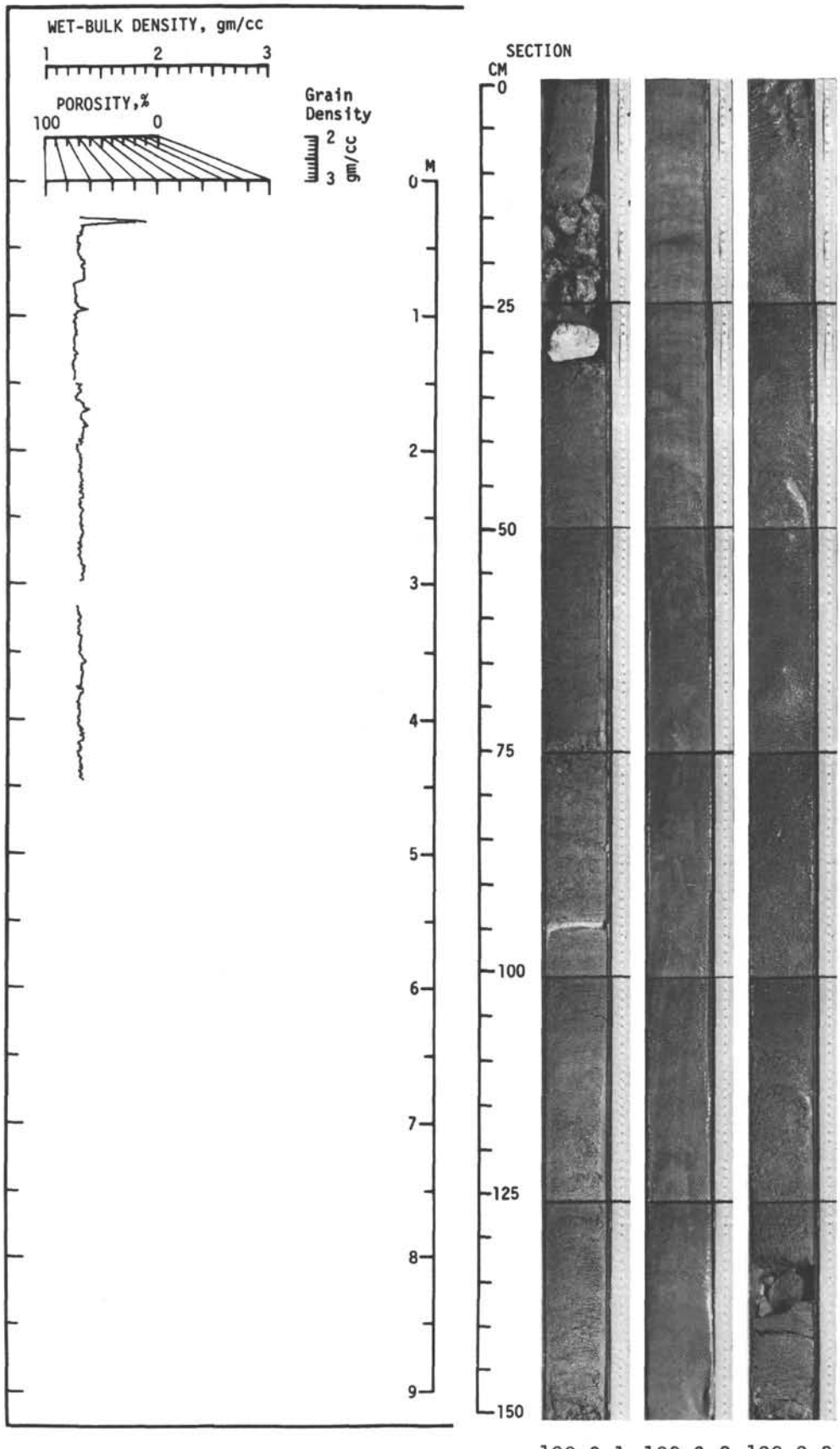
Site 188 Hole Core 9 Cored Interval: 283-292



