11. SITE 180

The Shipboard Scientific Party[1]

ABSTRACT

Site 180 is in the eastern Aleutian Trench at latitude 57°21.76'N and longitude 147°51.37'W in 4923 meters of water. It was cored and drilled to a total depth of 470.5 meters. The section is divided into seven units consisting mainly of graded silt turbidites and interbedded muds with silt laminae and ice-rafted erratics. Radiolarian and diatom assemblages indicate that the section is of late Pleistocene age, probably younger than 0.3 or 0.4 m.y., and lithologies suggest two glacial and one interglacial period. Foraminiferal and diatom assemblages displaced from littoral to bathyal environments attest to vigorous downslope movement of sediment. Sedimentation rates are 1500±300 m/m.y., although during interglacial times the rates were probably much less. These high rates of sedimentation, the dominance of fine-grained sediment, and absence of sand at this site indicate lateral facies changes to coarser-grained sediment in the trench axis where a turbidity current channel occurs.

SITE SUMMARY

Date Occupied: 8-11 July 1971.

Position (Satellite)::
Latitude: 57°21.76'N;
Longitude: 147°51.37'W.

Number of Holes: One.

Water Depth: 4923 meters.

Penetration: 470.5 meters below sea floor.

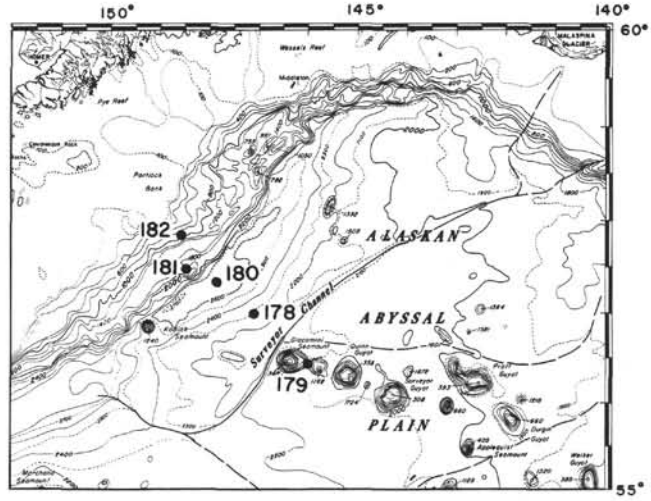
Number of Cores: 25.

Total Core Recovered: 81.5 meters, 34.3% recovery.

Age of Oldest Sediment: Late Pleistocene.

Acoustic Basement:
Nature: None.

Basement: Not penetrated.



BACKGROUND AND OBJECTIVES

Site Description

Site 180 is in the eastern Aleutian Trench (Figure 1) off Kodiak Island (57°27.76'N, 147°51.37'W). The trench is interrupted by Kodiak Seamount forming a northeast and a southwest basin; Site 180 is in the northeast basin 100 km north of the seamount where a prism of sediment has filled the axial part of the trench. Along the axis is a shallow 3- to 6-km-wide turbidity current channel with a low seaward levee. Site 180 is on the levee about 16 km from the continental slope on about 500 meters of trench fill. Below the fill is the section of turbidites and hemipelagic sediment drilled at Site 178.

Site Objectives

The major objective at this site was to study the lithology of a modern trench and to learn more about the glacial history of Alaska. Various sections on land have

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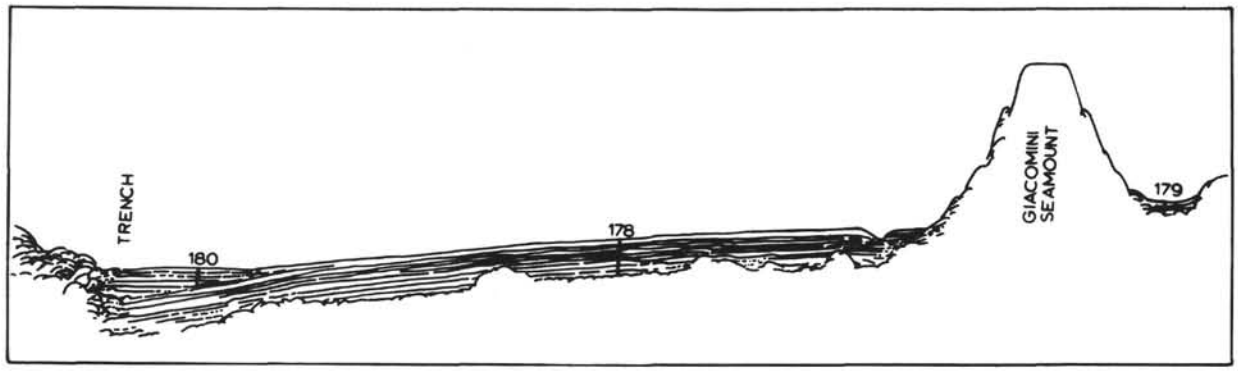

Figure 1. *Diagrammatic section across the Aleutian Trench and adjacent abyssal plain showing setting of Sites 178-180.*

been interpreted as typical facies of a trench and yet the trenches, because of their great depth, have rarely been sampled. Considering the assumptions made on the basis of inferred trench sections, a comprehensive modern trench lithology is of great interest. If a distinctive lithofacies can be established it might be used as a criteria to identify sediment that may have been folded against the continental margin because of subduction at the trench and subsequent uplift and erosion.

LITHOLOGIC SUMMARY

General Statement

The section is composed of graded silts and interbedded muds with silty laminae, which are probably all turbidites. The section is divided into six units on the basis of the amount of silt and its type of bedding, and the presence or absence of ice-rafted erratics. Since recovery was very low, and the lithologies are variable, these units should be viewed as descriptive devices rather than elements of a stratigraphic section. Many boundaries were established on the basis of changes in the seismic reflection record.

Lithologic Units

Unit 1 (0-2 m; Core 1)

This unit consists of dark greenish gray mud. The boundary with Unit 2 is gradational, and occasional coarse silt beds are found at the base of the unit. There is a 10-cm ash bed near the surface of the core.

Unit 2 (2-140 m; Cores 1-11)

This unit consists of gray muds with interbedded graded beds of silt (and occasionally of sand). There is little biogenous material and no ice-rafted erratics. Recovery was low; in general, barrels with high recovery (e.g., 2 and 8) have a relatively high mud-to-silt ratio. Coarse sands were found only as washings on top of Cores 7 and 9. The recovered section is probably biased towards finer lithologies. Because of poor recovery, the base of the unit is uncertain.

Two facies are distinguished in Unit 2; as described, they probably represent two points in a continuum of lithologies. The first is mud with 5 to 15 percent silt, mainly medium size. The silt is in thin graded beds 0.5 to 2 cm thick, often with alternating laminae of mud and silt at the top. Silt is also found in single or grouped laminae 0.5 to 1.5 mm thick in mud. Some of the silt laminae are well sorted, others poorly so. Such interlamination of mud and silt is a common feature of turbidites and has been previously described from Sites 177 and 178. The second facies is mud with 15 to 60 percent (usually around 30 percent) interbedded silt and very fine sand. The silt and sand is in poorly graded beds often 5 to 40 cm thick. Thin interbeds of the first facies are also found. The occurrence of these two facies in the intervals recovered is indicated in the graphic site summary.

The mud varies in grain size and rare clays are found; no system to this variation has been detected other than a tendency for coarse mud to directly overlie graded silt beds. In the transition between Units 1 and 2 (2-4 meters), and occasionally lower down in the section, the mud is dark greenish gray (5 GY 4/1) rather than the usual medium dark gray (N 4). The two different-colored muds cannot be distinguished lithologically in smear slides. The dark greenish gray beds usually grade up directly from graded silt beds, but are overlain by gray mud. This suggests they are not "inter-turbidite" sediments, in contrast to gray turbidite muds.

Bioturbation is slight. Most of the fine laminae of silt, and of dark gray (N 5) mud, are continuous; in other cases, the large size of "mottles" suggests disruption is due to coring disturbance.

Some of the coarser silts and the sands have up to 15 percent heavy minerals.

Unit 3 (140-165 m; Cores 12-17)

This unit is similar to Unit 2, but the muds contain granules and rare pebbles, presumably of ice-rafted origin. There are no dark greenish gray muds, and the muds are never sufficiently fine to be called clays.

Recovery down to about 240 meters was very low; from that point down, a different coring technique was used which gave better recovery. This means that core recovery bias differs from that in Unit 2, so that detailed comparison of the lithologies is difficult.

There is no trace of sands coarser than very fine grade in this unit. Lithologies are mostly similar to the second facies of Unit 2, with thinner interbeds resembling the first facies. Most of Core 12 is of the first facies. Most silt beds are 5 to 10 cm thick; the thickest is 53 cm.

Unit 4 (265-315 m; Cores 17-18)

This unit differs from Unit 3 as follows:

1) There are no ice-rafted granules or pebbles.

2) Much of the mud is dark greenish gray (5 GY 4/1) rather than medium gray (N 4).

3) Thin laminae of silt (c. f., the first facies of Unit 2) are almost absent; silts are mostly in beds 2 to 15 cm thick. There are no silt beds thicker than 15 cm.

4) Much of the mud contains 2 to 10 percent diatoms.

5) There are some pyritized nodules of silt ranging from granule to fine pebble size.

Unit 5 (315-390 m; Core 19)

This unit is similar to the second facies of Unit 2. Silt beds 2 to 25 cm thick make up 40 percent of the section. The silts are in graded beds, often with very fine sand at the base. The tops of silt beds, as well as the bases, are often sharp. The silts interbed with medium gray mud with very few silt laminae. No erratic granules were found.

Unit 6 (390-approximately 462 m; Cores 20-24)

Silt makes up less than 10 percent of this unit. The mud is medium gray (N 4) with almost no biogenous components, except for one 80-cm bed of dark greenish gray (5 GY 4/1) diatom-rich mud at about 420 meters. Coarse and medium silt occurs in graded beds up to 8 cm thick. Fine and medium silt laminae 0.5 to 5 mm thick are also found. These laminae are abundant; on average, there is a lamina or closely associated cluster of laminae every 5 cm in the mud. Most of the laminae are slightly bioturbated, and bioturbation is particularly intense in Core 24. This is the first unit in the section in which prominent bioturbation occurs. Some presumed ice-rafted granules and pebbles are found; associated sand and granule bearing muds are often harder than usual. There is an ash at 415 meters. The upper limit of this unit is based on the seismic record.

Unit 7 (462 m, Core 25)

Silt makes up 50 percent of this unit, occurring in graded beds 5 to 25 cm thick. Interbedded muds have only very rare thin laminae of silt. This core resembles Unit 5 in Core 19. Only 75 cm of section was recovered from this unit.

General Interpretation

Trends in sediment character. Correlation of Sites 178 and 180 by seismic reflection profiles indicates a seven-fold increase in the rate of sedimentation in the upper 400 meters of Site 180 compared with Site 178.[2]

No marked change in overall coarseness of sediment was found in the upper 400 meters of this site. There appears to be a slight decrease downwards in the percentage of silt and sand, but a correlation of silt and sand with depth is not statistically discernible.

Ice-rafted erratics first occur in Core 12 and disappear again in Core 19. There is sufficient data to indicate that this change is statistically significant. Furthermore, if overall sedimentation is seven times higher at Site 180 than at Site 178, then ice-rafted erratics should be about one-seventh as common in erratic-bearing intervals at Site 180 as at Site 178, assuming a constant flux of erratics at each site. The number of erratics found is consistent with this interpretation.

The presence/absence of glacial erratics most reasonably corresponds to glacial/interglacial conditions. On this basis, Cores 1 through 11 are probably Holocene, and Cores 12 through 17 were deposited during the last Pleistocene glaciation. This would imply no marked decrease in rate or coarseness of sedimentation from the late Pleistocene to the Holocene. However, overall sedimentation rates predict a Holocene sediment thickness of no more than 10 meters. Thus, the presence or absence of erratics may not strictly correspond to glacial/interglacial conditions, but also to some other variable such as the production, transport, and melting of icebergs. In this interpretation, the Holocene sedimentation rate is probably low; it is represented by Unit 1. Other warm periods are probably likewise thin. High sedimentation rates probably prevailed only during glacial periods.

The greater bioturbation in Unit 6 may well indicate a lower rate of sedimentation at that time. Equally few thick silts are found in Cores 2, 8, and 12, yet they show much less disturbance of silt laminae.

Environment of deposition. Turbidite silts, the thicker graded silts (Piper, Chapter 23, this volume), are typically found (a) when no coarser source material is available, (b) in an "overbank" relationship to turbidity current channels ("levee"), and (c) in truly distal turbidite environments ("abyssal plain").

In Unit 2, there is a trace of coarse sand, yet medium and fine sand are absent. Such a bimodal distribution suggests temporary encroachment of a channel across an overbank environment. This interpretation is supported by the apparent existence of a present-day channel at the foot of the trench wall.

Coring Disturbance in Core 22

Core 22 consists of mud with interbedded silt laminae, typical of Unit 6. Almost a complete barrel was recovered. The entire core is deformed apparently by 3- to 10-cm-long segments of core having rotated with respect to one another about a vertical axis. Segments are separated by sheared zones of mud 0.5 to 2 cm thick, of slightly darker gray color (N 5) than the undisturbed mud (N 4); there are no distinct fractures. Bedding was apparently tilted 40° before entering the barrel or extended barrel.

The shear zones show a slight bowing towards the edge of the core. Silt laminae in the muds are sharply truncated by the edge of the core, suggesting that tilting took place before entering the barrel, and that the shear zone bowing is a primary effect rather than a secondary distortion of an originally planar shear surface.

Longitudinal splitting of randomly rotated dipping beds reveals a distinctive chevron pattern of dipping beds, with occasional beds appearing horizontal in the plane of splitting.

[2] This value was calculated without correction for compaction. With a compaction correction the value increases to almost ten-fold.

The muds were sufficiently hard to prevent cutting by cheese-wire, but cut easily on the band saw. When drilling Core 22, the bit weight was 195,000 to 210,000 pounds with continuous pumping at 5 to 10 strokes/minute.

The top 50 cm of Core 23 show a similar deformation. Otherwise underlying and overlying beds are horizontally bedded and undeformed. Therefore, the tilting of the beds to 40° is believed to be due to coring disturbance before the core enters the barrel.

PALEONTOLOGIC SUMMARY

Introduction

Foraminifera, calcareous nannofossils, and diatoms are found in low abundances but generally well preserved throughout the 470.5 meters of graded silts, sands, and muds penetrated at Site 180. Badly oxidized palynomorphs occur rarely. Rapid burial by turbidite sedimentation within the trench environment apparently accounts for the preservation of calcareous microfossils at this site despite the depth of deposition (4923 m). Benthonic foraminiferal faunas are in fact dominated by species indicative of littoral, shelf, upper bathyal, and middle bathyal environments, attesting to the vigorous downslope transport experienced by these sediments during the interval represented.

Calcareous and siliceous microfossils indicate that the sequence penetrated at Site 180 encompasses the Holocene-Upper Pleistocene interval. A precise Holocene-Pleistocene boundary could not be recognized biostratigraphically but may be represented by the initial appearance of glacial erratics in Core 11 (123 meters). Correlation of diatom zones with the paleomagnetic-radiometric time scale indicates that the entire sequence penetrated is no older than 0.26 m.y. resulting in an estimated minimum rate of sedimentation of 1700 m/m.y. for this portion of the Aleutian Trench.[3]

Calcareous Nannofossils

Well-preserved Pleistocene calcareous nannofossils are present in small numbers in Cores 1 through 19 (0 to 356.5 meters) at Site 180. *Gephyrocapsa* sp. and associated small coccoliths are common in some samples down to 180-19(CC) (356.5 meters), but are extremely rare in Cores 20 to 25 (413.5 to 470.5 meters). *Coccolithus pelagicus* and *C. pliopelagicus* Wise n. sp. show similar distribution patterns. A few reworked Oligocene and Miocene coccoliths were noted in isolated samples. The core catcher of Core 20 (423 meters) contains a specimen of the Mesozoic coccolith *Watznaueria barnesea*. The nearshore indicator, *Braurudosphaera bigelowi* was not observed within the entire sequence.

Diatoms

Diatoms are rare or absent in most samples examined from Site 180. The best floras occur in Core 20 (180-20-4, 86-88cm). Quantitative analysis of floras revealed that three periods of relatively warm surface temperature occurred during deposition of this section. No older reworked diatoms were found but sporadic occurrences of displaced littoral marine species were encountered within warmer intervals.

The base of Pleistocene NPD Zone I could not be located within the 0- to 450-meter interval (Cores 1 to 23) as none of the basal index species were found. Thus, it is assumed that this section is younger than 0.26 m.y. based on correlation of NPD Zone I with the paleomagnetic-radiometric time scale.

Planktonic Foraminifera

Good to poorly preserved planktonic foraminifera occur in low abundances throughout the sequence penetrated, despite the depth of the sediment-water interface (4923 meters), due to rapid burial. Many specimens exhibit effects of dissolution.

Planktonic faunas encountered in Hole 180 are commonly dominated by sinistral coiling populations of *Globigerina pachyderma* with lesser percentages of *G. bulloides, G. quinqueloba, Globigerinita uvula,* and rare specimens of *Globorotalia scitula*. This species group is characteristic of the present Alaskan Current gyre and indicates a Holocene-Upper Pleistocene age for the sediments penetrated.

Benthonic Foraminifera

Well to poorly preserved benthonic foraminifera are present in low abundances throughout Hole 180. Faunas are predominantly composed of species displaced from littoral through middle bathyal environments along with marginal percentages of species representing the in situ abyssal biofacies. Littoral and shelf-dwelling species include *Buliminella elegantissima, Nonionella miocenica stella, Cassidulina minuta, Elphidium clavatum, E. incertum,* and *Buccella frigida.* Displaced upper bathyal and shelf-edge species present include *Buliminella exilis, Cassidulina transluscens, C. subglobosa,* and *Uvigerina peregrina*. Upper middle bathyal species recognized include *Epistominella pacifica, Cassidulina delicata,* and *"Loxostomum" pseudoberichyi* with only rare occurrences of lower bathyal-abyssal species such as *Melonis pompilioides*.

Most samples contain many unidentifiable fragments of broken and abraded benthonic and planktonic foraminifera in addition to fragments of broken mollusk shells all attesting to the considerable downslope transport experienced by sediments at this site.

Radiolaria

Radiolarians occur sporadically throughout Hole 180. The most abundant and diverse assemblages are present in Cores 17, 18, and 19 (261 to 356.5 meters). Faunas include a variety of Recent species but lack *Stylacontrarium acquilonium* and *Axoprunum angelinum* indicating that the entire section penetrated is within the Upper Pleistocene (to Holocene) *Artostrobium miralestense* (= *Eucyrtidium tumidulum*) Zone of Hays (1970) correlated with an estimated radiometric age of 0.4 m.y. to the present.

Spores and Pollen

Except for occasional, badly oxidized palynomorphs, samples examined at Site 180 are barren of spores and

[3] Uncorrected for compaction.

pollen. The rarity and poor preservation of grains is probably due to a dilution effect produced by a high rate of sedimentation and destruction of grains in sediments of high porosity. Oxidized woody fragments are present throughout the cores.

PHYSICAL PROPERTIES

At this site, syringe sampling procedures were modified in order to improve confidence in the measurements. To estimate reproducibility of the syringe method and the accuracy of the GRAPE, two syringe samples were taken where the porosity trace of the GRAPE record was straight. Otherwise, procedures were the same as at previous sites.

