8. SITE 189

The Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 18-22 Aug 71.

Position:
54°02.14′N
170°13.38′E.

Water Depth: 3437 meters.

Penetration: 871 meters.

Number of Holes: One.

Number of Cores: 20.

Total Core Recovered: 74.2 meters.

Acoustic Basement:
Depth: 730 meters
Nature: Sediments, possibly deformed
Velocity: Approximately 2.3 km/sec.

Age of Oldest Sediment: Upper Miocene.

Basement: Upper Miocene or older.

SUMMARY

Site 189 is located on a deeply submerged ridge (3400 m) at the base of the north flank of the Aleutian Ridge, Bering Sea (Figure 1).

The 871-meter thick sediment and sedimentary rock sequence drilled and cored consists of a Pleistocene to Pliocene (0-260 m) diatomaceous silty clay to clay-rich diatom ooze, an upper Pliocene (260-370 m) diatom-, carbonate-, and pyrite-bearing silty clay, and an upper Pliocene to upper Miocene and possibly older (370-871 m) mudstone sequence that includes sedimentary breccia.

Diatoms show a regular and gradual increase from ~5% at the top to ~40 to 50% at a depth of 260 meters (upper Pliocene). Discrete beds of ash and sand, pumice pebbles, and erratic sedimentary rock pebbles occur in the Pleistocene section. Part of the Pliocene section (260-360 m) is a transitional facies of silty clay with 5 to 10% diatoms showing solution effects and pyritization.

The mudstone (370-871 m) is mottled and burrowed with beds dipping up to 30 degrees below 640 meters and showing tension cracks normal to the bedding.

The prominent acoustic basement beneath Site 189 (0.87 sec total reflection time) was determined to be a deformed 20- to 40-meter thick sequence at 730 meters of size-graded sedimentary breccia and calcite-cemented sandstone of probable late Miocene age. Claystone with inclined bedding also occurs for about 100 meters above the breccia. This discovery implies that a thick apron or insular rise unit flanking the base of the Aleutian Ridge was arched after or during late Miocene time to form the Site 189 ridge. Since this time the ridge has received a thick covering of terrigenous-rich hemipelagic deposits. Uplift of the ridge, beginning shortly after the turbidite layers of sandstone and breccia were deposited, appears to coincide with a late Miocene orogenic episode that affected the length of the Aleutian Ridge.

The terrigenous nature of the sedimentary section drilled at Site 189 attests to the importance of the adjacent Aleutian Ridge as a source of detrital debris. However, terrigenous debris from Kamchatka and eastern Siberia can also reach this area via a Pacific route (Lisitzin, 1969; see Scholl and Creager, and Fullam et al., this volume. At other Bering Sea sites (e.g., 184, 185, and 188) the late Miocene and younger deposits are dominated by diatomaceous

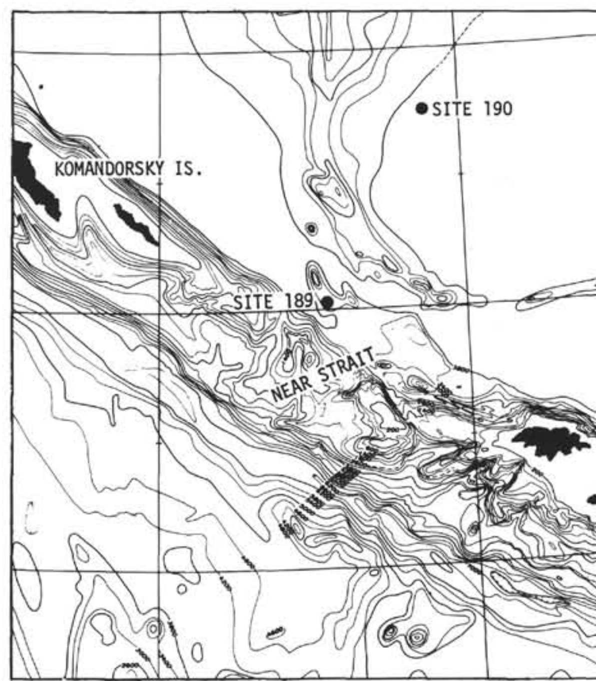


Figure 1. *Base map showing the location of Site 189.*

[1]David W. Scholl, U.S. Geological Survey, Menlo Park, California; Joe S. Creager, University of Washington, Seattle, Washington; Robert E. Boyce, Scripps Institution of Oceanography, La Jolla, California; Ronald J. Echols, University of Washington, Seattle, Washington; Timothy J. Fullam, Standard Oil Company of California, La Habra, California; John A. Grow, Massachusetts Institute of Technology, Cambridge, Massachusetts; Itaru Koizumi, Osaka University, Osaka, Japan; Homa J. Lee, Naval Civil Engineering Laboratory, Port Hueneme, California; Hsin Yi Ling, University of Washington, Seattle, Washington; Richard J. Stewart, University of Washington, Seattle, Washington; Peter R. Supko, Scripps Institution of Oceanography, La Jolla, California; Thomas R. Worsley, University of Washington, Seattle, Washington.

debris. In contrast, except for a short upper Pliocene-lower Pleistocene section, diatoms at Site 189 are only an important secondary constituent. In comparison to other sites, the lower diatom content of Site 189 deposits may also reflect oceanographic conditions less favorable to planktonic productivity. Also noted at Site 189 was the uphole appearance of calcareous foraminifera and nannoplankton near the Plio-Pleistocene boundary, a phenomenon found at all other Bering Sea sites that implies a major downward shift in the carbonate compensation depth in the early Pleistocene.

BACKGROUND AND OBJECTIVES

Description

A very thick (i.e., 800-1000 m) layer of turbidite deposits normally abuts the base of the north flank of the Aleutian Ridge. However, at Site 189 the pelagic (judged from their acoustic characteristic and depositional geometry) deposits underlying the turbidite section swing upward and cap a narrow and deeply submerged (3400 m) ridge trending parallel to and lying at the base of the north flank of the Aleutian Ridge (Figure 1 and 2). Site 189 was located over the crest of this ridge because here the pelagic sequence, which appears to rest on a well-defined acoustic basement, could be sampled to basement without first penetrating a thick turbidite section.

Objectives

The principal objective in drilling Site 189 was to obtain information about the lithology and age of the pelagic sequence and the acoustic basement. This information should permit a realistic appraisal of (1) the nearby Aleutian Ridge as a Neogene sediment source, and (2) the formative history of the acoustic basement beneath Site 189 in relation to that of the Paleogene sedimentary and volcanic rocks that construct the bulk of the ridge.

OPERATIONS

Pre- and Post-drilling Survey

Site 189 is located near the summit of a deeply submerged northwest-trending ridge at the base of the north flank of the Aleutian Ridge. The site occupied is about 2.7 km northwest of the originally selected location and, hence, that far from the reference profile obtained by D. W. Scholl on 26 Aug 70 (Figure 2). The site was approached with a ship's heading of 300°T which was approximately at a right angle to the heading used in the collection of the reference profile. Winds and slow computing times for satellite fixes caused the desired site to be missed. However, the air-gun profile collected during the approach (Figure 3) revealed enough similar features to permit dropping the beacon on the fly at 2030 hrs 18 Aug 71. The finally accepted position is: 54°02.14'N,

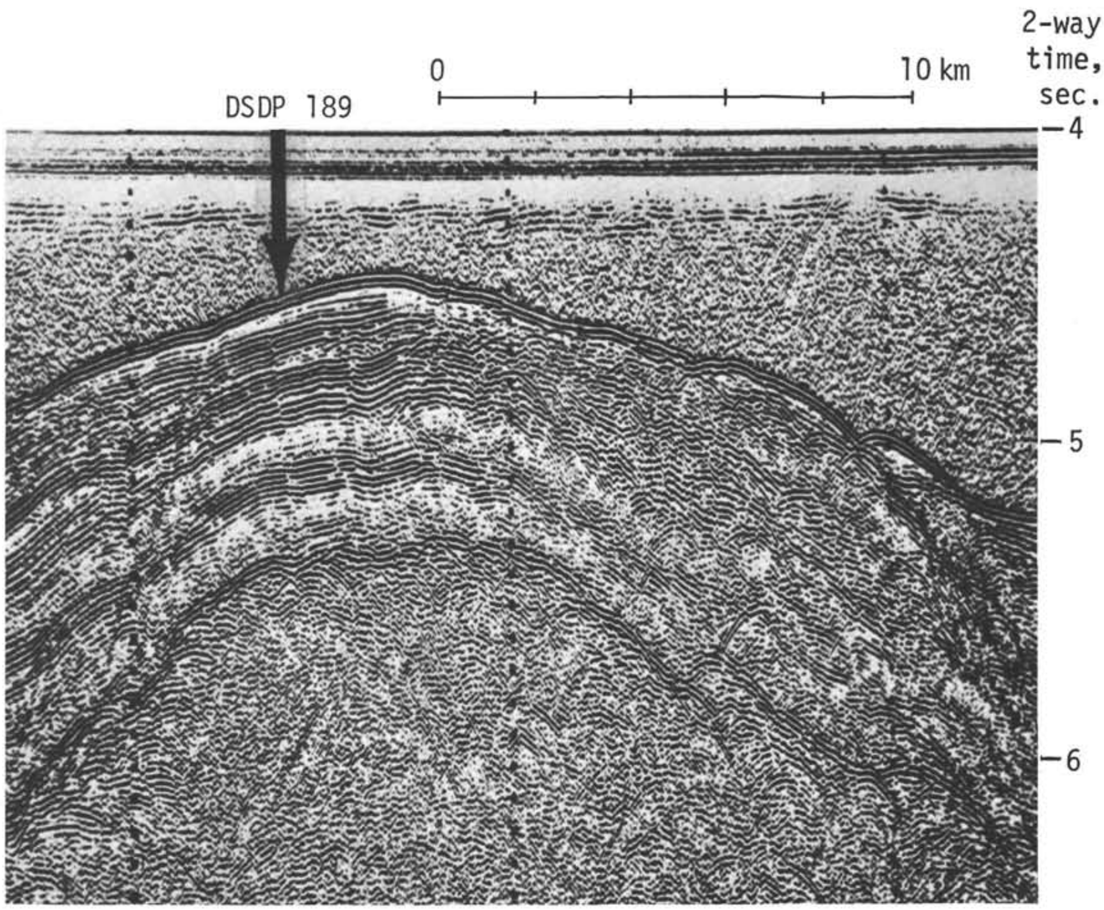


Figure 2. *Reference seismic reflection profile, obtained by D. W. Scholl, 26 Aug 70.*

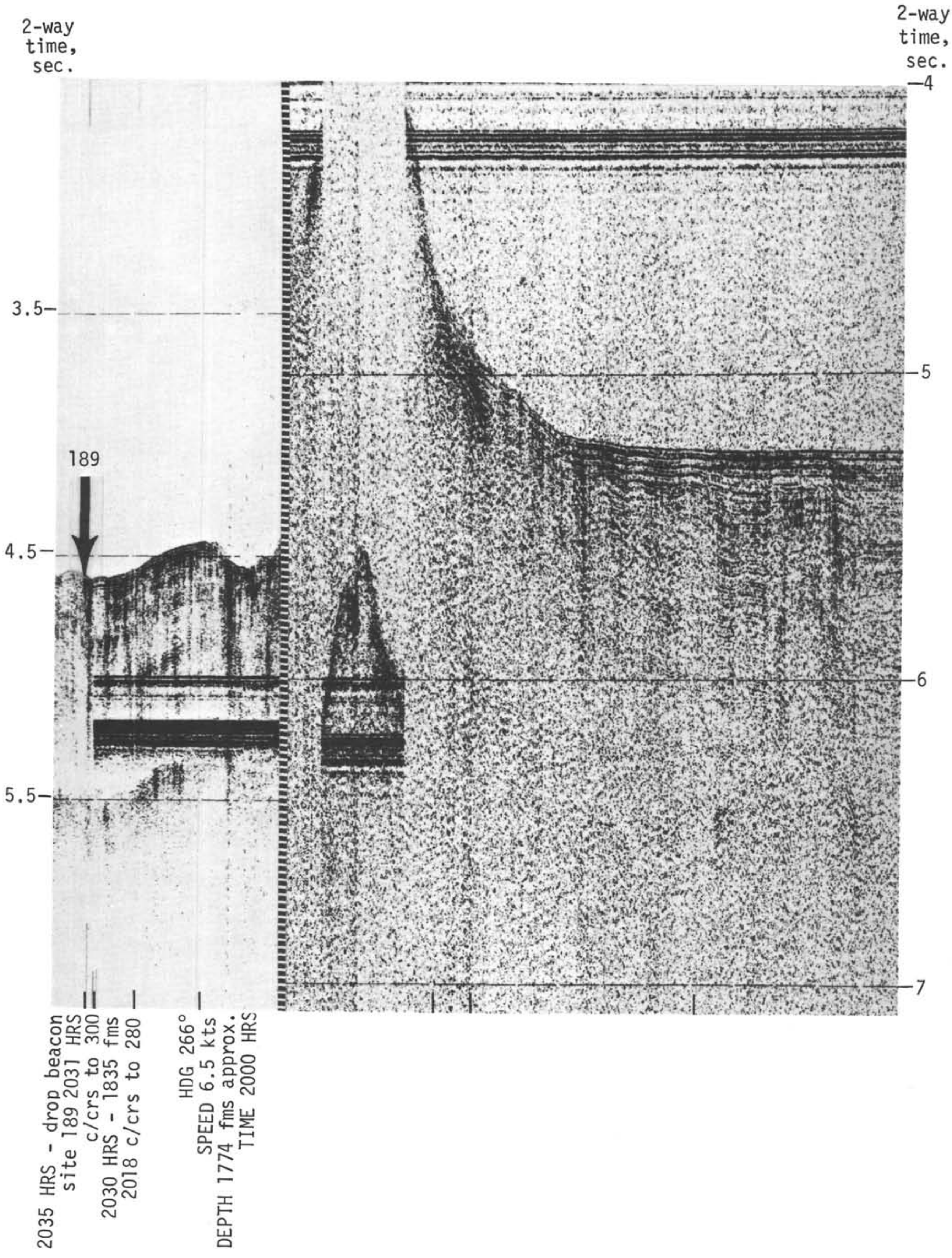


Figure 3. Glomar Challenger *air-gun profile obtained on approaching Site 189.*

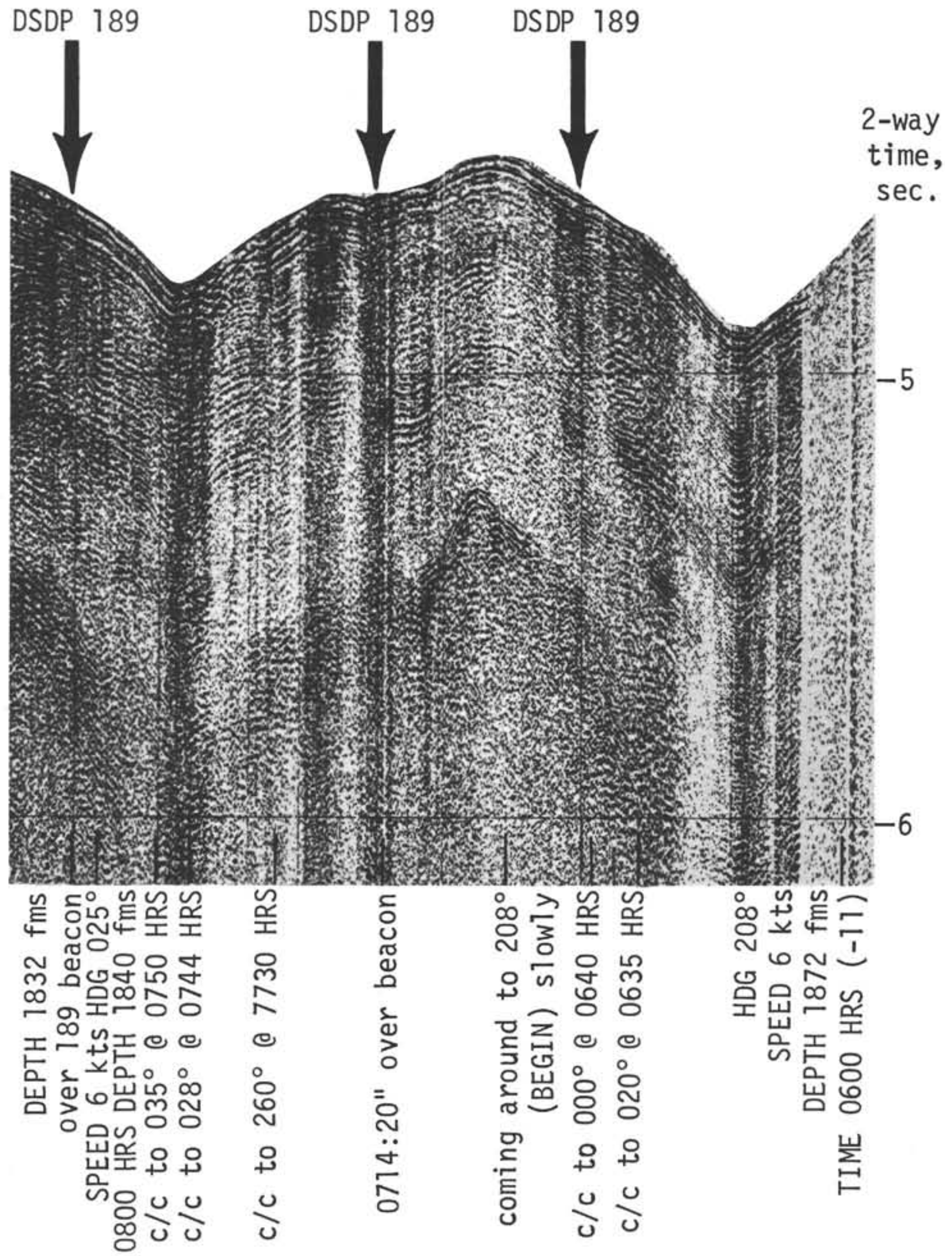


Figure 4. Glomar Challenger *air-gun record obtained during post-site survey, Site 189.*

170°13.38'E. Because the final site was so far removed from the selected site, a post-drilling survey was run (Figure 4). A map showing the approach and departure tracks plus the site location is shown in Figure 5.

Drilling Program

Site 189 was occupied from 2030 hrs 18 Aug 71 (beacon away) until 0600 hrs 22 Aug 71 with alternating coring and washing from the sea floor to a subbottom depth of 871 meters. At 730 meters a breccia in a claystone matrix without diagnostic fossils was encountered. This sedimentary rock correlates well with the expected deepest reflector, the site target. Six additional cores were collected downhole before this fact was accepted. Time limitations and the wearing of the bearings on the bit caused termination of the hole.

Using Matthews Tables, the sonic depth of 1832 fms was corrected to 3404 meters giving a water depth of 3410 meters and depth from the drill floor of 3420 meters. This compares with 3447 meters below drill floor established on the basis of the first core collected containing sediment, after one water core had been pulled. The 3447 meters below drill floor, or 3437 meters below sea level, is the accepted depth for this site.

No drilling difficulties were encountered in drilling the upper 370 meters of silty clay and diatom ooze. Drilling slowed considerably through the claystones from 370 to 871 meters (Figure 6), with the bearing in the drill bit wearing out completely. A coring summary is given in Table 1.