Site 188 Hole Core 10 Cored Interval: 292-293



Explanatory notes in Chapter 1



188-9-1 188-9-2 188-9-3

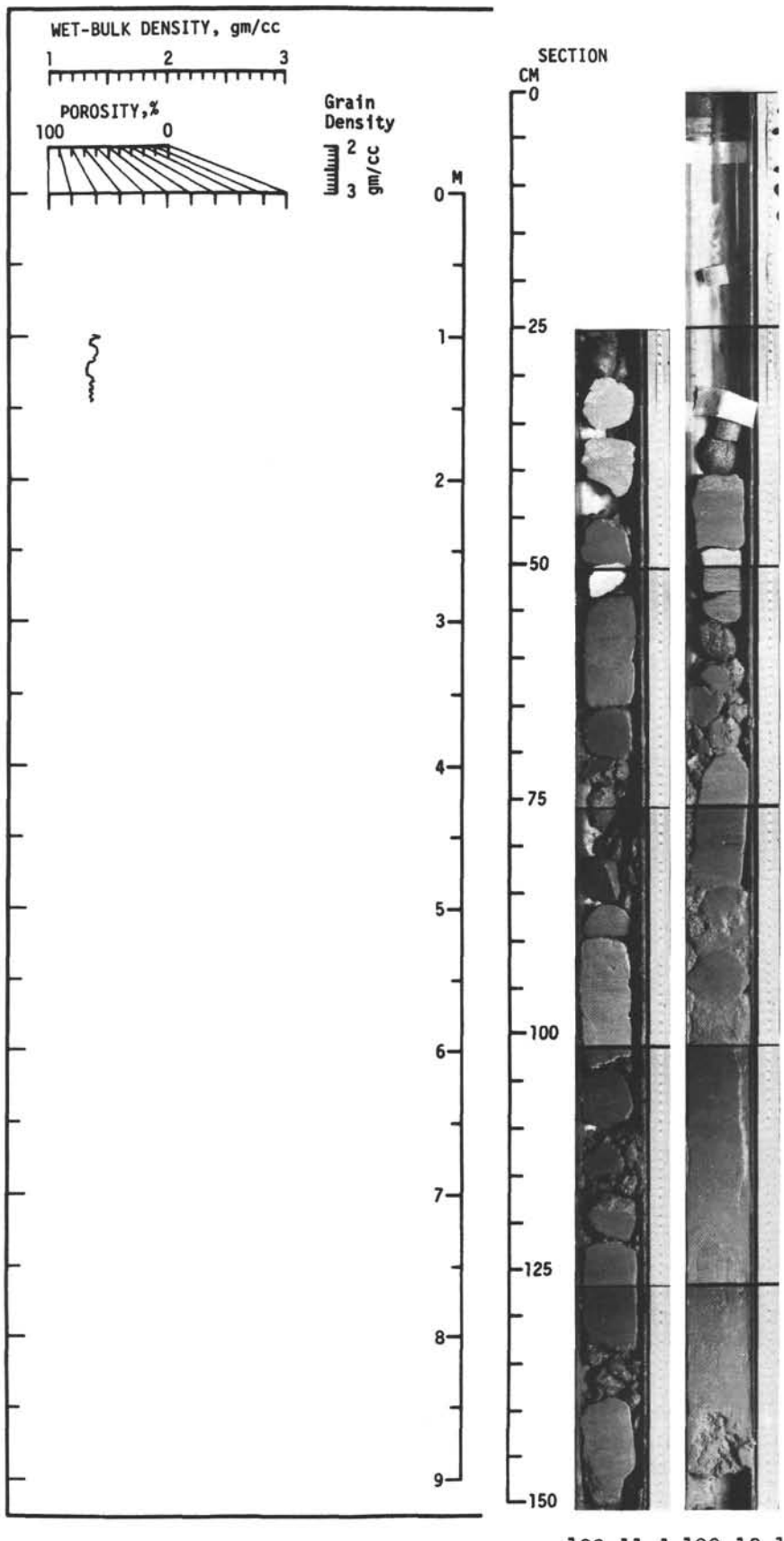
Site 188 Hole Core 11 Cored Interval: 330-339