Sonic velocity values are relatively lower than values for equivalent depths at Site 178. They first exceed 1.6 km/sec at 265 meters, or virtually on the boundary of Units 4 and 5. The average interval velocity from 0 to 460 meters is 1.60 km/sec. Sonobuoy velocities for the same interval closer to the axis of the trench give velocities of 1.71±0.03 km/sec. (von Huene, 1972). This difference may be caused by a greater abundance of sand near the turbidity current channel running along the axis of the trench and/or by changes in structure of the sediment from decrease in confining pressure as the sample is brought to the surface.

From previous data assessments, it was concluded that syringe samples should be taken where no porosity changes occurred on the GRAPE records to remove some of the uncertainty in the syringe porosity value reproducibility. A comparison of carefully sampled syringe and GRAPE values is presented in Figure 2. There appears to be a systematic difference of 10 percent in the two types of measurement with the syringe method giving higher values, a trend seen at previous sites. GRAPE records were compared with lithologic records to eliminate disturbed core areas and to roughly separate porosity intervals and representing sand and mud fractions. Porosity values correspond well with changes in velocity and lithology showing a step change between Units 3 and 4 and again between Units 6 and 7.

CORRELATION BETWEEN REFLECTION RECORDS AND THE STRATIGRAPHIC COLUMN

Correlations between seismic and lithologic data were made using a record from the pre-drilling site survey (Figure 3), the *Challenger* on-station record, and an airgun record made by Holmes (written communication). Very subtile amplitude and frequency changes were sought in these records and since each record had its individual character, various aspects of the interpretation came from various records. The upper part of the section was best correlated with the on-station record and the first multiple of the pre-drilling site survey record (Figure 3). In these records, the signal strengths from the upper part of the section were not so strong as to cause electronic saturation and oscillation, and the clipping of high-amplitude signals did not destroy indications of relative reflectivity. In the lower part of the section, the record written with a strong signal was more informative. Table 1 shows correlations based on some very subtile acoustic effects.

The depth to the discontinuity between the abyssal and trench-fill facies is unclear in the seismic records. Site 180 is off-line by an unknown amount from the pre-drilling site survey seismic record. Because the *Challenger* on-station record was taken from a stationary ship, no angular discordance appeared. The discontinuity may be at 0.52 sec but it could also be at 0.56 sec. Thus, the uncertainty in the depth and the velocity result in limits of 416 to 465 meters for the discontinuity from seismic records.

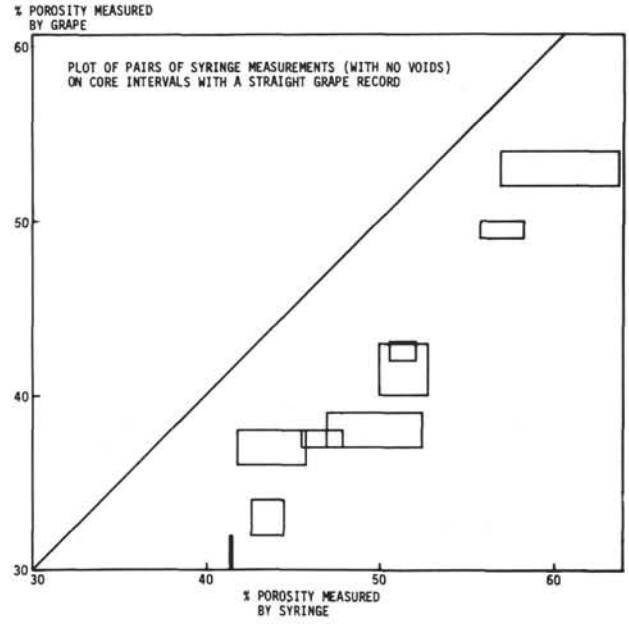

Figure 2. *Comparison of syringe and GRAPE values, Site 180.*

SUMMARY AND CONCLUSIONS

Site 180 is located in the eastern Aleutian Trench and was drilled and cored to 470.5 meters. The major objectives here were to study lithologies in an active trench, to possibly distinguish various glacial and interglacial intervals, and to determine an age of the sediments filling the trench. The objectives were only partially achieved because limited time forced interval coring, and poor recovery was experienced in the silty and sandy sediments.

The section consists of graded silt turbidites and interbedded muds with silt laminae that are possibly turbidites. Variations in the amount of silt and the presence of ice-rafted erratics provides a basis for dividing the section into seven units. Unit 1 (0 to about 2 meters) consists of greenish gray mud; a 10-cm ash bed occurs almost at the surface. Unit 2 (2-125 meters) consists of gray muds with interbedded silt and occasional sand. Unit 3 (125-265 meters) is similar to Unit 2, but contains erratics whereas Unit 4 (265-below 280 meters) contains no erratics and has diatom-bearing mud and fewer silt beds. Unit 5 (represented by one core at 350 meters) has more sand and silt but Unit 6 (about 386 meters to 465 meters) has few silts, is bioturbated, and has some glacial erratics. Unit 7 (a 75-cm sample at 462 meters) has 50 percent silt.

Foraminifers, calcareous nannofossils, and diatoms were found in varying amounts throughout much of the section;

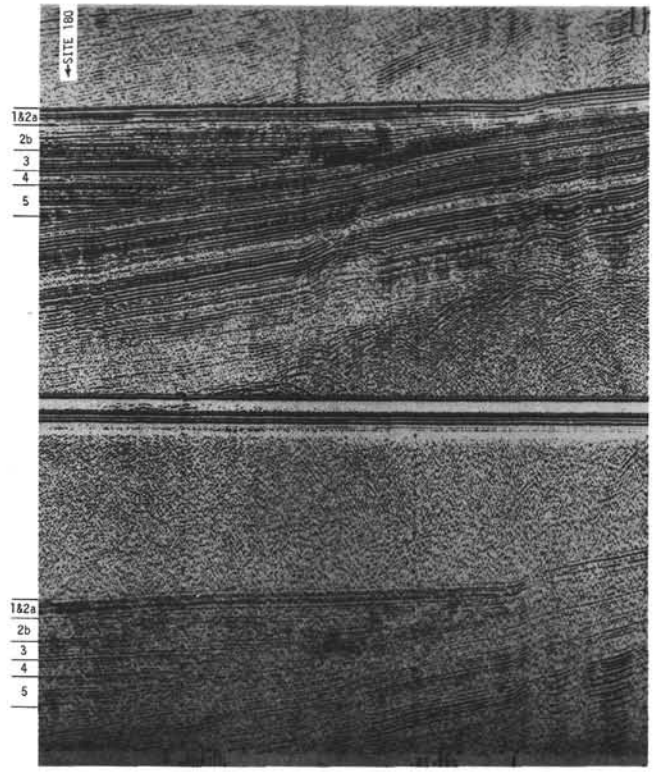

Figure 3. *Seismic record (U.S.G.S.) across the Aleutian Trench. Upper record is the primary, lower record is the first multiple, subtle amplitude differences in the upper four units are best seen in the multiple.*

radiolarians are rare. All assemblages indicate a Quaternary age and diatoms suggest an age of less than 0.26 m.y. The Holocene-late Pleistocene boundary was not recognized paleontologically. Benthic foraminifers from littoral, shelf, upper bathyal, and middle bathyal biofacies are found throughout the hole emphasizing the volume of sediment transported downslope. A few displaced littoral diatom species were found in the warmer intervals.

From the sparse core recovery in a highly variable lithology, conclusions regarding glacial events and modern trench sedimentation are not as certain as was anticipated prior to drilling. Nevertheless, distinct events are indicated by the lithology. The ash at the top of the section is presumed to be from the 1912 eruption of Mt. Katmai because this is a frequent occurrence in the western Gulf of Alaska (see Pratt, et. al., Chapter 20, this volume). The most intense glaciation, as indicated by the size and number of erratics, occurs in Unit 6 at the bottom of the trench fill. This may correspond to the intense glacial period between 0.22 and 0.28 m.y. (Kent and others, 1971) because (a) diatoms indicate an age of less than 0.26 m.y., (b) radiolaria indicate an age of less than 0.3 m.y., and (c) tracing reflectors in the abyssal section from 180 to 178 suggests an age of 0.3±0.05 m.y. for the bottom of Hole 180. The discrepancy in age between the biostratigraphy and reflector tracing is probably within the limits of precision in the methods applied here.

Other lithologic units are more difficult to fit into a definite unifying scheme. Unit 4 represents an interglacial

TABLE 1
DSDP Site 180–Acoustic and Lithologic Summary

Unit	Depth (m)	Acoustic Character	Lithologic Character
1 and 2a	0-55	On multiple record, sharp, narrow, evenly spaced, very continuous reflectors; at 55 meters, a wide strong reflector.	Mostly thick silt interbedded in a dominantly gray mud section; a sand bed occurs at 55 meters.
2b	55-140 (0-0.18)[a]	On multiple and onstation records, less continuous and more ragged reflectors than Units 1 and 2a reflecting higher frequencies (80 cps) more readily.	As above except that silt laminae may be thinner (recovery in this interval is 8 percent of depth drilled).
3	140-265 (0.18-0.30)[a]	On multiple and onstation records, continuous, evenly spaced sharp reflections similar to Units 1 and 2a. A wide high-amplitude reflection at 265 corresponds to a change in measured sediment velocity and porosity.	Same as Unit 1 with erratic granules and pebbles.
4	265-315 (0.30-0.39)[a]	On multiple and onstation records, weak, irregular, and evenly spaced reflectors that are less continuous than those of Unit 3. Rates of sedimentation in trench nearly as low as abyssal section as determined at contact between them.	Greenish-gray diatom-bearing mud with a few silt beds. (Warm-water diatoms noted)
5	315-390 (0.39-0.48)[a]	Separated from Unit 4 by a strong reflector, has moderately stronger reflections.	Gray mud and silt.
6	390-462	Strong and continuous reflections.	Gray mud with many silt laminae and erratics.

[a]Depth interval from seismic records, in seconds.

period which may have occurred at about 0.09 m.y. Alternatively, it may have occurred at 0.2 m.y. and an undetected interglacial period may occur in intervals of Units 2 and 3. From 95 to 140 meters, for instance, only a single core catcher was recovered. These alternate explanations give acceptable rates of trench sedimentation.

It is probable that erratics were not recovered from the upper Wisconsin (because of sparsity and poor core recovery) since the consequence of ending the Wisconsin glaciation at 120 meters is unreasonable. Sedimentation in the trench during Holocene time has probably been relatively low because glacial and fluviatile sediments have been trapped in fjords or have built deltas on the continental shelf whereas during intense glaciation both ice and streams entered the sea near the shelf break. The Holocene in the Gulf of Alaska is about 10,000 years long (Hopkins, 1967) and to deposit 120 meters of sediment in this time results in an unreasonable sedimentation rate more than an order of magnitude greater than sedimentation rates during glacial periods. A reasonable rate of

sedimentation results from placing the boundary at the change from greenish gray to gray sediment (2 meters).

To establish a comprehensive modern trench lithology, one drill hole with poor recovery is not sufficient because the trench has multiple sediment sources. Seismic records indicate that sediment enters the trench from canyons in the continental slope, probably as creep deposits or as slumps of various sizes. This sediment is at least partly redistributed by turbidity currents that have built the channel frequently observed at the foot of the continental slope. The large quantities of fine sediments at Site 180 may be overbank deposits associated with the turbidity current channel even though it is 8 km away. Coarser sediment may be concentrated along the channel.

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APPENDIX A. OPERATIONS

Pre-drilling Survey

Site 180 is located on the sedimentary wedge that fills the axis of the Aleutian Trench. A continuous seismic record was made at a 4-second sweep and fire rate from Site 179 to Site 180. The seismic line was run along course 304°T at a speed of 10 knots. Because of an error in the position of the site as given in the perspectus, the seismic line was run about 37 km beyond the site location. At 0925 (8 July), *Challenger* reversed course to 113° T. At 1145, speed was reduced to 6 knots and then to 5 knots at 1155. A spar buoy was dropped at 1203 and the beacon dropped after it was checked.

Drilling Program

The water depth at Site 180 is 4923 meters. The vessel was positioned over the beacon on 8 July at about 0200 hours and remained stable throughout the drilling period. The length of drill pipe to the bottom coincided with the PDR depth. The water depth was calculated using the closest Matthews table available for this area, "Area 44."

Hole 180 was cored continuously to a depth of 95 meters below the sea floor with coring and drilling to a total depth of 470.5 meters (see Table 2 for the coring summary). The first core was brought on board at 0225, 9 July. It consists of soft gray muds. Succeeding cores contain higher percentages of silt and very fine sand, which reduced the recovery to less than a meter per core from ten of the twenty-five cores obtained at the site. The poor recovery rate, which averaged 34.3 percent, is believed to be largely the result of the coarse silts and very fine sands. Frequently, silts were so tightly jammed into the core catcher and extended barrel that great difficulty was encountered in extracting them. However, these materials were easily washed away by the stream of water from the laboratory tap. Therefore, it is likely that the core barrel jammed easily and once the condition occurred, the sediment was easily washed away with normal drilling circulation. Somewhat similar lithologies were cored at various intervals in the holes at previous sites on this leg with better recovery, but these intervals were not as long as the one encountered in Hole 180.

The average position of several satellite fixes for Site 180 is 57°21.76′N latitude and 147°52.17′W longitude.

TABLE 2
DSDP Site 180 Coring Summary

Core	Cored Interval Below: Derrick Floor (m)	Cored Interval Below: Sea Floor (m)	Cored (m)	Recovered (m)	Recovered (%)
1	4933.0-4942.5	0-9.5	9.5	4.0	42.1
2	4942.5-4952.0	9.5-19.0	9.5	4.5	47.4
3	4952.0-4961.5	19.0-28.5	9.5	2.5	26.3
4	4961.5-4971.0	28.5-38.0	9.5	4.0	42.1
5	4971.0-4980.5	38.0-47.5	9.5	5.0	52.6
6	4980.5-4990.0	47.5-57.0	9.5	0.5	5.3
7	4990.0-4999.5	57.0-66.5	9.5	1.0	10.5
8	4999.5-5009.0	66.5-76.0	9.5	6.5	68.4
9	5009.0-5018.5	76.0-85.5	9.5	0.5	5.3
10	5018.5-5028.0	85.5-95.0	9.5	CC	–
11	5052.0-5061.5	119.0-128.5	9.5	CC	–
12	5080.5-5090.0	147.5-157.0	9.5	3.5	36.8
13	5109.0-5118.5	176.0-185.5	9.5	CC	–
14	5118.5-5128.0	185.5-195.0	9.5	CC	–
15	5175.5-5185.0	242.5-252.0	9.5	4.0	42.1
16	5185.0-5194.5	252.0-261.5	9.5	1.5	15.8
17	5194.5-4204.0	261.5-271.0	9.5	6.0	63.2
18	5204.0-5213.5	271.0-280.5	9.5	6.0	63.2
19	5280.0-8356.5	347.0-356.5	9.5	3.0	31.6
20	5346.5-5356.0	413.5-423.0	9.5	7.5	78.9
21	5356.0-5365.5	423.0-432.5	9.5	CC	–
22	5365.5-5375.0	432.5-442.0	9.5	9.5	100.0
23	5375.0-5384.5	442.0-451.5	9.5	5.0	52.6
24	5384.5-5394.0	451.5-461.0	9.5	6.0	63.2
25	5394.0-5403.5	461.0-470.5	9.5	1.0	10.5
		Total	237.5	81.5	34.3

Drilling Specifications

The water depth at Site 180 was 4933 meters. Subbottom penetration was 470.5 meters. A total of 233 meters was drilled and 237.5 meters were cored. The total core recovered was 81.5 meters resulting in a 34.3 percent recovery. Time on site was 70.25 hours, of which 4.75 hours were spent drilling and 44.75 hours coring.

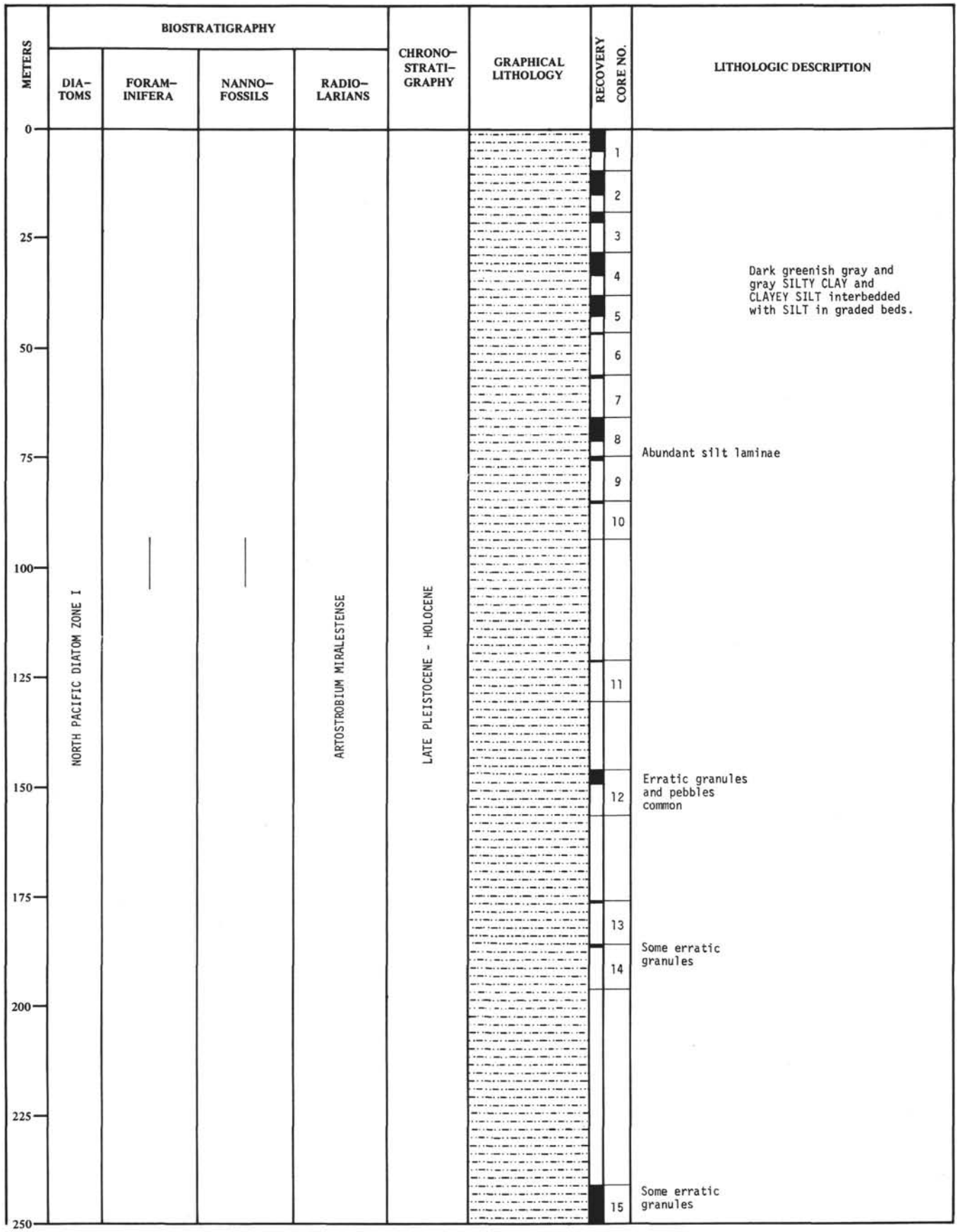
A Smith 11¼-inch button bit and the extended, rotating inner core barrel were run with the same bottom hole assembly that was used on the last three sites.