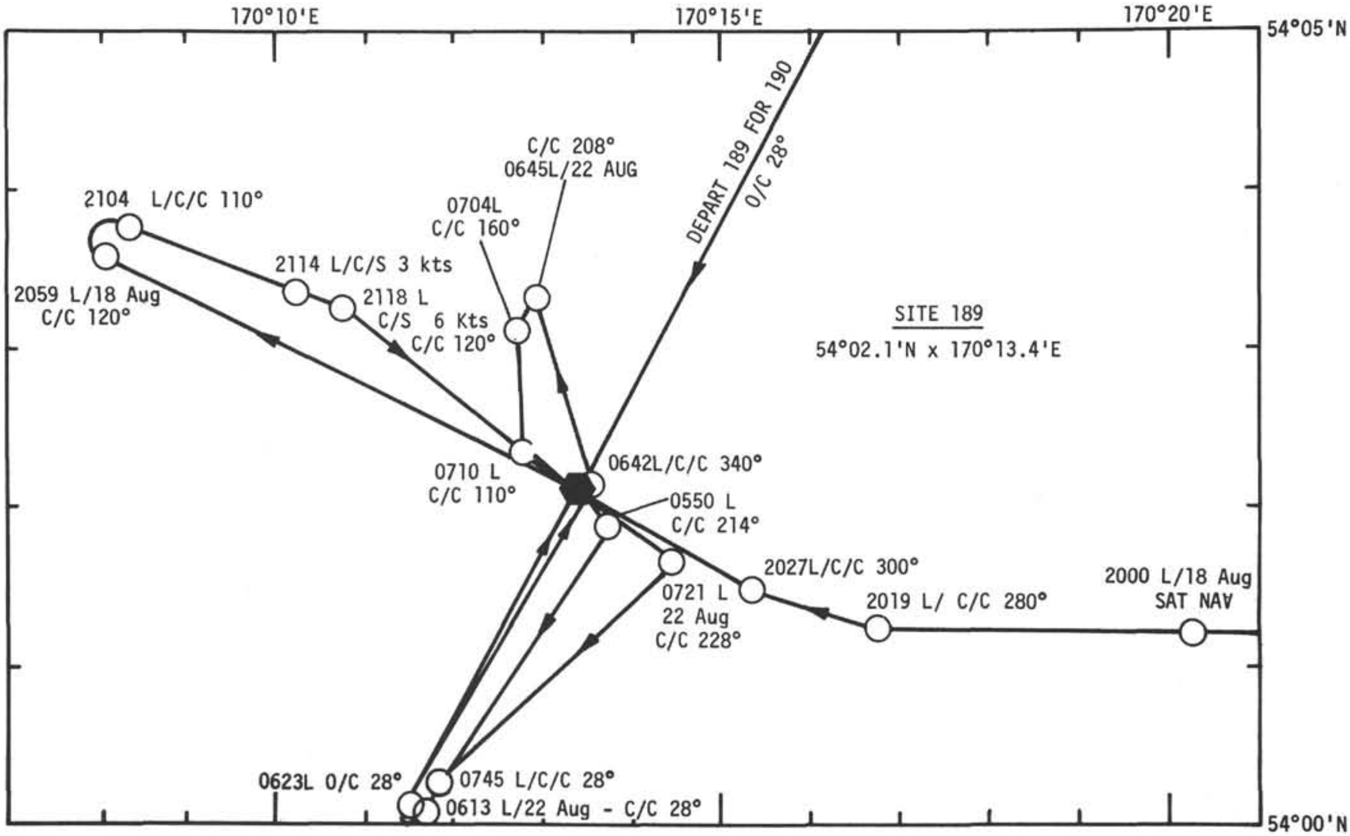


Figure 5. Glomar Challenger *track showing approach to and departure from Site 189.*

LITHOSTRATIGRAPHY

A single hole at Site 189 penetrated 871 meters of sediment; the lithologic sequence is shown in the site summary.

Two lithologic units are recognized. Unit A (0-370 m) is a mixture of diatoms and terrigenous sand and silt, diatoms showing a regular and gradual increase from ~5% at the top to ~40 to 50% near the base of the section. Discrete beds of ash and sand, pumice pebbles, and erratic sedimentary rock pebbles occur more commonly in the upper (Pleistocene) part of the unit. Cores 5 and 6, toward the bottom of the unit, are rather gassy. Cores 7 and 8 contain a transitional facies, consisting of silty clays with 5 to 10% diatoms showing solution effects and pyritization. Faint lenses and bedding become noticeable.

Unit B (370-871 m) is essentially a mottled and burrowed mudstone, with beds dipping up to 30 degrees below about 640 meters and showing tension cracks perpendicular to bedding. Between 730 and 755 meters the unit includes a sedimentary breccia and sandstone which presumably correlates with an "acoustic basement."

Units A and B are lithostratigraphically equivalent to the same units defined at Sites 184, 185, and 188.

Unit A – 0 to 390 Meters

Unit A, from 0 to 370 meters below bottom, consists of dark greenish gray diatom-bearing silty clay at the top of the section grading downward to diatomaceous silty clay and clay-rich diatom ooze at about 250 meters. The trend with depth of the terrigenous:diatom ratio is roughly paralleled by the silt:clay ratio, which decreases from almost 1:1 in Core 1 to about 1:4 in the lower sections. Thin (<5 cm) beds of light gray vitric ash, dark crystal ash, and dark sands and silts occur throughout the unit, but are more common in the upper (Pleistocene) section, where pumice and sedimentary rock pebble erratics are also found. Cores 3 and 4, and especially Cores 5 and 6, were gassy, characteristic of Unit A at earlier Bering Sea sites.

Sediments of Cores 7 and 8 are olive gray diatom-, carbonate-, and pyrite-bearing silty clays. They are transitional between the true Unit A facies and the Unit B lithology in that (1) diatoms fall off sharply (<10%) and show solution effects and pyritization, (2) faint lenses and bedding are apparent, and (3) a few burrows are seen.

Unit B – 370 to 871 Meters

The top of Unit B is just below Core 8 at 370 meters where the drilling rate slowed abruptly from 4.5 to 1.5 m/min. (Figure 6). The sediment is an olive gray and olive black mudstone, typically containing 75 to 90% clay, 5 to 20% terrigenous silt (mostly plagioclase feldspar), and up to 5% pyrite. Microspar (recrystallized nanno ooze?) forms limestone layers about 10 cm thick; calcite also occurs as veins up to 1 cm thick in disrupted claystone in Core 11. Discrete layers of volcanic silts and glassy ash (largely devitrified and altering to clay) occur, as do layers rich in diatoms. These diatoms are often pyritized or recrystallized

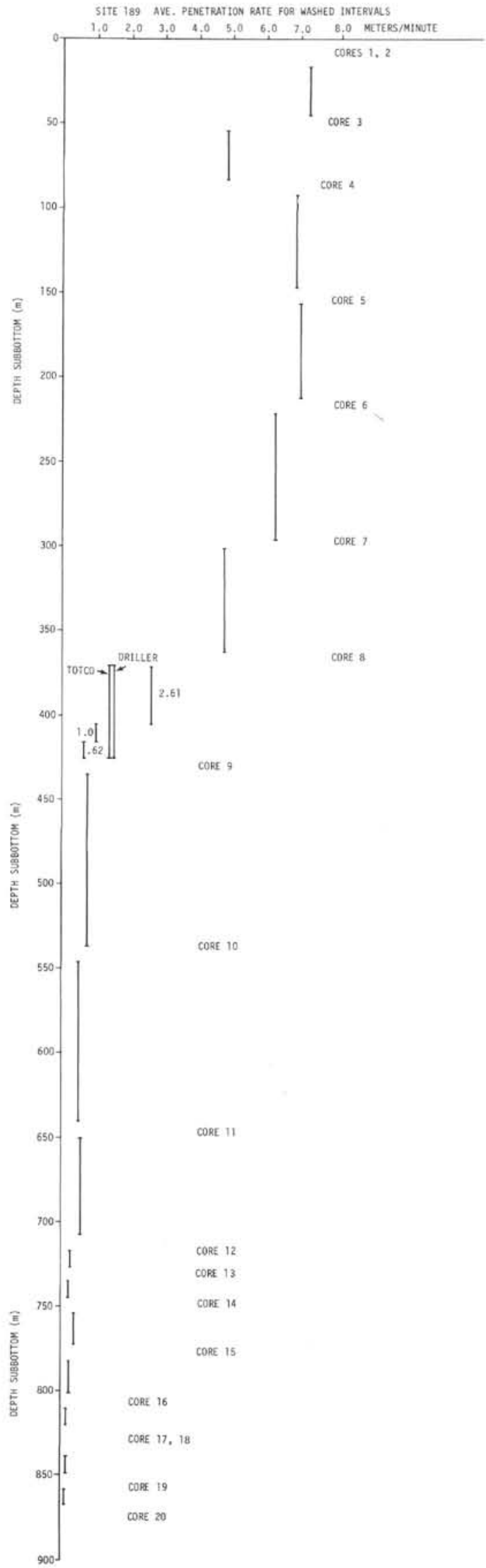


Figure 6. *Subbottom penetration rate, Site 189.*

TABLE 1
Core Summary – Site 189

Core	Cored Interval Below Bottom (m)	Cored (m)	Recovered (m)	Recovered (%)
1	0-7	7	6.6	94.3
2	7-16	9	CC	0.0
Wash				
3	45-54	9	9.1	101.1
Wash				
4	83-92	9	4.7	52.2
Wash				
5	147-156	9	6.0	66.7
Wash				
6	212-221	9	2.5	27.8
Wash				
7	296-305	9	3.6	40.0
Wash				
8	362-371	9	1.1	12.2
Wash				
9	426-435	9	0.8	8.9
Wash				
10	537-546	9	3.0	33.3
Wash				
11	641-650	9	4.3	47.8
Wash	650-706		0.1 cuttings in center bit	
12	706-715	9	1.7	18.9
Wash				
13	725-733	8	4.3	53.8
Wash				
14	743-752	9	5.6	62.2
Wash				
15	771-780	9	6.5	72.2
Wash				
16	799-808	9	4.6	51.1
Wash				
17	818-827	9	2.2	24.4
18	827-836	9	2.7	30.0
Wash				
19	847-856	9	2.5	27.8
Wash				
20	867-871	6	2.4	40.0
		174	74.2	42.6

as silica. In one limestone bed studied closely, the diatoms were seen to be completely calcitized. Agglutinated benthic foraminifera are common.

Burrows are common in Unit B, (both tiny "fucoid" burrows (~1-mm diameter) and larger burrows (~1-cm diameter) showing the characteristic en echelon chevron folds of backfill.

Beginning in Core 10, bedding is characteristically inclined, and tension cracks (filled with dark gray clay) arranged normal to the bedding appear. In Core 10, the bedding dips ~10 degrees to the horizontal; from Core 11 to the bottom of the hole the inclination is about 30 degrees. The tension cracks are up to 10 cm deep and are often sinuously bent, presumably by differential creep (Figure 7). The cracks may end abruptly; Figure 8 shows cracks abutting against a darker, burrowed clay bed.

Figure 7. *Tension cracks normal to inclined bedding. The cracks are up to 10 cm deep, are filled with dark clay, and are often sinuously bent, presumably by differential creep (189-13-2, 115-127 cm). Full core width.*

A sandstone and sedimentary breccia in a claystone matrix occurs between 730 and 755 meters. Angular volcanic lithic fragments, claystone pebbles, pyrite nodules, and chert pebbles make up the larger grains. Core 14 contains a large (6 X 3 X 2 cm) well-rounded gabbro pebble. Beds of coarse sand and lithic fragments occur throughout (Figure 9) and in two places are cemented by calcite spar (Figure 10).

PHYSICAL PROPERTIES

Bulk density, water content, natural gamma radiation, acoustic velocity, vane shear strength, and residual pore water pressure were measured. The density was measured in three ways: with the GRAPE system, from shore laboratory samples, and by the water displacement method. Most of the samples to a sediment depth of about 300 meters were disturbed by gas expansion during sampling.

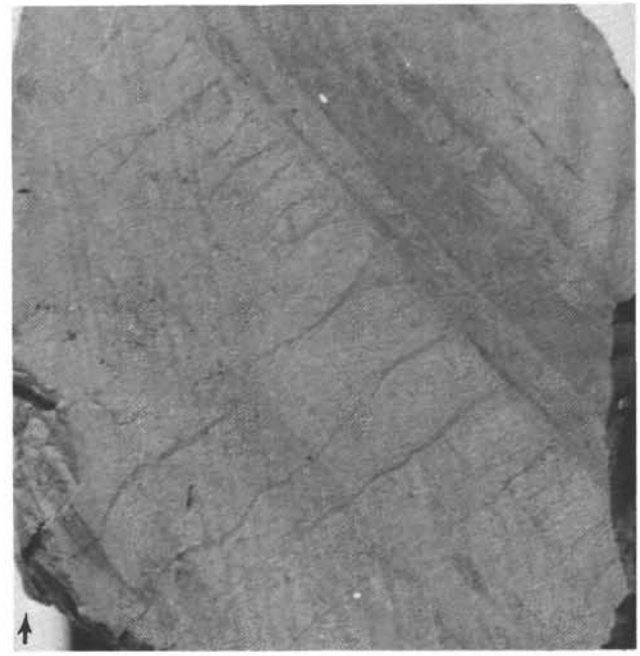


Figure 8. *Clay-filled tension cracks abutting against a darker, burrowed clay bed (189-12-2, 113-116 cm). Full core width.*

The complete GRAPE bulk densities are shown on the core summary sheets. As at Site 187, the samples which were most affected by gas expansion disturbance yielded discontinuous GRAPE records. These are shown on the summary sheets as dashed lines which represent envelopes of the peak GRAPE densities. Mean GRAPE densities for each section, shore laboratory densities, water displacement densities, and measured acoustic velocities are shown on the site summary sheet.

Bulk Density

GRAPE densities were measured from sediment depths of about 50 to 300 meters. This entire region contained considerable gas, therefore the measurements may differ significantly from the in situ densities. Below 300 meters the sediment did not fill the core liner and was not analyzed with the GRAPE system. Numerous water displacement densities were obtained for the sediment depth range 420 to 870 meters.

The densities obtained indicate a sharp increase from 1.45 to 1.65 g/cm^3 over the first core, followed by a zone extending down to 300 meters where the cores were gassy and the data are scattered. The mean density for this zone appears to be about 1.5 g/cm^3 although this could be in error because of disturbance. The shore laboratory densities are probably closer to the in situ condition than are the GRAPE densities. From a sediment depth of 425 to 550 meters, the density increases from 1.75 to 1.80 g/cm^3; and from 650 meters to the bottom of the hole, the density increases gradually and consistently from 2.0 to 2.10 g/cm^3. A sharp break evidently occurs between 550 and 650 meters.

Figure 9. *Inclined beds of coarse sand and lithic fragments (189-14-3, 142-150 cm). Full core width.*

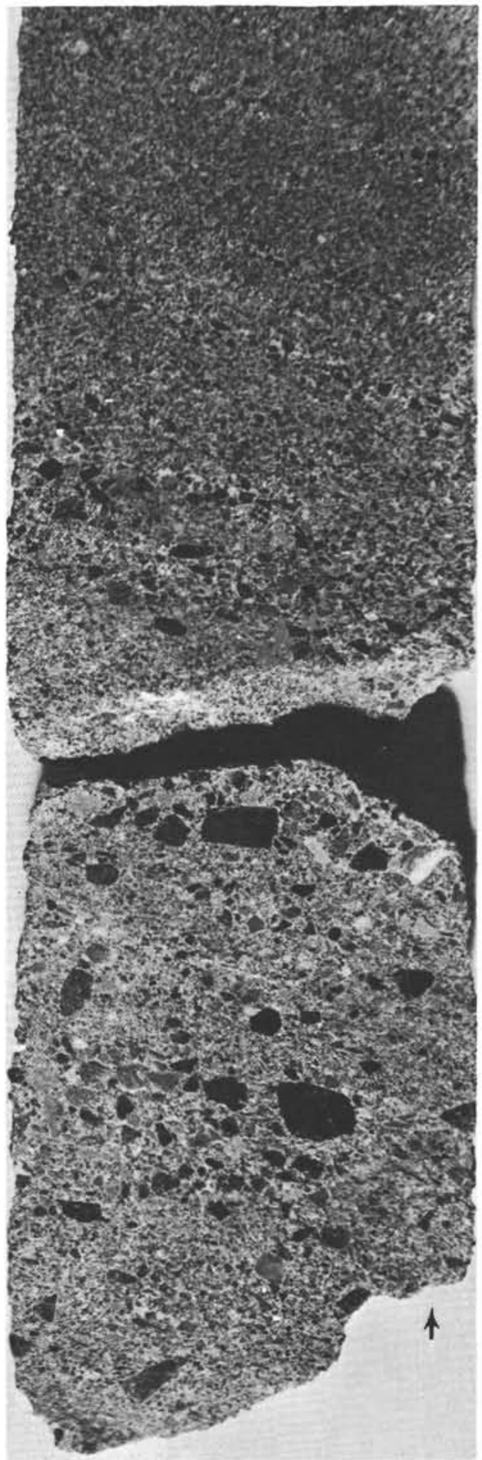


Figure 10. *Inclined graded bed of lithic fragments and sand cemented by calcite spar (189-14-1, 38-54 cm). Full core width.*

Acoustic Velocity

The measured sound velocity increases consistently from 1.5 to 1.75 km/sec over the sediment depth range 0 to 300 meters, and from 2.05 to 2.35 km/sec from 425 meters to the bottom of the hole. Measurements could not be made between 300 and 425 meters because of gas contained by the sediment. Therefore, it is impossible to determine whether the velocity increases gradually over this region or changes rapidly at some point.

Summary

The physical property data are not totally conclusive with regard to differentiating zones at this site. The density data indicate a break between 550 and 650 meters, but this is not clearly substantiated by the sonic velocity data. There is also a significant change in both velocity and density over the range 300 to 425 meters, but it is not possible to determine whether this change occurs rapidly at some point or gradually over the entire interval.

In general, it appears as if there are three physical property zones: (1) 0 to 300 meters, (2) 425 to 550 meters, and (3) 650 to 870 meters. Each zone is relatively homogeneous with the density and sonic velocity changing in the sections between the zones. This zonal distribution may be in error, however, because of a scarcity of data at critical points.

PALEONTOLOGY

Stratigraphic control by diatoms and silicoflagellates is good through the Pleistocene and Pliocene diatomaceous sediments, although the numbers of these fossils are less than at previous sites. Below Core 9, however, identifiable individuals of the siliceous flora become rare in semilithified sediments, then very rare in Cores 11 and 12. Still deeper cores at this site have only highly altered, unidentifiable valves of the most resistant types of diatoms. Evidence for an early Pliocene or upper Miocene age from diatoms below Core 10 is tenuous but gains support from rare sinistral specimens of the foraminiferan *Globorotalia (T.) pachyderma* in Core 13.