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	*	D R S	A R F	G M M	1	0.5 1.0	VOID		-41 -?	Basic lithology SILT BEARING DIATOM OOZE brownish gray (10YR 4/1) 80 - 90% diatoms irregular lenses and pods of DIATOM OOZE, light olive gray (5Y 6/1), and PYRITE BEARING DIATOM OOZE, dark olive gray (5YR 3/1)
					Core Catcher					Core Catcher: D A G; PF - ; BF R ; N - - ; R R M ; S R M

Site 188 Hole Core 12 Cored Interval: 425-434

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	*	D R S	A R A	G M M	1	0.5 1.0	VOID		-93	LIMESTONE yellowish gray (5Y 7/2) Basic lithology CLAY BEARING, SILTY RICH DIATOM OOZE grayish olive (10Y 4/2) Slide 1-93: 75% diatoms; 20% silt; 5% clay XR 1-110: 80% amorph., 5% quartz, 7% plag., 4% mica; 2% chlor., 2% mont., 1% pyrite, TR amphib.
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica (S) Ebriopsis antiqua (without spine)	D PF BF N R S	A - - - R F	G - - - M M	Core Catcher					

Explanatory notes in Chapter 1 *(D) Thalassiosira zabelinae
(S) Ammodochium rectangulare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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
188-11-1
188-12-1

Site 188 Hole Core 13 Cored Interval: 527-536

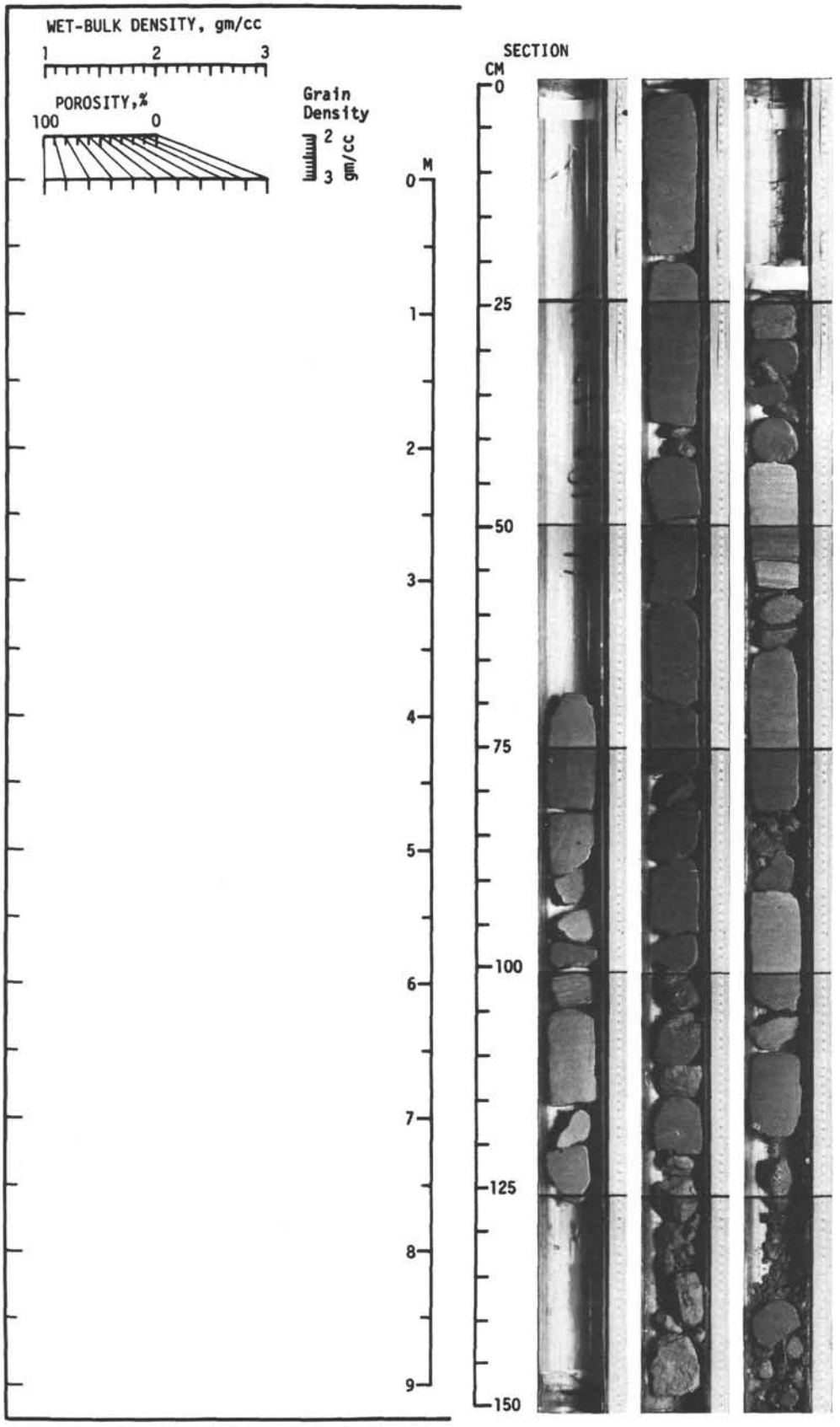
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLIOCENE	(D) Denticula seminae - D. kamtschatica (S) Cannopilus hemisphaericus *	D R S	A R C	G M M	1	0.5 1.0	VOID		110	SILT and CLAY RICH DIATOM OOZE grayish olive (10Y 4/2) to light olive gray (5Y 5/2) generally uniform but with a few burrows and scattered sponge remains pod of CLAY RICH DIATOM OOZE 75 - 85% diatoms 5 - 15% clay 0 - 20% silt Core Catcher: D C G N - - R R M S F M
					2				75 125	
					Core Catcher					