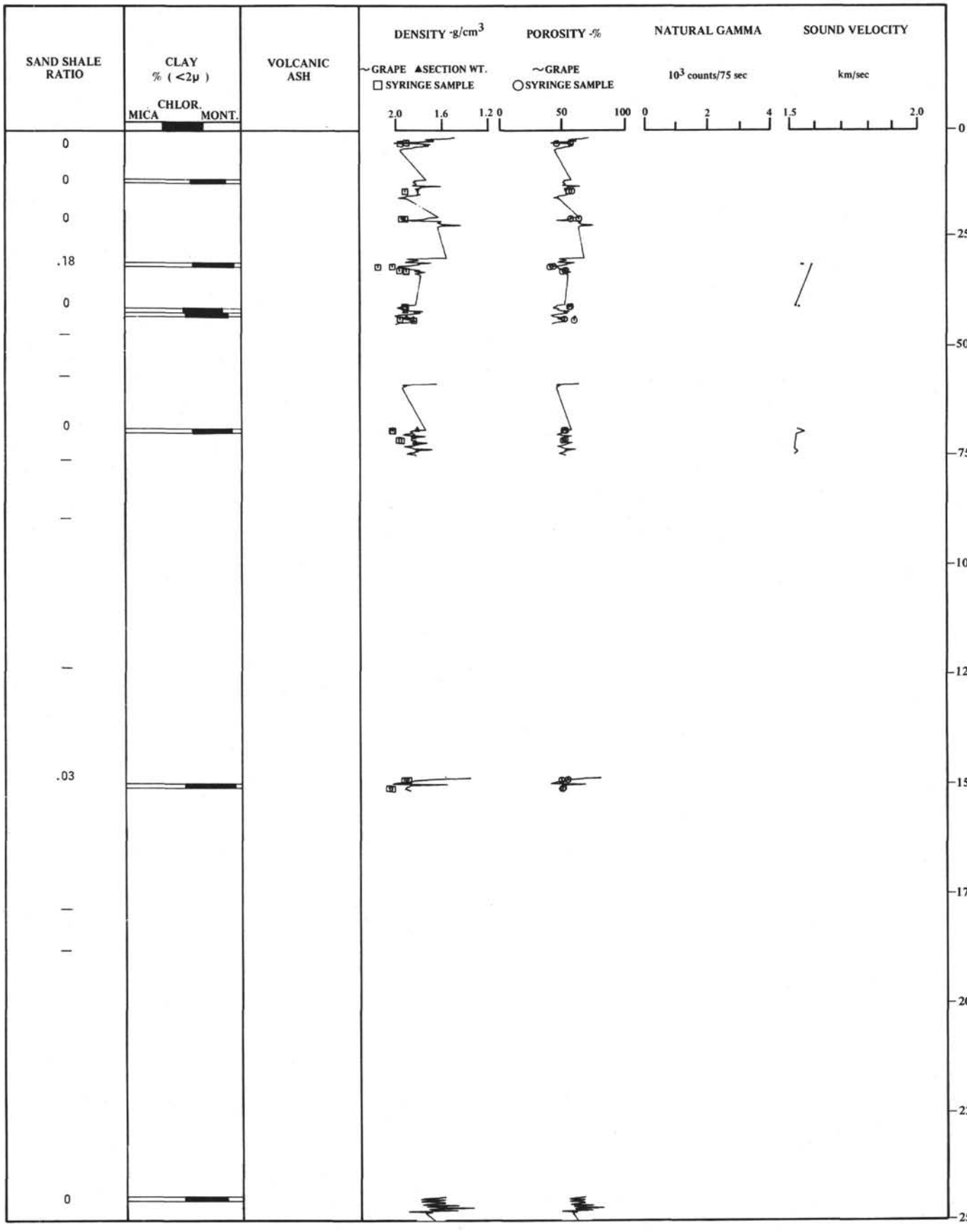
The Aleutian Trench proved to be the most difficult site for core recoveries of all the sites so far investigated on Leg 18. For the first fourteen cores, the recovery was only 23.3 percent. The sticky gray clay jammed the core barrel and

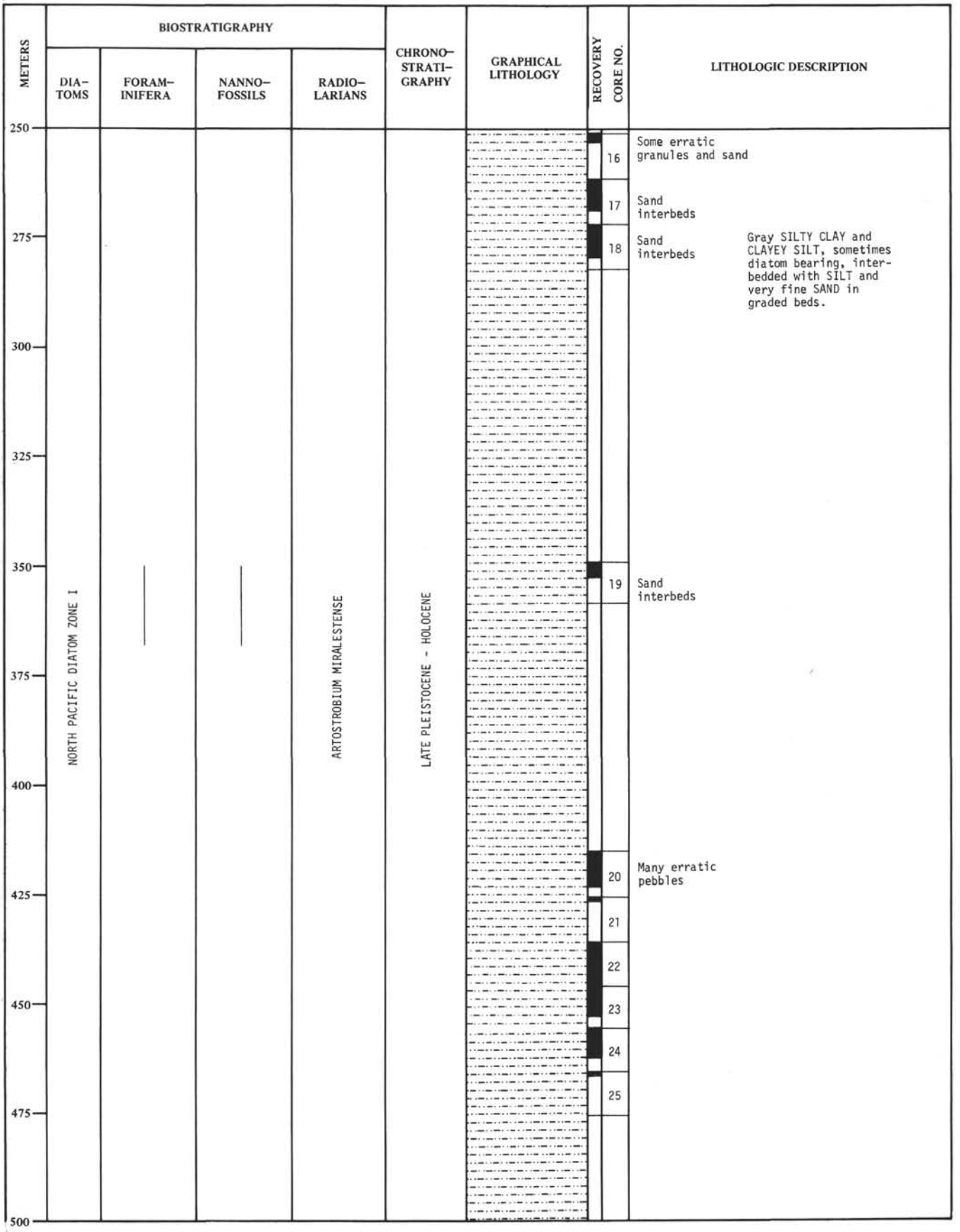
Postscript: Since completion of this summary, additional work which is reported in Chapters 21 and 33, has permitted a more certain set of conclusions which are summarized in Chapter 33.

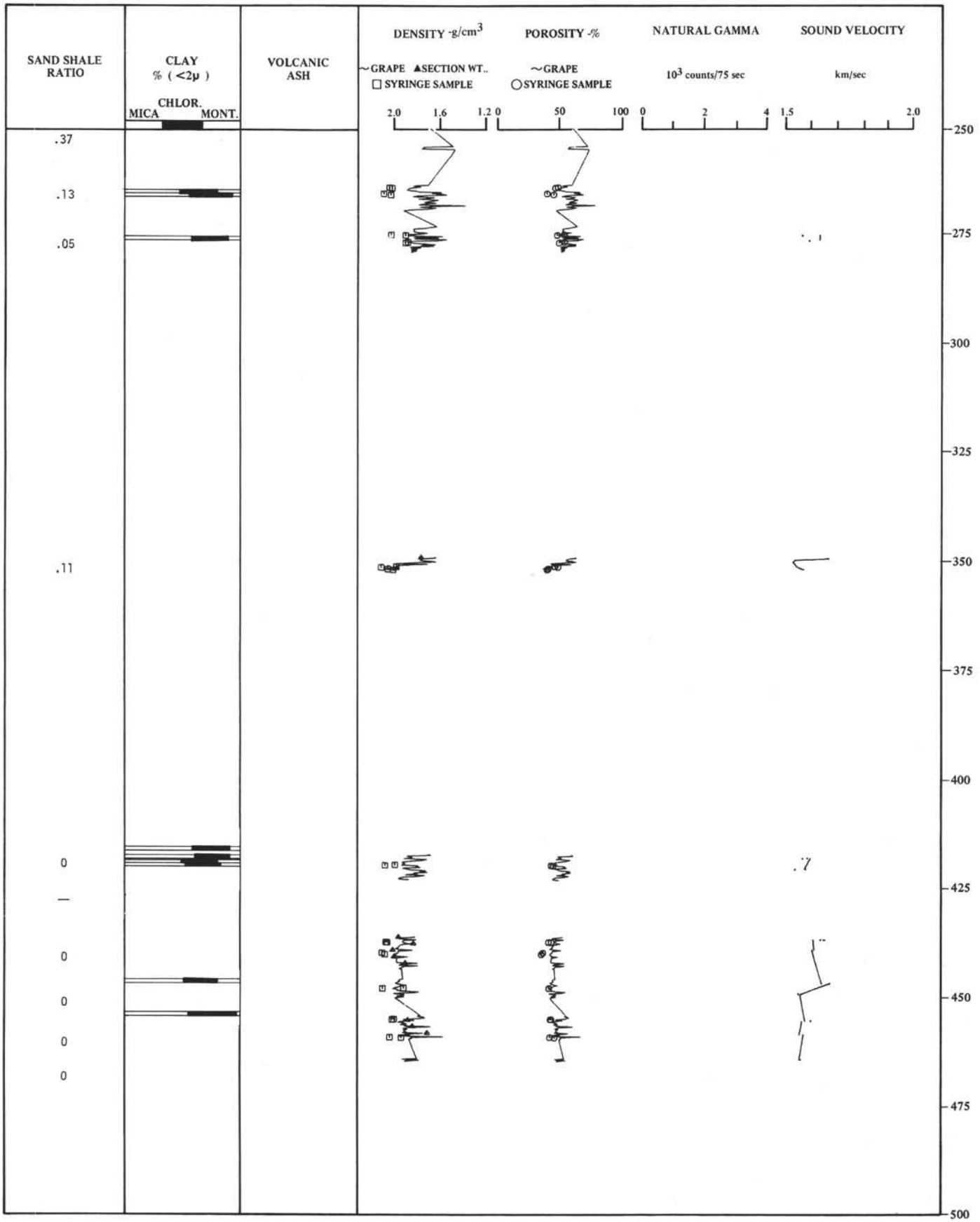
the fine sand washed out of the barrel if the pump was used. If no pump was used, the drill string jammed causing high torques. Some success was achieved in coring the sticky clay by dry drilling 2 meters with 3500 pounds of weight on the bit, then raising the drill string 2 meters off the bottom and circulating to clean the bit. By repeating this sequence every two meters, the overall core recovery was increased to 34.3 percent.

The drill hole was filled with 197 barrels of drilling mud (10.2 p.p.g.).

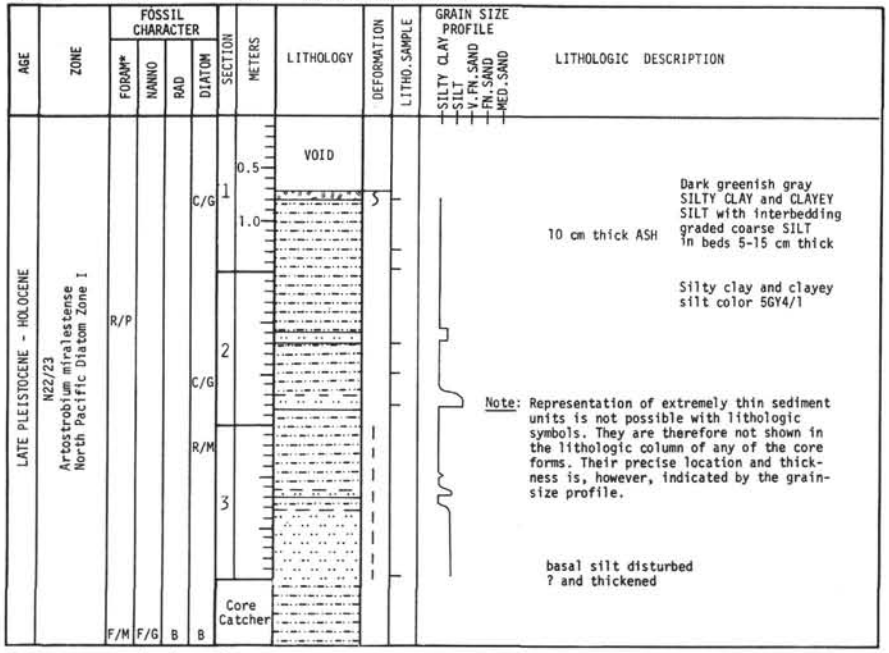

METERS
BIOSTRATIGRAPHY
DIA-TOMS
FORAM-INIFERA
NANNO-FOSSILS
RADIO-LARIANS
CHRONO-STRATI-GRAPHY
GRAPHICAL LITHOLOGY
RECOVERY
CORE NO.
LITHOLOGIC DESCRIPTION
0
25
50
75
100
125
150
175
200
225
250
NORTH PACIFIC DIATOM ZONE I
ARTOSTROBIUM MIRALESTENSE
LATE PLEISTOCENE - HOLOCENE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Dark greenish gray and gray SILTY CLAY and CLAYEY SILT interbedded with SILT in graded beds.
Abundant silt laminae
Erratic granules and pebbles common
Some erratic granules
Some erratic granules


SAND SHALE RATIO
CLAY % (<2μ)
MICA
CHLOR.
MONT.
VOLCANIC ASH
DENSITY -g/cm3
~GRAPE ▲SECTION WT.
□ SYRINGE SAMPLE
2.0
1.6
1.2
POROSITY -%
~GRAPE
○ SYRINGE SAMPLE
0
50
100
NATURAL GAMMA
10³ counts/75 sec
0
2
4
SOUND VELOCITY
km/sec
1.5
2.0
0
.18
0
.03
0
0
25
50
75
100
125
150
175
200
225
250


METERS
BIOSTRATIGRAPHY
DIA-TOMS
FORAM-INIFERA
NANNO-FOSSILS
RADIO-LARIANS
CHRONO-STRATI-GRAPHY
GRAPHICAL LITHOLOGY
RECOVERY
CORE NO.
LITHOLOGIC DESCRIPTION
250
275
300
325
350
375
400
425
450
475
500
NORTH PACIFIC DIATOM ZONE I
ARTOSTROBIUM MIRALESTENSE
LATE PLEISTOCENE - HOLOCENE
16
17
18
19
20
21
22
23
24
25
Some erratic granules and sand
Sand interbeds
Sand interbeds
Gray SILTY CLAY and CLAYEY SILT, sometimes diatom bearing, interbedded with SILT and very fine SAND in graded beds.
Sand interbeds
Many erratic pebbles

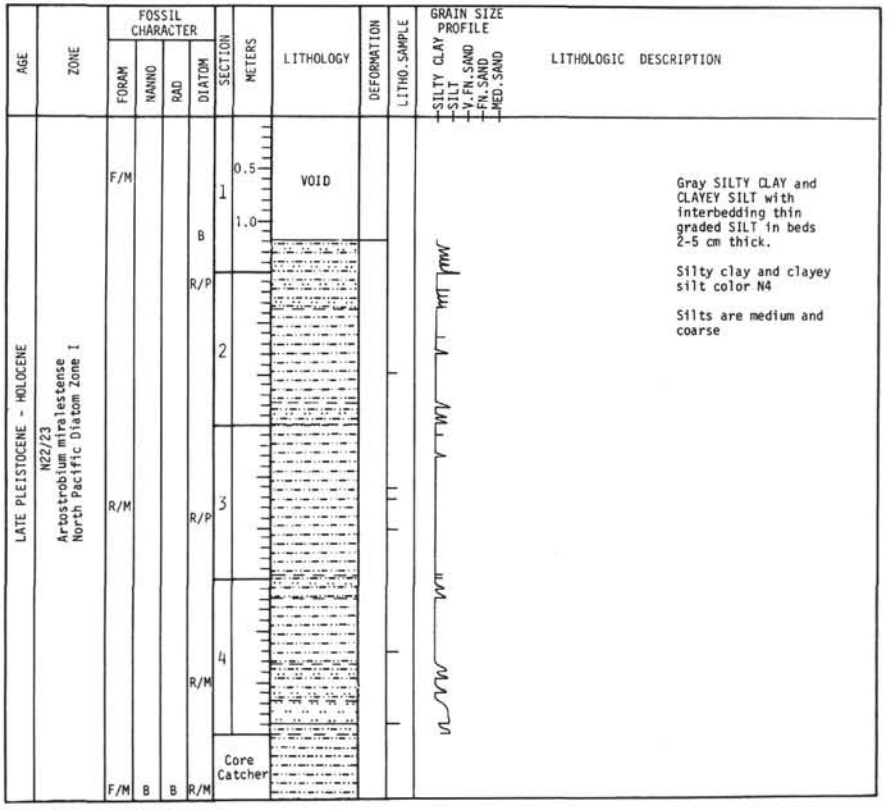

SAND SHALE RATIO
CLAY % (<2μ)
CHLOR.
MICA
MONT.
VOLCANIC ASH
DENSITY -g/cm3
~GRAPE ▲SECTION WT..
□ SYRINGE SAMPLE
POROSITY -%
~GRAPE
○ SYRINGE SAMPLE
NATURAL GAMMA
10^3 counts/75 sec
SOUND VELOCITY
km/sec
2.0 1.6 1.2
0 50 100
0 2 4
1.5 2.0
.37
.13
.05
.11
0
0
0
0
0
250
275
300
325
350
375
400
425
450
475
500

Site 180 Hole Core 1 Cored Interval: 0-9.5 m



Explanatory notes in chapter 1
*PLANKTONIC FORAMINIFERA

Site 180 Hole Core 2 Cored Interval: 9.5-19.0 m



Explanatory notes in chapter 1

Site 180 Hole Core 3 Cored Interval: 19.0-28.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/M			R/M	1	0.5 – 1.0	VOID				Gray SILTY CLAY with interbedding coarse graded SILT beds Silty clay color N4
					R/G	2						base of core is very soupy and color 5GY4/1
		R/M	F/G	R/M		Core Catcher						

Site 180 Hole Core 4 Cored Interval: 28.5-38.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/P			R/P	1	0.5 – 1.0	VOID				Gray SILTY CLAY with interbedding SILT in graded beds 2-25 cm thick Silty clay color N4 Silts are medium and coarse
					R/P	2						
		B			R/P	3						
		R/M	F/G	R/M	R/P	Core Catcher						