Calcareous foraminifera and nannofossils disappear downhole near the Pliocene-Pleistocene boundary, as has been the case at all previous Bering Sea sites. This suggests that the carbonate compensation depth stood at some depth less than 2000 meters in the Pliocene and then intermittently fell below 2700 meters in the Pleistocene. Dominantly arenaceous faunas at deeper levels at this site suggest that the carbonate compensation depth was also shallow in the upper Miocene.

Sediment layers penetrated toward the bottom of the hole at Site 189 include sandstone and conglomerate intercalated in mudstone; they bear tension cracks and have a marked dip relative to the long axis of the cores. These features suggest tectonic deformation, therefore evidence from the fossil assemblages for important vertical displacement of the sea floor at Site 189 has been sought. Benthic foraminiferal assemblages indicate that the deformed sediment layers were deposited at paleodepths in the middle bathyal to abyssal range and also show that Pleistocene sediments were deposited at depths comparable to that at which the site presently occurs. There is no positive evidence of paleobathymetry for Pliocene sediments because foraminifera are absent, and diatoms, the most abundant fossils, are undiagnostic of bathymetry below shelf depths. However, absence of calcareous fossils, which are common on the upper and middle parts of the continental slope of the Bering Sea today, in some places to depths of more than 3000 meters (Saidova, 1961), may be negative evidence for considerable Pliocene depth of deposition. This assumes that calcareous tests are absent because of solution or nonproduction below the carbonate compensation depth and that the carbonate compensation depth did not migrate to depths much above 2000 meters in the Pliocene. Arenaceous tests may be absent from Pliocene sediments because of unfavorable conditions for *Eggerella* sp., the only species that is consistently preserved in overlying sediments. There is, therefore, no paleontological evidence for vertical displacement of the sea floor. However, vertical movements raising the sea floor to depths of about 2000 meters could probably go undetected from paleontological evidence.

Foraminifera

Good planktonic and calcareous benthic assemblages alternate with sparse assemblages through Core 4. Foraminifera are rare in Core 5, and in Cores 6 through 10 no foraminifera were found in the core catcher samples. From Core 11 to Core 20, the bottom of the hole, a fauna consisting almost entirely of species with agglutinated walls is present. Specimens of agglutinating foraminifera are conspicuous as white spots on partially dried, cut surfaces of these lower cores. The level at which foraminifera disappear down the hole (between Cores 5 and 6) corresponds to the Pleistocene-Pliocene boundary as determined from study of diatoms. As at Site 188 a noncalcareous *Eggerella* becomes the dominant benthic form near the Pleistocene-Pliocene boundary.

Foraminifera from the lower part of Site 189 (principally from Cores 13 and 16) include *Cyclammina cancellata, C. pusilla, C. trullisata, Glomospira charoides, Bathysiphon rusticum?, Martinottiella communis, Cribrostomoides subglososus, Rhizammina* sp., and *Ammodiscus* sp.. Most of these species are unusually large compared to other foraminifera; specimens larger than 1 mm are common. Many specimens are flattened along bedding planes and almost all arenaceous individuals are, to some degree, distorted. Rare calcareous forms in Core 13 include *Pullenia bulloides, Robulus* sp., and three sinistrally coiled specimens of *Globigerina pachyderma.*

Coiling of *G. pachyderma* follows the pattern established at Site 188. That is, dextral tests appear downcore in significant numbers in the middle Pleistocene and become dominant in the lower Pleistocene. The three sinistral specimens of *G. pachyderma* in Core 13, occurring below Pliocene diatom floras, suggest late Miocene age because late Miocene populations of this species are sinistral, while known middle Miocene and early Pliocene populations are dominantly dextral.

The dominantly agglutinated faunas of the lower part of this site suggest a middle bathyal to abyssal habitat below the local carbonate compensation depth at the time, which is unknown. The dominantly arenaceous, lowest Pleistocene benthic fauna at this site, similar to that of the highest Pliocene of Site 188, suggests that the carbonate compensation depth remained above the present water depths of these sites through the barren zone of the upper Miocene and Pliocene and then fell to deeper levels near the Pliocene-Pleistocene boundary.

Calcareous Nannoflora

Rare nannofossils occur in the Pleistocene section (Cores 1 through 5), but not below. This parallels the stratigraphic distribution of nannofossils at other sites in the Bering Sea.

Radiolaria and Silicoflagellates

Sediments of Site 189 contain generally rather poor assemblages of radiolarians and silicoflagellates in paucity of specimens as well as low species diversity. This is particularly true for the sediments below Core 6, Miocene interval, where these microfossils are essentially absent.

Radiolarians in Core 1 are a typical Bering Sea (surface sediments) fauna. As shown in Table 8, Chapter 28, samples of Core 3 yield *Eucyrtidium(?) tumidulum* and *Stylacontarium acquilonium,* but without *Axoprunum angelinum,* suggesting that the sample is still in the late Pleistocene *Eucyrtidium tumidulum* zone of Hays (1970). Radiolarians were absent below the level of Core 6.

Only a few species of silicoflagellates were recovered (Table 8, Chapter 27), but early Pliocene or Miocene index forms were completely absent from this site.

Diatoms

Diatoms were less abundant in sediments throughout the site than those from other previous Bering Sea sites. Stratigraphic occurrence of this microfossil group is shown in Table 7, Chapter 30. The age of Cores 11 and 12 could still be considered as late Pliocene based on the similarity of microfloral composition with the unit immediately above.

CORRELATION BETWEEN REFLECTION PROFILE AND STRATIGRAPHIC COLUMN

The reflection profile obtained by D.W. Scholl, 1970, which was used for selecting Site 189 is shown in Figure 11 along with the stratigraphic column and physical properties. The track for this profile is 028°T (to the right). Although the total sediment thickness appears to be 0.83 sec on this profile, the actual position of Site 189 was about 3 km west of this profile; and the *Glomar Challenger's* records show a total sediment thickness of 0.87 sec.

The upper 0.40 sec of well-stratified reflectors correlate with Unit A. The light zone between 0.40-0.50 sec appears to correlate to less diatomaceous silty clay. At 0.50 sec a strong reflector is present which correlates well with the top of the mudstone (Unit B) at 370 meters. Hard drilling was also first encountered there. Velocities in this upper 370 meters were near 1.6 km/sec according to the laboratory measurements and were 1.48 km/sec according to the travel-time method (370 m by 0.50 sec).

The dark reflector at 0.50 and the terminal reflector at 0.87 sec appear to mark the top of the mudstone (Unit B) at 370 meters and the sedimentary breccia at 730 meters.

The velocities within Unit B also present a slight problem. The few laboratory measurements made in this interval yielded values between 2.0 and 2.4 km/sec while a travel-time estimate (370-730 m and 0.50-0.87 sec) suggests a velocity of 1.95 km/sec. The discrepancy between these two values may be due to the fact that this unit, in which the drilling was alternately hard and soft, probably recovered the hardest and most lithified strata while washing out the softer layers. Likewise, laboratory measurements are sometimes difficult to obtain on the softer and more disturbed sections, again biasing toward high values.

Before drilling Site 189, it had been assumed that the strong terminal reflector at 0.87 sec was an "igneous" basement near 720 meters depth (using 1.65 km/sec for an average velocity, which was typical of our previous Bering Sea sites). However, a sedimentary breccia was encountered between 730 and 755 meters with another mudstone below. Because of uncertainty in the velocities, drilling was continued to 870 meters in search of an igneous basement. Because the 0.87-sec reflector would require an average velocity greater than 2.0 km/sec to be deeper than 870 meters, it was concluded that the sedimentary breccia must have been the 0.87-sec reflector and the hole was terminated. Furthermore, because the densities and velocities in Unit B are all near 2.0 g/cc and 2.3 km/sec, the high reflectivity of the sedimentary breccia must be related to its coarse texture. The 30-degree inclined bedding observed below 730 meters also suggests that the lower part of Unit B is deformed sediments, accounting for the absence of coherent reflections below the 0.87-sec reflector.

In summary, the well-defined terminal reflector or "acoustic basement" at Site 189 is composed of sedimentary breccia underlain by deformed sediments rather than the typical igneous basement expected. Site 187 on the Aleutian Terrace had a similar terminal reflector underlain by deformed terrace sediments.

REFERENCES

Hays, J.D., 1970. The stratigraphy and evolutionary trends of Radiolaria in North Pacific deep-sea sediments. Geol. Soc. Am. Mem. 126. 185.

Lisitzin, A.P., 1969. Recent sedimentation in the Bering Sea: Nat. Sci. Foundation, Washington, D.C., Israel Program for Sci. Translations, 614 p.

Saidova, H.M., 1961. Ekologiia foraminifer i paleogeografiia dal'nevostochnykh movei SSSR; severo-zapadnoi chast; Tikhogo Okeana. Akad. Nauk SSSR, Inst. Okeanologii. 182 p.

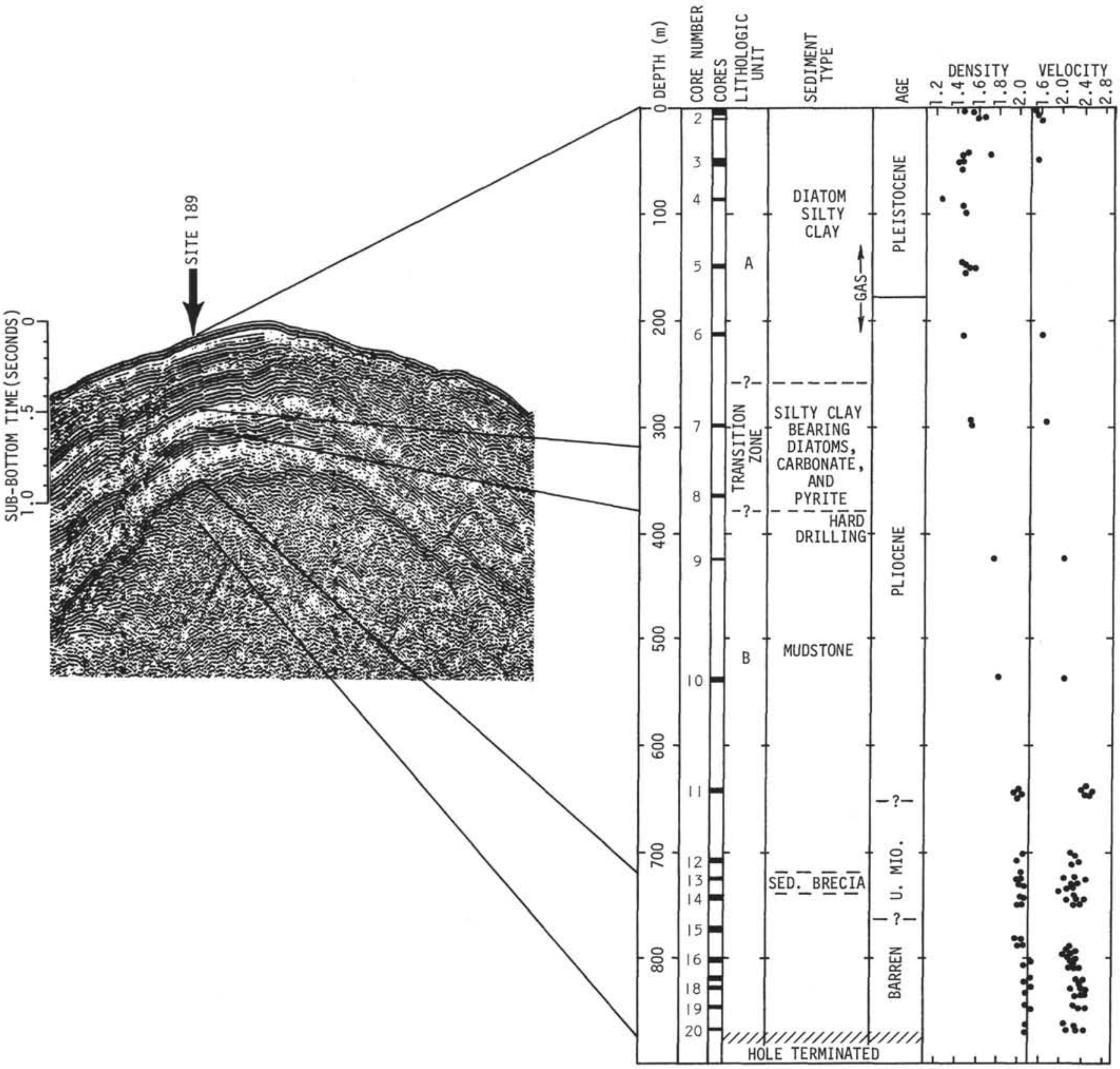
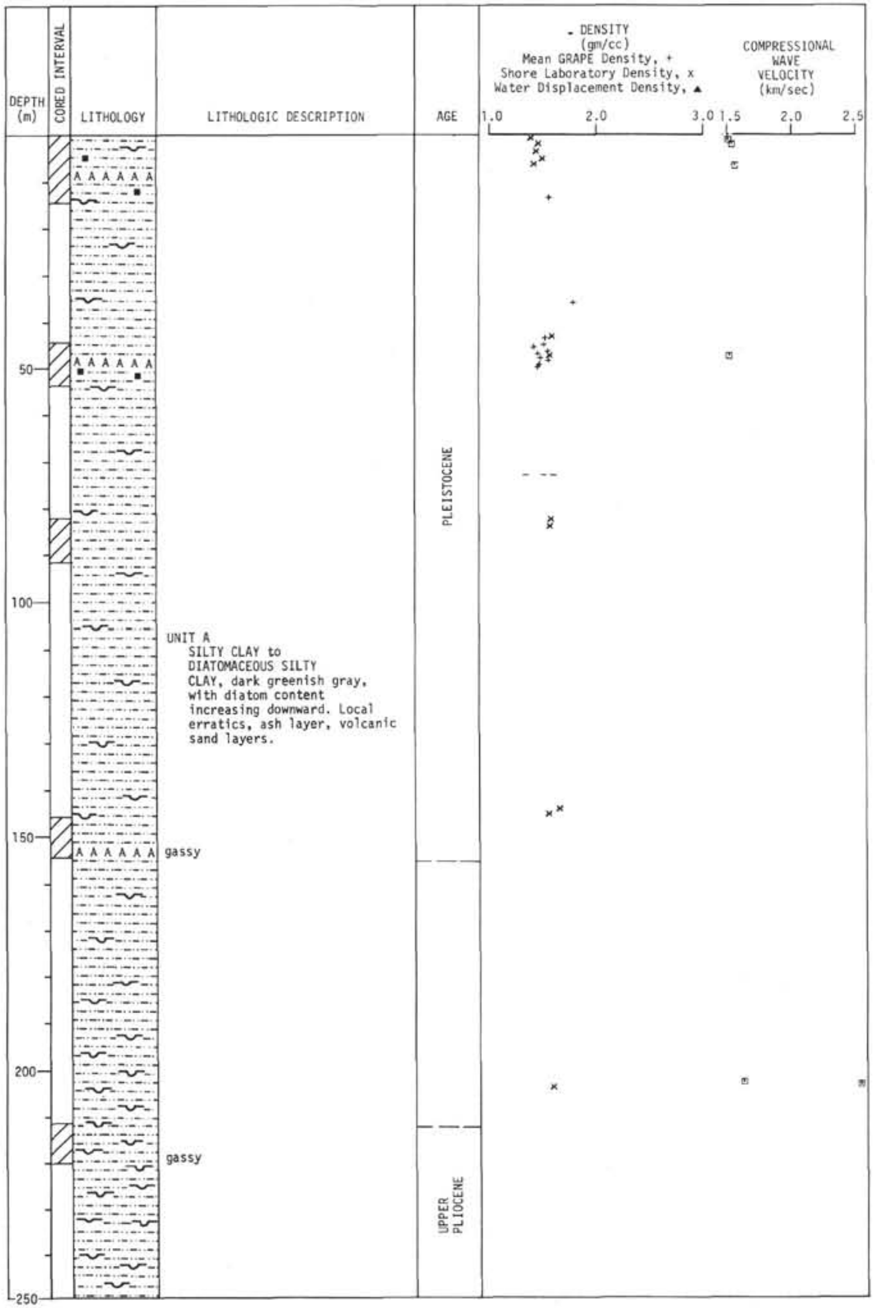
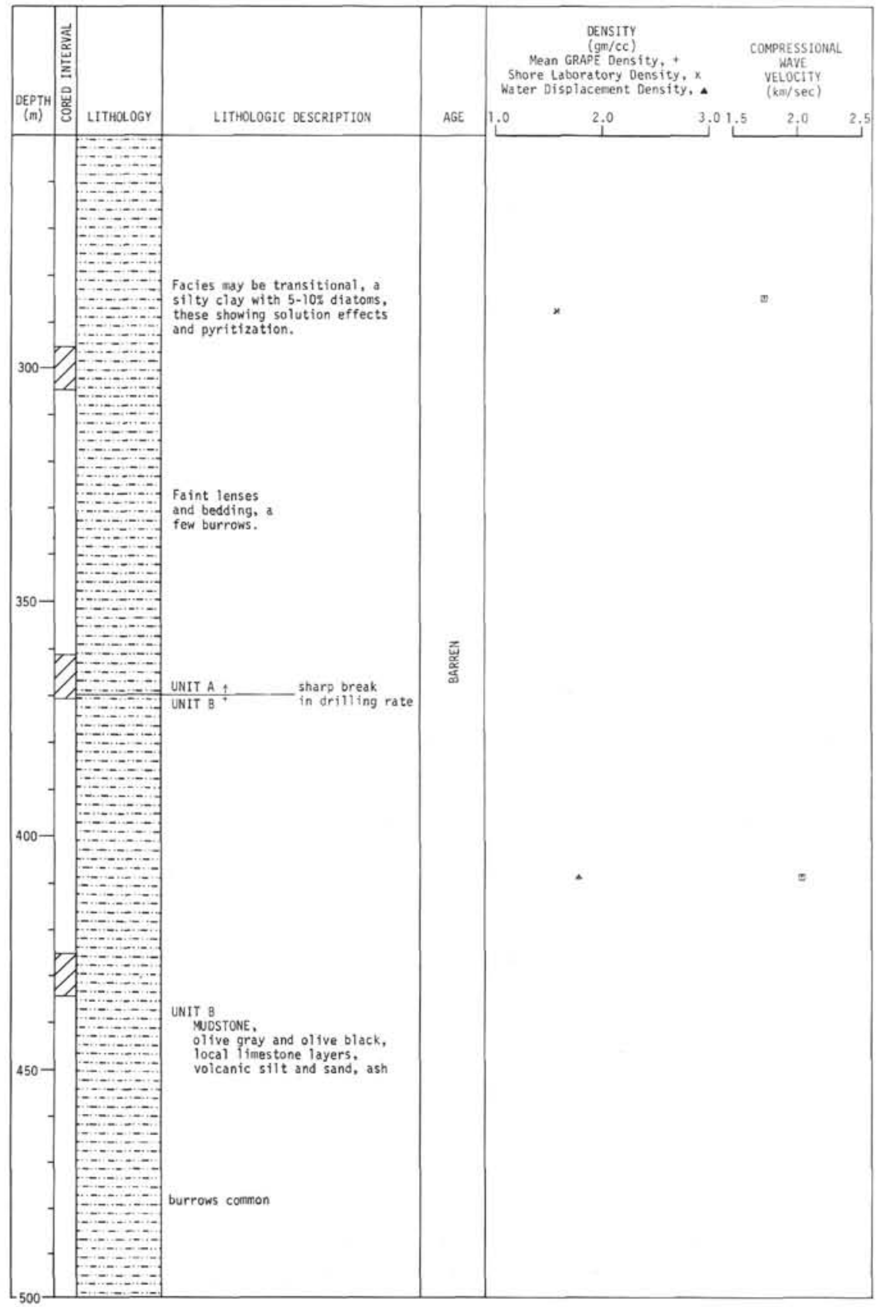