(S) Ebriopsis antiqua (without spine)

Site 188 Hole Core 14 Cored Interval: 564-573

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE / LOWER PLIOCENE	(D) Denticula kamtschatica (S) Cannopilus hemisphaericus (S) Distephanus speculum var. pentagonus	R S	F C	M M	1	0.5 1.0	VOID		80 105	SILT RICH DIATOM OOZE moderate olive brown (5Y 4/4) pyrite associated with diatoms (up to 15% pyrite) semi-lithified core catcher sample contains small (3 x 2 x 1 cm) fragments of hard MUDSTONE, olive black XR 1-130 84% amorph. 3% quartz 6% plag. 1% mica 1% chlor. 3% mont. 1% pyrite TR halite
		D N R S	A - R R	G - M M	Core Catcher					

Explanatory notes in Chapter 1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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
188-13-1
188-13-2
188-14-1

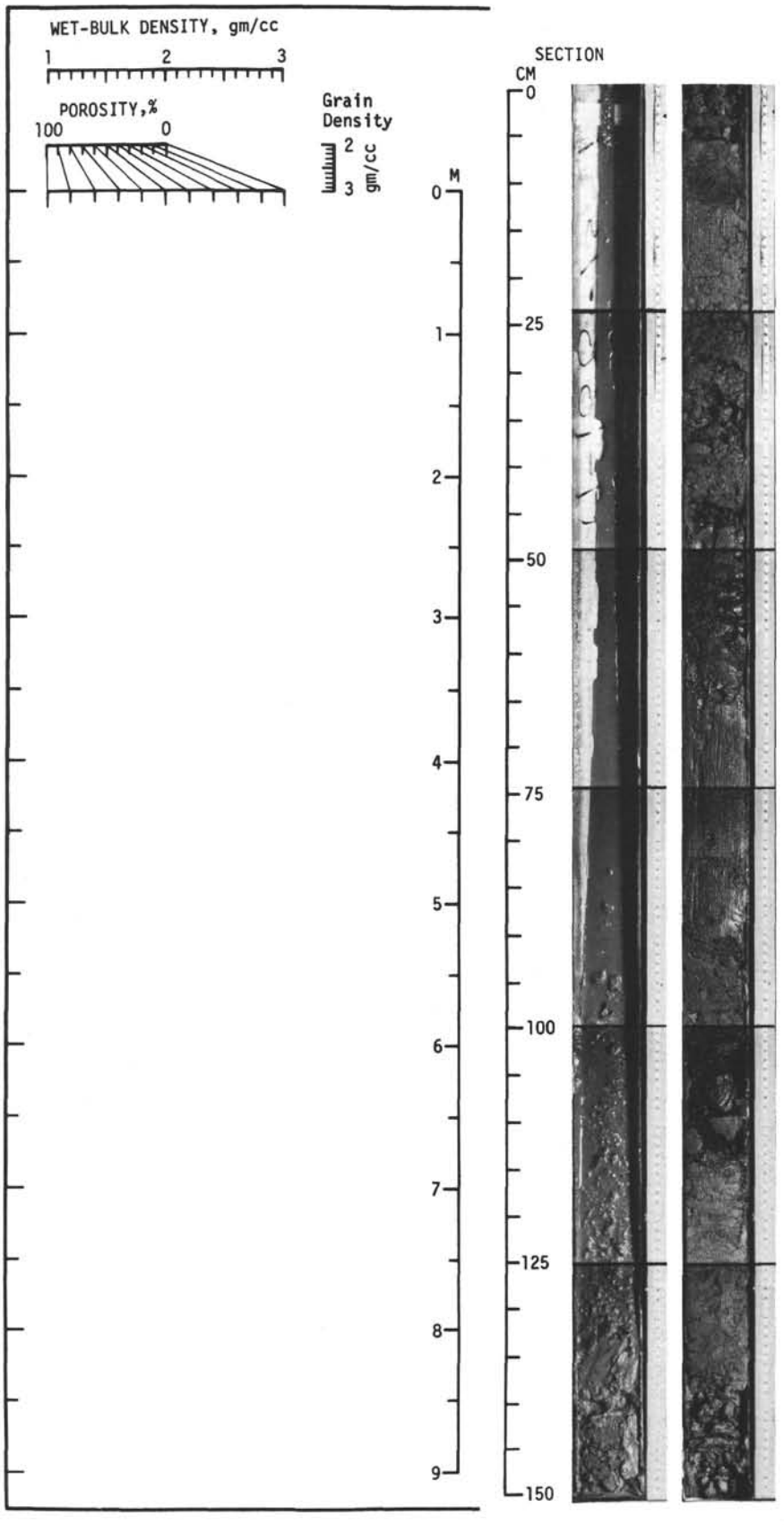
Site 188 Hole Core 15 Cored Interval: 573-582

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE	(D) Denticula kamtschatica (S) Distephanus speculum var. pentagonus	R S	F R	M M	1	0.5 VOID 1.0				CLAY BEARING SILT RICH DIATOM OOZE light olive brown (5Y 5/6) Slide 2-80 70% diatoms, 25% silt, 5% clay
					2				-80	XR 2-120 93% amorph. TR calcite 1% quartz 4% plag. TR mica 1% chlorite 1% mont. TR pyrite
									-130	Core Catcher: D A G; PF -; BF -; N - -; R R M; S R M
										MUDSTONE olive black (5Y 2/1)
					Core Catcher					SILT and CLAY BEARING DIATOM OOZE dusky yellowish brown (10YR 2/2) Slide 2-130 85% diatoms, 10% silt, 5% clay
										core catcher sample contains fragments of mudstone similar to that in section 2

Site 188 Hole Core 16 Cored Interval: 582-591

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		D N R S	R R - -	P M - -	Core Catcher					MUDSTONE olive gray (5Y 4/1) fragments