Explanatory notes in chapter 1

Site 180 Hole Core 5 Cored Interval: 38.0-47.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/P			B	1	0.5 – 1.0	VOID				Gray SILTY CLAY with interbedding coarse SILT in graded beds 30-70 cm thick
					R/M	2						
		R/M			R/P	3						silty clay color dark greenish gray 5GY4/1
					R/P	4						
		F/M	F/G	R/M	R/M	Core Catcher						silty clay color dark greenish gray 5GY4/1

Explanatory notes in chapter 1

Site 180 Hole Core 6 Cored Interval: 47.5-57.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone 1	R/M	F/G	B	B	1	0.5 1.0	VOID				Gray CLAYEY SILT overlying a 15 cm thick graded bed of medium SILT Clayey silt color N4 COARSE SAND found in washings on top of core 7
						Core Catcher						

Site 180 Hole Core 7 Cored Interval: 57.0-66.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone 1	R/M			B	1	0.5 1.0	VOID				Gray SILTY CLAY and CLAYEY SILT with interbedding SILT in graded beds 3-6 cm thick. Silty clay and clayey silt color ranges between N4 and 5GY4/1. Silt mostly medium, but is coarse at base of some beds.
		R/M	F/G	B	B	Core Catcher						

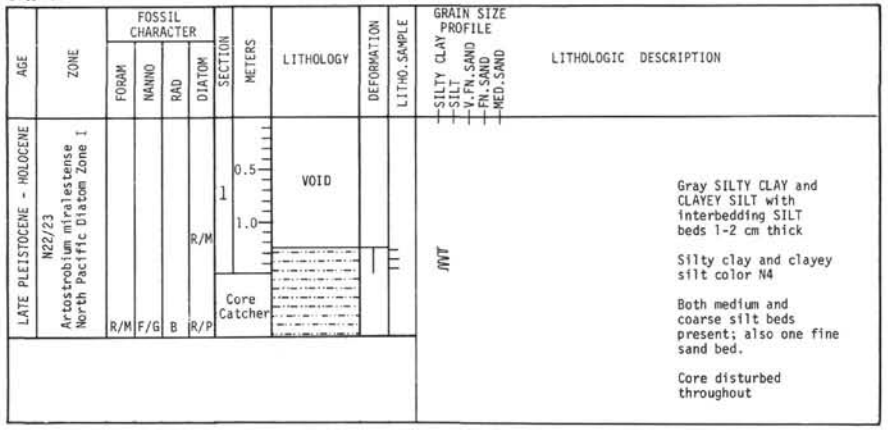
Explanatory notes in chapter 1

Site 180 Hole Core 8 Cored Interval: 66.5-76.0 m

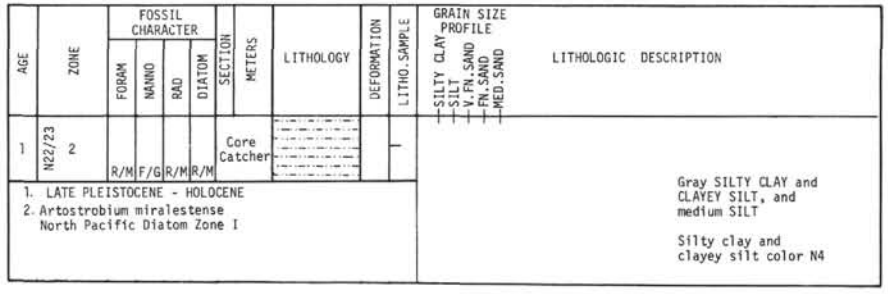
AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone 1				R/P	1	0.5 1.0	VOID				Gray CLAYEY SILT and SILTY CLAY, with a few graded SILT beds Abundant thin silt laminae (0.5-1 mm thick), often clustered, especially in lower part of core Clayey silt and silty clay color N4 Silt beds mainly medium silt, rarely coarse.
		F/M			R/P	2						
		B			R/P	3						
		R/M			R/P	4						
					R/P	5						
		F/M	F/G	R/M	B	Core Catcher						

Explanatory notes in chapter 1

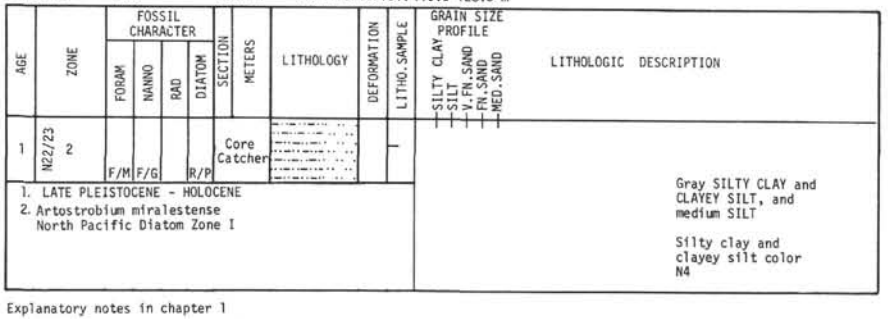
Site 180 Hole Core 9 Cored Interval: 76.0-85.5 m



Site 180 Hole Core 10 Cored Interval: 85.5-95.0 m

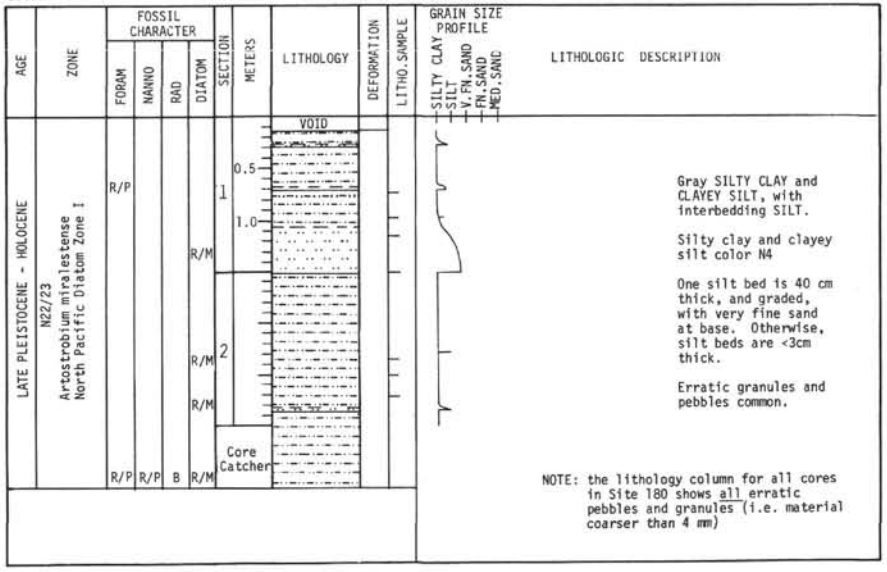


Site 180 Hole Core 11 Cored Interval: 119.0-128.5 m

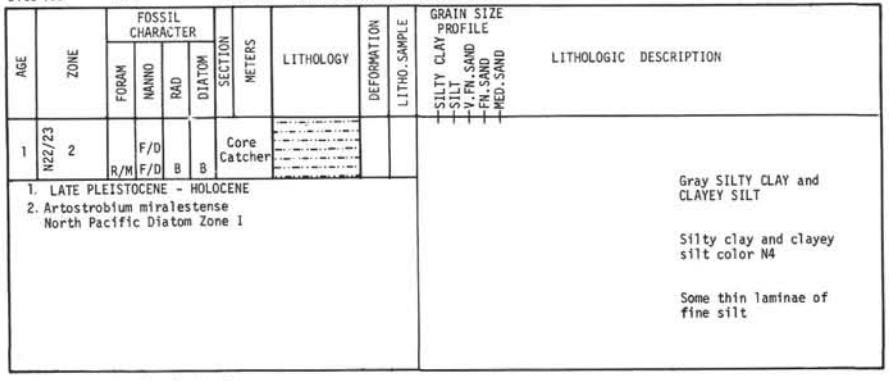


Explanatory notes in chapter 1

Site 180 Hole Core 12 Cored Interval: 147.5-157.0 m



Site 180 Hole Core 13 Cored Interval: 176.0-185.5 m



Explanatory notes in chapter 1

Site 180 Hole Core 14 Cored Interval: 185.5-195.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
1	N22/23 2	R/M	B	B	R/P	Core Catcher						

1. LATE PLEISTOCENE - HOLOCENE
2. Artostrobium miralestense North Pacific Diatom Zone I

Gray SILTY CLAY and CLAYEY SILT

Silty clay and clayey silt color N4

Some thin laminae of fine silt

Some erratic granules

Site 180 Hole Core 15 Cored Interval: 242.5-252.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/P			R/M	1	0.5	VOID				
							1.0					
		∞			R/P	2						
		B				3						
		R/P	F/G	R/M	C/G	Core Catcher						

Gray SILTY CLAY and CLAYEY SILT with interbedding graded beds of SILT 5-15 cm thick

Silty clay and clayey silt color N4

Some erratic granules

Explanatory notes in chapter 1

Site 180 Hole Core 16 Cored Interval: 252.0-261.5 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/P			C/G	1	0.5	VOID				
							1.0					
		R/P	F/G	B	R/M	Core Catcher						

Gray SILTY CLAY and CLAYEY SILT with interbedding graded beds of SILT and VERY FINE SAND 5-10 cm thick.

Silty clay and clayey silt color N4

Some erratic granules

Core was gassy

Site 180 Hole Core 17 Cored Interval: 261.5-271.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO.SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	B			R/M	1	0.5					
							1.0					
		B			R/M	2						
		R/P			R/P	3						
					C/G							
		R/P				4						
		R/P	F/G	F/M	C/G	Core Catcher						

Upper part of core: gray SILTY CLAY and CLAYEY SILT with interbedding SILT and VERY FINE SAND in graded beds 10-30 cm thick

Silty clay and clayey silt color N4

Some erratic granules

Lower part of core: gray DIATOM BEARING SILTY CLAY with interbedding SILT in graded beds 5-10 cm thick.

Silty clay color dark greenish gray 5GY4/1

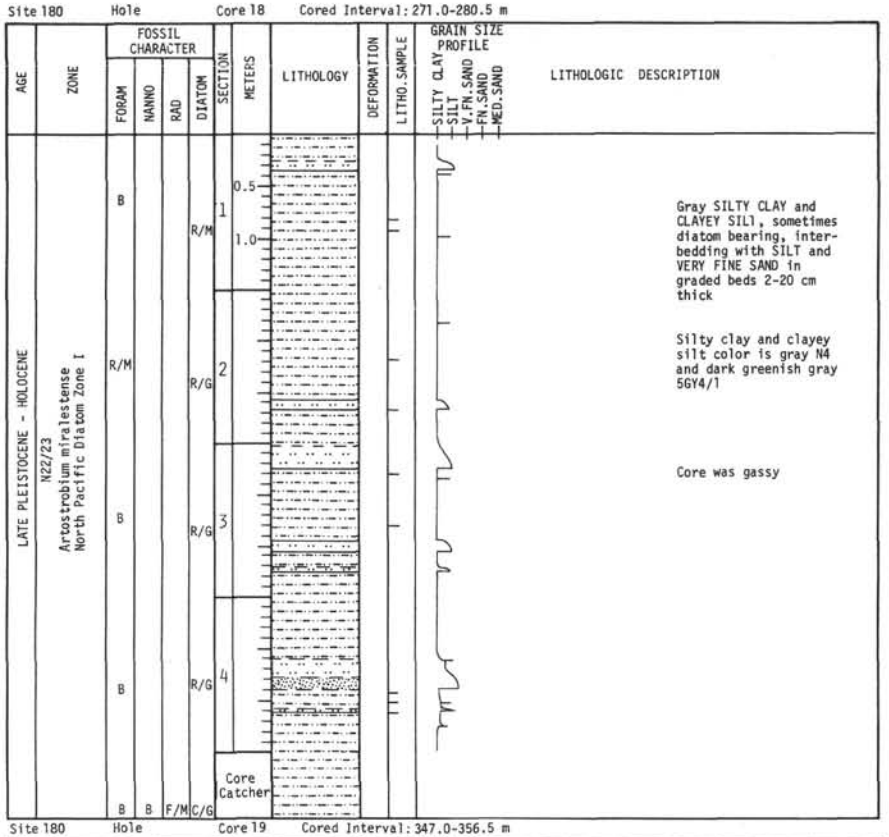
Some clayey silt

(Erratic granules, and thin laminae of fine silt, both absent).

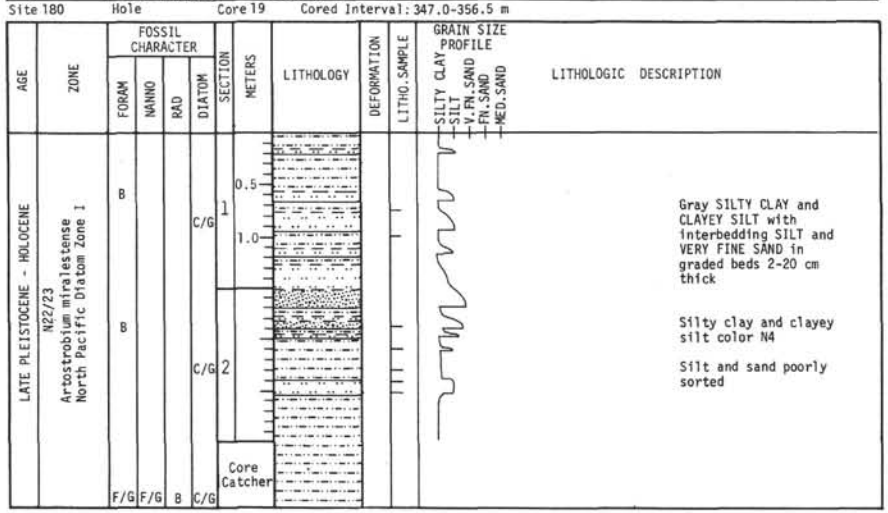
Core was gassy

Explanatory notes in chapter 1

Site 180 Hole Core 18 Cored Interval: 271.0-280.5 m

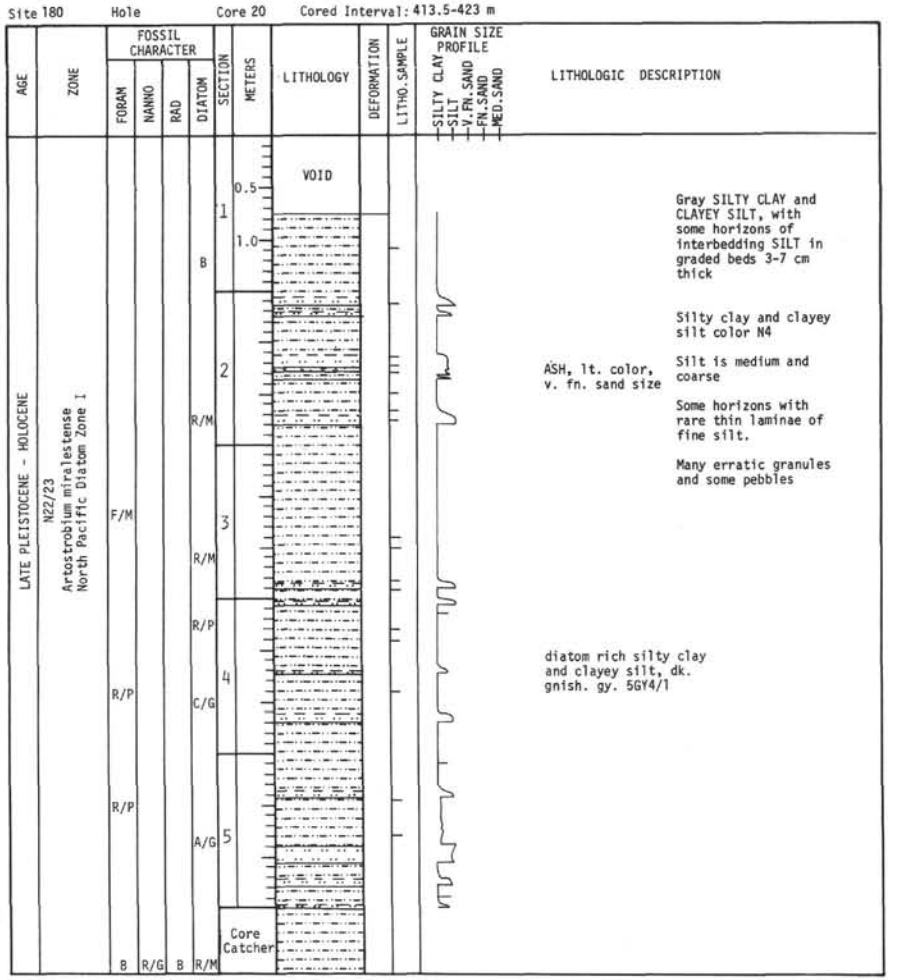


Site 180 Hole Core 19 Cored Interval: 347.0-356.5 m

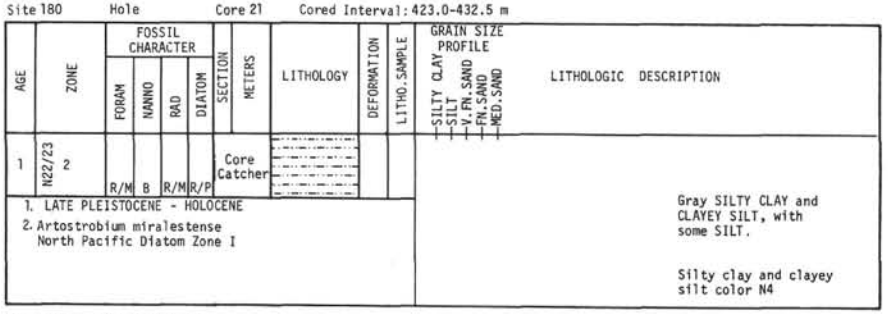


Explanatory notes in chapter 1

Site 180 Hole Core 20 Cored Interval: 413.5-423 m



Site 180 Hole Core 21 Cored Interval: 423.0-432.5 m



Explanatory notes in chapter 1

Site 180 Hole Core 22 Cored Interval: 432.5-442.0 m

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I	R/P			R/P	1	0.5 – 1.0					Gray SILTY CLAY and CLAYEY SILT 2-4% interbedding SILT, in laminae 0.1-1 cm thick
		R/P			B	2						Core completely disturbed. Bedding tilted to 45° and individual 2-5 cm segments rotated with respect to one another about a vertical axis.
		F/P			B	3						
		R/P			B	4						
		F/M			B	5						
		R/P			B	6						
		R/M	R/P	B	B	Core Catcher						