Figure 11. *Correlation of the seismic reflection record with physical properties and the lithologic column, Site 189.*

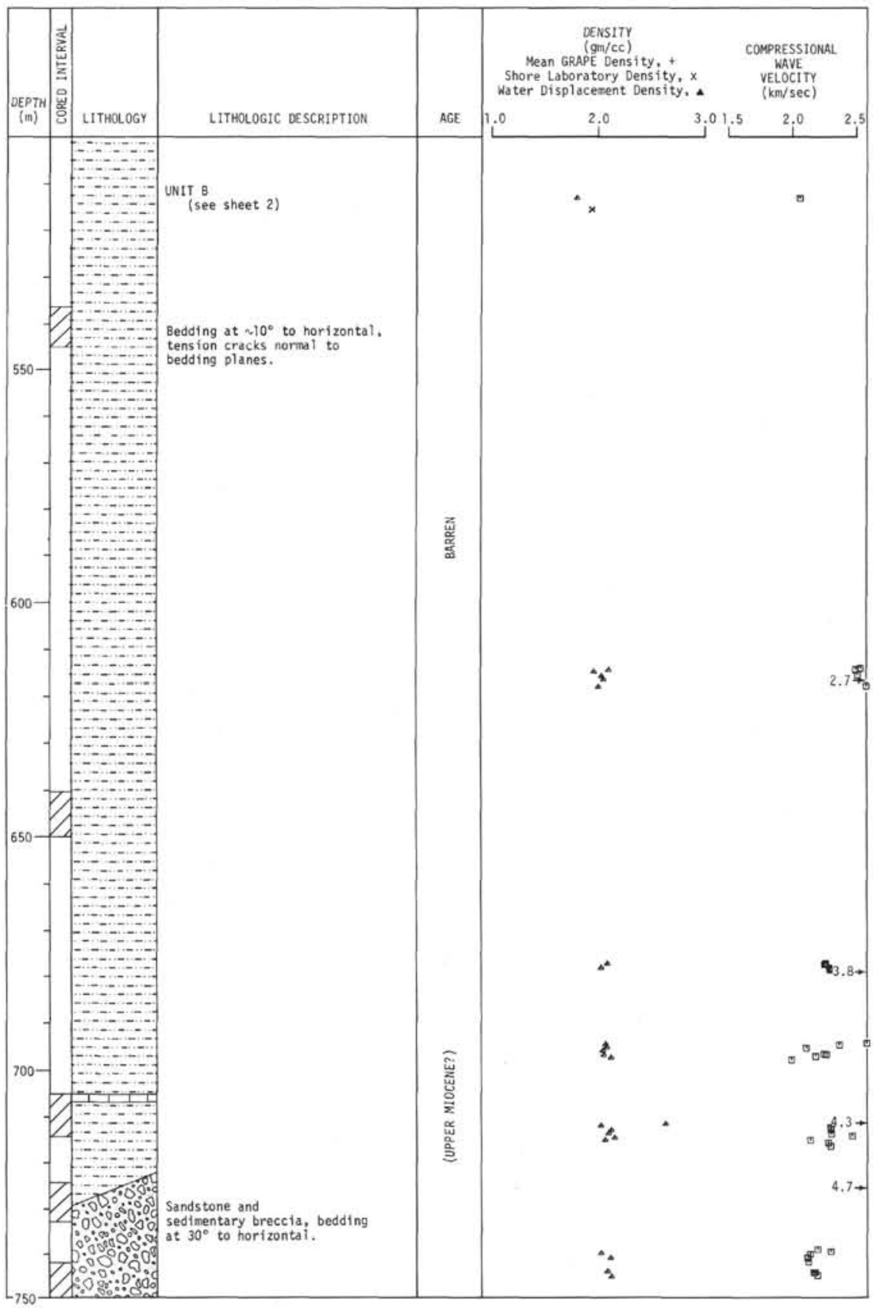
SITE 189



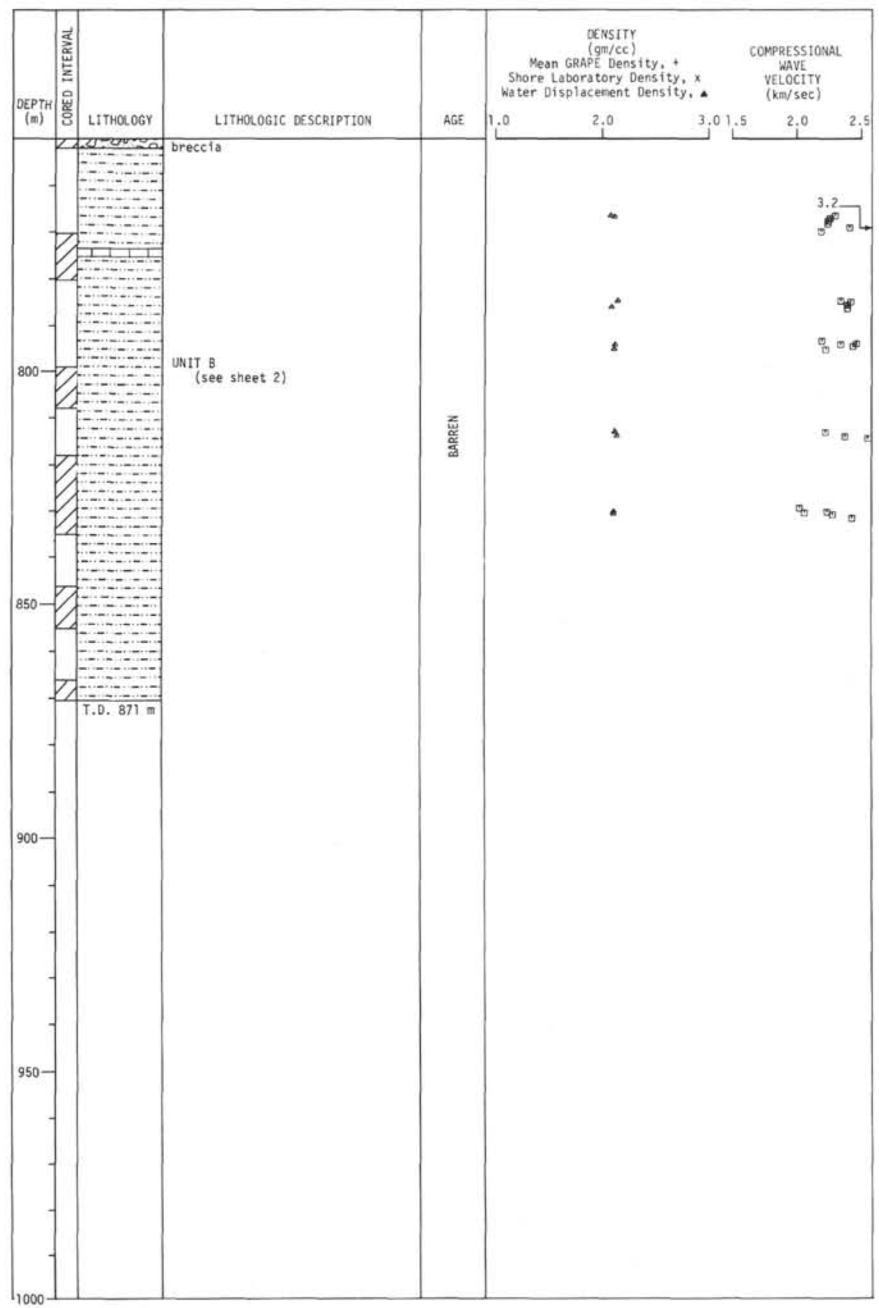
SITE 189



SITE 189



SITE 189



Site 189 Hole Core 1 Cored Interval: 0-7

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE
UPPER PLEISTOCENE	(D) Denticula seminae (S) Distephanus octangulatus	PF BF D R S N	A F A F R -	P G M M -	1	0.5 1.0	VOID		100
		PF BF N	A F R	P M	2				130
		PF BF N	- R -	 -	3				112 120
		PF BF PF BF N	- R R R -	 -	4				10 20 85 122
		PF BF N	- R -	 -	5				104? VOID 145
		D N R S	A C R R	G M G M	Core Catcher				

LITHOLOGIC DESCRIPTION

Basic lithology, sections 1, 2, 3
SILTY CLAY
very dark gray (5Y 3/1)
Slide 1-100
55% clay, 45% silt
Slide 2-130
55% clay, 40% silt, 3% diatoms

DIATOM BEARING SILTY CLAY

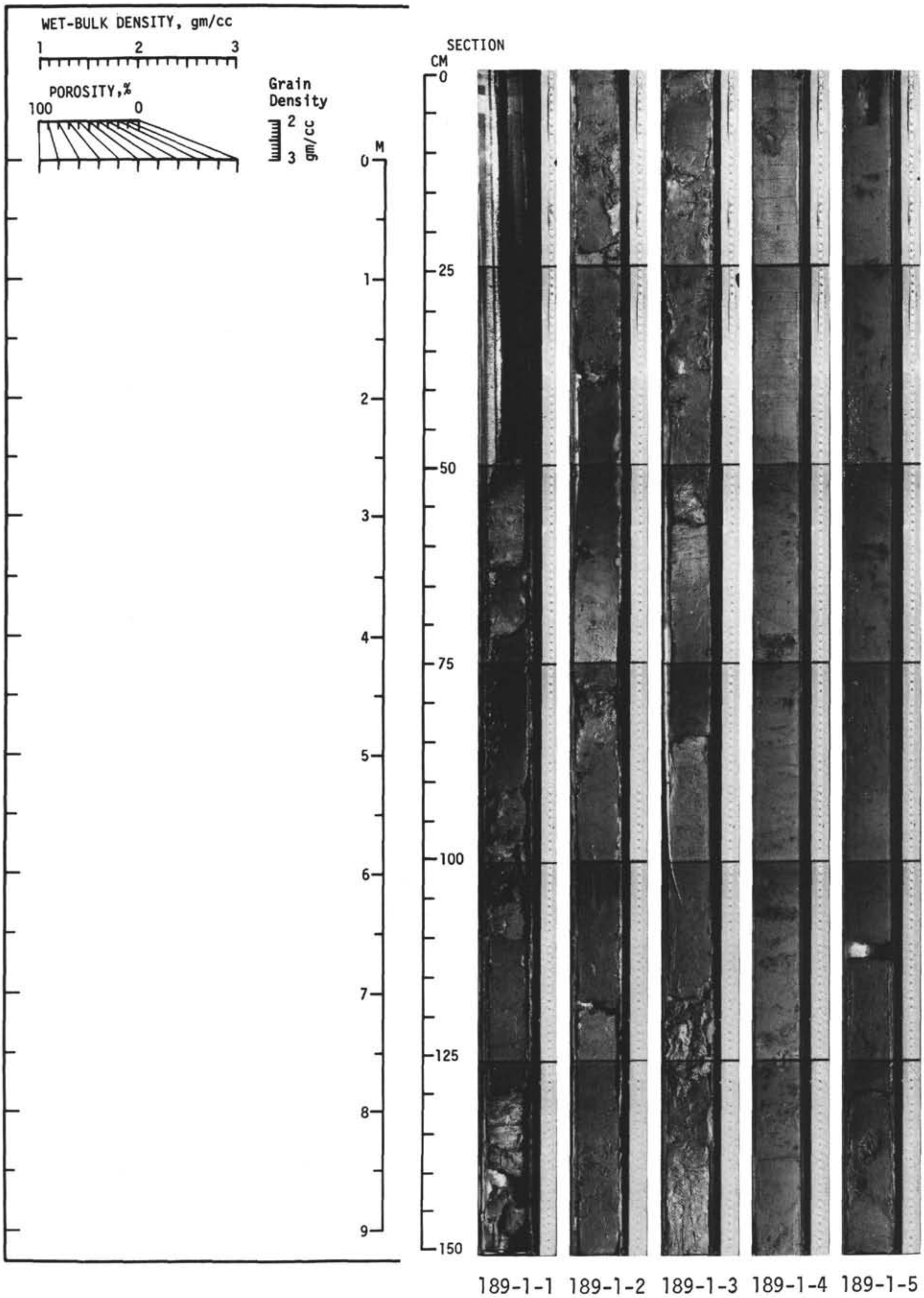
SILT and CLAY RICH DIATOM OOZE, dark grayish olive (10Y 3/2)
VITRIC ASH dark grayish brown (2.5Y 4/2)

disturbed and mixed DIATOM OOZE and
SILTY CLAY with pods of VITRIC ASH
greenish gray (5GY 6/1)

Basic lithology, sections 4, 5
DIATOM BEARING SILTY CLAY
dark greenish gray (5GY 4/1)
contains disturbed pods and steaks of:
SILT RICH DIATOM OOZE
SILTY CLAY, greenish black (5GY 2/1)
DIATOM RICH SILTY CLAY
and VITRIC ASH light olive gray (5Y 6/1)

Slide 4-85
50% clay
45% silt
5% diatoms

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
189-1-1
189-1-2
189-1-3
189-1-4
189-1-5

Site 189 Hole Core 2 Cored Interval: 7-16

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
*	*	D N R S	F - R R	G - M M	Core Catcher					core catcher sample contained 2 pebbles, both 1-2 cm diameter: 1) hornblende diorite (angular) 2) sandstone (volc. source ?) (subrounded)

Explanatory notes in Chapter 1

* UPPER PLEISTOCENE
* (D) Denticula seminae

Site 189 Hole Core 3 Cored Interval: 45-54

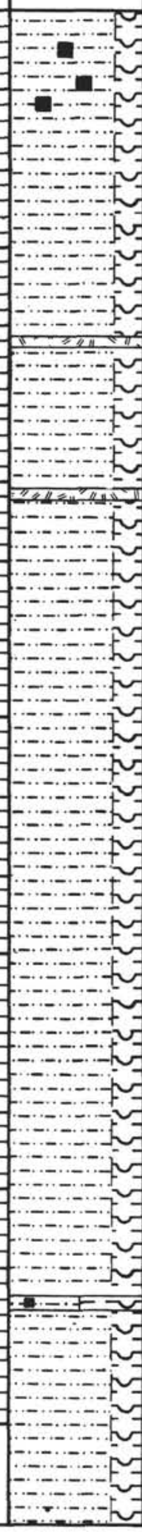
AGE: MIDDLE PLEISTOCENE

ZONE: (D) Rhizosolenia curvirostris

SECTION	FOSSIL	ABUND.	PRES.	LITHO. SAMPLE
1	PF	F	M	18
	BF	R		75
	D	C	M	
	R	R	M	
	S	-	-	
2	PF	R		60
	BF	-		
3	PF	-		10
	BF	R		
	PF	C	M	75
	BF	F		80
	N	R	M	111
	N	R	M	
	N	-	-	
4	N	R	M	
	PF	C	P	
	BF	R		
	N	R	M	
5	PF	A	M	75
	BF	F		125
	N	-	-	
6	PF	F	P	75
	BF	R		
Core Catcher	D	C	G	
	N	-	-	
	R	R	M	
	S	R	M	

METERS: 0.5, 1.0

LITHOLOGY



LITHOLOGIC DESCRIPTION

PUMICE PEBBLES

Basic lithology slides

1-75	3-75	5-75
55% clay	65% clay	70% clay
30% quartz, feldspar	30% silt	20% silt
10% diatoms	5% diatoms	10% diatoms
5% other		

CRYSTAL ASH, olive black (5Y 2/1)

CRYSTAL ASH, olive black (5Y 2/1)

Basic lithology
DIATOM BEARING to DIATOM RICH SILTY CLAY
dark greenish gray (5GY 4/1)

section 1 contains pods of light colored VITRIC ASH (95% glass, 5% feldspar)

sections 2-6 contain pods, streaks and thinbeds of dark colored CRYSTAL ASH

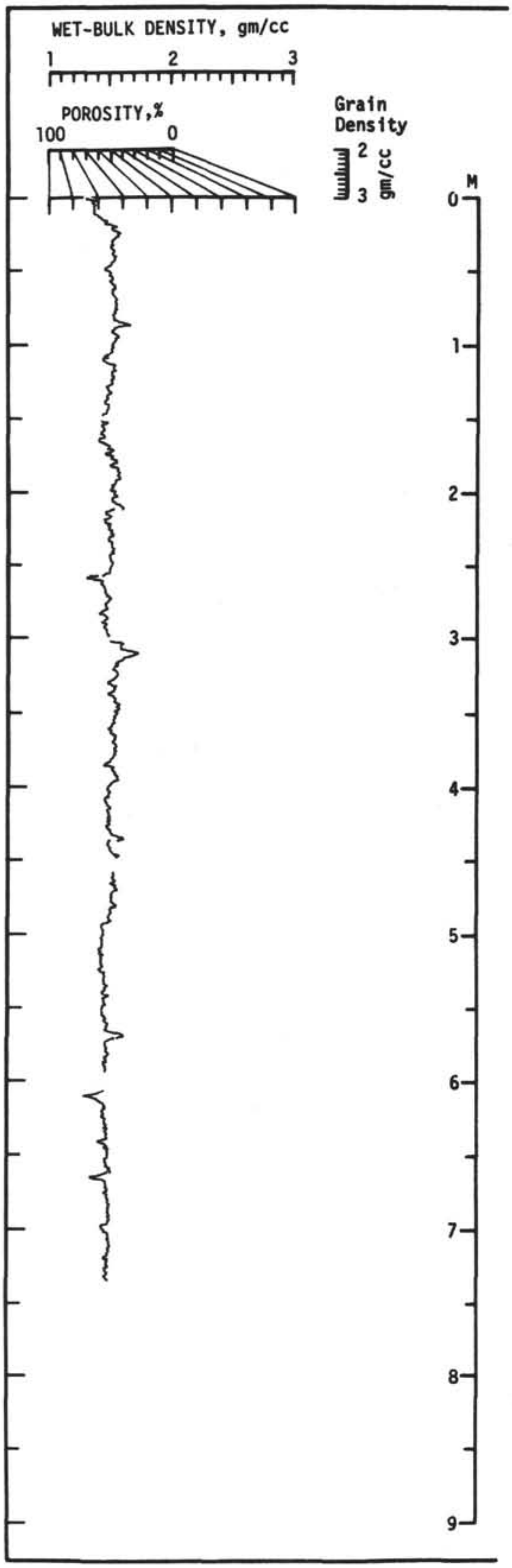
Slide 3-10	Slide 5-125
30% glass	40% glass
25% lith. frags. & opaque	35% feldspar
20% feldspar	20% lith. frags.
20% clay	2% pyroxene
2% pyroxene	