Explanatory notes in Chapter 1



188-15-1 188-15-2

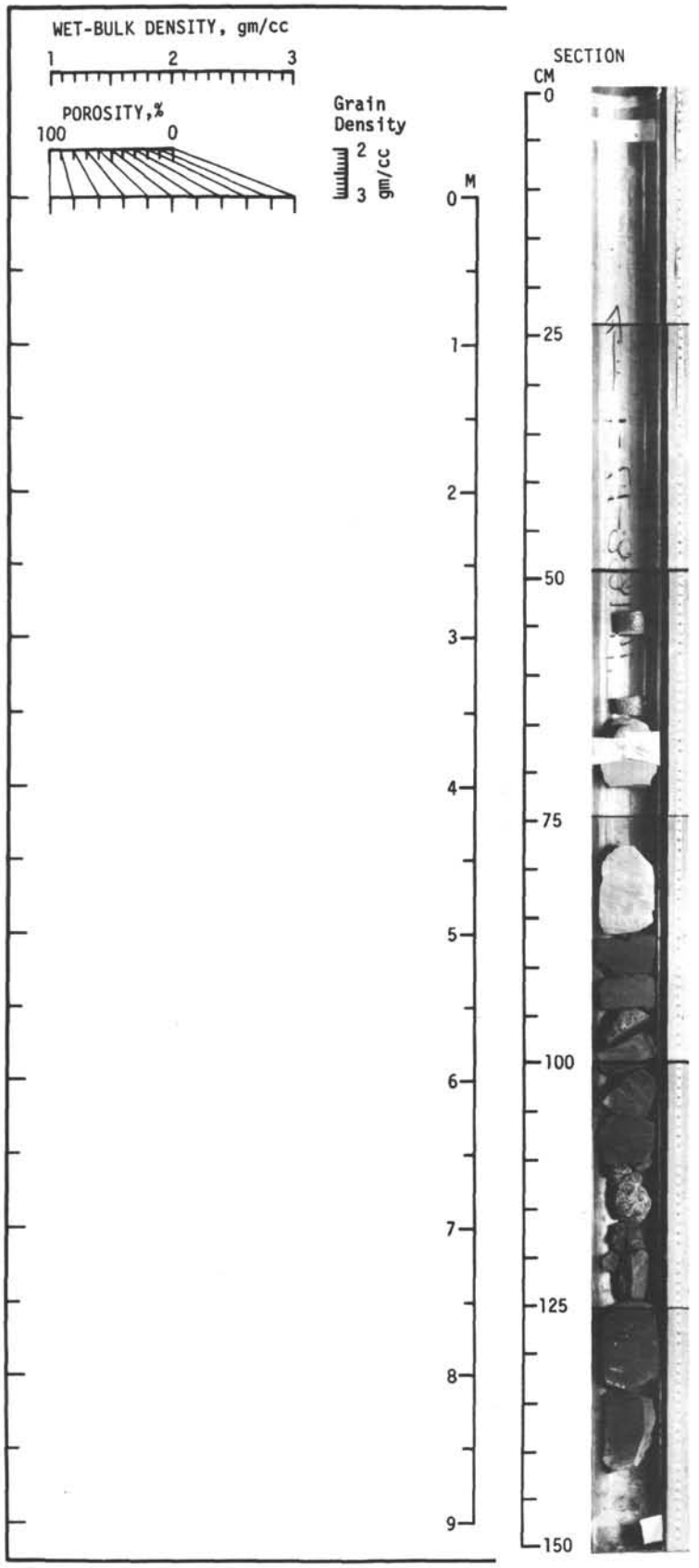
Site 188 Hole Core 17 Cored Interval: 601-610

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		D R S	R - -	M - -	1	0.5 1.0	VOID			XR 1-80, 1-90, 1-100 41% 87% 84% amorph. 55% dolomite 1% TR 1% quartz 11% 12% cristo. DOLOMITE light olive gray (5Y 5/2) 2% 1% 1% plag. TR mica TR TR chlor. MUDSTONE black (5Y 2/2) TR TR mont. TR clinop. few scattered sponge remains TR TR pyrite rare diatom fragments, largely dissolved and unidentifiable
		D PF BF N R S	- - R - - -	- - - - - -	Core Catcher				-135	

Site 188 Hole Core 18 Cored Interval: 629-638

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		D N R S	- - - -	- - - -	Core Catcher					MUDSTONE olive black (5Y 3/1)

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

188-17-1