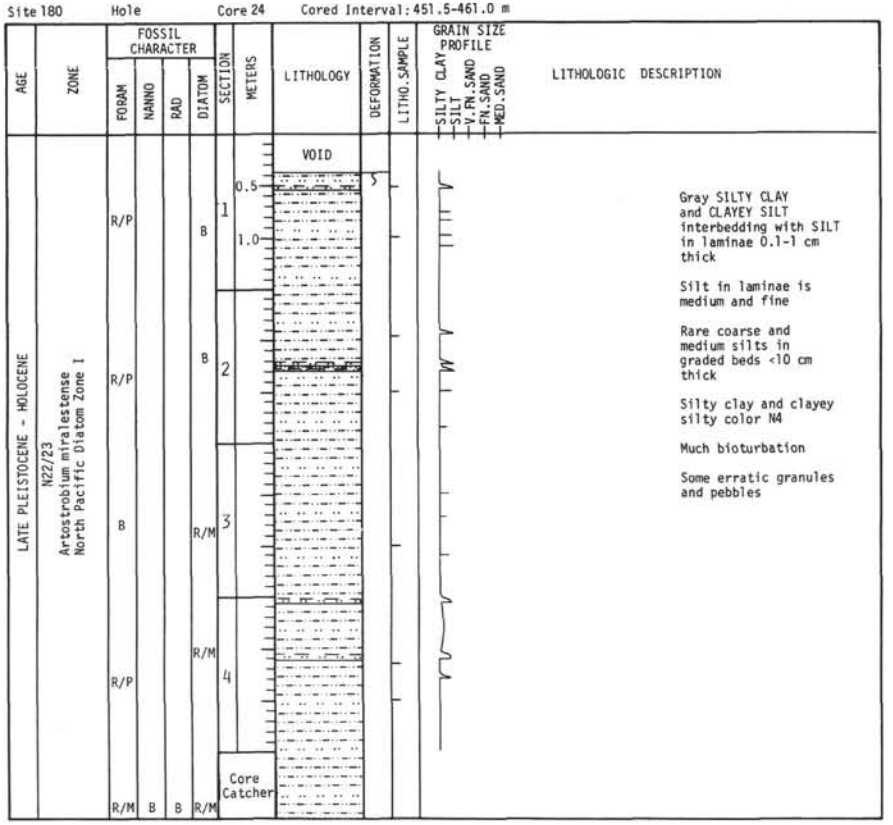
Explanatory notes in chapter 1

Site 180 Hole Core 23 Cored Interval: 442.0-451.5 m

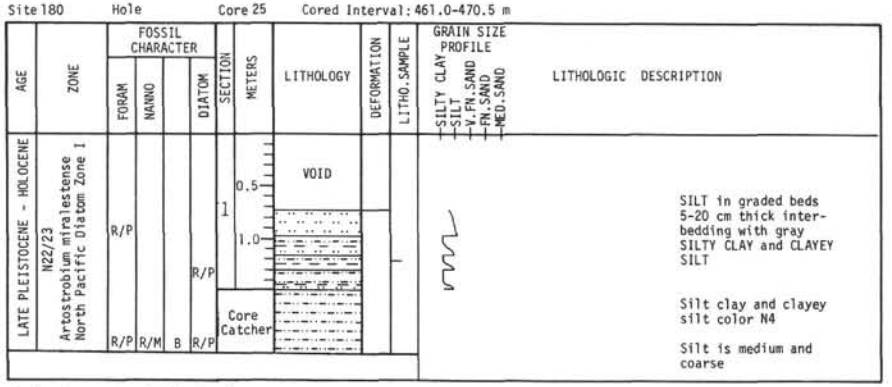
AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	GRAIN SIZE PROFILE: SILTY CLAY / SILT / V.FN.SAND / FN.SAND / MED.SAND	LITHOLOGIC DESCRIPTION
LATE PLEISTOCENE - HOLOCENE	N22/23 Artostrobium miralestense North Pacific Diatom Zone I				B	1	0.5 – 1.0	VOID				Section 1 disturbed in the same way as Core 22
		R/P			B	2						Gray SILTY CLAY and CLAYEY SILT interbedding with SILT in graded beds <8 cm thick. Silty clay and clayey silt color N4 Many 1-3 mm thick laminae of fine silt Some bioturbation Rare erratic granules
		R/P			B	3						
		R/P			B	4						
		R/M	B	B	R/P	Core Catcher						

Explanatory notes in chapter 1

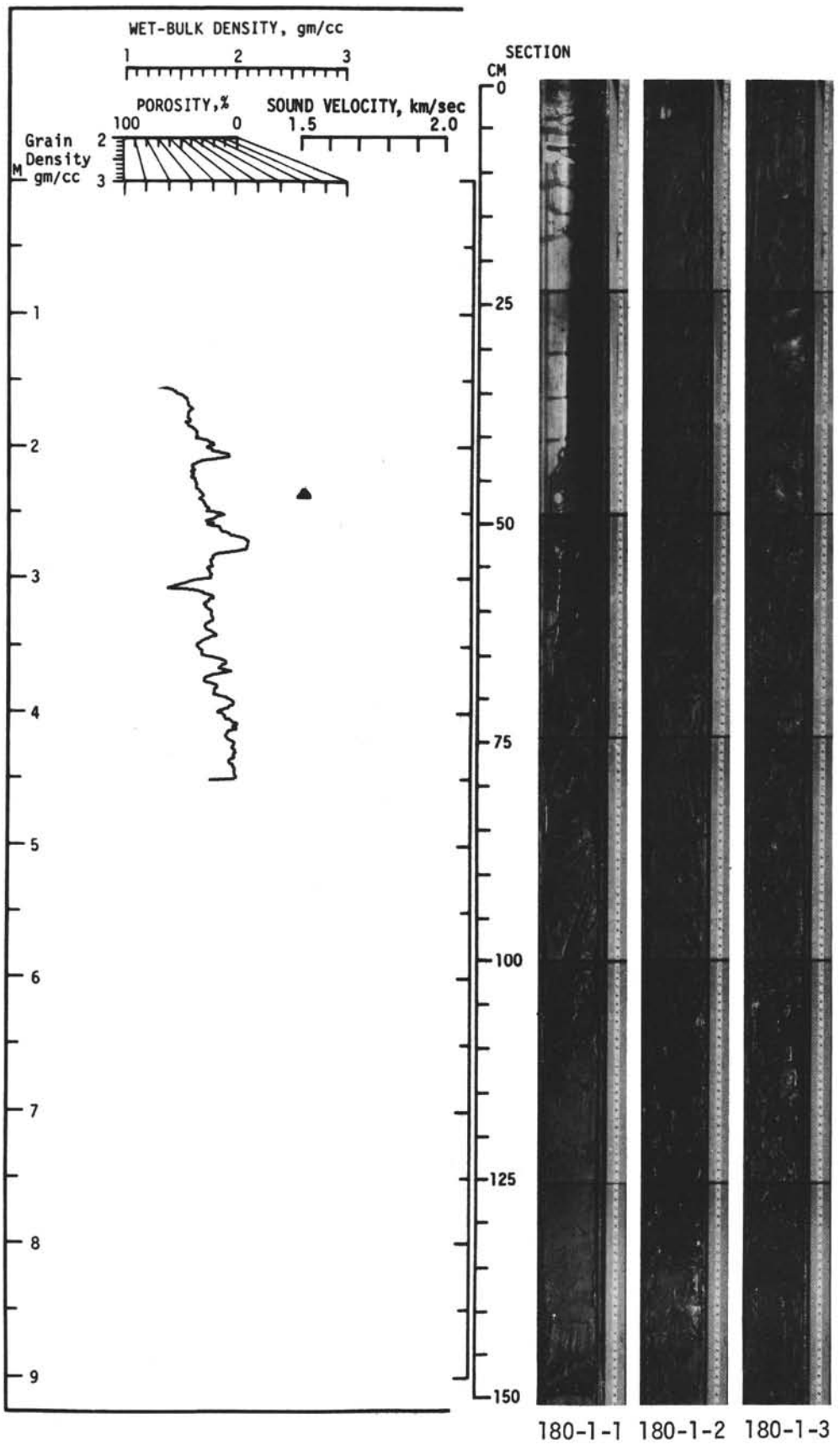
Site 180 Hole Core 24 Cored Interval: 451.5-461.0 m