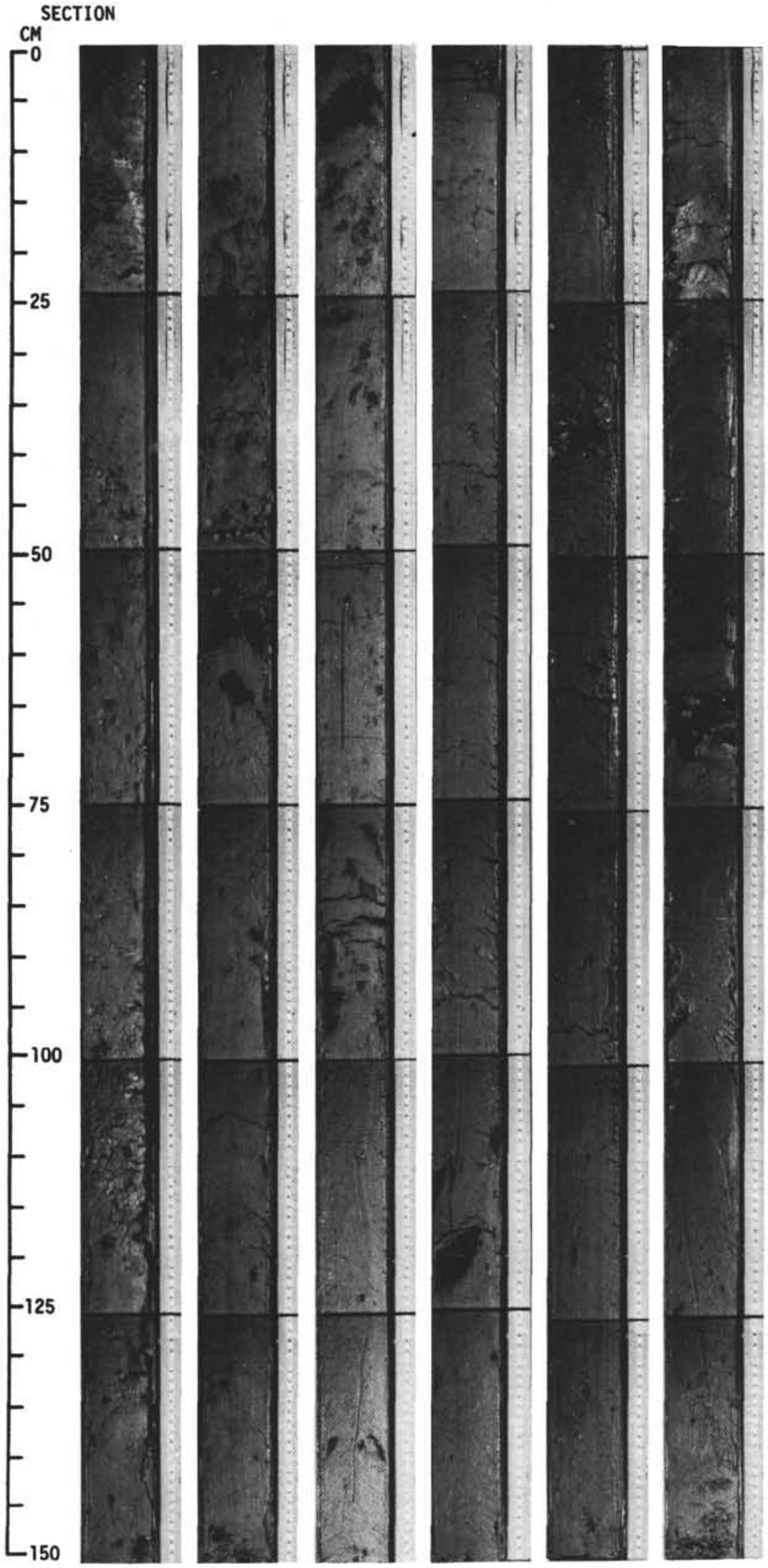
Gassy core

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

erratic pebble is METASEDIMENT

Explanatory notes in Chapter 1

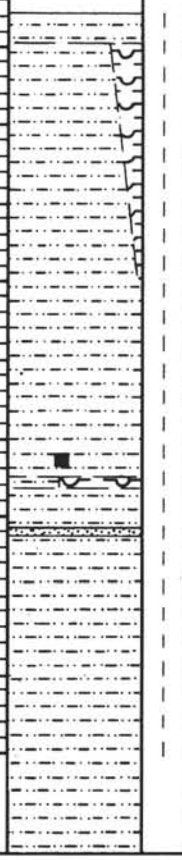




189-3-1 189-3-2 189-3-3 189-3-4 189-3-5 189-3-6

Site 189 Hole Core 4 Cored Interval: 83-92

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
MIDDLE PLEISTOCENE	(D) Rhizosolenia curvirostris (S) Dictyocha subarctios				1	0.5 1.0	VOID		140	DIATOM BEARING SILTY CLAY dark greenish gray (5G 3/1) 70% clay, 20% silt, 10% diatoms
		D R S	A R C	G M M	2					Basic lithology DIATOMACEOUS SILTY CLAY dark greenish gray (5G 4/1)
		PF BF	C C	M					75	transitional downwards to
		PF BF N	F R R	M M	3				75	DIATOM BEARING SILTY CLAY dark greenish gray (5G 4/1)
									129	SILT RICH, CLAYEY DIATOM OOZE olive gray (5Y 4/1)
					4				10	SANDY SILT dusky yellowish brown (10YR 2/2) major minerals: pyroxene and plagioclase very well sorted
		PF BF N	- - -	-					80	
*	*	D N R S	A - R R	G - M M	Core Catcher					

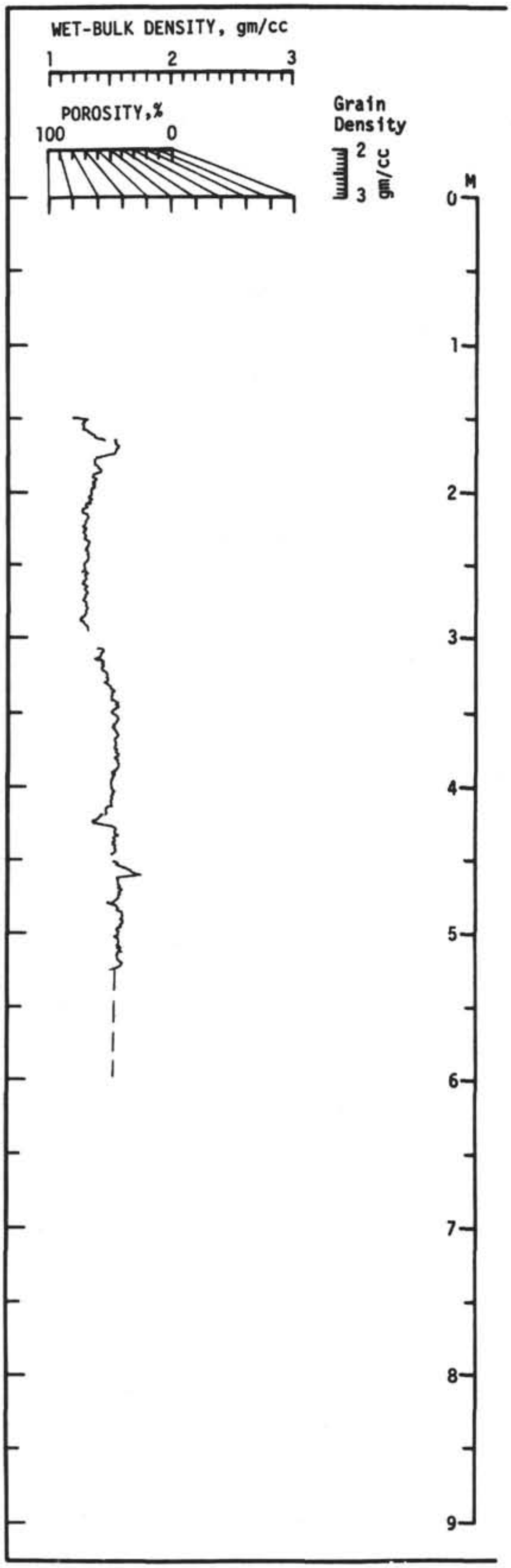


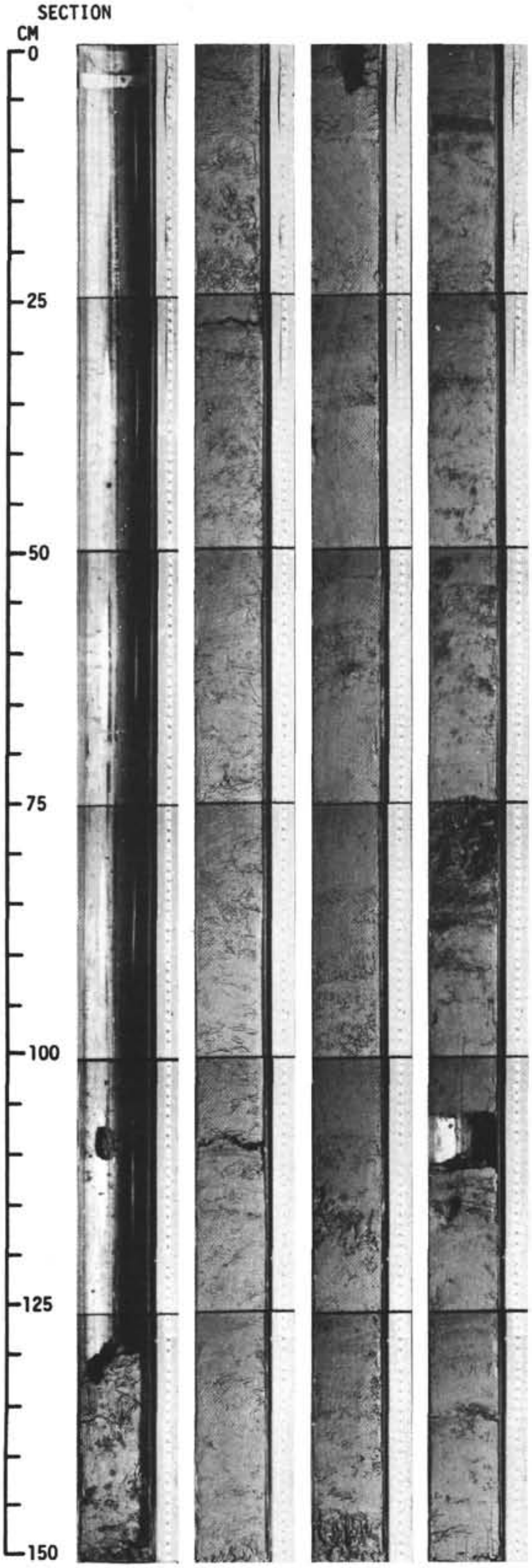
Slide 2-75
50% clay
20% feldspar, quartz
2% pyroxene
2% opaque
25% diatoms

Slide 3-75
60% clay
35% silt (mostly feldspar)
3% diatoms

Explanatory notes in Chapter 1

* LOWER PLEISTOCENE
* (D) Actinocyclus oculatus



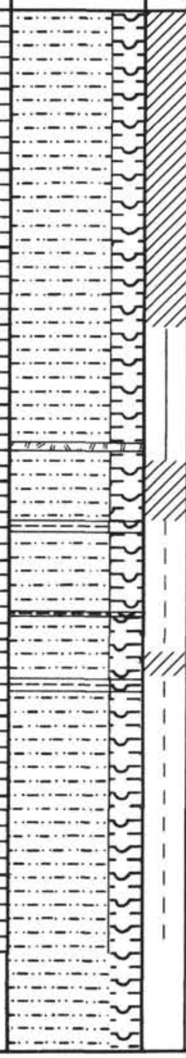


189-4-1 189-4-2 189-4-3 189-4-4

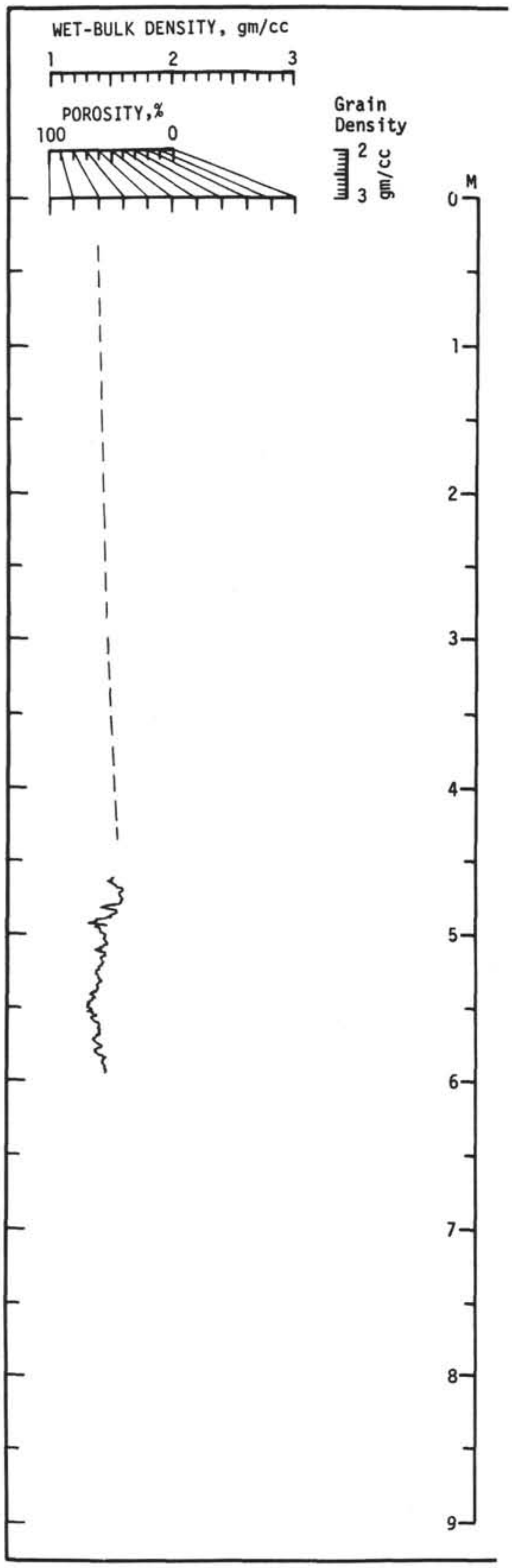
Site 189 Hole Core 5 Cored Interval: 147-156

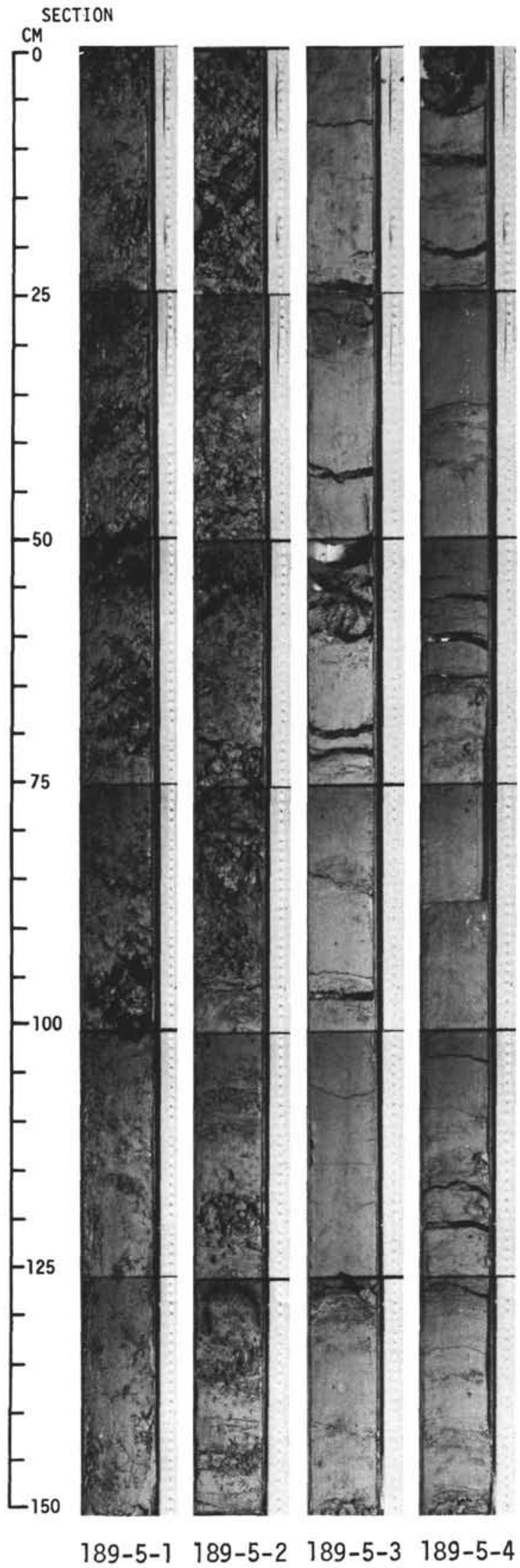
AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
LOWER PLEISTOCENE	(D) *Actinocyclus oculatus*	D R S PF BF	C R R - R	G M M	1	0.5 1.0	75	Basic lithology DIATOM RICH SILTY CLAY dark greenish gray (5GY 4/1) 60 - 70% clay 10 - 20% feldspar 15 - 25% diatoms ~2% opaques and pyroxene
		PF BF N	R R -	-	2		128	VITRIC ASH olive gray (5Y 4/1)
		PF BF N	R R R	M	3		32 75 131	SILT BEARING DIATOM RICH CLAY layers olive gray - greenish black (5Y 4/1 - 5GY 3/1) 80% clay 5 - 10% silt 10 - 15% diatoms
		N	-	-	4			Gassy core
					Core Catcher			Core Catcher: D C M PF - BF R N - - R R M S R M