Site 180 Hole Core 25 Cored Interval: 461.0-470.5 m



Explanatory notes in chapter 1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Grain Density gm/cc
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M
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4
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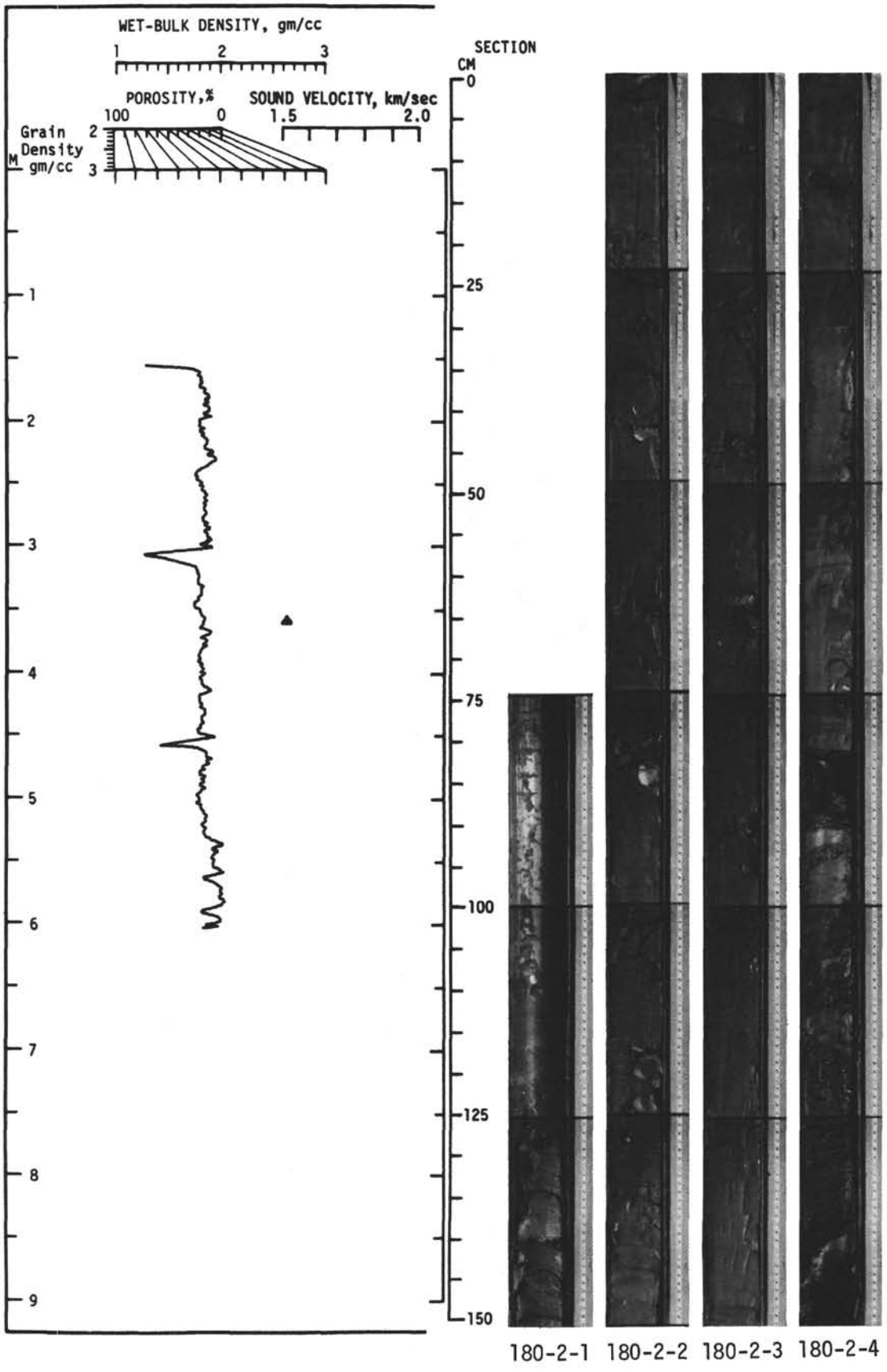
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Grain Density gm/cc
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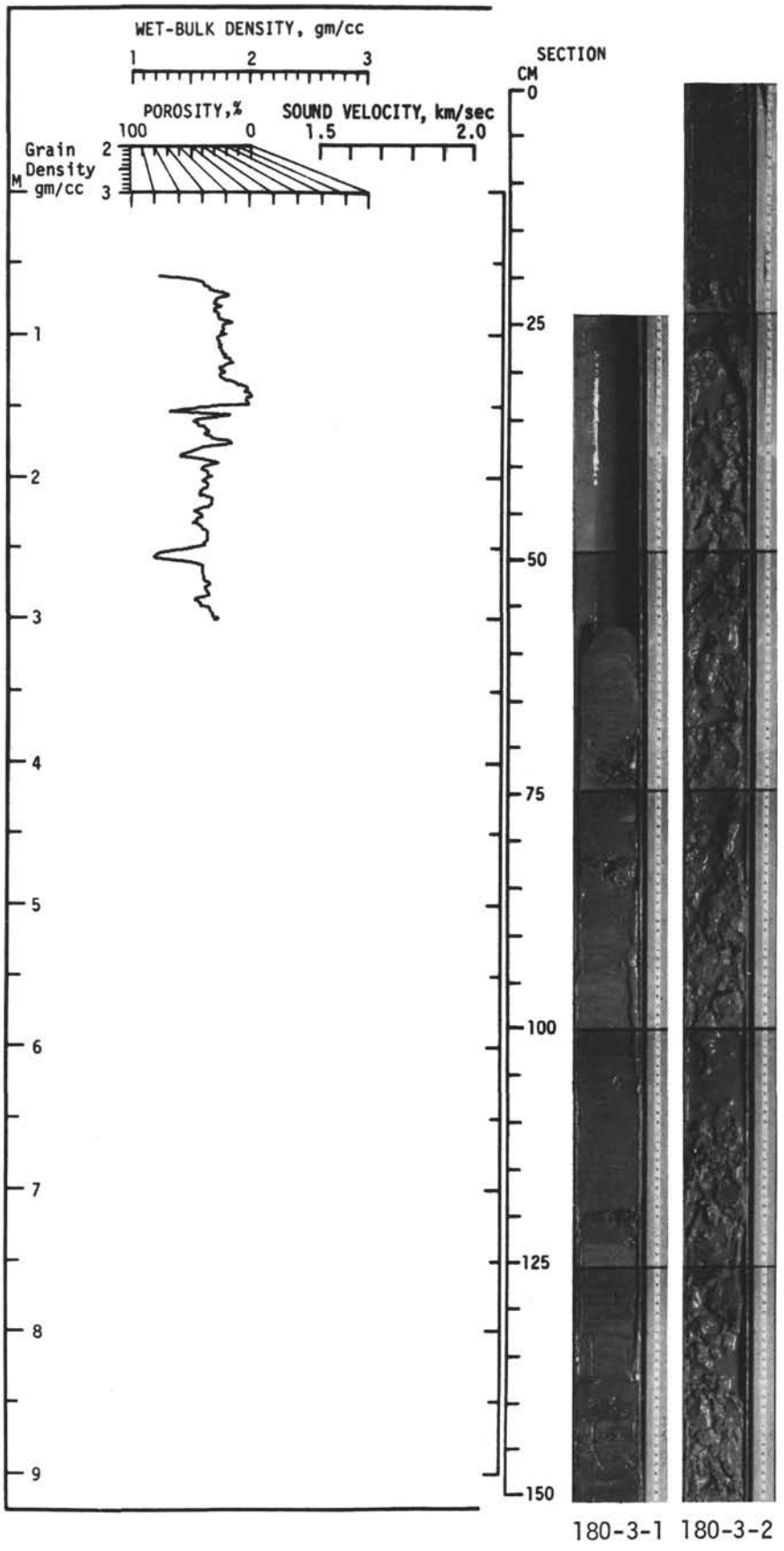
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Grain Density gm/cc
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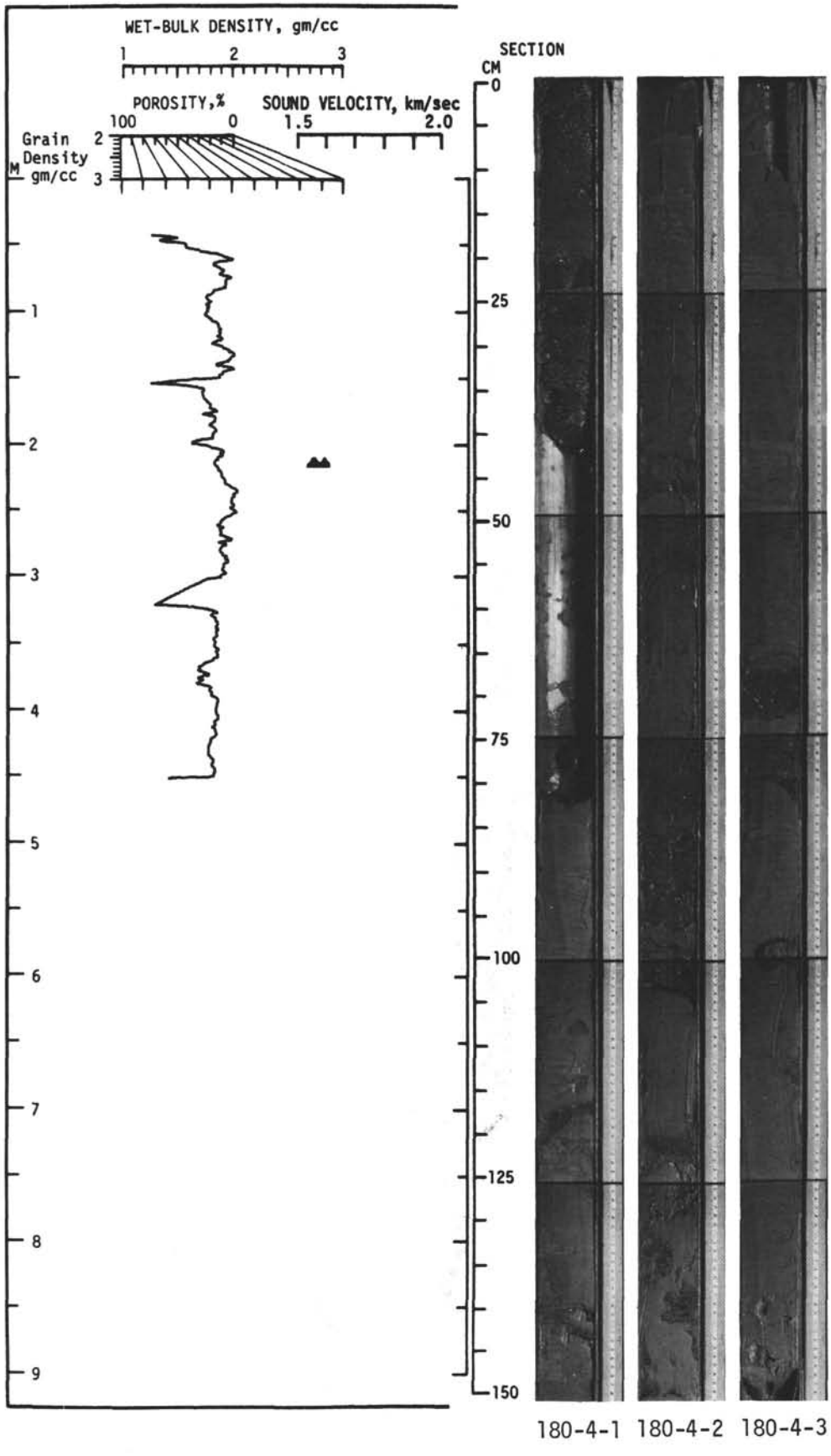
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Grain Density gm/cc
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M
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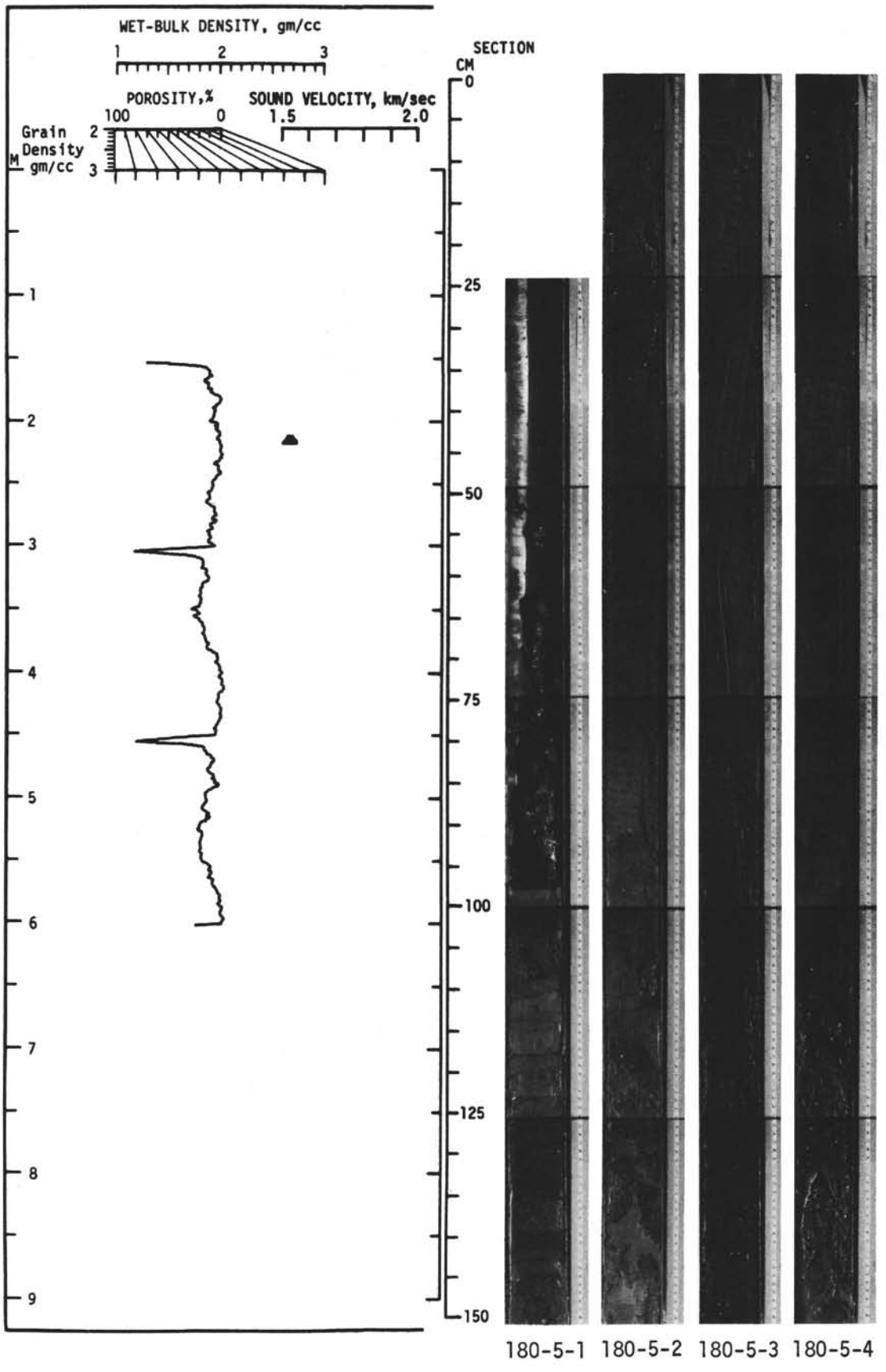
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Grain Density gm/cc
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M
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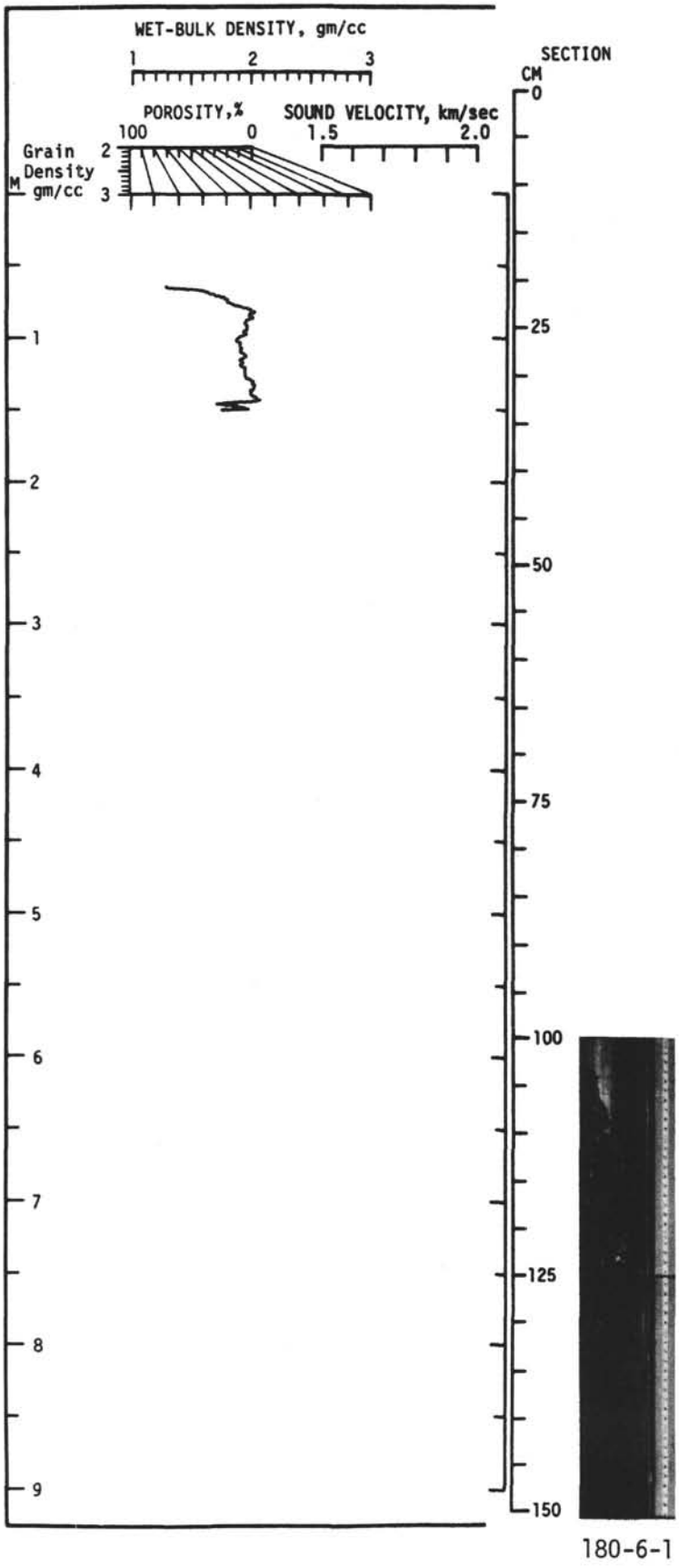
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Grain Density gm/cc
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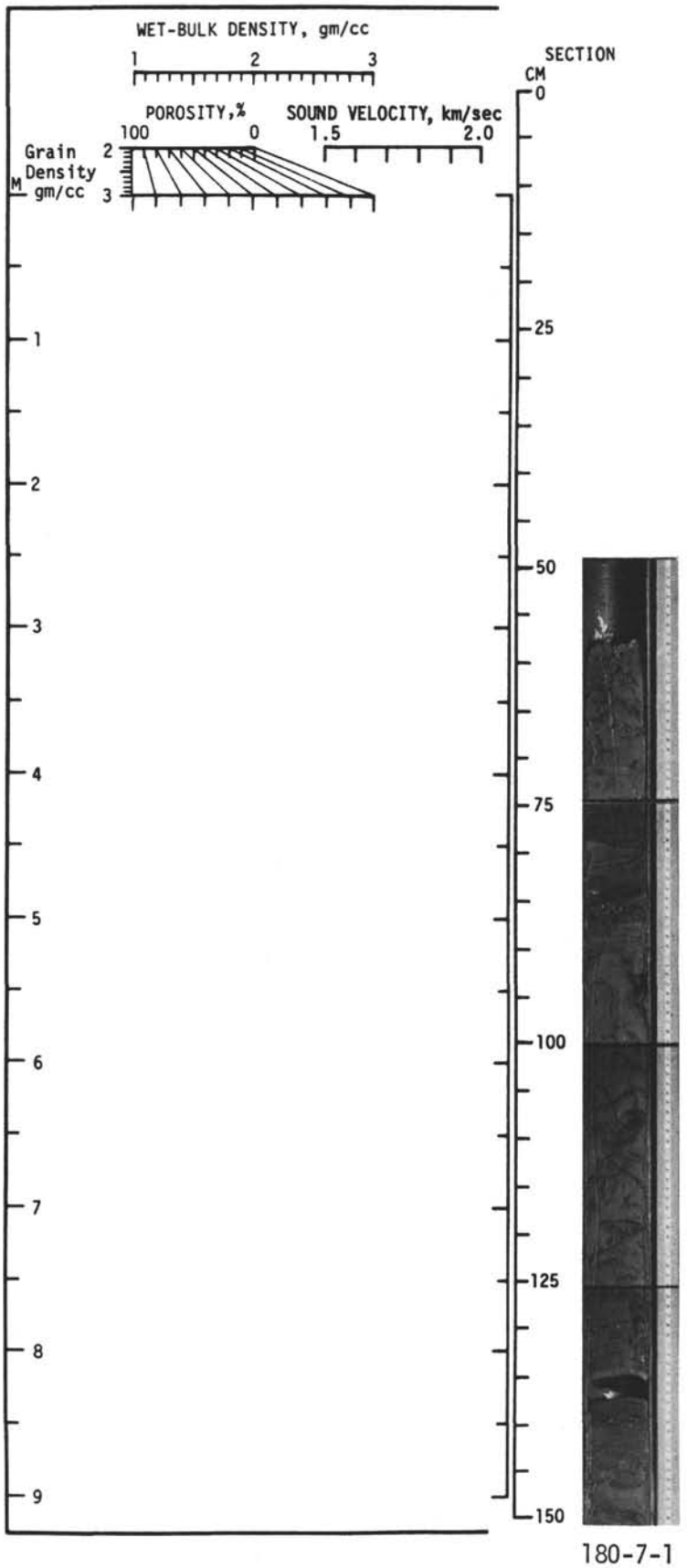
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Grain Density gm/cc
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M
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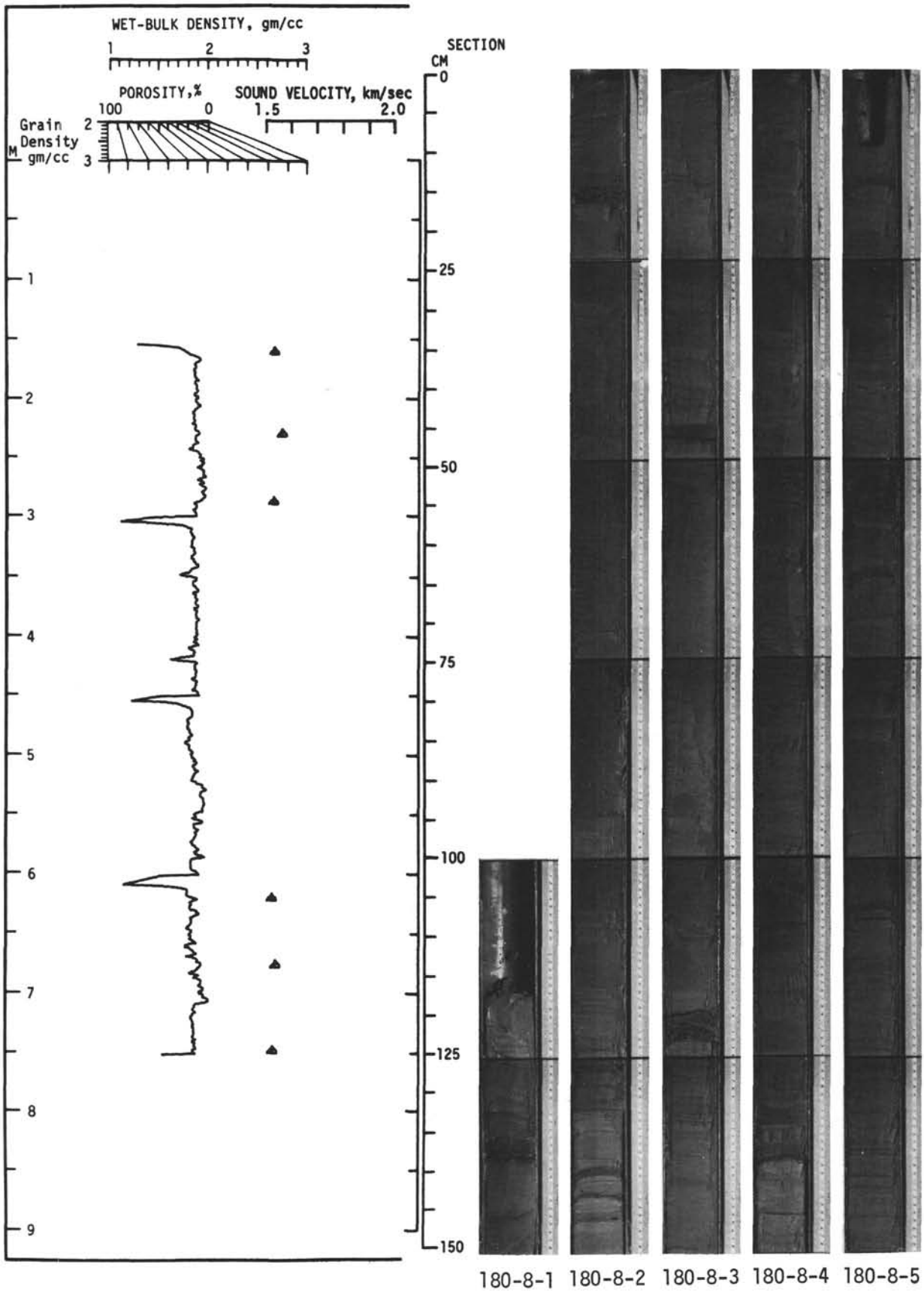
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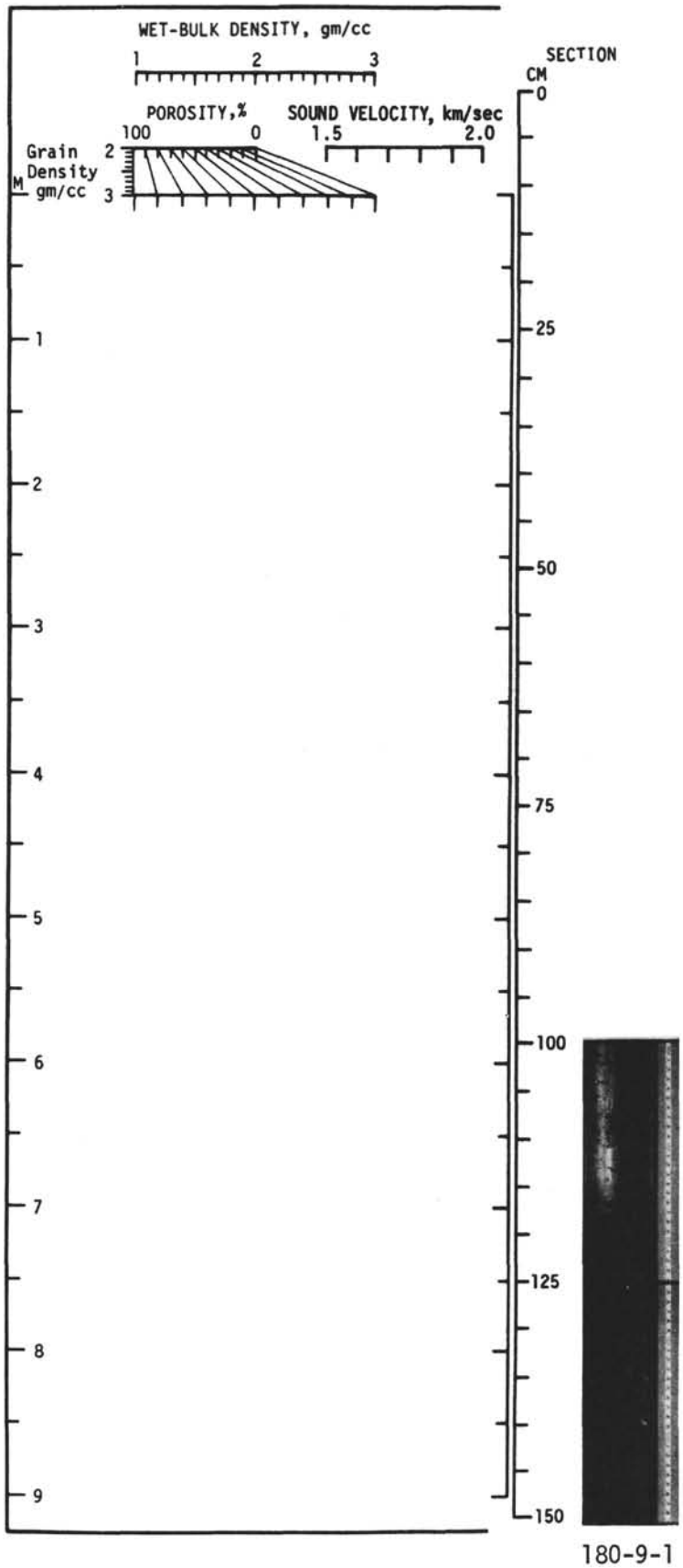
180-8-5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Grain Density gm/cc
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SECTION
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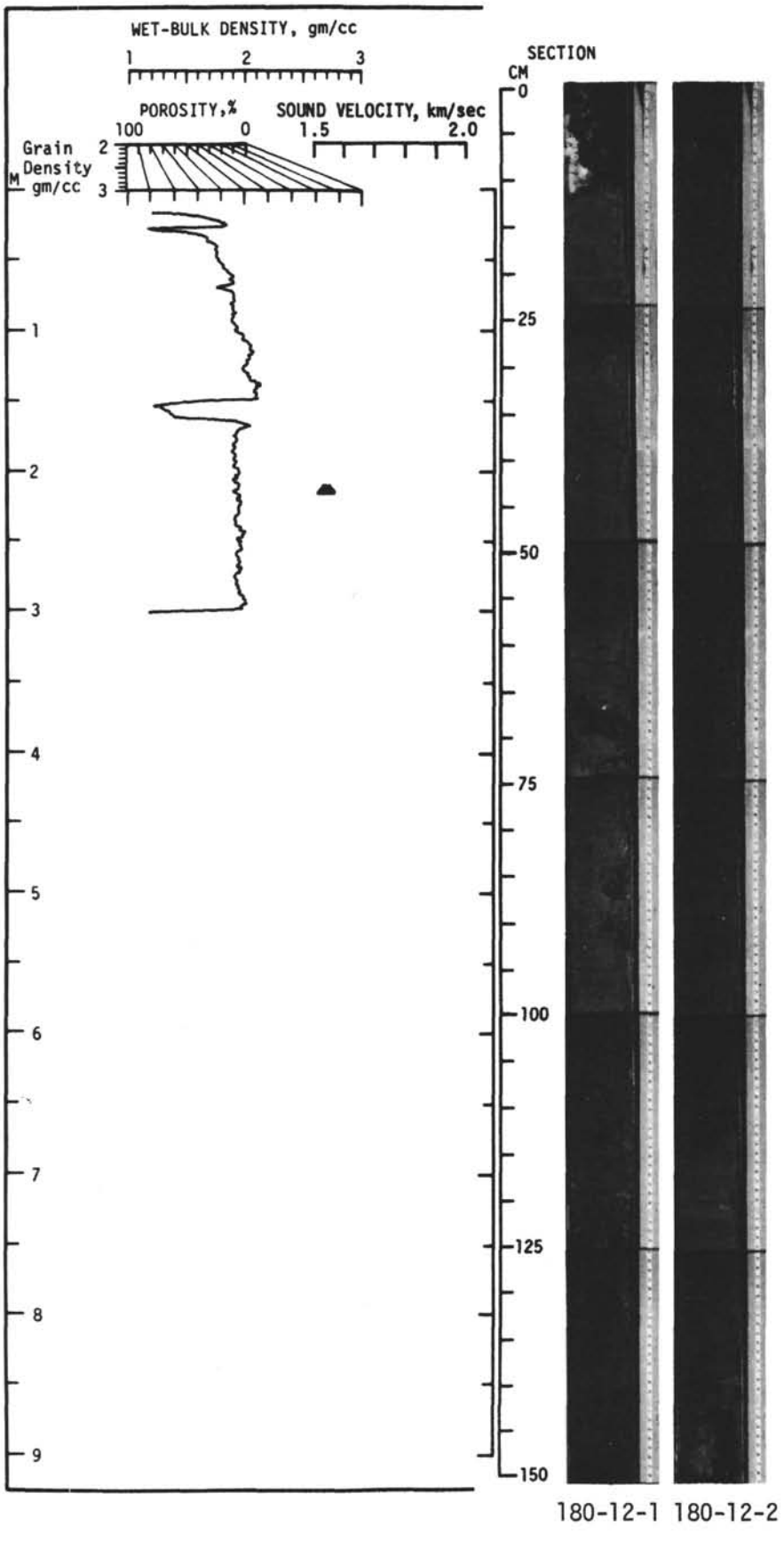