LITHOLOGY / DEFORMATION

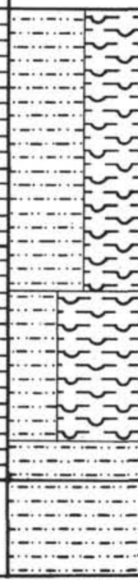


Explanatory notes in Chapter 1

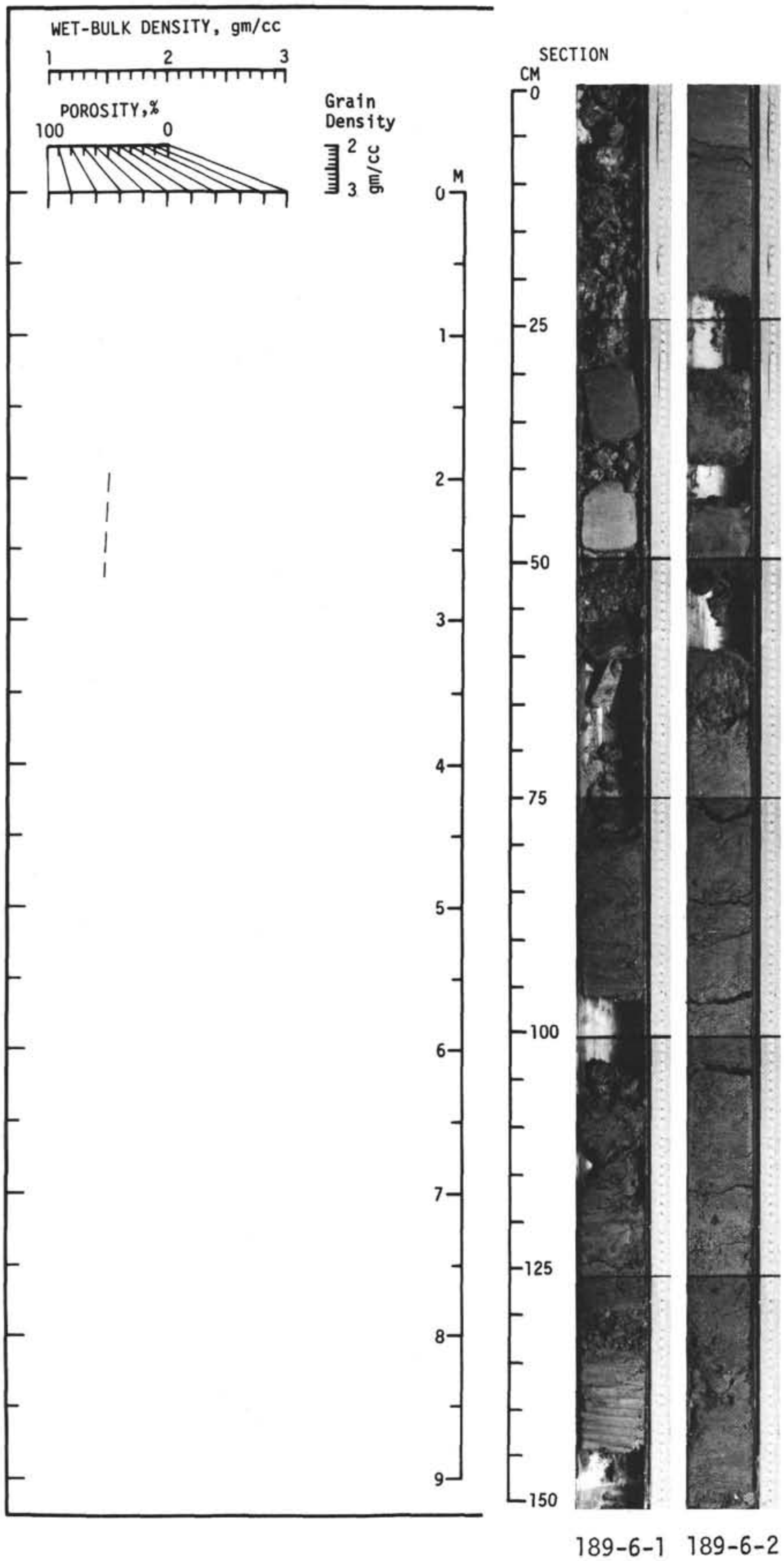

WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9


SECTION
CM
0
25
50
75
100
125
150
189-5-1
189-5-2
189-5-3
189-5-4

Site 189 Hole Core 6 Cored Interval: 212-221

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare	D R S PF BF	F R C - -	G M M	1	0.5 1.0			87	DIATOMACEOUS SILTY CLAY dark grayish green (5GY 4/1) 40% clay, 20% silt, 40% diatoms XR 2-20 70% amorph. 10% quartz 7% plag. 6% mica 1% chlor. 5% mont. 1% clinop. Core Catcher: D C G PF - BF - N R R M S R M
		PF BF N	- - -	-	2				80 136	SILT and CLAY RICH DIATOM OOZE dark greenish gray (5G 4/1) 65% diatoms, 20% clay, 15% silt CLAYEY SILT olive black (5Y 3/1) 60% feldspar (& qtz ?), 10% opaque, 3% pyroxene, 25% clay
					Core Catcher					
										5-10 cm voids throughout core due to gas expansion

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
189-6-1
189-6-2

Site 189 Hole Core 7 Cored Interval: 296-305

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare				1	0.5, 1.0	VOID		115	
					2				60	SILT and DIATOM RICH CLAY dark greenish gray (5GY 3/1) 60 - 80% clay 10 - 15% silt 10 - 15% diatoms locally up to 15% carbonate
					3				35, 80	DIATOM RICH SILTY CLAY olive gray (5Y 3/2) 60% clay 30% feldspar (& qtz ?) 10% diatoms locally pyrite bearing some burrowing in lower part
					Core Catcher					

XR 2-10
72% amorph.
9% quartz
9% plag.
3% mica
2% chlor.
4% mont.
3% clinop.

Core Catcher:

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

Site 189 Hole Core 8 Cored Interval: 362-371

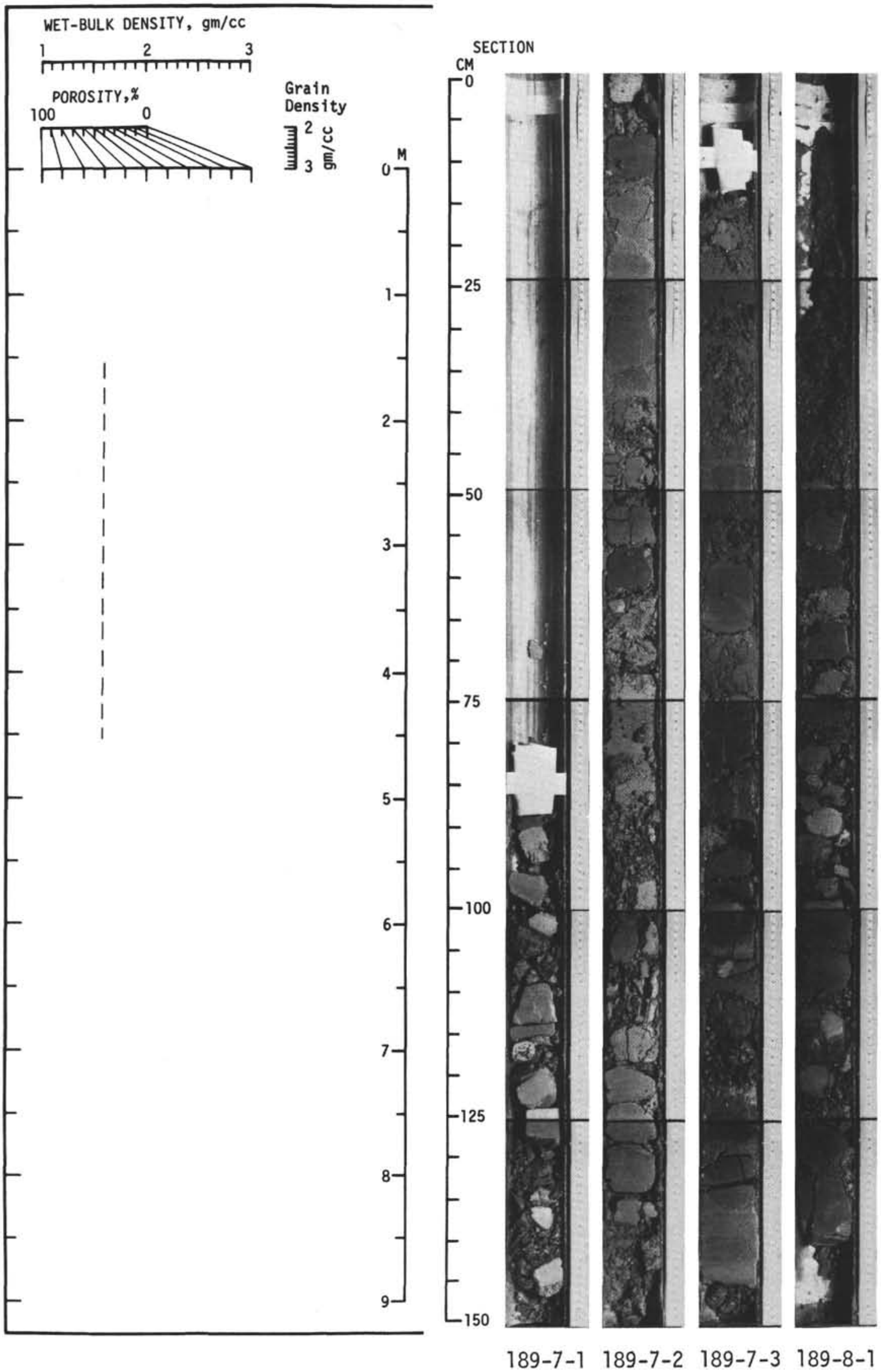
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare				1	0.5, 1.0	VOID		110?	SILT RICH CLAY olive gray (5Y 4/1) 85% clay 15% silt ~1% diatoms faint bedding
					Core Catcher					

XR 1-110
64% amorph.
12% quartz
8% plag.
11% mica
2% chlor
2% mont.
TR. clinop.
1% amphib.

Core Catcher:

	D	C	M
PF	-		
BF	-		
N	-	-	
R	-	-	
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
189-7-1 189-7-2 189-7-3 189-8-1

Site 189 Hole Core 9 Cored Interval: 426-435

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare	D R S	C - -	M - -	1	0.5 1.0	VOID		-125	diatom fragment bearing SILT RICH CLAY dark greenish gray (5GY 4/1)
					Core Catcher					

Slide 1-125
75% clay
20% silt (qtz. feldspar etc.)
5% diatom fragments

slight mottling and burrowing

XR 1-120	Core Catcher:		
	D	R	M
81% amorph.	PF	-	
5% quartz	BF	-	
5% plag.	N	-	-
2% mica	R	R	P
4% chlor.	S	R	P
3% mont.			
1% clinop.			

Site 189 Hole Core 10 Cored Interval: 537-546

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PLIOCENE	(D) Thalassiosira zabelinae (S) Ammodochium rectangulare				1	0.5 1.0			-91 -105 -135	CLAY olive black (5Y 2/1) SILT
					2		VOID			
					Core Catcher					

XR 1-60	Core Catcher:		
65% amorph.	D	F	M
13% quartz	PF	-	
5% plag.	BF	-	
14% mica	N	-	-
3% chlor.	R	-	-
1% mont.	S	R	M

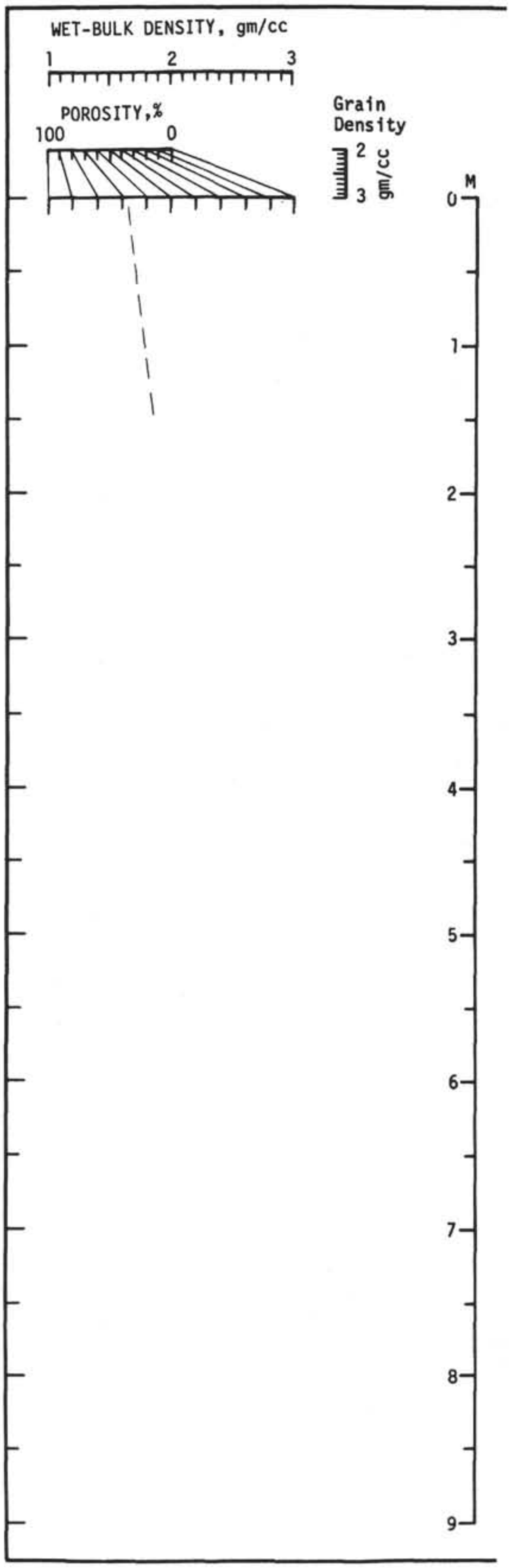
Basic lithology
SILTY CLAY
dark gray (N3) to olive black (5Y 2/1)

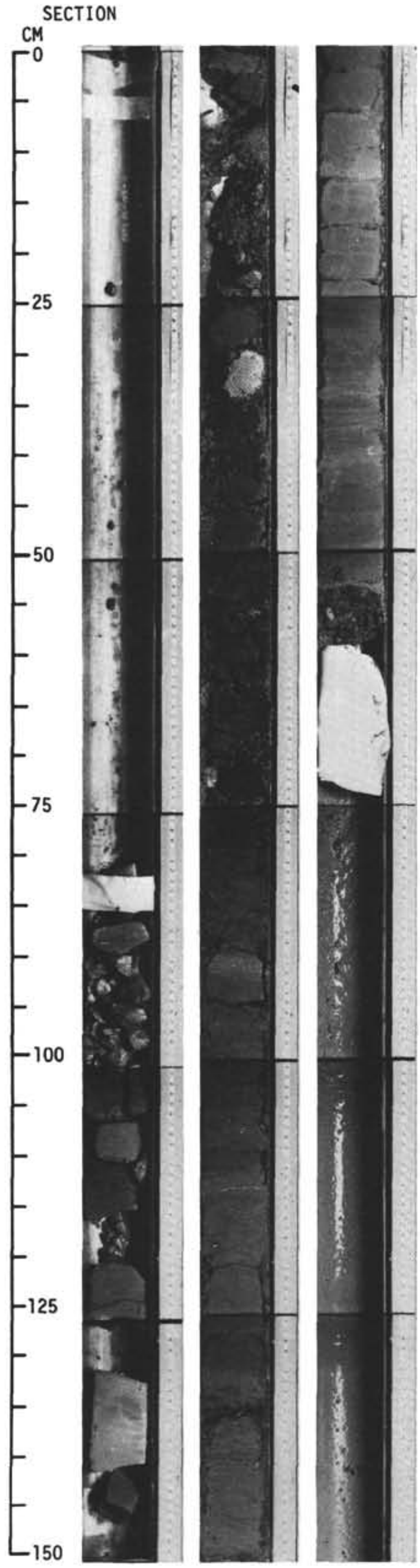
locally calcareous (up to 85% carbonate)
in thin beds

fine burrowing throughout
bedding may be inclined about 10°
in lower part of core

section is SILTY CLAY with 1% or less
of partially dissolved diatoms

Explanatory notes in Chapter 1





189-9-1 189-10-1 189-10-2

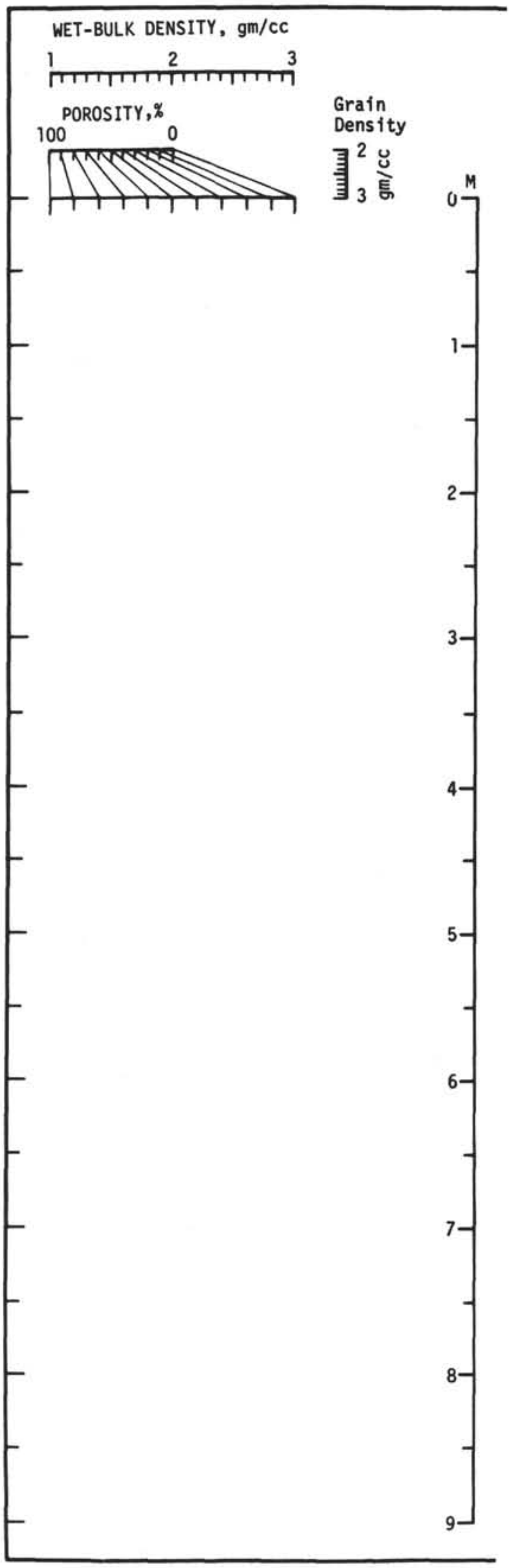
Site 189 Hole Core 11 Cored Interval: 641-650

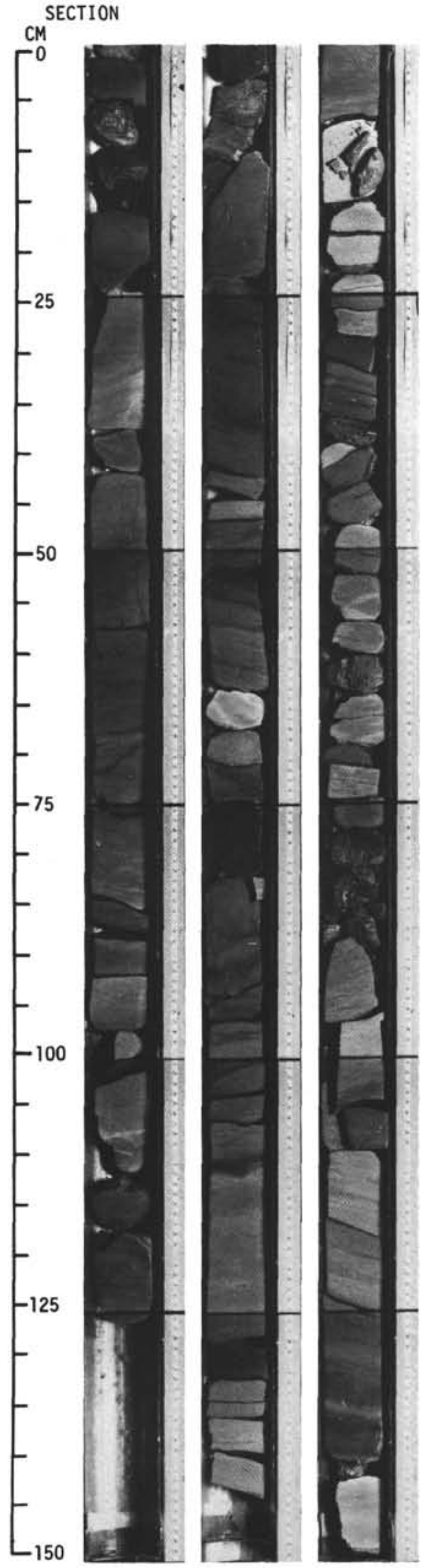
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1		VOID 			
									38	
						0.5			67	
						1.0				zone of vertical fractures filled with dark gray (N3) CLAY
									118	
					2				25	zone of calcite veins in the basic lithology clay filled fractures
										Basic lithology SILT BEARING to SILT RICH CLAYSTONE olive gray (5Y 2/1 - 4/1)
		D	R	M					120	VITRIC ASH
		R	-	-					130	
		S	-	-						
					3					beds 1 cm - 3 cm thick, inclined up to 25° burrows
										scattered small sponge ? remains
		PF	-							
		BF	-						75	
									137?	
		D	R	M	Core Catcher					
		N	-	-						
		R	-	-						
		S	-	-						