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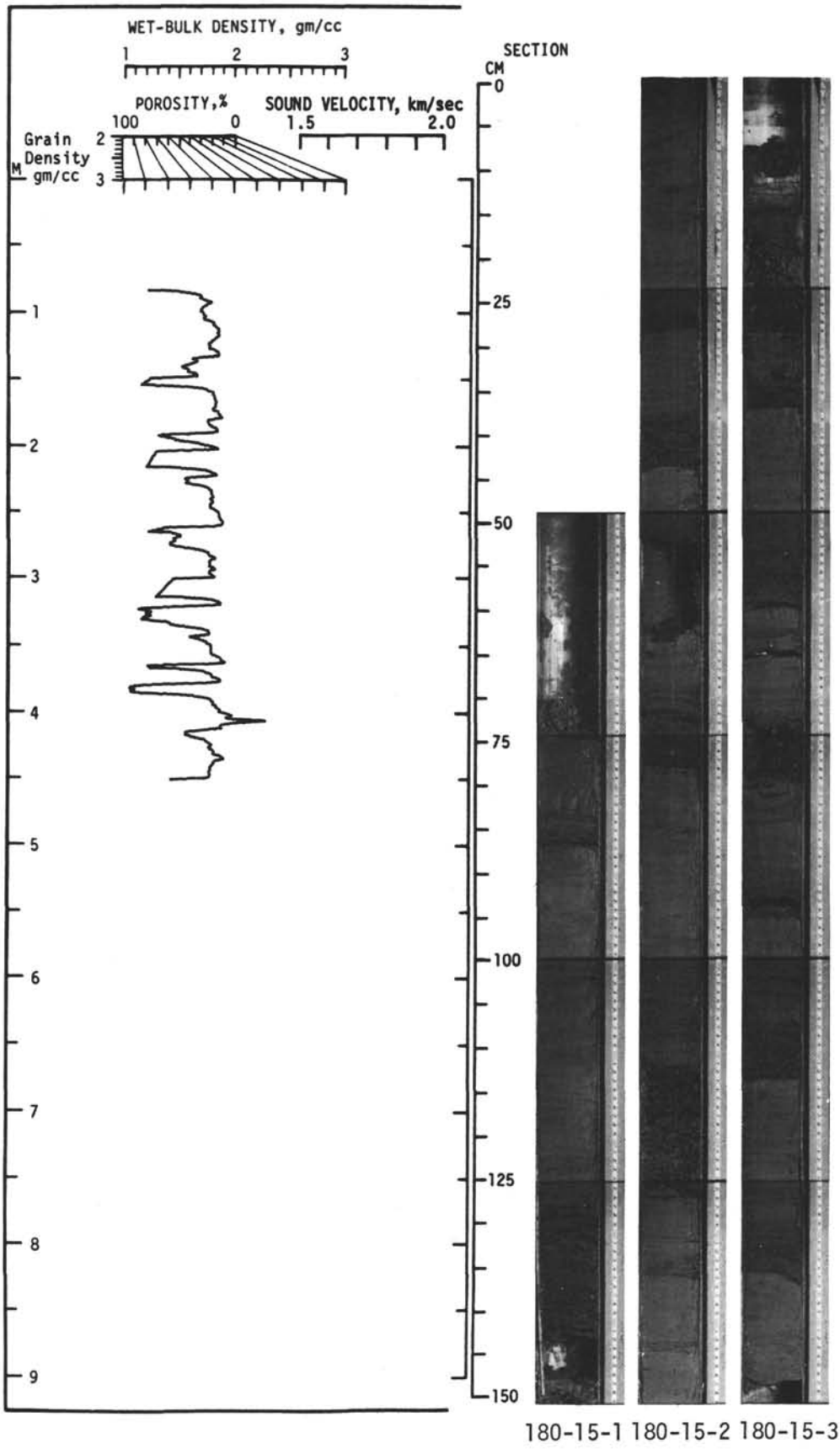
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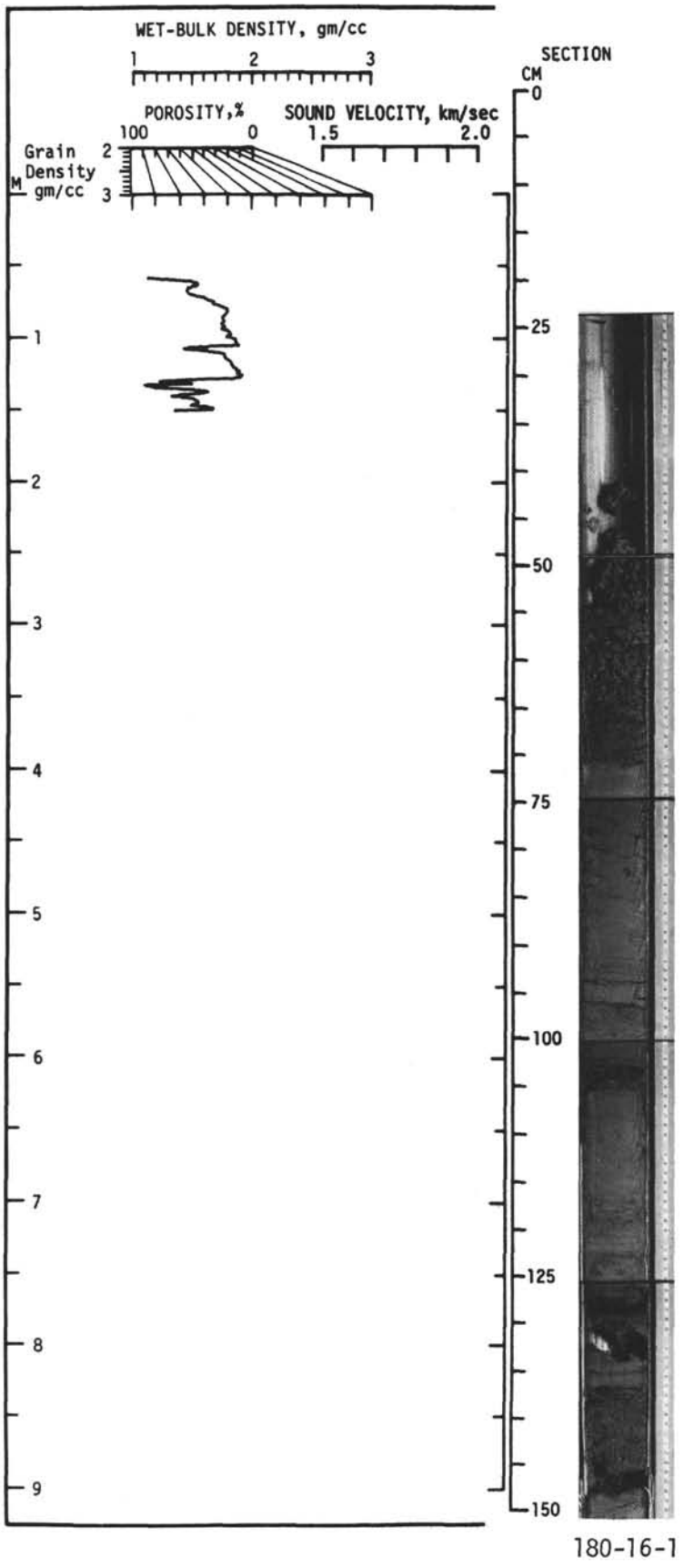
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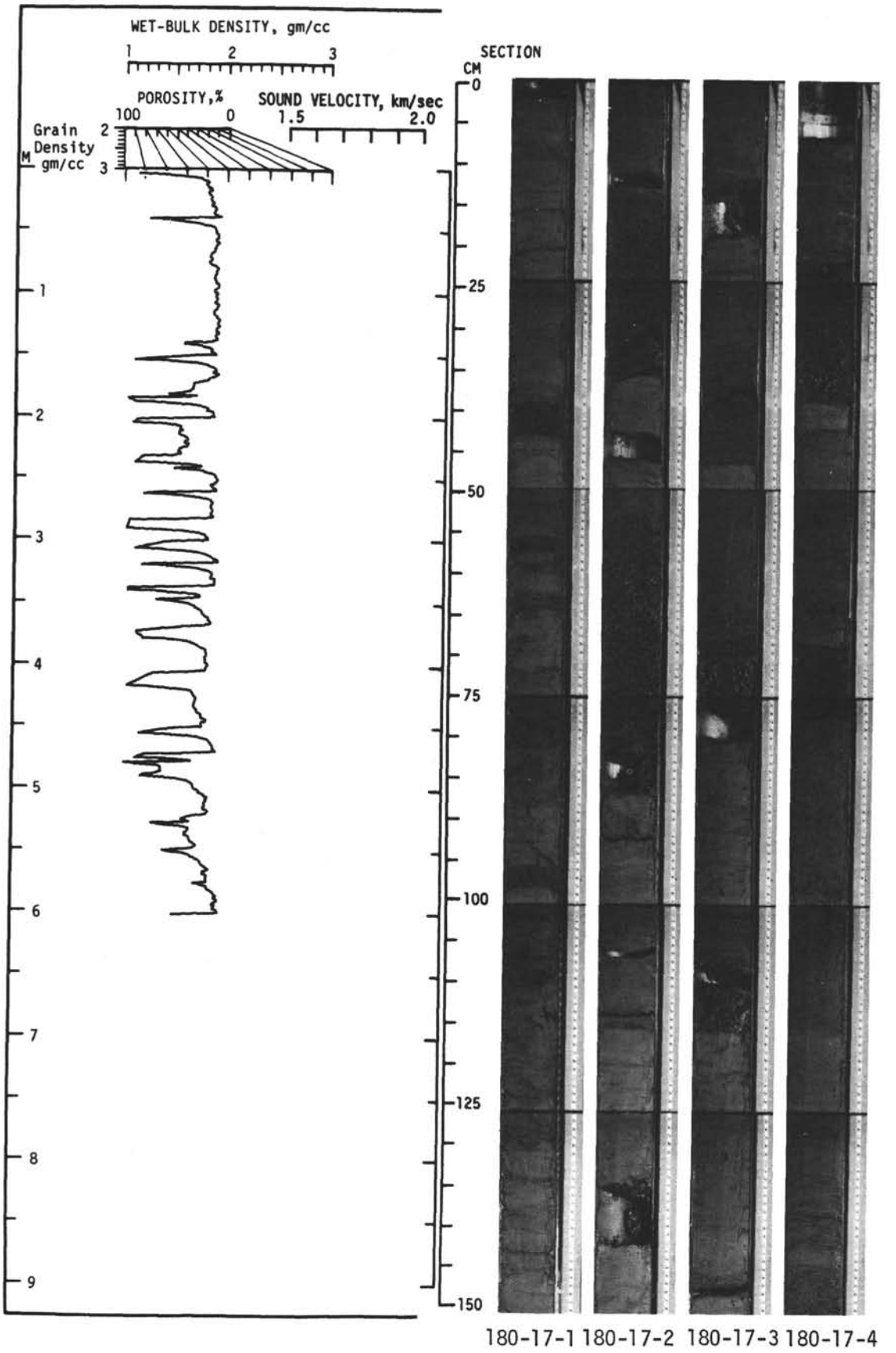
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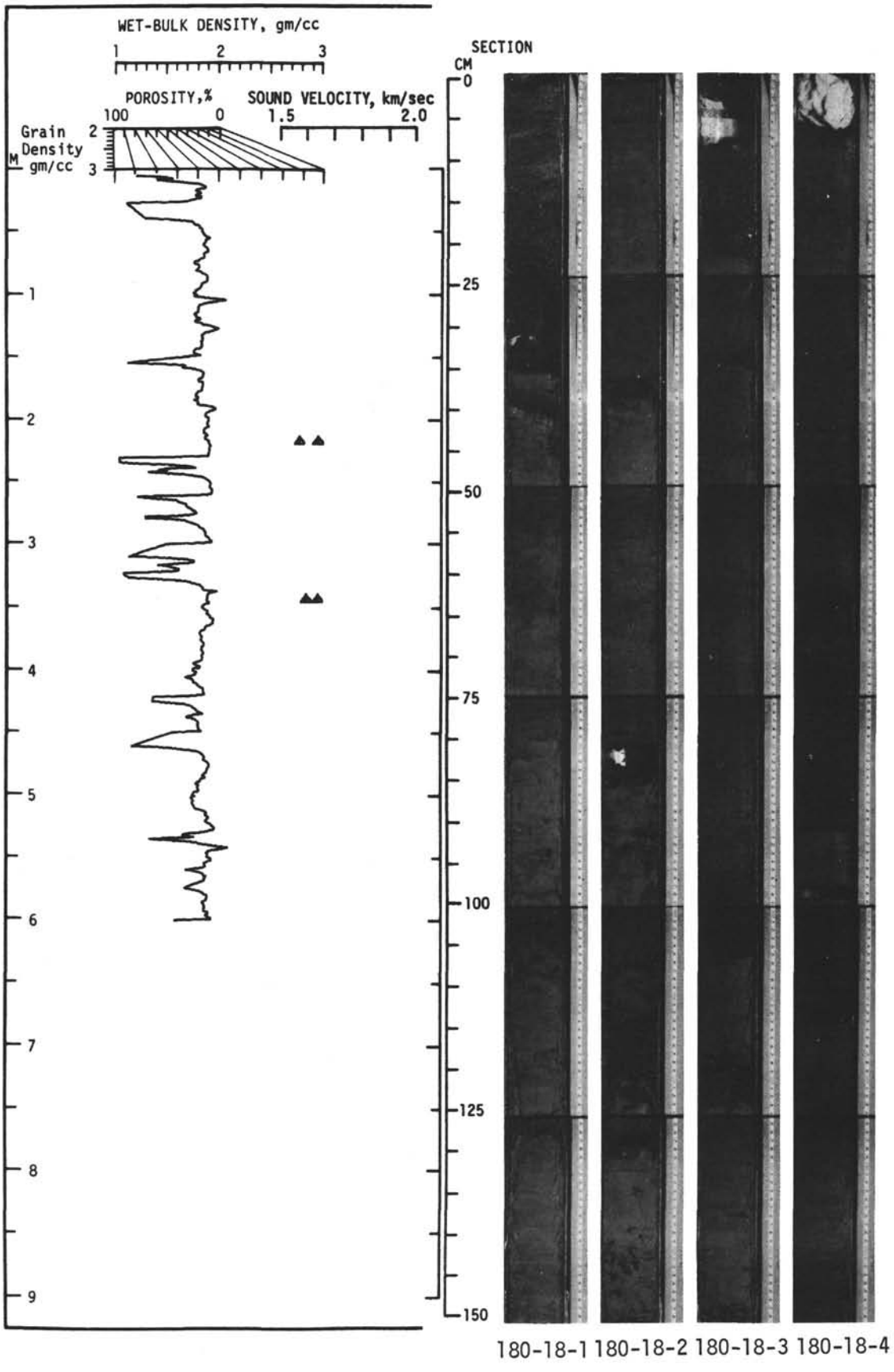
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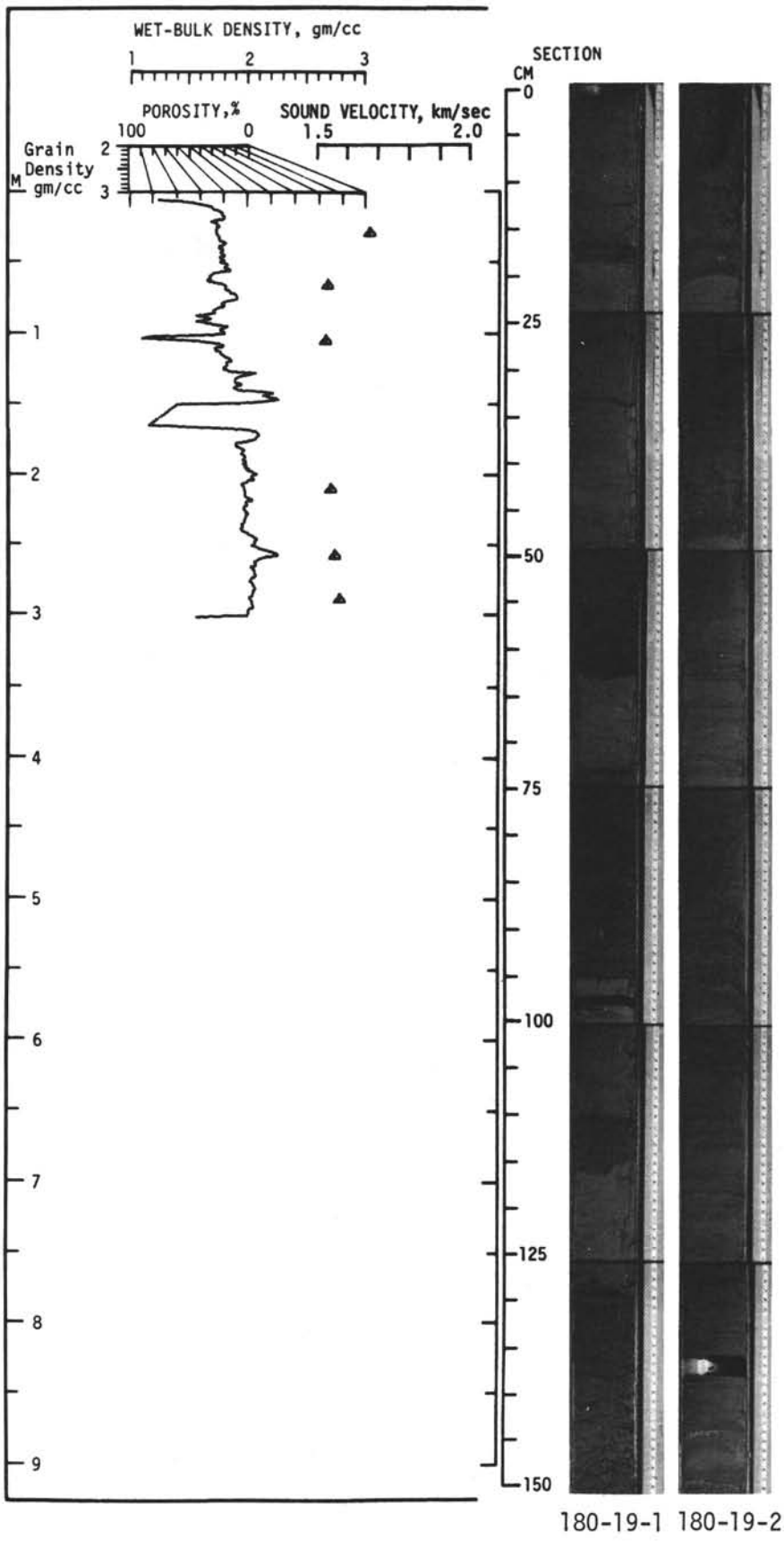
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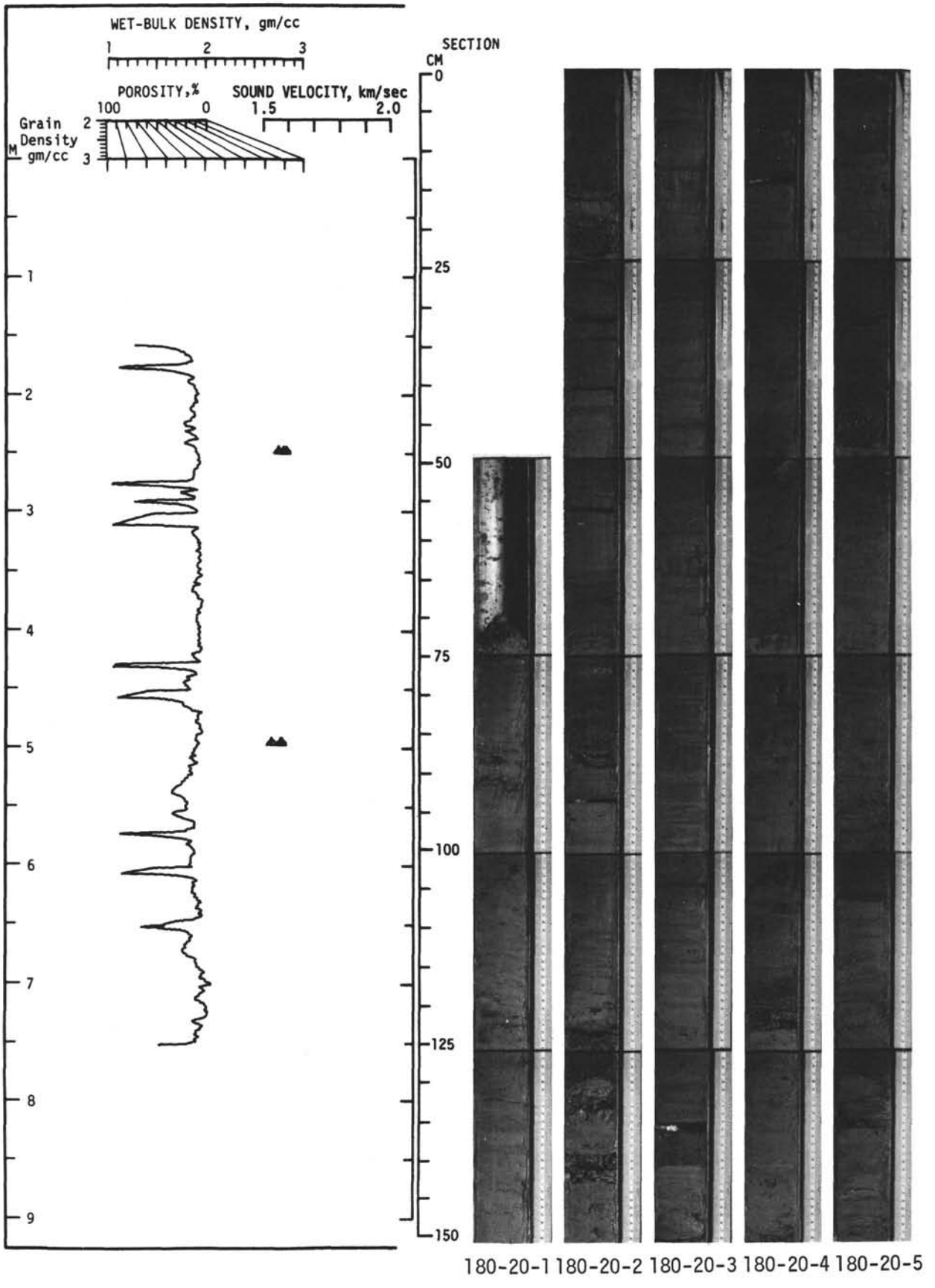
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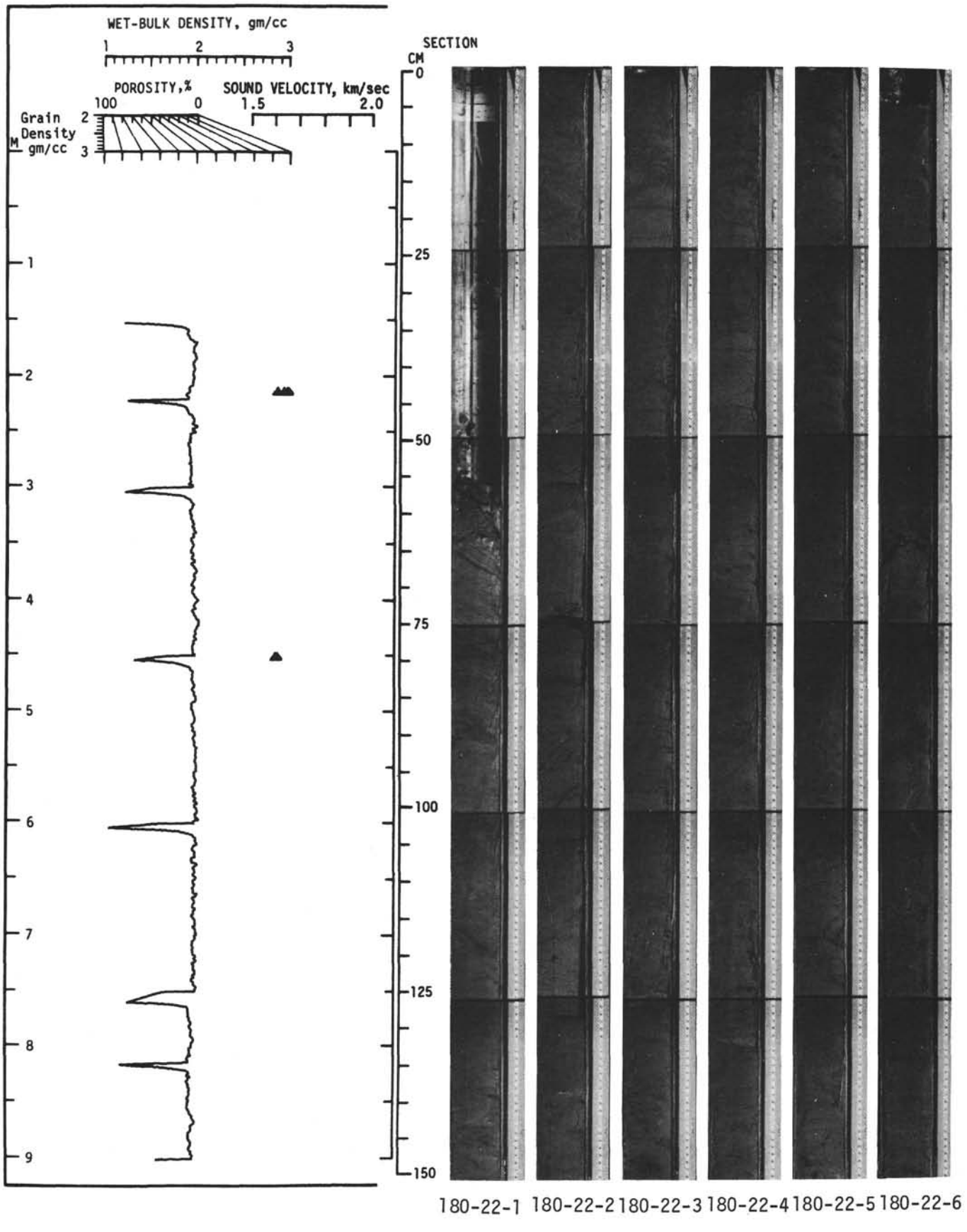
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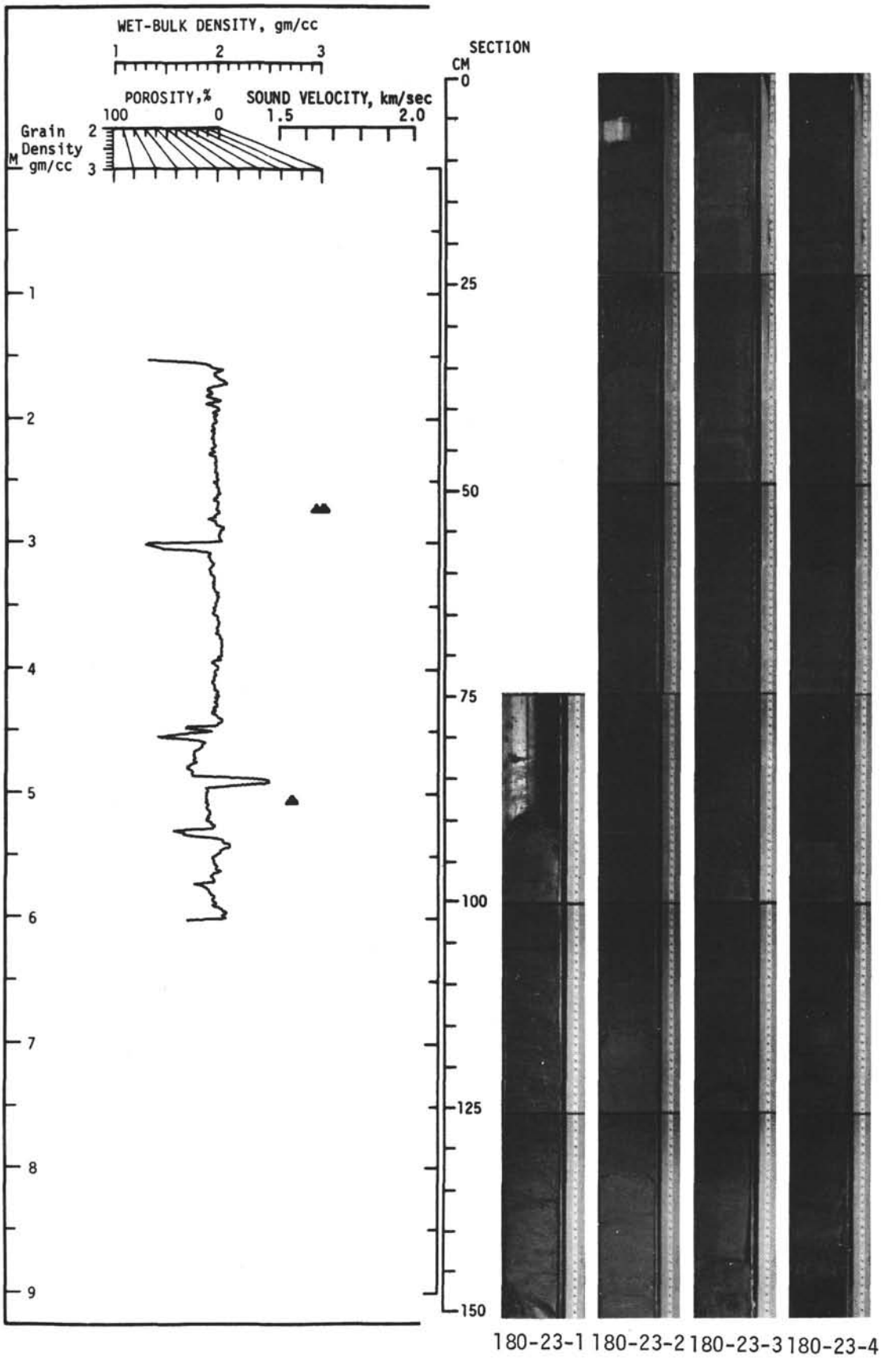
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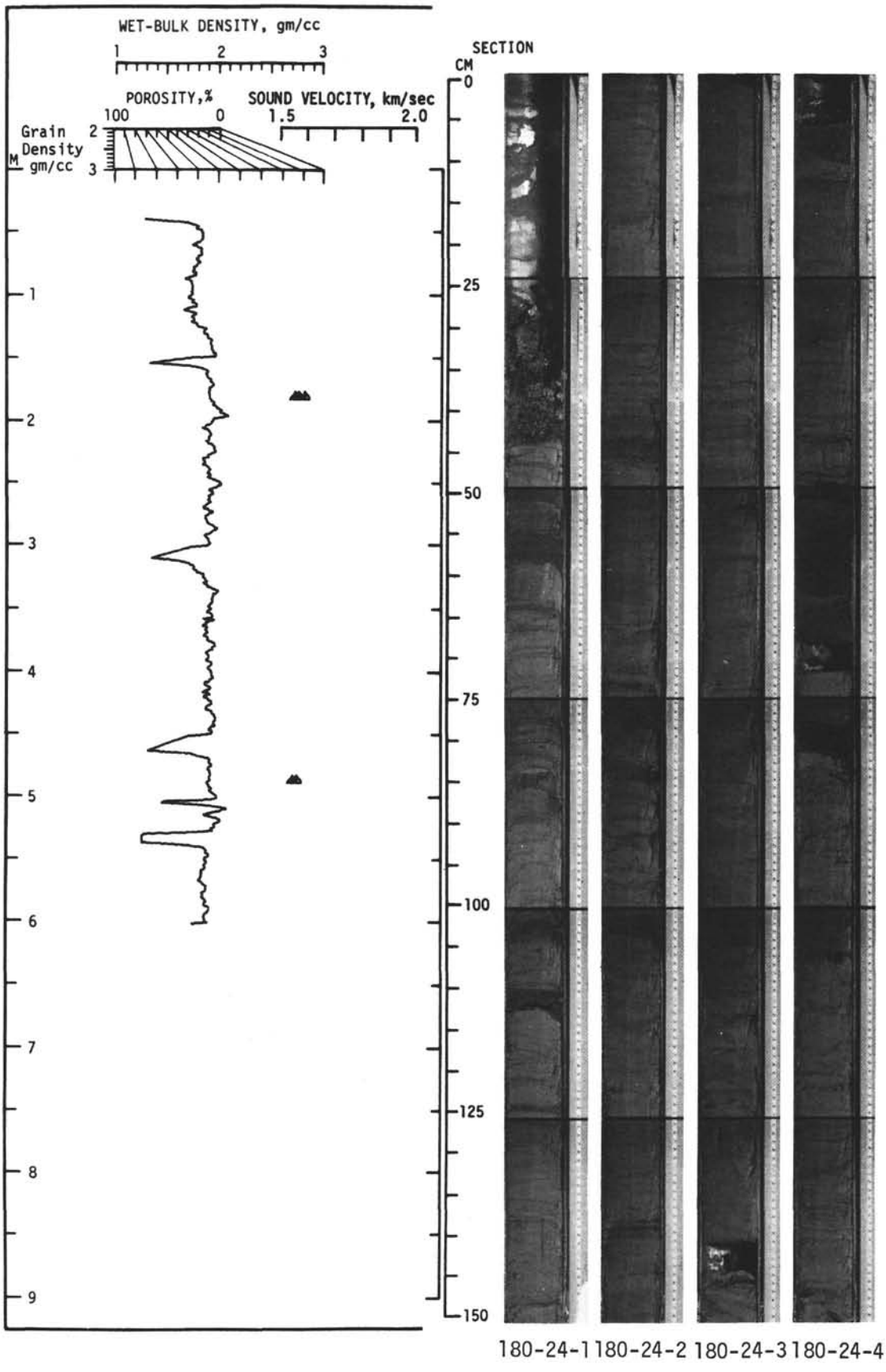
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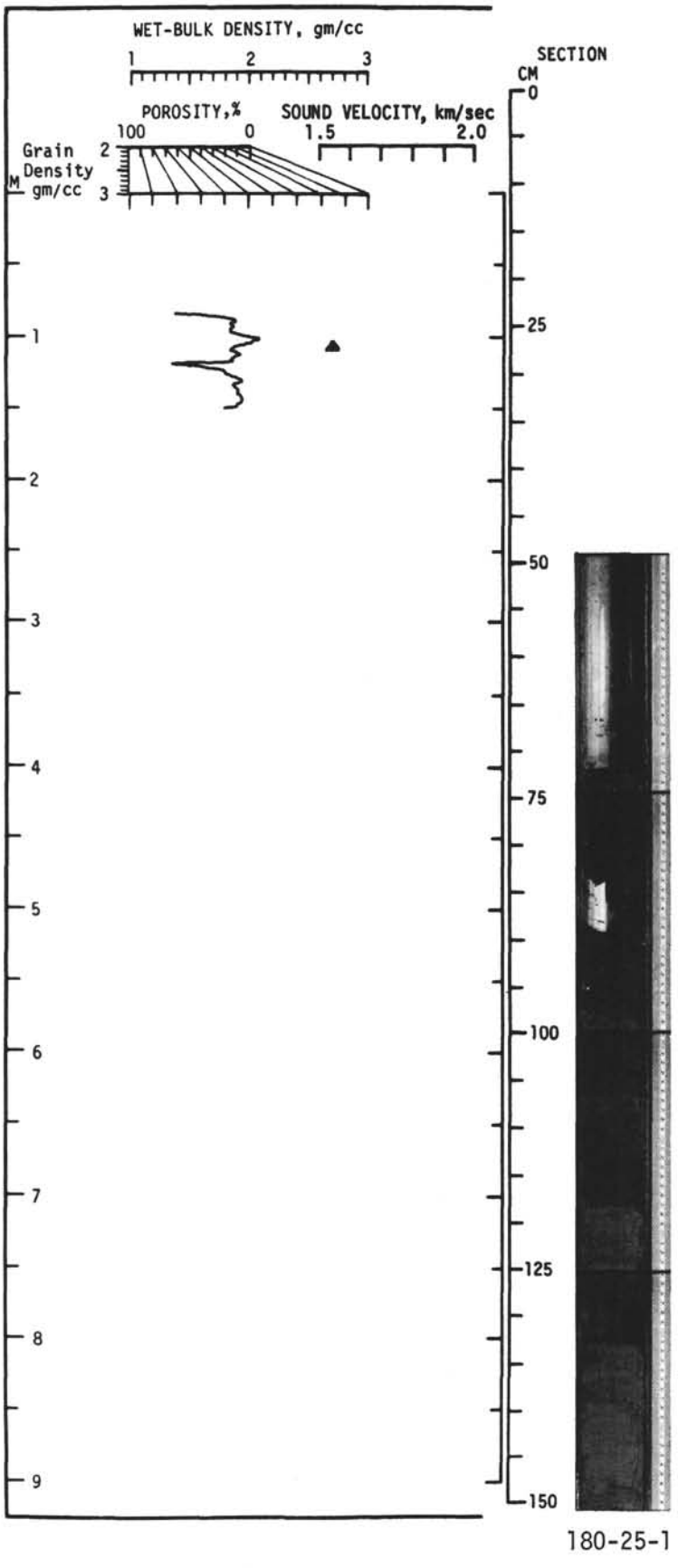
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