XR 3-30, 3-80, 3-130

3-30	3-80	3-130	
59%	47%	58%	amorph.
20%	33%	28%	quartz
4%	8%	6%	plag.
5%	4%	2%	mica
1%	2%	1%	chlor.
10%	3%	3%	mont.
	2%		clinop.
	1%	1%	pyrite

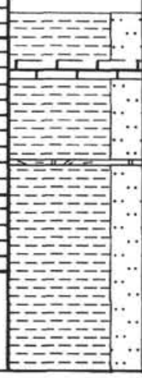
Explanatory notes in Chapter 1



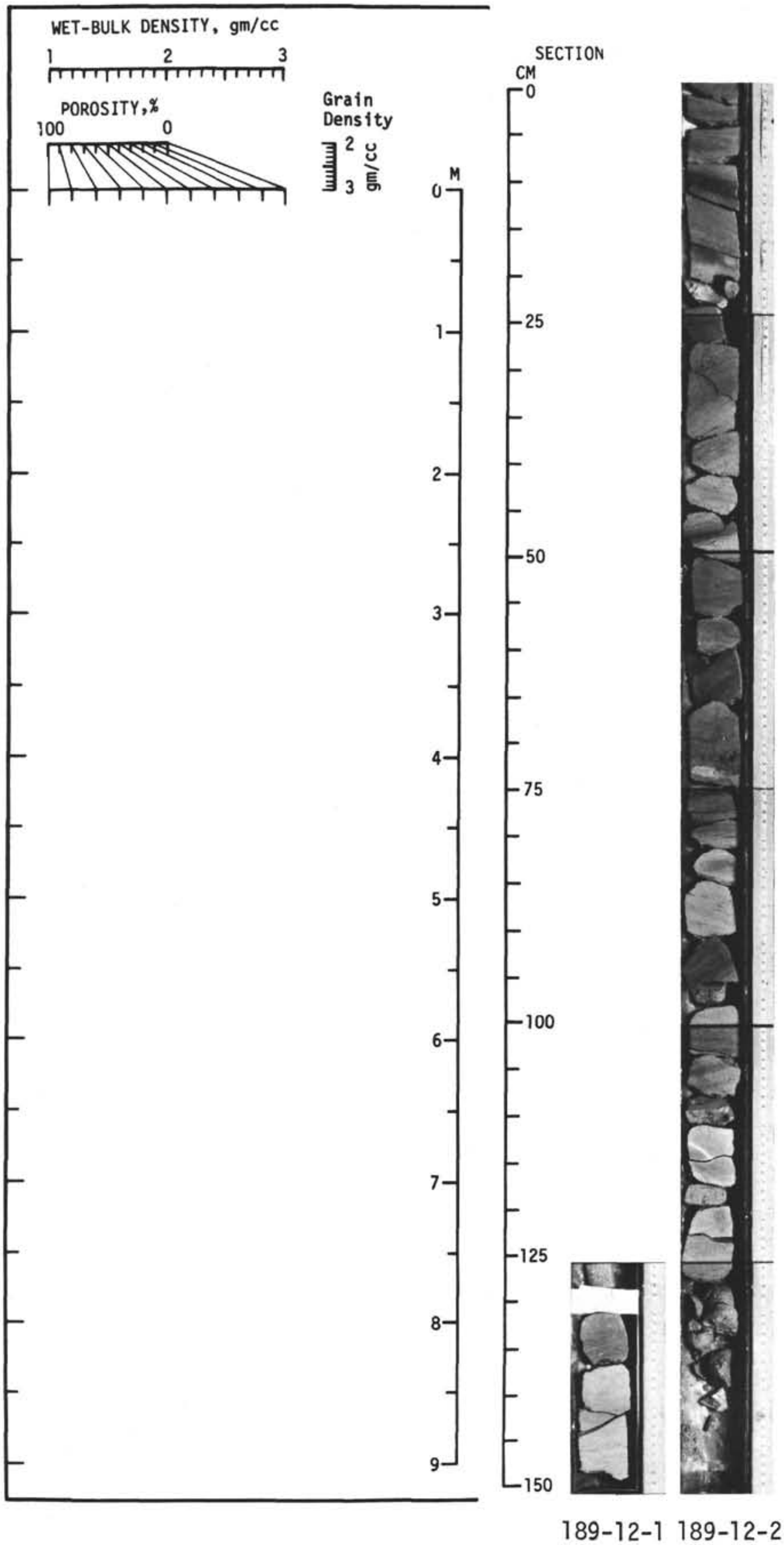


189-11-1 189-11-2 189-11-3

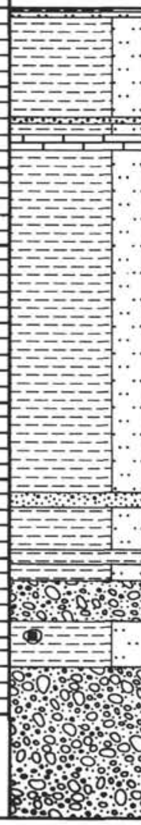
Site 189 Hole Core 12 Cored Interval: 706-715

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID			XR 2-50, 2-80 44% 38% amorph. 41% 7% quartz 7% 19% plag. 4% 3% mica 2% 1% chlor. 2% 26% mont. 5% clinop. 1% pyrite
		D R S	R - -	M - -	2				22 67 75 80	LIMESTONE, very light gray (N8), upper contact gradational Basic lithology SILT RICH CLAYSTONE olive gray - olive black (5Y 4/1 - 2/1) 90% clay, 10% silt sec. 2, ~40 cm and ~67 cm: thin diatom rich layers sec. 2, ~80 cm: devitrified ash layer sec. 2, 30, 46, 110, 122 cm: zones of tensional, clay-filled fractures oriented generally normal to bedding
					Core Catcher					Core Catcher: D R M N - - R - - S - - burrows bedding inclined up to 30°

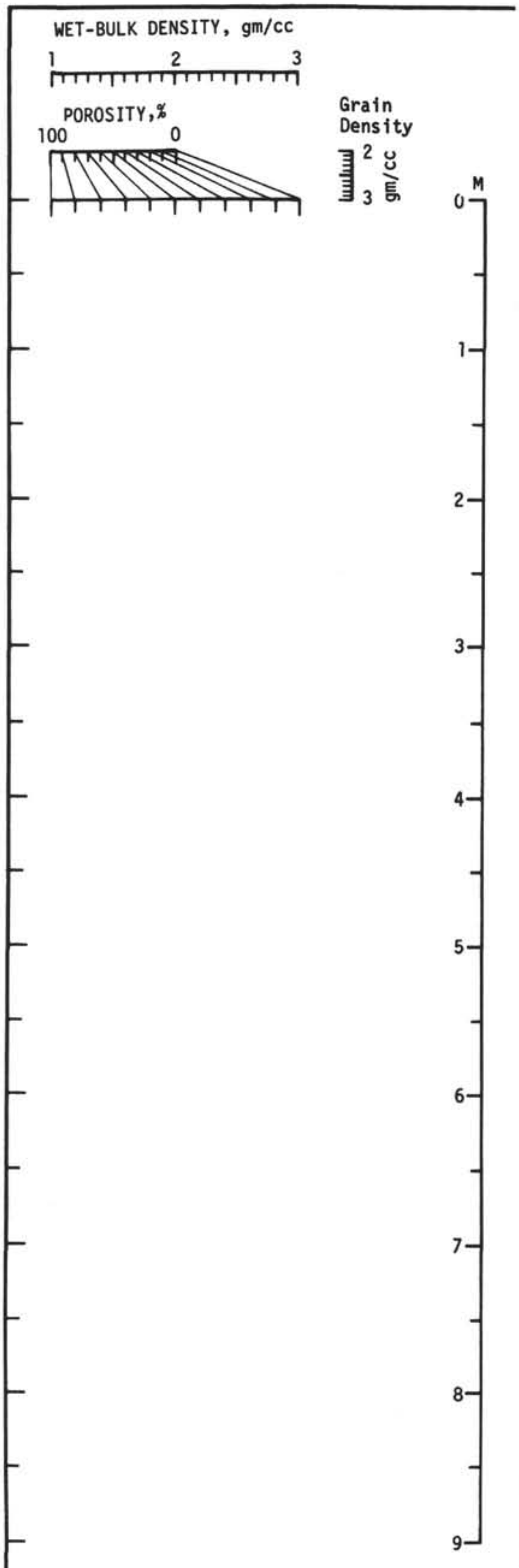
Explanatory notes in Chapter 1

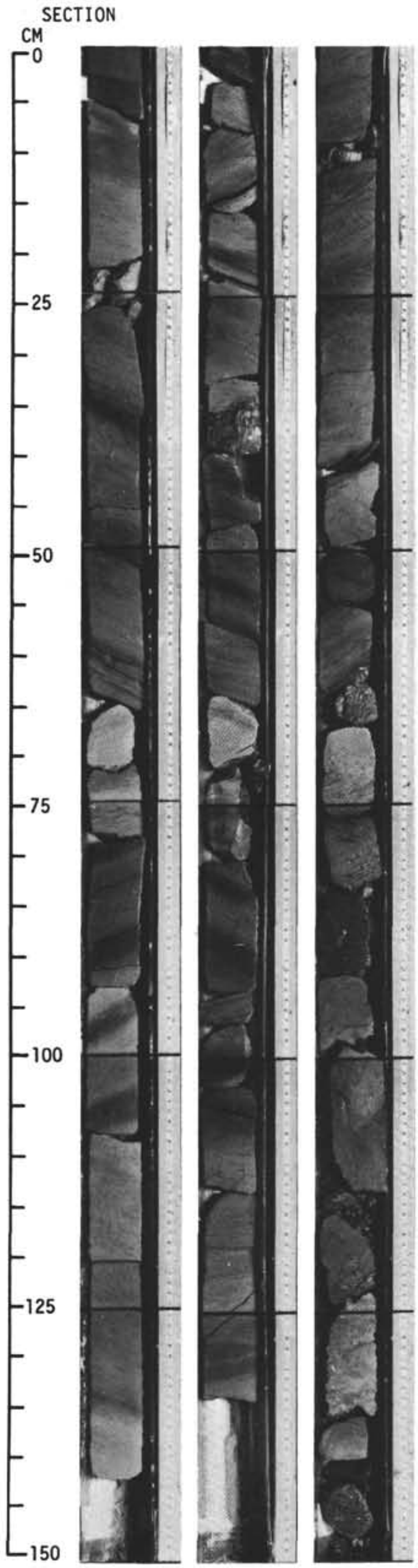

WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
Grain Density
2
3
gm/cc
M
0
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
189-12-1
189-12-2

Site 189 Hole Core 13 Cored Interval: 725-733

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
PROBABLY UPPER MIOCENE	(F) Rare Globorotalia (T.) pachyderma - sinistral	PF BF	R F		1	0.5 1.0			5 72 84 92 98	SILTSTONE SANDY SILTSTONE, dark greenish gray (5G 4/1) LIMESTONE 40% glass, 30% pyroxene, 30% feldspar Basic lithology SILT BEARING to SILT RICH CLAY olive gray 5Y 3/2 average composition: 90% clay, 10% silt
					2				94	bedding inclined about 30° XR 3-50 69% amorph. 17% quartz 7% plag. 3% mica 2% chlor. 2% mont. 1% pyrite
					3				40	SAND CLAY, greenish gray (5G 6/1) SAND, very coarse and CLAY PEBBLE CONGLOMERATE olive gray (5Y 3/2) pyrite nodules coarse SAND and CLAY PEBBLE CONGLOMERATE
		D N R S	- - - -	- - - -	Core Catcher					

Explanatory notes in Chapter 1





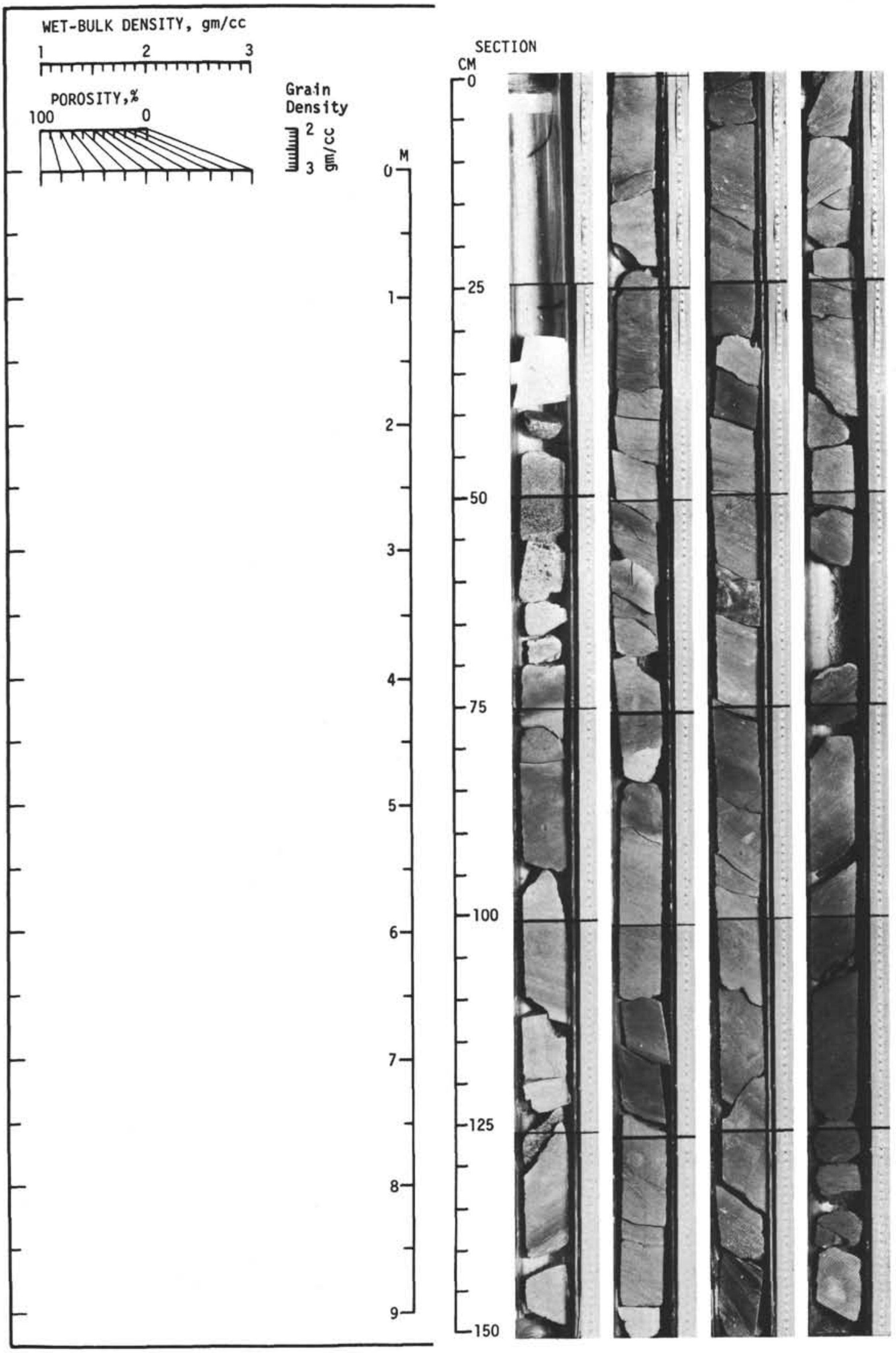
189-13-1 189-13-2 189-13-3

Site 189 Hole Core 14 Cored Interval: 743-752

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	 VOID		82, 92	GABBRO pebble (5 x 6 x 3 cm) at top of core coarse LITHIC FRAGMENT SANDSTONE, calcite cemented with 1-2 cm thick interbeds of SHALE PEBBLE CONGLOMERATE Basic lithology SILT BEARING CLAYSTONE olive gray (5Y 3/2 - 5Y 4/1) 85% clay, 5-10% silt, 5-10% pyritized diatoms bedding inclined 30% irregular, lensy bedding, vertical tensional fractures
					2				82, 84	LIMESTONE 85% calcite, 10% clay, 5% pyritized diatoms coarse SAND laminae in CLAY matrix
					3				95	VOLCANIC PEBBLE coarse SAND and fine GRAVEL in clay matrix
					4				?	coarse SAND
		D N R S	- - - -	- - - -	Core Catcher					calcite cemented SAND

XR 3-140,	4-80,	4-150	
48%	47%	44%	amorph.
		19%	calcite
24%	12%	7%	quartz
17%	20%	21%	plag.
6%	5%	2%	mica
5%	16%	4%	chlorite
		3%	clinop.

Explanatory notes in Chapter 1

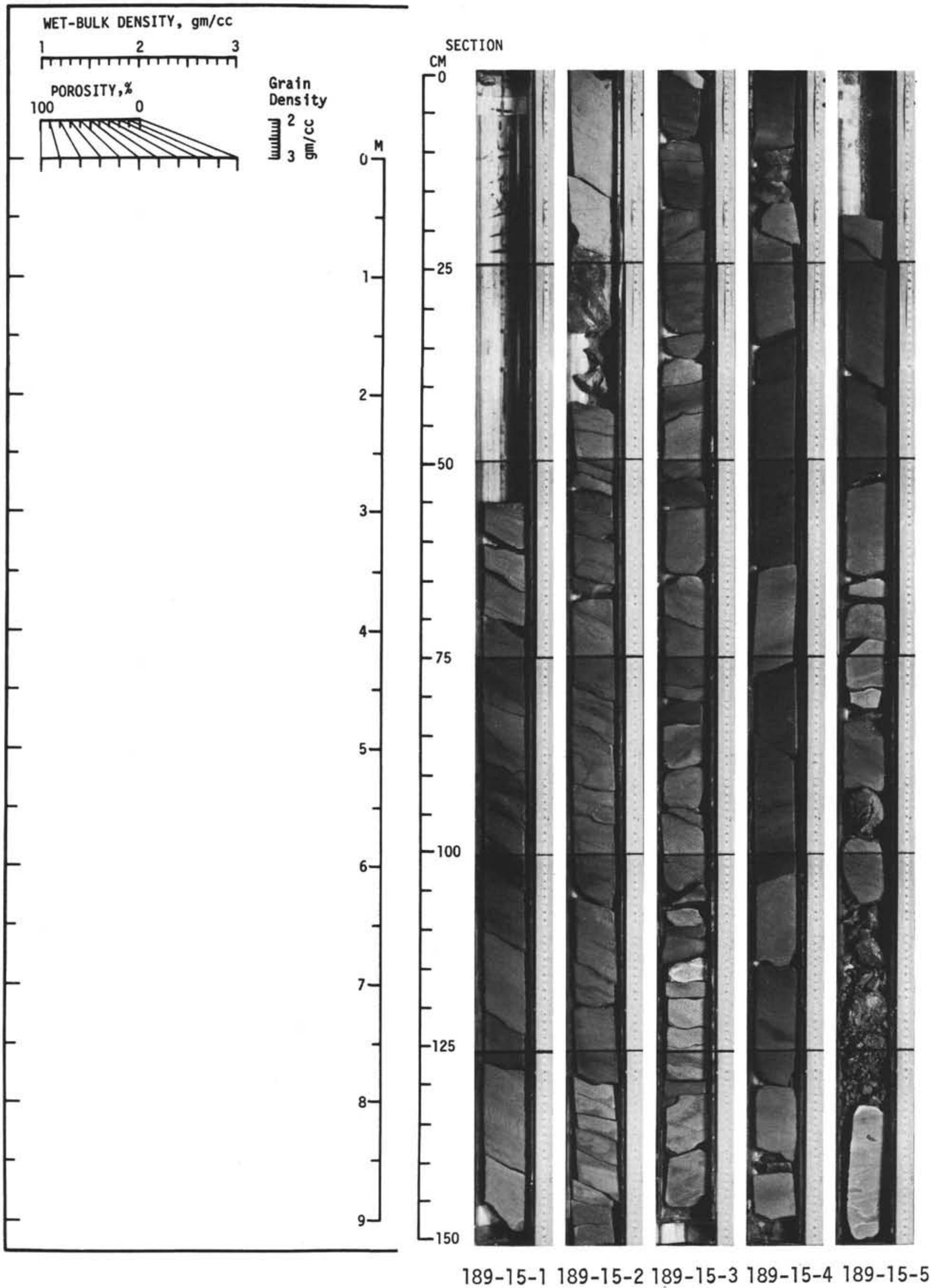


189-14-1 189-14-2 189-14-3 189-14-4

Site 189 Hole Core 15 Cored Interval: 771-780

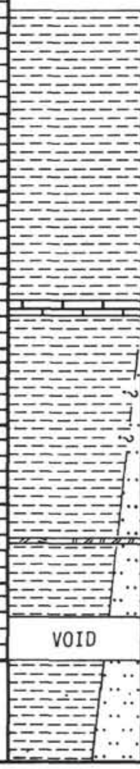
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID		?	
					2					Basic lithology SILT BEARING CLAYSTONE olive gray to olive black (5Y 2/1 - 4/1) bedding inclined about 30° burrows vertical tension cracks filled with clay and deformed (?) apparently by subsequent flowage.
					3					90% clay 6% feldspar, quartz 2% pyrite 2% glass
					4				?	SILT and PYRITE BEARING LIMESTONE upper contact gradational to basic lithology XR 1-90, 2-120 36% 68% amorph. 37% 17% quartz 12% 5% plag. 10% 6% mica 4% 2% chlor. 1% 1% mont. 1% 1% pyrite
					5		VOID		75	
					Core Catcher					Core Catcher: D - - N - - R - - S - - PF - BF -

Explanatory notes in Chapter 1

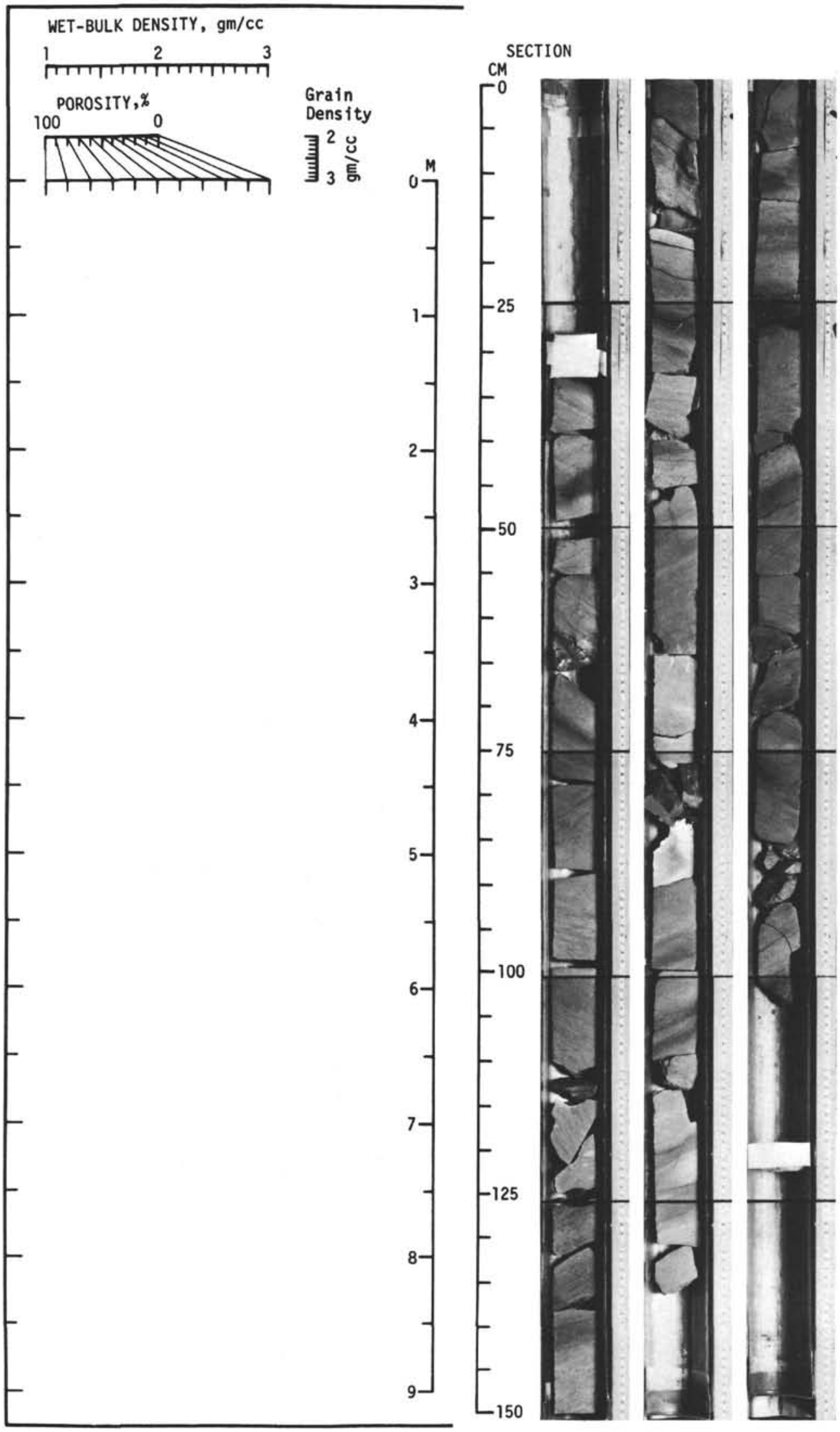

WET-BULK DENSITY, gm/cc
1 2 3
POROSITY,%
100 0
Grain Density
2 3 gm/cc
M
0 1 2 3 4 5 6 7 8 9
SECTION
CM
0 25 50 75 100 125 150
189-15-1 189-15-2 189-15-3 189-15-4 189-15-5

Site 189 Hole Core 16 Cored Interval: 799-808

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	FOSSIL CHARACTER: ABUND.	FOSSIL CHARACTER: PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID			Basic lithology SILT BEARING CLAYSTONE olive gray - olive black (5Y 4/1 - 2/1) 90% clay, 10% silt toward bottom of core becomes: SILT RICH CLAYSTONE olive gray (5Y 3/2)
					2				75 110 130	LIMESTONE 85% clay, 15% silt bedding lensy, laminae 1 cm - 4 cm thick; light and dark color bands 3-4 cm thick; back filled burrows; bedding inclined up to 40°
		PF BF	- F		3		VOID		24 40 73	diatom frag. or pollen (?) rich layer devitrified VITRIC ASH XR 3-80 74% amorph. 3% quartz 9% plag. 15% mont.
		D N R S	- - - -	- - - -	Core Catcher					



Explanatory notes in Chapter 1



189-16-1 189-16-2 189-16-3

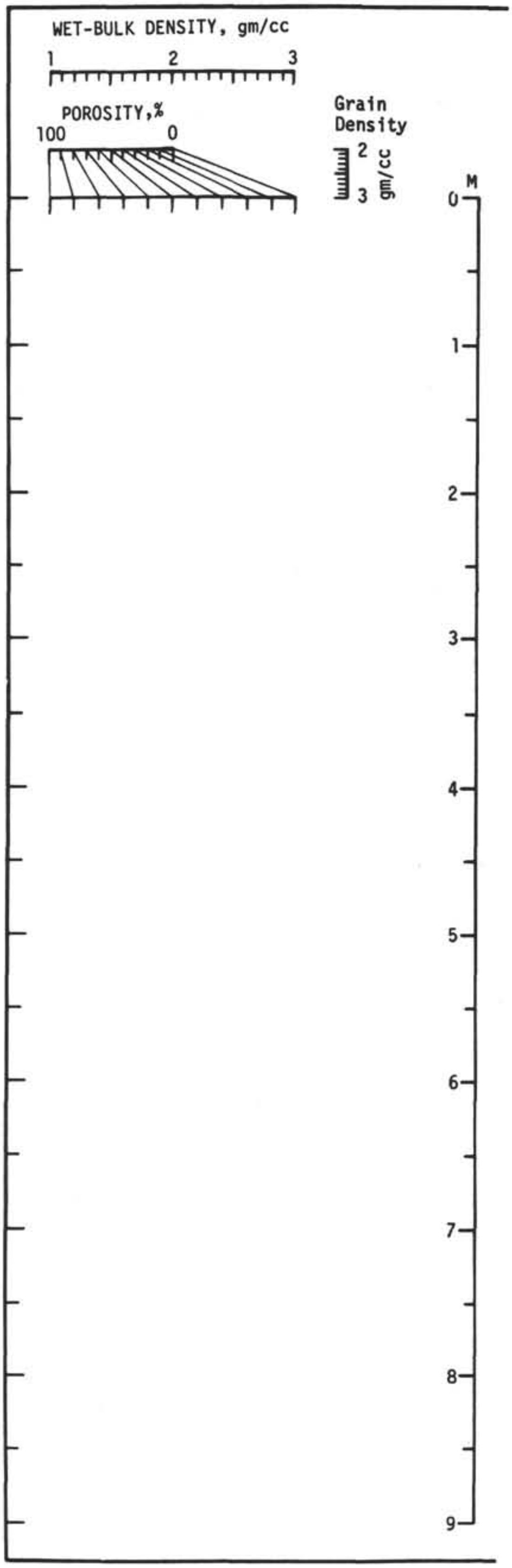
Site 189 Hole Core 17 Cored Interval: 818-827

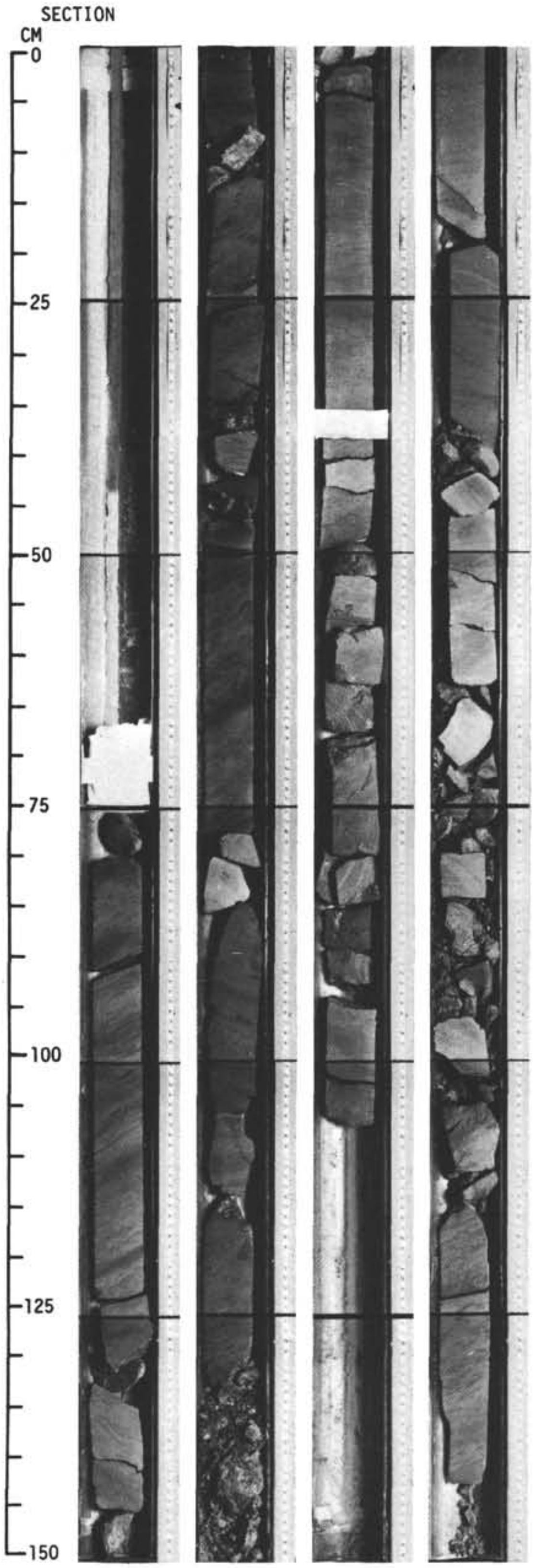
AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	VOID		120	SILT RICH CLAYSTONE olive gray to olive black (5Y 4/1 - 2/1) bedding inclined 30° burrows XR 2-100 64% amorph. 22% quartz 6% plag. 6% mica 1% chlor.
					2					
		D	-	-	Core Catcher					
		N	-	-						
		R	-	-						
		S	-	-						

Site 189 Hole Core 18 Cored Interval: 827-836

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5, 1.0	VOID			SILT RICH CLAYSTONE olive gray to dark greenish gray (5Y 3/2 - 5GY 4/1) bedding inclined 30° burrows Core Catcher: D - - N - - R - - S - - PF - BF F
					2					
					Core Catcher					

Explanatory notes in Chapter 1





189-17-1 189-17-2 189-18-1 189-18-2

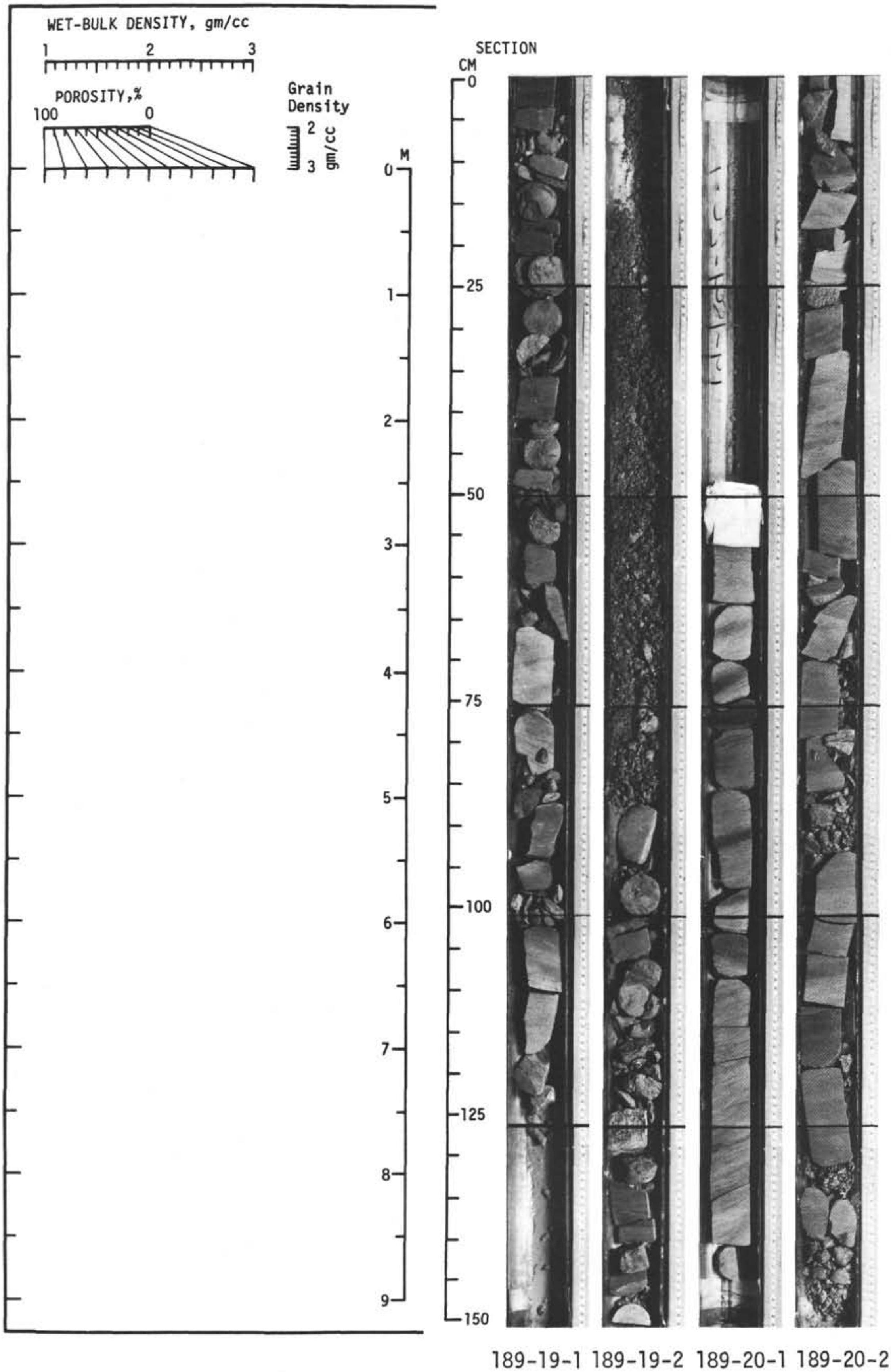
Site 189 Hole Core 19 Cored Interval: 847-856

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID CUTTINGS		90	CLAY RICH LIMESTONE (10-15% clay) Basic lithology SILT RICH CLAYSTONE olive gray (5Y 3/2) average composition 85% clay, 15% silt
					2				47 128	bedding inclined 30-40° devitrified VITRIC ASH, 70% glass, 25% feldspar, 5% opaque, chlorite, etc.
		D N R S	- - - -	- - - -	Core Catcher					

Site 189 Hole Core 20 Cored Interval: 865-871

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
					1	0.5 1.0	VOID		100	SILT RICH CLAYSTONE olive gray - olive black (5Y 4/1 - 2/1) burrows, bedding inclined 30°
		PF BF	- F		2				130	XR 2-70 52% amorph. 35% quartz 8% plag. 4% mica 2% chlor.
		D N R S	- - - -	- - - -	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
189-19-1
189-19-2
189-20-1
189-20-2